National Park Service
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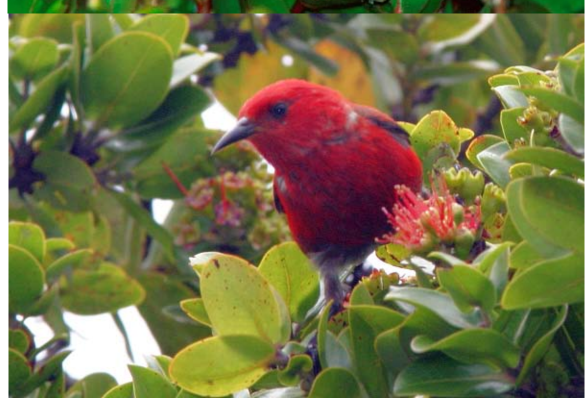
Natural Resource Program Center

Landbirds Vital Sign Monitoring Protocol – Pacific Island Network

Version 1.0

Natural Resource Report NPS NPS/PACN/NRR—2011/402



ON THE COVER
Akohekohe (Palmeria dolei), Hawaii akepa (Loxops coccineus), and apapane (Himatione sanguinea)
Photographs by: Jack Jeffrey

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Richard J. Camp
Hawaii Cooperative Studies Unit
University of Hawaii at Hilo
P.O. Box 44, Hawaii National Park, Hawaii 96718

Thane K. Pratt
U.S. Geological Survey
Pacific Island Ecosystems Research Center
P.O. Box 44, Hawaii National Park, Hawaii 96718

Cathleen Bailey
U.S. National Park Service
Haleakala National Park
P.O. Box 369, Makawao, Hawaii 96768

Darcy Hu
U.S. National Park Service
Pacific West Regional Office Honolulu
P.O. Box 52, Hawaii National Park, Hawaii 96718

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Only changes specific to this document 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 2.00, 3.00, 4.00). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

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Abstract

As part of the partnership between the U. S. Geological Survey-Biological Resources Discipline (USGS-BRD) and the National Park Service, we developed this vital sign monitoring protocol to be followed for monitoring landbirds at Pacific Island Network (PACN) parks. The PACN Landbirds Monitoring Protocol is organized as follows: NARRATIVE of the protocol is intended to provide detail on the objectives of the monitoring protocol and to provide justification for the sampling program. Extensive incorporation of relevant literature and presentation of data collected by other federal, state and conservation agencies were used to justify a particular sampling design, sampling method, and data analysis technique. Included in the narrative is a description of the data management, reporting, personnel requirements and training, and operational requirements. STANDARD OPERATING PROCEDURES (SOPs) of the protocol is a step-by-step description of the field, data analysis, and data management aspects of the protocol. The SOPs provide details on researchers' procedures and tasks, and guidelines for actions and work to be accomplished.

Of highest priority is collecting data to determine species-specific estimates of bird numbers, densities with variance, and track trends by either Park or Park unit. Landbird monitoring will occur at Haleakala National Park (HALE), Hawaii Volcanoes National Park (HAVO) and National Park of American Samoa (NPSA) units Tutuila and Tau. We prepared this protocol specific to PACN requirements, but kept it broad enough to be useful to other federal and state agencies, and other conservation organizations (e.g., The Nature Conservancy). Thus, the park bird survey effort can be part of wider scaled monitoring programs (e.g., monitoring of broadly distributed populations or island-wide monitoring). We have also included brief descriptions of alternative sampling and monitoring methods that are important for PACN and Park units to consider if more detailed population pattern information is needed.

Surveys of native and non-native forest landbird species will occur during peak vocalization periods using point-transect sampling methods. Point-transect counts with unlimited radius are to be placed every 150 m along fixed and random panel transects. Surveys are to be conducted between January and June for Hawaiian parks and between July and November for NPSA units. All birds seen or heard are to be recorded during an 8-minute sampling period between one half hour before sunrise and 1100 h when sampling conditions are favorable. In addition, habitat measurements will be taken both at the fixed and random panel sampling stations each time they are sampled.

Annual reports of survey results will include species lists, maps of species distributions, and indices of bird status (i.e., birds per station and frequency of occurrence). Estimation of bird densities and trends are to be produced every 6 years, after completion of the sampling rotation. At the same time, there will be a protocol review to ensure that operating procedures and data gathered are adequate to address the monitoring objectives. Determining and detecting biologically meaningful changes over short periods is difficult, therefore, it may require numerous rotations (> 5 rotations; 25 years) before trends are detected.

Collecting habitat measurements and co-locating surveys will tie bird status and trends into vegetation and landscape monitoring, and provide information needed for policy decisions by

Park management. Furthermore, the second objective of the protocol fits into current management activities and allows an adaptive management approach to be applied.

Acknowledgements

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Acronyms

AIC	Akaike Information Criteria
AMEF	Avian Monitoring Entry Form
AMME	American Memorial National Park
AOU	American Ornithologists' Union
B	Regular Breeder
BACI	Before-After-Control-Impact
BBC	Breeding Bird Census
BBIRD	Breeding Biology Research and Monitoring Database
BBS	Breeding Bird Survey
BRD	Biological Resources Discipline
BTO	British Trust for Ornithology
CBC	Christmas Bird Count
CES	Constant-Effort Sites
CJS	Cormack-Jolly-Seber mark-recapture models
CV	Coefficient of Variation
D	Density
DMWR	Department of Marine and Wildlife Resources
DOFAW	Division of Forestry and Wildlife
DS	Distance Sampling
E	Endangered Bird
EDD	Effective Detection Distance
FGDC	Federal Geographic Data Committee
GIS	Geographic Information System
GPS	Global Positioning System
HALE	Haleakala National Park
HAVO	Hawaii Volcanoes National Park
HFBIDP	Hawaii Forest Bird Interagency Database Project
HFBS	Hawaii Forest Bird Survey
I	Introduced Bird
I&M	Inventory & Monitoring Program
IBP	Institute for Bird Populations
KALA	Kalaupapa National Park
M	Migrant Bird
MAPS	Monitoring Avian Productivity and Survivorship
MVT	Master Version Table
MS	Microsoft
NPS	National Park Service
NPSA	National Park of American Samoa
NRDT	Natural Resources Database Template
NVCS	National Vegetation Classification Standard
O	Occasional Breeder
P	Adult Recapture Probability
P/A	Presence/Absence
PACN	Pacific Island Network

Acronyms (continued)

PAO	Percent Area Occupied
PSI	Population Size Index
R	Resident Bird
RBS	Rare Bird Search
RCUH	Research Cooperation of the University of Hawaii
S	Adult Survival Probability
SE	Standard Error
SOP	Standard Operating Procedure
T	Transient Bird
U	Usual Breeder
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
V	Visitor Bird
VBA	Visual Basic Applications
WAPA	War in the Pacific National Park

Background and Objectives

Issue Being Addressed and Rationale for Monitoring Landbirds

Birds are the principal, and sometimes only, terrestrial vertebrates on islands. Empowered by flight, birds typically out-distance mammals, reptiles, and amphibians in their ability to reach and colonize islands. This same long-distance filter also hinders the competitors, diseases, and predators of birds from reaching islands. Largely free from the factors that limit bird populations on continents, the Pacific islands originally were havens for birds. Two characteristics of island bird communities are (a) population densities were, and often still are, much higher than on continents, and (b) island birds have lost some defenses to biotic factors that would exploit them. Furthermore, from their position at the top of the terrestrial food chain, birds more strongly influence ecological processes on islands than on continents as consumers, pollinators, and seed vectors. On Pacific islands, birds pollinate many woody plant species and disperse their seeds. Lastly, bird populations marooned on islands inevitably change, and with enough time, evolve into new species. Consequently, the avifauna of Pacific islands are composed overwhelmingly of endemic species.

Since humans have settled Pacific islands and introduced a long and growing roster of alien species, the biota of islands are becoming more continental in composition and ecology, almost invariably to the detriment of native birds. The most drastic and infamous impacts, for example non-native rats and avian diseases, have brought about extinction of a large proportion of the original avifauna, and many of the surviving species are greatly reduced. However, hope remains for Pacific island birds in situations where they can escape alien threats (e.g. high elevation rainforests), be assisted by human management of ecosystems, or ultimately can adapt to novel pressures.

The native forests in PACN harbor bird communities that not only are representative for each island, but in many cases are of greatest importance to the conservation of the birds themselves. Significant examples include the bird communities at Kipahulu in HALE, Kahuku in HAVO, and Tutuila and Tau units in NPSA. Focal terrestrial vertebrate species, for the most part birds, were ranked fourth as vital signs by the PACN network.

History of Bird Studies and Monitoring in PACN Parks

There is an extensive legacy of surveying terrestrial birds, collectively known as "landbirds," in Hawaii and the South and West Pacific (Appendix A). American Memorial National Park (AMME), HAVO and NPSA previously participated in the Christmas Bird Count (CBC) national monitoring program; no other national programs have been conducted in PACN park units. Local programs surveying landbirds are ongoing in HALE and Kalaupapa National Park (KALA), and habitats in vicinity to HAVO. Local programs were conducted in AMME, HAVO and NPSA; however, monitoring was discontinued by 2002. These surveys have used distance-sampling methods, allowing for estimating actual densities and abundances, and for tracking trends and species composition patterns. However, most were not designed to detect specific levels of change, and notably lack random site selection. Inference in these studies is generally limited to the sampled areas.

The landmark Hawaii Forest Bird Survey (HFBS; Scott et al. 1986) established the basis for long-term population monitoring in Hawaii. This survey included forested portions of HALE and

HAVO, and high elevation forested portions of KALA. Since the HFBS, portions of all three Hawaii parks have been surveyed irregularly (Gorresen et al. 2005, Camp et al. 2009a), and HAVO has discontinued participation in the CBC (although a route is sampled adjacent to HAVO). The U. S. National Park Service (NPS) acquired the Kahuku tract of HAVO in 2004, and in 2005 conducted a survey in forested environments (Tweed et al. 2007). These surveys provided information for establishing a long-term monitoring program for forest birds in HALE and HAVO (this study).

Engbring et al. (1986) and Engbring and Ramsey (1989) established the basis for long-term population monitoring in the Mariana Islands and American Samoa, respectively. These surveys provided island-wide coverage and sampling stations were included within park unit boundaries. Subsequent landbird survey work in AMME, War in the Pacific National Park (WAPA) and NPSA has been limited to inventories, survey work done for research, and participation in the CBC. The inventories (Amerson et al. 1982, Engbring 1986, Engbring et al. 1986) and research surveys (Trail et al. 1992; Freifeld 1996, 1999; Freifeld et al. 2001, 2004) conducted in NPSA and surrounding environments were used to establish the long-term landbird monitoring program (this study).

We will not consider here materials specific to monitoring landbird species using Rare Bird Searches (RBS), point count methods adjusted for detection probabilities such as Proportion Area Occupied (PAO), mark-resighting methods such as Monitoring Avian Productivity and Survivorship (MAPS), or nest searching and monitoring methods such as Breeding Biology Research and Monitoring Database (BBIRD). These survey methods are beyond the scope of this protocol given the protocol budget and the costs to implement them. We do however present information necessary to establish future long-term monitoring programs for each method if additional funding becomes available and identify those species for which these techniques may be more appropriate for assessing population changes (RBS: Supplemental Materials 1, PAO: Supplemental Materials 2, MAPS: Supplemental Materials 3, BBIRD: Supplemental Materials 4).

Monitoring Objectives

Monitoring landbirds as vital sign can be met with two objectives: (1) monitor long-term trends in species composition (richness), distribution, and density, and (2) monitor species composition and density changes relative to management actions. This protocol contains SOPs for both monitoring objectives:

Determine long-term trends in species composition, distribution and density of native and non-native forest landbird species in PACN parks: HALE, HAVO, and NPSA units Tutuila and Tau.

Monitor changes in species composition and density of native and non-native forest landbird species relative to management activities in PACN parks: HALE, HAVO, and NPSA units Tutuila and Tau.

Objective 1

Determine long-term trends in species composition, distribution and density of landbird species.

Species Composition: The sampling objective of the PACN Landbirds Protocol is an 80% probability of detecting a 25% change in species composition (species richness) over a 25-year period, with a Type I error rate of 20%. *Distribution*: the sampling objective of the PACN Landbirds Protocol is an 80% probability of detecting a 25% change in species' distribution over a 25-year period, with a Type I error rate of 20%.

Density: For all non-threatened native and most non-native landbird species the sampling objective of the PACN Landbirds Protocol is an 80% probability of detecting a 25% change in species' density over a 25-year period, with a Type I error rate of 20%.

For birds of special interest, including threatened and endangered species, and species of concern, the sampling objective of the PACN Landbirds Protocol is an 80% probability of detecting a 50% change in species' density over a 25-year period, with a Type I error rate of 20%.

Objective 2

Monitor the changes in species composition and density of native and non-native forest passerine species relative to management actions corresponding to forest restoration (i.e., alien plant and animal control) and reforestation.

Species Composition: The sampling objective of the PACN Landbirds Protocol is an 80% probability of detecting a 50% change in species composition (species richness) over a 25-year period, with a Type I error rate of 20%. *Density*: the sampling objective of the PACN Landbirds Protocol is an 80% probability of detecting a 50% change in species' density over a 25-year period, with a Type I error rate of 20%.

This second objective is included in the monitoring protocol specifically to address management concerns. In general, birds respond to changes in habitat and stressors; therefore, they are good indicators of management's efficacy. Results of landbird monitoring will be provided to park biologists through the reporting process, allowing managers to make informed management decisions.

Both sets of objectives used a twenty-eighty convention (Di Stefano 2003), the probability of making either a Type I or Type II error is 20%. This sets the cost of making either error equal instead of the standard approach of weighting a Type I error (five-eighty convention, where a Type I error is four times more important than a Type II error). Compared to the standard approach the twenty-eighty convention used here places a higher cost of making a Type II error (concluding there is no decline when there is one), and a lower cost for inadvertently making a Type I error (mistakenly identifying a population decline). Power to detect either a 25% or 50% decline in landbirds was low even when sampling occurred over long periods (25 years; see Sampling Frequency and Replication, below). Thus, more conservative or stringent objectives (e.g., 80% probability of detecting a 10% change over 25 years, or a 25% change over 5 years) were not selected.

The following section through and including Table 1 is adapted from Camp and Gorresen (2010). A monitoring program provides the necessary information to both trigger and assess the responses to management actions. Alert limits for specific population metrics provide threshold levels that trigger an alternative action. Alert limits for distribution, density and demography should include both short and long-term changes in these metrics and over a variety of threshold levels (Table 1). The IUCN (2001) developed a global standard for species listing and conservation assessment—the IUCN Red List categories and criteria. The Red List combines distribution and density alert limits that are useful for defining changes in both factors. Combining those metrics captures the interaction between these factors and could be crucial for determining the most appropriate remedial actions. In general, a species must be declining at specified rates (ranging over 20 to 90% declines) in either or both distribution (ranging from <10 to <20,000 km^2) and abundance (ranging between <50 to <10,000 mature individuals). These changes can be observed, estimated, inferred, or projected, allowing for latitude in the quantitative analyses over five or 10 years and extending up to 100 years.

The IUCN Red List provides detailed criteria quantifying changes is species distributions, including both the extent of occurrence and area of occupancy. The extent of occurrence is generally defined as the minimum convex polygon that encompasses all known or inferred sites of occurrence. The area of occupancy matches that of the extent of occurrence except unsuitable or unoccupied habitats within the polygon are excluded. Table 1 details the various IUCN criteria for assessing changes in occurrence and occupancy that are applicable to Pacific Island forest bird monitoring.

The U.S. Breeding Bird Survey has an alert limit threshold for detecting a halving or doubling in abundance over 25 years level (USBBS; Peterjohn et al. 1995). The thresholds used by the United Kingdom Breeding Bird Survey (UKBBS; Crick et al. 1997) is a bit more sensitive as it includes two alert limit levels, a high limit when bird abundance declines by at least 50% over 25 years, and a medium alert limit to indicate when trends declined between 25 and 49% over 25 years. In contrast, the IUCN (2001) established a range of declines in abundance specific for each extinction risk category. These ranged from a moderate 20% decline within five years or two generations to a catastrophic decline of 90% over 10 years or three generations. In addition to trends in species' abundances, the IUCN established alert limits to identify when a minimum population size is achieved, and is applicable for mature individuals regardless of estimator variability. Table 1 details the various USBBS, UKBBS and IUCN criteria for assessing changes in abundance.

Table 1. Metrics, criteria and timeframe for setting the risk of extinction, and possible monitoring and management actions suggested. Threshold limits adopted from the IUCN (BirdLife 2000), U.S. Breeding Bird Survey (Peterjohn et al. 1995), and United Kingdom Breeding Bird Survey (see Crick et al. 1997). For each metric and criteria, we suggest alternative monitoring and management actions. Recommending specific management actions is beyond the scope of this report, management actions could include forest protection, habitat restoration, predator control, control of avian disease, control of nonnative plant species, and fencing and removal of ungulates (see USFWS 2006 for specific actions).

Metric	Criteria	Timeframe (years)	Alternative Action(s)
Density	>25% decline	25	Monitoring: 1) Continue density monitoring. Management: 1) Identify and mitigate the external factor(s) causing the decline.
	>50% decline	25	Monitoring: 1) Continue density monitoring. Management: 1) Identify and mitigate the external factor(s) causing the decline
	>30% decline	10	Monitoring: 1) Continue density monitoring. Management: 1) Identify and mitigate the external factor(s) causing the decline.
	>50% decline	10	Monitoring: 1) Continue density monitoring. Management: 1) Identify and mitigate the external factor(s) causing the decline.
	>70% decline	10	Monitoring: 1) Continue density monitoring. Management: as above 2) Establish a captive breeding flock.

Sampling Design

Many different sampling approaches have been used to quantify status or trends in bird populations and many different monitoring programs are currently in place throughout the world to determine local, regional, or national trends in bird numbers. Most survey methods allow simultaneous collection of information about species that share a common life history or habitat, but no single method will adequately sample the diversity of either habitats that birds occupy or life history groups such as seabirds, songbirds, raptors, and shorebirds (Peitz et al. 2002).

Objectives determine the parameters estimated and the field measurements recorded. The most common objective of bird monitoring is to detect changes in abundance. Meeting this objective requires estimating species' status with low (or no) bias and high precision, and assessing population trends. Inventory and Monitoring (I&M) Program requires park-wide, or at least biome-wide status estimates; thus, the sampling frame covers large portions of the parks (e.g., >35 km^2 for the NPSA Tutuila unit). Sampling techniques appropriate for such spatially large scaled programs are generally limited to count based techniques (e.g., area count, point count, strip transect, spot mapping, variable-distance transect, variable circular-plot, or distance sampling). Index counts (area count, point count, strip transect, and spot mapping) do not provide measures of precision and were therefore eliminated as potential survey methods (Anderson 2001). Sampling involving variable-distance transect, variable circular-plot and distance sampling methods can be used to obtain relatively unbiased, regional information on bird abundance, and track changes in population trends through time. The biggest difference between these methods is how distance measurements are assigned. Variable-distance transect and variable circular-plot methods typically assign bird locations to distance bands, whereas distance sampling, including both line-transect and point-transect methods, assign exact distance measurements to birds detected.

Rare Bird Searches can be used to identify individuals/populations of species thought to be extinct. Changes in area-specific or regional spatial distribution of a species can be identified using PAO sampling methods. Population trends do not identify the causes of population change. Identifying the factors suspected to cause population change requires knowledge of demographic processes: productivity and survival. The MAPS protocol can be used to provide indices of annual variation in regional productivity and survival. The BBIRD protocol can be used to obtain relatively unbiased, area-specific information on reproductive success. BBIRD and MAPS protocols involve intensive monitoring of fixed-sized plots (e.g., 20-ha), and collectively, involve marking individuals, mapping nests and territories, and recording fledging success through repeat visits. MAPS and BBIRD approaches provide very detailed demographic information about relatively small areas, and are relatively expensive compared to count-based sampling.

The sampling design described in this protocol is based on distance sampling techniques. For most situations, distance sampling is the best method currently available for determining abundance and monitoring trends for landbirds. As noted above, point-transect sampling has been used extensively throughout the Pacific, and has been used for almost 30 years in some PACN parks (e.g., HALE, HAVO and NPSA).

Point-transect sampling is the preferred approach for multi-species studies, in patchy habitats where bird data will be associated with vegetation or other habitat information, in dense vegetation, and rugged or hazardous terrain. This protocol uses point-transect sampling instead of line-transect sampling or unadjusted point counts (as used in the Breeding Bird Survey [BBS]) to address the two objectives for the following reasons:

An important benefit of using the point-transect sampling is the ability to accommodate a wide range of bird species, each of which possesses a different singing style, and each of which may occur in a variety of acoustically different habitats (BCRIB 1999). Even though the method accommodates a wide range of birds it is unlikely that sufficient numbers of detections for specific birds will be made to calculate reliable density estimates. Data for those species however can be summarized as presence/absence and either tracked qualitatively or analyzed using PAO methods (analysis dependent on recording detections during bird and habitat sampling; see Supplemental Information 2). Thus, the distance sampling methods described herein will provide the necessary monitoring information for 62 of the 70 Hawaiian birds, and 22 of the 23 American Samoa birds (see Appendix B). Point-transect sampling essentially allows the habitat to determine the size of the area surveyed. The maximum detectable distance to a bird may change between different habitats, but the radius of the survey will also change. For example, surveys of grassland birds usually cover a larger area per point because of the absence of a screen of trees, and because bird species may be flushed at greater distances in open habitats (BCRIB 1999).

Including a distance measurement to the count method permits derivation of a species-specific density estimate adjusted by a species' detection probability (Ralph et al. 1995), allowing for estimating the number of individuals missed. Unadjusted point counts do not account for the number of birds missed during the counting interval, and, therefore, are a measure of relative abundance (e.g., number of observations/visits/area sampled; an index). Index based methods should be avoided (Anderson 2001). Without a measure of the detection probability, counts of birds are an unreliable measure of differences in the actual number of birds present (see Burnham 1981, Barker and Sauer 1995, Nelson and Fancy 1999). Thus, to obtain relatively unbiased long-term trend data the sampling design will incorporate distance measures.

Point-transect sampling is conducted at the scale of populations, thus inference is to the whole population instead of producing information at a site- or area-specific level (see Scott et al. 1981, Buckland 2006).

Another advantage of point-transect sampling is that data can be directly compared to historical point count data such as those obtained during BBS counts and can contribute to ongoing programs such as the National Point Count Database and the Hawaii Forest Bird Interagency Database Project (HFBIDP).

The second objective of this protocol is to monitor the changes in species composition and density of native and non-native forest passerine species relative to management actions corresponding to forest restoration (i.e., alien plant and animal control) and reforestation. Sampling station placement (according to a simple random sampling scheme; see Site Selection below) will allow for experimental or BACI (before-after-control-impact) sampling designs to investigate changes in bird composition and density because of changes in vegetation or other habitat characteristics. Park Biologists, NPS Lead and other resource managers should establish thresholds or trigger points for implementing management actions.

Note: Although line-transect sampling is more efficient (continuous sampling while walking along transects), the point-transect sampling is preferred in dense vegetation, and rugged or hazardous terrain where simultaneously traversing transects and recording bird detections is difficult (all PACN parks). In addition, point-transect sampling is preferred in patchy habitats where line-transect sampling units span more than one environment and detection probabilities differ among habitats (Buckland 2006). Occasionally, there are detectability issues in bird sampling that point-transect sampling and other estimation procedures cannot address. For example, there may be unobservable portions of the population (such as cryptic and silent females) that are not detected at all during counting, or it may be impossible to estimate detectability at the appropriate scale, for example, when habitat-specific detectability exists in a rare species. In structurally complex habitats (e.g., rain forests) it may be difficult or impossible to detect birds at close horizontal distances to the counter. Thus, even with a measure of detectability factored into estimates derived from counts of birds, such estimates may still be an unreliable measure of differences in the actual number of birds present in some situations. However, it is important to note that although data may be less reliable for species encountered at low rates, it is still valuable to collect the data, and pooling of data over time may allow certain limited analyses. Interpretation of survey data requires sensitivity to these extra-statistical limitations of the estimation procedures.

Point-transect count stations, typically spaced 150-m apart along transects, are sampled during 8-minute counts (Reynolds et al. 1980, Scott et al. 1986, Buckland et al. 2001; Figure 1). For the first detection of an individual of each bird heard or seen during the count, the counter records the species, method of detection, and radial (horizontal) distance from the station center-point to the bird. All birds detected from a station are recorded, regardless of the distance from the station center-point. In addition, sampling location, habitat type, and sampling conditions are recorded for each survey station. While walking between stations on transects, counters record low-density, rare, or unusual species (where radial distance is estimated to the nearest station center-point).

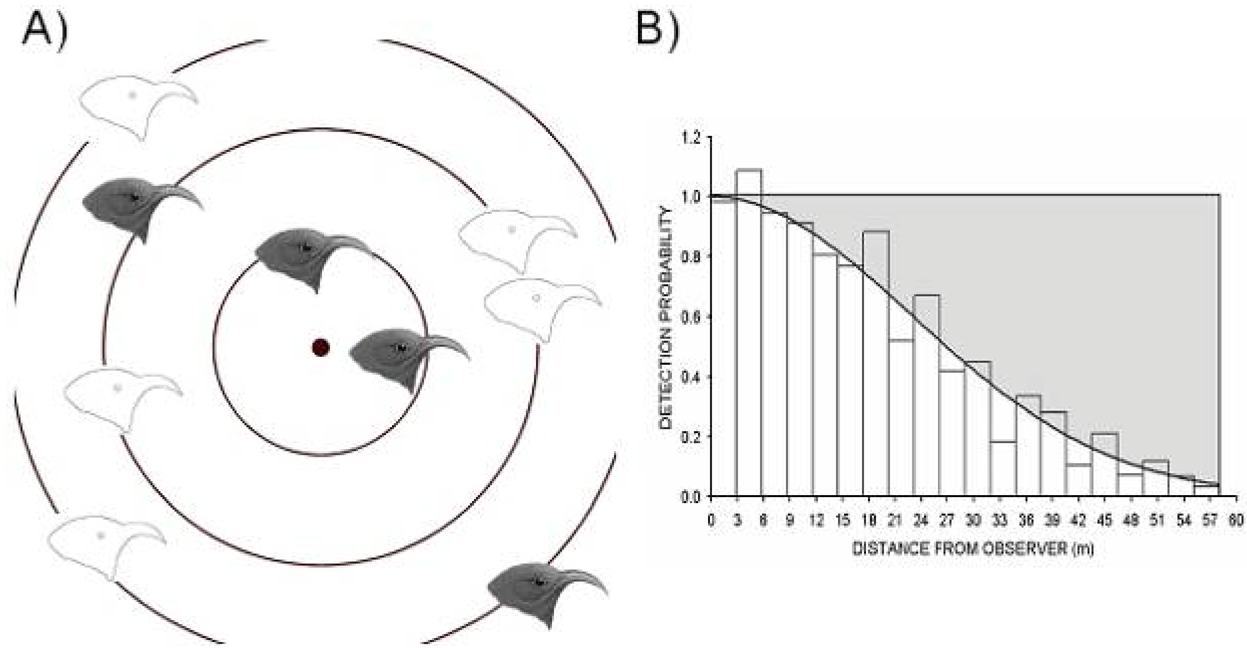

Figure 1. Distance sampling methods estimate absolute abundance by determining the relationship of observed birds with a probability of detection. A) Closed birds represent a bird detected (distance from station center point to bird measured in meters), while open birds are undetected birds. The bulls-eye represents the station center point, and the circles are distance intervals from the center point. (B) Histogram of distance data and best fitting detection function. The curve represents the corresponding estimated detection function. Fewer birds are detected at greater distances from the center point. The estimate of the proportion of birds missed during sampling is shown in the shaded area. Density is then calculated as the number of birds detected divided by the expected proportion of birds in the effective area of detection (from Camp et al. 2009b).

Site Selection

Details on site selection are provided in SOPs 5 and 7. To summarize, landbirds (both native and non-native) will be monitored in the PACN parks HALE, HAVO, and NPSA units Tutuila and Tau by the NPS.

Biomes (i.e., habitat types barren / lava, grassland / shrub land, forest, and alpine) will be identified on park land-cover maps. Park tracts (sections or portions of the park [herein referred to as tracts]) will be overlaid on the biomes map. The sampling frame is the sum of park tracts within a biome, where transect placement within tracts will be either randomly established (random) or selected from legacy transects (fixed). Hazardous terrain is not included in the sampling frame for tracts. Regions with hazardous terrain are those that include active lava flows, steep slopes or ground cracks and settling (e.g., the forested area between Napau Crater, Puu Oo and the Pulama Pali, East Rift Zone of HAVO). For non-legacy transects, the location of each transect is comprised of two factors, the start point and transect orientation. Each transect start point is identified using the "Hawth's Analysis Tools" in Geographic Information System (GIS) (http://www.spatialecology.com/htools/tooldesc.php), and the orientation is determined by a random bearing (see SOP 5 for details). Ten sampling stations are spaced 150-m apart, using the "way-points" feature on the global positioning system (GPS) unit to ensure the correct straight-line distance. Sampling stations do not need to be physically marked, so it is imperative that waypoints are accurate and recorded in the GPS as well as on the data sheet (see SOP 5). Each transect accommodates 10 stations unless the transect traverses impassable terrain or reaches the park/unit boundary, with a minimum transect length of 3 stations. Additional transects will be selected until the desired number of stations is achieved.

Additional constraints are applied to the HALE and NPSA Tutuila unit random panel transect selection (SOPs 4 and 7, respectively). Random panel transects in HALE must intersect an existing “access corridor” and a detailed transect selection process is described in SOP 4. This procedure introduces a potential bias because not all locations can intersect an existing access corridor. This bias was assessed and found to be acceptably low (SOP 4). Truncation of transects because of topographic barriers may also introduce bias. This bias was assessed using the HALE data set. There was no barrier effect and hence truncated transects can be expected, in the long run, to yield unbiased estimates of density (SOP 4). The Tutuila NPSA unit was divided roughly in half into east-west strata to balance sampling across the entire unit (SOP 7). The strata are only administrative, not ecological, and the demarcation is only to help balance the sampling effort between the strata. Therefore, substituting stations in one stratum for the other is not a concern..

Legacy transects used to sample landbirds exist in many of the PACN parks, e.g., HALE, HAVO, and NPSA. A subset of these will be included in the sampling units as fixed sites for panel design sampling (Figures 2, 3, 4 and 5; see Sampling Frequency and Replication, below). Statistical inference is limited to within tracts; however, biological inference will be to the entire park (or to subset of biomes within a park if all biomes are not sampled, e.g., alpine biome in HAVO will not be sampled).

Populations Being Monitored

Sampling will target all landbird species that may potentially breed in the parks (see Appendix B). Although landbird sampling is not targeted at shorebirds, water birds, game birds, and raptors, data collected using this sampling design will provide new information on the presence and distribution of these species. Non-targeted species will be removed before analyses, because the sampling methods will not adequately sample these species. Sampling will be limited to the peak vocalization periods (Hawaii parks: January through June; NPSA units: July through November).

The emphasis of this landbird protocol is to monitor bird species at a tract level within a park, not at a park level. Statistical inference at the park level likely will not be appropriate. Thus, this protocol is designed to provide statistical inference to the populations of bird species that occur in each of the biomes within the collection of selected park units.

One sampling design does not fit all species (Appendix C). Bird species vary in their detectability as well as in their relative abundances (Thompson et al. 1998). Thus, different species will require different numbers of sampling units (i.e., stations) to attain the minimum number of detections necessary to adequately fit the detection function. A number of species will be too hard to detect (for a variety of reasons) to produce reliable density estimates. We will undoubtedly have to pool detections across sampling units and species. Pooling will be restricted to sampling units (e.g., similar habitats) and species with similar detection rates.

Sampling Frequency and Replication

There is a tradeoff between sampling for status versus sampling for trends, and any long-term monitoring program has to balance these two according to the monitoring objectives. Panel design based monitoring programs improve the detection of spatial (i.e., status) and temporal (i.e., trend) changes (Skalski 1990). In general, panel designs consist of two or more panel members where the sampling units in each member are either repeatedly sampled during each sampling occasion, or the sampling units are rotated into the sampling scheme for a specified duration (one or more sampling occasions) and then retired.

Repeated observations over time are needed to document and track changes in status (i.e., trends), and trends detection is best achieved from repeatedly surveying the same sampling units. Repeated surveying can however result in biased estimates as populations and habitats change through time. Surveying new sampling units minimizes bias in status estimates. Thus surveying effort is optimized by combining panel members that maximize trends detection and minimize bias.

We used guidelines in McDonald (2003, and references therein) to develop a split panel design of [1-0,1-n] sampling for PACN parks (Table 2). The first member panel, [1-0], is an "always revisit" during each sampling occasion, which optimizes trend detection, and legacy transects should be used to populate this member. The second member, [1-n], is a "never revisit" panel which optimizes status estimation. This member is populated with newly, randomly located transects during each sampling occasion. The legacy transects in the "always revisit" panel have the potential to produce biased estimates, but we can measure and correct this bias by comparing the estimate with those produced from the "never revisit" panel.

Power to detect a 25% and 50% decline in landbirds is low ($1-\beta < 40\%$; Appendix D). This is partially due to large amounts of variance (both within and between density estimates; Camp et al. 2009a) and because we pooled across species and sites to derive the power to detect a decline in the "average bird." The sampling effort (sample size; n = number of sampling units or stations) varies by species and park tracts. Using observed density and variance estimates for native Hawaiian forest birds (Camp et al. 2009a), we estimate that between 20 and 200 sampling stations are needed to meet monitoring objectives (Table 3; Appendix D). Sampling effort may be adjusted to accommodate the ability to derive credible detection functions for density estimation. Buckland et al. (2001) recommends 60–80 detections per species for adequate estimation of a detection function. For those species of greatest importance to the parks (e.g., threatened and endangered species, species of concern, and species of interest), the formula recommended by Buckland et al. (2001) will also guide determining the appropriate number of samples. This sample-size requirement can be met by pooling data from tracts among years, or by pooling data from other surveys in similar habitats (e.g., survey data between 1976 to present, compiled by HFBIDP). In addition, if the detectability of a particular species is high and factors affecting detection rate are not complex, it is possible to obtain adequate results with slightly fewer than 60 detections. Both the number of detections per tract and the inter-annual variability will be examined after several years of data collection to determine necessary adjustments to sampling effort.

Table 2. Schematic representation of the panel survey schedule for the split panel design, [1-0, 1-n], with permanent/fixed (i.e., always revisited) and rotating (i.e., panel sampled for one period and then dropped) member panels.

	Sampling Occasion (showing sampling years for one unit with a 5-yr park unit rotation)									
Panel	**1** **Yr1**	**2** **Yr6**	**3** **Yr11**	**4** **Yr16**	**5** **Yr21**	**6** **Yr26**	**7** **Yr31**	**8** **Yr36**	**9** **Yr41**	**…**
1	X	X	X	X	X	X	X	X	X	X
2	X									
3		X								
4			X							
5				X						
6					X					
7						X				
8							X			
9								X		
10									X	
⋮										X

Table 3. Sample sizes and the number of stations allocated to the fixed and random panels by park or park tract (see Appendix D and E for details).

Park/Tract	Sample Size	Allocation (fixed:random)
HALE	150	100:50
HAVO: Olaa	100	50:50
HAVO: East Rift	120	60:60
HAVO: Mauna Loa Strip	80	40:40
HAVO: Kau	200	100:100
HAVO: Honomalino	100	50:50
HAVO: South Flank	120	60:60
HAVO: Northwest	100	50:50
HAVO: Papa	20	10:10
NPSA: Tutuila	100	50:50
NPSA: Tau	100	50:50

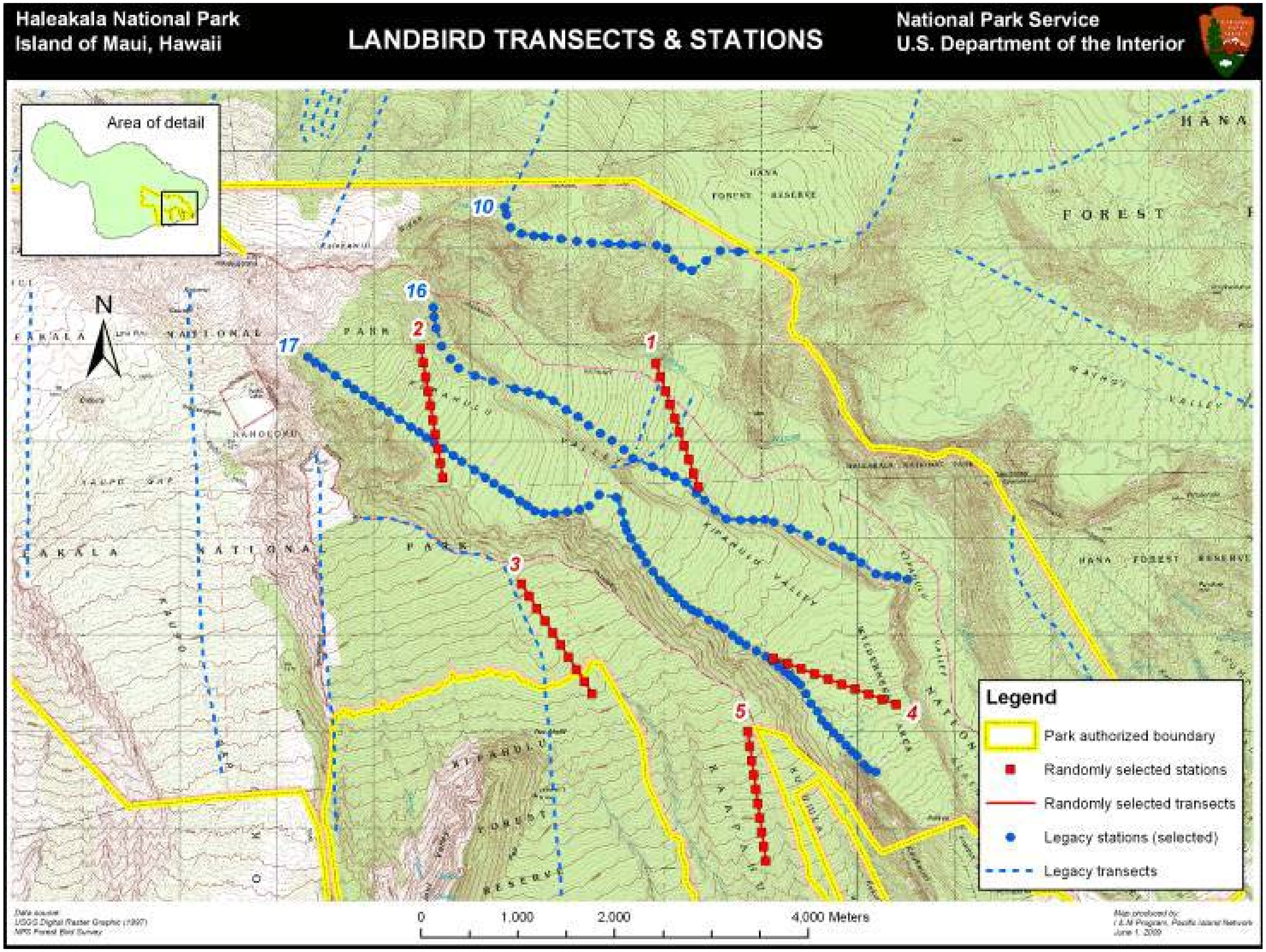

Figure 2. Location of landbird sampling stations within HALE. Legacy stations (blue dots) should be sampled on each survey occasion, whereas these random stations (red diamonds) should be sampled only during the first survey occasion.

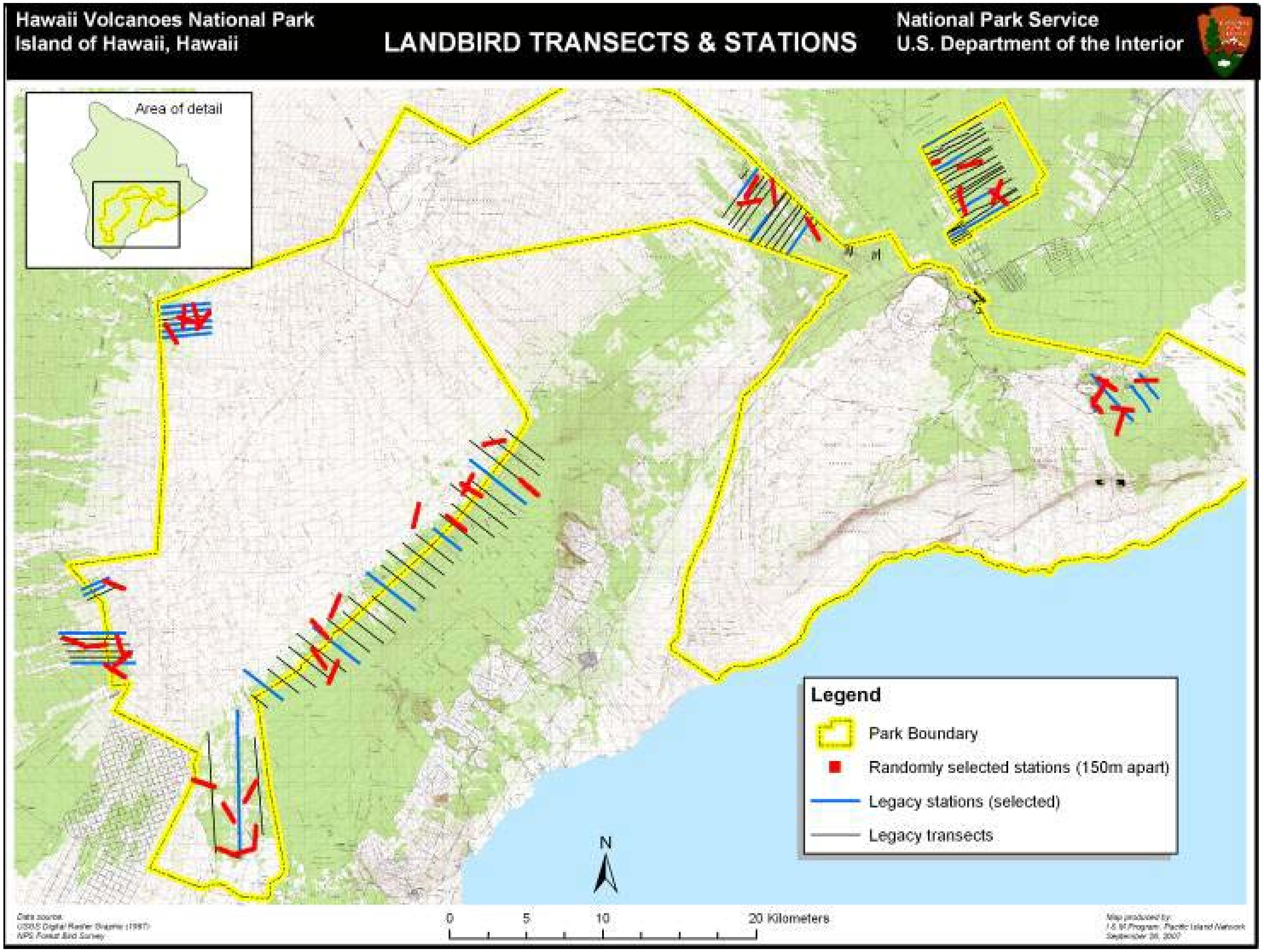

Figure 3. Location of landbird sampling within HAVO. Legacy transects (blue lines) should be sampled on each survey occasion, whereas these random transects (red lines) should be sampled only during the first survey occasion. Maps detailing sampling locations are provided for the new acquisition (Figure 3b), old acquisition (Figure 3c), and Northwest Kahuku (Figure 3d).

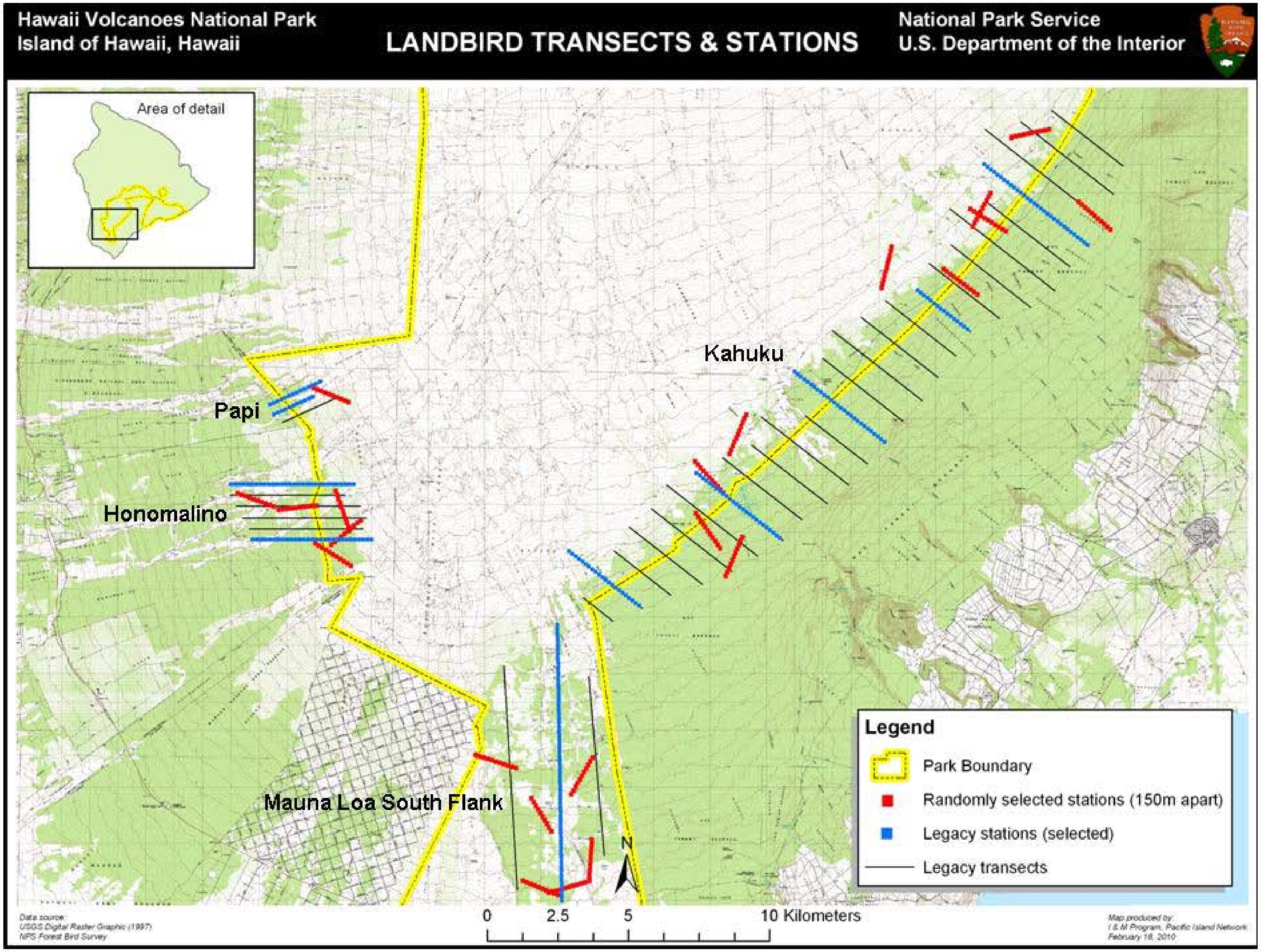

Figure 3a. Detailed map of sampling locations for the new acquisition.

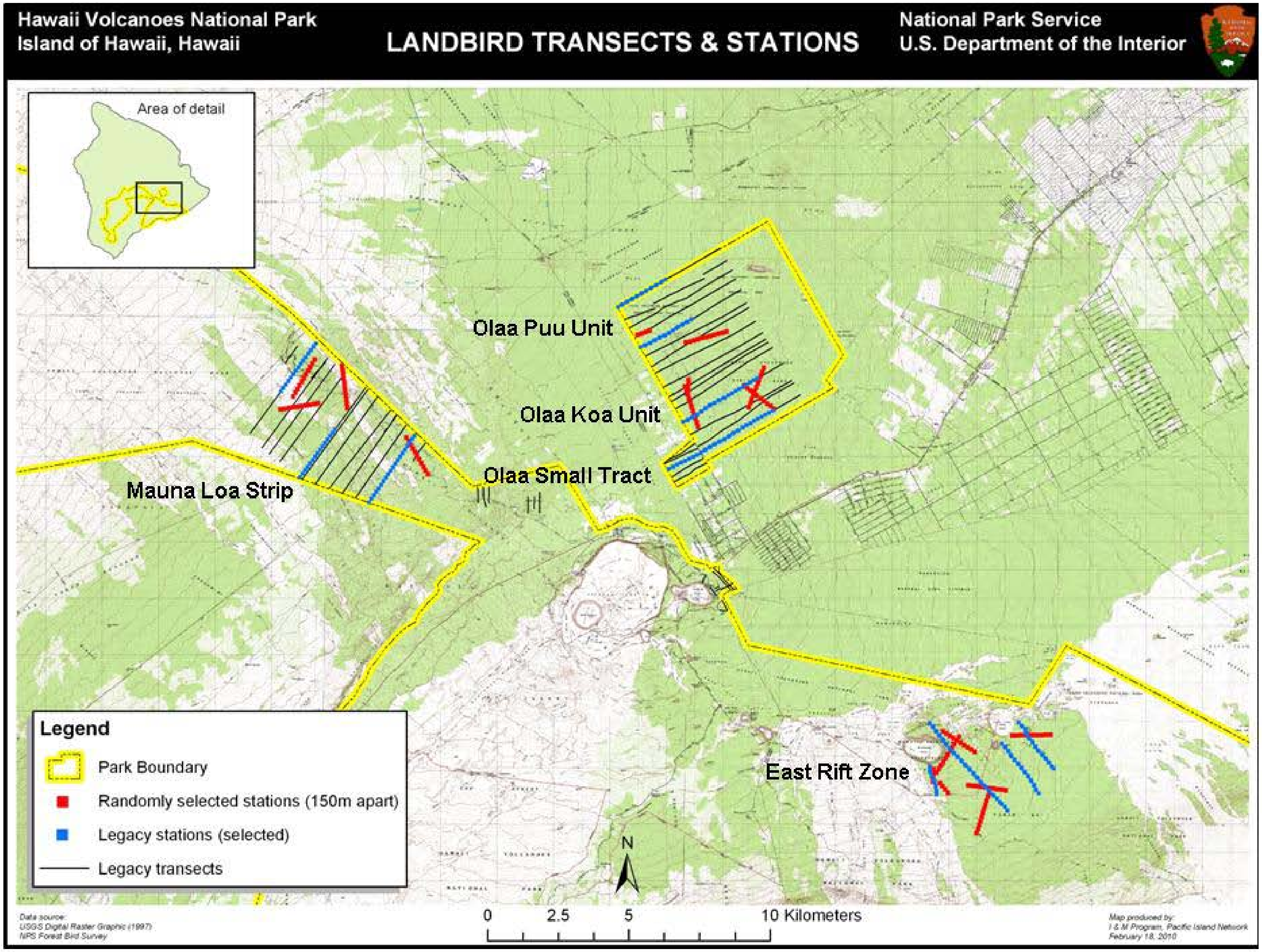

Figure 3b. Detailed map of sampling locations for the old acquisition.

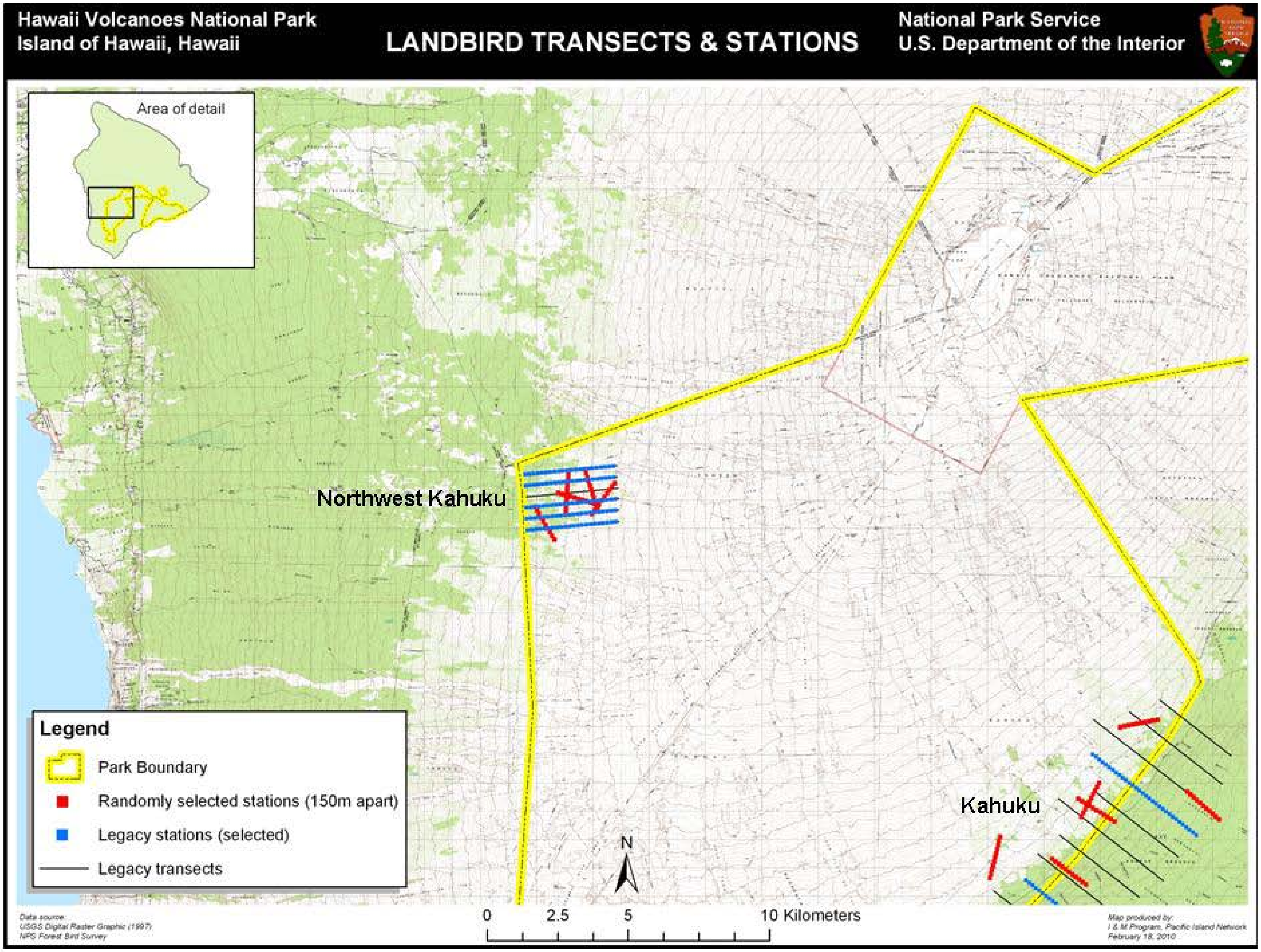

Figure 3c. Detailed map of sampling locations for Northwest Kahuku.

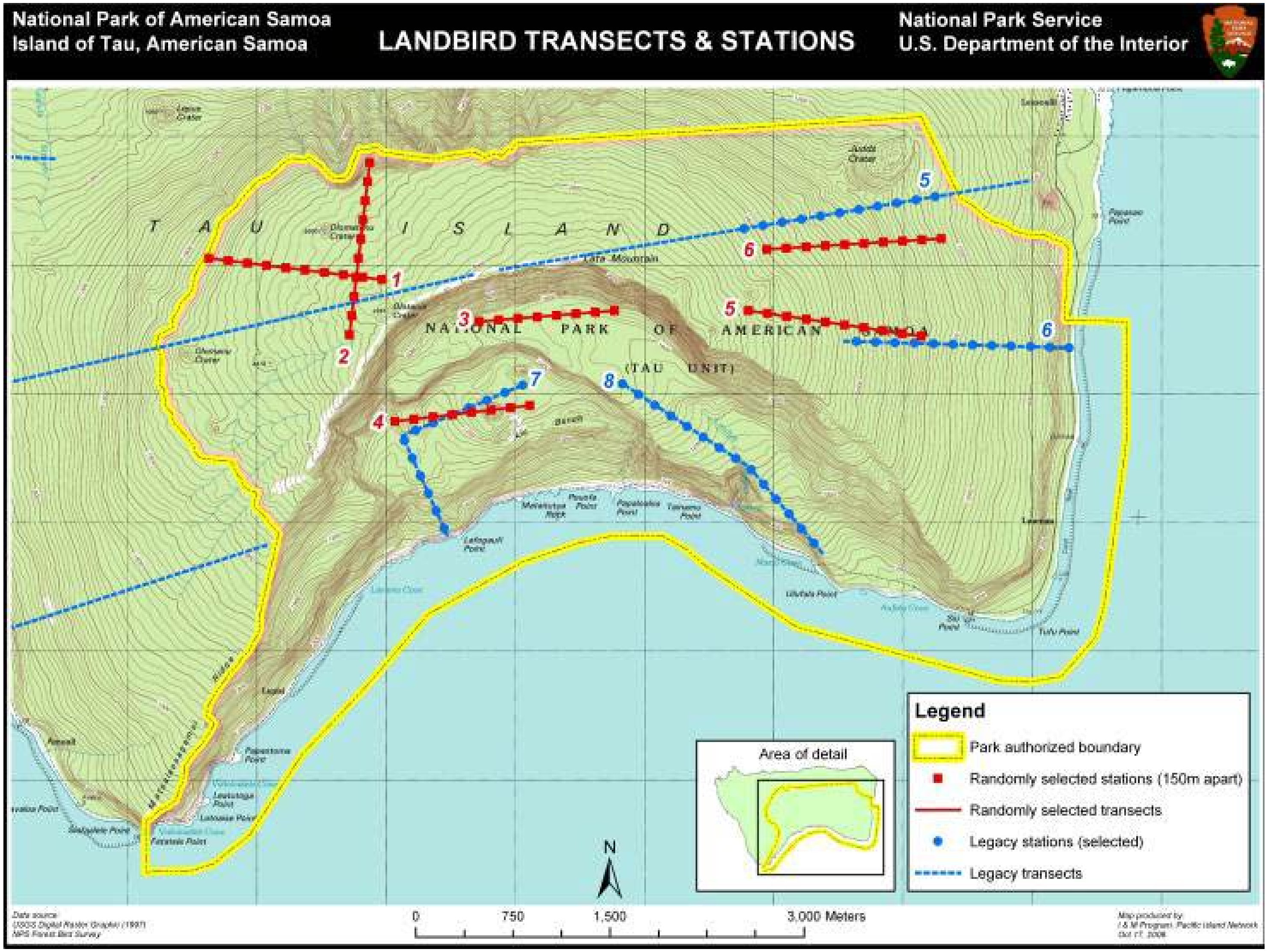

Figure 4. Location of landbird sampling stations within NPSA, Tau unit. Legacy stations (blue dots) should be sampled on each survey occasion, whereas these random stations (red diamonds) should be sampled only during the first survey occasion.

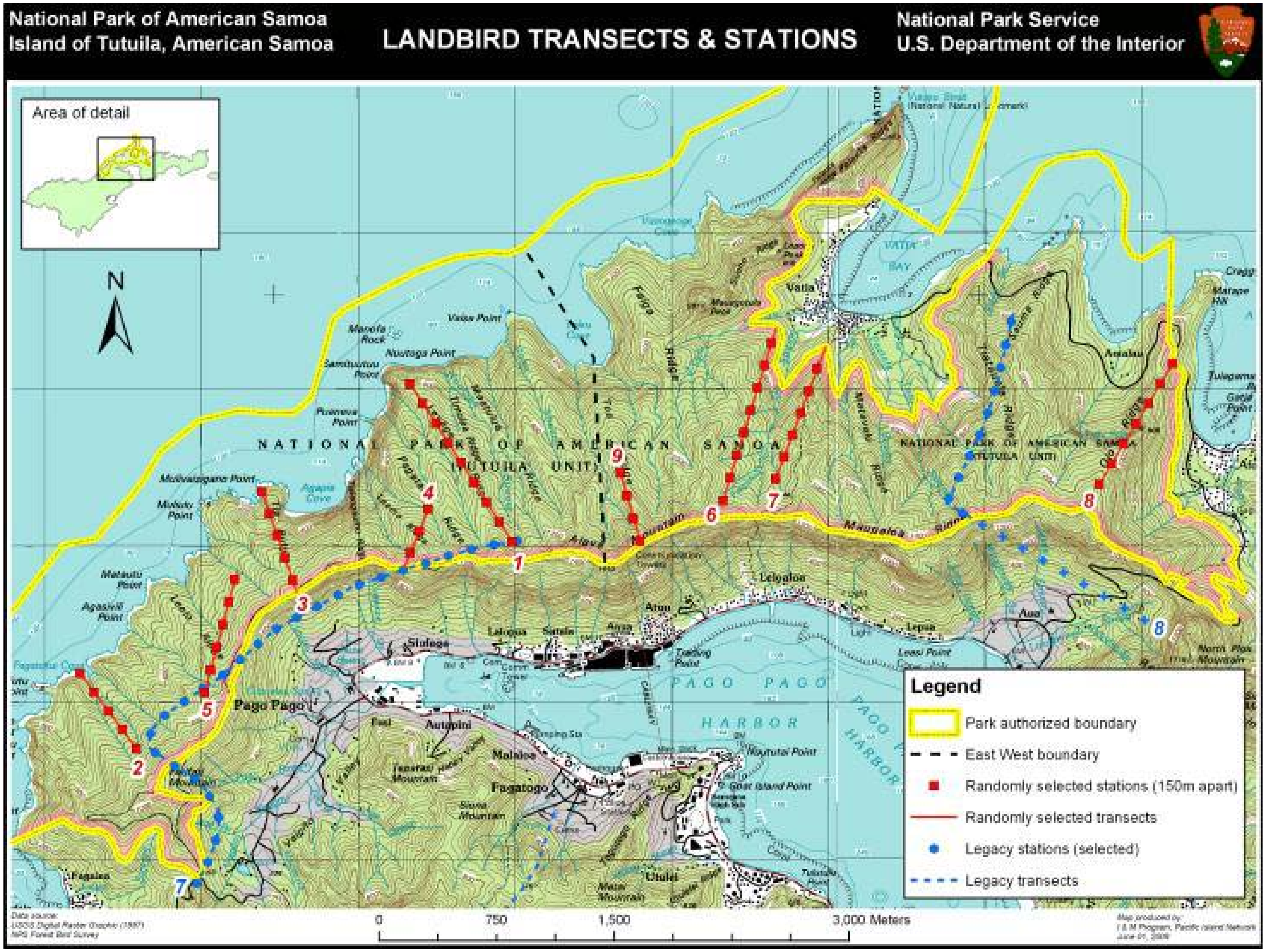

Figure 5. Location of landbird sampling stations within NPSA, Tutuila unit. Legacy stations (blue dots) should be sampled on each survey occasion, whereas these random stations (red diamonds) should be sampled only during the first survey occasion.

We used the correlation of density estimates among years to determine the number of sampling stations allocated to fixed and rotating panels (Appendix E). Data from Mauna Loa Strip tract was the only NPS continuous long-term data set available for this correlation analysis. Based on this data stations should be allocated to the fixed and rotating panels in a 1:1 ratio.

The spatial sampling arrangement of a long-term monitoring program, in general, can be grouped or ungrouped (stratified or unstratified; Appendix F). The spatial arrangement of sampling stations is applicable only for the rotating panels. Legacy transect stations are allocated to the fixed panel, and stations in the rotating panels will be allocated following an unstratified sampling design. We advise against arranging the stations in a grid. Instead, stations are to be randomly located (Buckland et al. 2001) and that analyses using domains be used to reduce variance about the density estimates (see Appendix F).

Sampling frequency is a compromise between monitoring power and logistic constraints. The more frequently samples are collected (e.g., annually versus decadal) the sooner a trend may be observed (i.e., greater power). Therefore, sampling should occur annually, or as frequent as possible. This is especially important due to the low power to detect trends (see Appendix D). Not all PACN park units can be surveyed on each annual sampling occasion because of fiscal and sampling period (i.e., peak vocalizations) limitations. At the present time, PACN will survey parks on a rotating basis (Table 4; see SOP 7 for survey stations) by implementing the park specific split panel design. If additional funding becomes available, or collaborative agreements can be established, sampling parks concurrently would allow for detecting smaller trends and detecting them sooner.

Table 4. Rotation for sampling PACN park units.

Sampling Years					
1	2	3	4	5	…
HAVO[1]	HAVO[2]	HALE	NPSA[3]	NPSA[4]	…

[1]Surveys conducted in old HAVO park tracts Olaa, East Rift, Mauna Loa Strip and Northwest (new HAVO).

[2]Surveys conducted in the new HAVO park tracts Kau, South Flank, Honomalino and Papa.

[3]Surveys conducted in Tutuila unit of NPSA.

[4]Surveys conducted in Tau unit of NPSA.

Integration with Vegetation Monitoring

A primary objective of landbird monitoring is to assess how bird communities (composition, distribution, and abundance) respond to changes in vegetation, particularly with respect to habitat restoration. Management actions (forest restoration and reforestation), in addition to fire, windstorms, disease, and insects play an important role in shaping the structure and composition of vegetation communities in PACN units. Large-scale changes in vegetation are likely to have cascading effects on avian communities in PACN units. Therefore, an important component of the landbird monitoring program is measuring the response of bird populations to changes in their habitat.

Bird crews will be responsible for collecting vegetation or habitat data. This requires additional training and additional fieldwork. By co-locating landbird sampling points with those used by landscapes and vegetation vital signs, sampling for protocols are optimized when crews collect detailed data on vegetation and/or habitat without adversely affecting bird sampling.

Field Methods

PACN landbirds field method procedures are detailed in SOPs 1–9 (see page v for complete list of SOP titles), and summarized here.

Field Season Preparations, Field Schedule and Equipment Setup

Field crews for the PACN Landbirds Protocol consist of two primary counters, who conduct the surveys and record the detections on standardized data sheets, and two interns who fulfill NPS safety requirements and assist the primary counters. The Project/Field Lead and all field crewmembers will review this entire protocol, including all of the SOPs before the field season. The Project/Field Lead will pay particularly close attention to the tasks described in SOPs 1–3. All counters must attend a safety briefing (detailed in SOP 2; and all field crew must understand the safety plans, including check-in methods and times, contingency plans, emergency procedures, etc.), and participate in a bird and habitat training program. This training covers bird identification, distance estimation, and habitat-collection procedures. Training is particularly important, as the misidentification of a species is perhaps the most serious error that can be made during a bird count. Misidentification is much more serious than errors in estimating distances or double-counting a bird. All of the equipment and supplies listed in SOP 1 will be organized and made ready for the field season, and copies of the field data forms (found in SOP 1) will be made, all of which will be on weatherproof field paper. Counters working in PACN units will be provided with a GPS unit for initially recording transect waypoints, and for subsequent navigating. Instructions for using GPS units are provided in SOP 5. Before going into the field, waypoints of established transects must be uploaded into the GPS (see SOPs 4 and 5). Also, transect-location information should be transcribed to the field-data sheets (see SOP 7).

The Project/Field Lead will schedule sampling dates and organize logistics at least one month before the start of each field season. This is important, particularly for ensuring transportation to sampling stations that require airlift support. Unpredictable weather and the availability of helicopters necessitate maintaining some flexibility in scheduling the sequence and duration of sampling trips (see SOP 1: Table 2 for transportation requirements). Ten (in difficult terrain) and 12 to 15 (in open habitats) point-transect counts should be scheduled for each field day. Multiple field trips, up to ten days in length, will be required to complete the bird surveys within the allocated sampling period. Transects separated by the least amount of distance should be scheduled for completion within the same day.

Sampling Methods

Methods for locating transects are detailed in SOPs 4 and 5. Legacy transects are permanently marked following methods described in SOP 6, and a GPS is used to navigate to transects and sampling stations (see SOP 5). Non-legacy survey locations are not physically marked, but must be located using previously recorded Universal Transverse Mercator (UTM) coordinates. The use of a GPS to mark and to navigate to survey transects and sampling stations is thus critical, and is described in SOP 5. If GPS units cannot be used (i.e., satellite signals are “blocked”), navigation to and establishment of stations must be accomplished using compasses, altimeters, hip-chains, measuring tapes, and maps. Note: hip-chain string must be removed after stations have been established.

General survey procedures are described in SOP 7. The field crew should arrive at the park sufficiently early to familiarize themselves with the area and the birds present (Appendix B), and complete in-park training and calibration. Before sampling commences, the field crew will discuss the strategy for traveling to sampling stations and sampling. Surveys should only be conducted in weather conditions that allow birds to be adequately heard and seen. Counts should be stopped if winds exceed 13–18 mph (category 4 on the Beaufort scale; raising dust, leaves, loose paper; small branches in motion) and if precipitation exceeds a drizzle (category 3 on the rain scale). The counters arrive at the first sampling station each day before sunrise and begin sampling as soon as it is light enough to do so. Thus, surveys begin approximately one half hour before sunrise and end no later than 11:00 am. Habitat sampling should be conducted on all of the stations sampled, after 11:00 am. Co-location and coordination with other vital signs should avoid disrupting the birds and bias survey results. In addition, loud voices, motion, or walking in proximity to sampling stations (within 500 m) should be avoided until bird observations are completed. Refer to SOP 7 for conducting bird counts and SOP 8 for sampling habitat.

Before leaving the field each day, data books are checked for completeness and readability. All information pertinent to the stations sampled that day is recorded to avoid repeating or skipping sampling stations. The Project/Field Lead is responsible for the safekeeping and organization of the data books, and ensuring that data get entered into the database.

Conducting the Point-transect Count

The SOP 7 provides details on how to conduct point-transect counts and for filling in data books, and is summarized here. All birds seen or heard at each sampling station are recorded during an 8-minute sampling period. The species, method of detection, and exact measure from the station center-point to all birds, regardless of distance are recorded. Distances are to be measured to the nearest 1 meter. Rounding (e.g., to the nearest 5 or 10 meters) is to be avoided because this introduces bias in a detection function. For most species, each individual bird will be recorded as a separate observation. For species that usually occur in clusters or flocks, the appropriate unit to record is the distance to the cluster or flock (not the individual bird), and the size of the cluster or flock should be recorded (number of individuals in the cluster or flock).

Point-transect counts attempt to get an “instantaneous count” of birds present. Birds flushed from the sampling station when approached by the counter will be recorded, and the count started as soon as the counter is at the sampling station center. The method relies on the fact that birds close to the counter have a higher probability of being detected (if they are not flushed) than birds far from the counter and that different species have different detection functions (i.e., the probability of detecting a bird at different distances from the counter). An important assumption of the method is that a bird exactly at the center of the plot has a 100% chance of being detected, and that there is a high probability of detecting birds within the first 5–10 or so meters of the sampling station center. While at the station center, avoid unnecessary movement, making loud noises, and other actions that would encourage nearby birds to move away without being detected. Likewise, it is important not to attract birds to the station because this inflates the probability of detectability and biases the population estimate. While the primary counter is conducting the point-transect count, the secondary counter will record each species detected independent of the primary counter, and in a separate field book. After completing a count and filling in the data book, the counters use a GPS unit to navigate to the next sampling station.

Collecting Habitat Data

Habitat data are collected from each sampling station to aid in producing a detection function (as a habitat covariate), and understanding potential reasons for trends in bird densities. These potential relationships may have practical applications in the management of habitat. The SOP 8 provides details on how to describe and document habitat, and is summarized here. Habitat data are collected in a 50-m radius at each sampling station; and describe the canopy dominant species composition (at the association level), canopy height and closure, and dominant understory species composition (at the association level) and percent cover. In addition to habitat data, slope, aspect, and topographic position station attributes are collected. Habitat data are collected at point-count stations after completing the bird count (either after completing the station count, or after completing the daily counts).

Habitat data are collected to meet several objectives, in addition to adjusting the detection probability and establishing a detection function. Large-scale plot attributes such as vegetation type and slope are relevant to avian community composition and place the station in a landscape context. Canopy height and closure, and understory classification and percent cover characterize habitat structure available to birds and also link bird data to park vegetation maps. Integrating habitat data and bird densities will allow us to provide feedback to management, which in turn affects bird community composition and abundance.

End of Season Procedures

Following the field season, the Project/Field Lead is responsible for collecting all field gear and data books. The Project/Field Lead is also responsible for ensuring that all field data are compiled in the project databases and maps are submitted following Data Management, Data Analysis and Reporting sections, below. In addition, the Project/Field Lead will compile the satellite databases (e.g., habitat data), conduct summary analysis, and generate the season's annual report (see SOP 9 for details).

Data Management

The PACN landbird data-management procedures are detailed in SOP 10, and summarized here.

Overview of Database Design

The Hawaii Forest Bird Interagency Database Project has designed and maintains a Microsoft Access database for entering and managing forest bird survey data (not an Natural Resources Database Template [NRDT] design). The database accommodates only data collected using point-transect sampling methodology. Data from field books are entered into the Avian Monitoring Entry Form (AMEF Version 2.1; Camp et al. 2005) by the person conducting the surveys. The AMEF database consists of forms, queries, and Visual Basic Applications (VBA) code for the application itself and represents the user interface for the data, and contains the data tables in a front-end/back-end configuration. After a series of quality control checks, these database records are then uploaded into the central Hawaii Forest Bird Monitoring Database (Camp 2006) located at the HFBIDP offices in Hawaii Volcanoes National Park, Hawaii. The Hawaii Forest Bird Monitoring Database consists of forms, queries, and VBA code for the application itself and represents the user interface for the data, and contains the data tables. The PACN developed a database for habitat surveys, and this database is consistent with the NRDT design. A more detailed explanation of the database components and procedures are described in SOP 10.

Data Entry, Verification, and Editing

See SOP 10 for details. At the conclusion of a field season, the person conducting the surveys enters data from bird survey field books into the AMEF. After data have been entered, a two step verification process will be implemented to ensure data quality. This entails line-item checking each record between the field books and database (which is done in the form), and a random spot-checking process to document transcription error rate. The AMEF allows for direct editing of data in the form. Data entry of habitat surveys are input into the Habitat Monitoring Database, and verification and editing follows the same procedures described above.

Database Management Procedures

See SOP 10 for details. Following the end of the survey season, the Project/Field Lead ensures data entry and verification, and generates summary reports. After data entry and validation, the data will be transferred to HFBIDP and a copy retained by PACN. In addition, photocopies of the field books are transferred to HFBIDP for archiving purposes. A copy of the database is backed up during the automated, nightly and monthly network backup.

Metadata Procedures

See SOP 10 for details. The PACN will complete and maintain an I&M Dataset Catalog record for the project and the database, and will update the record contents annually. Any spatial datasets created by the PACN that are used for data analysis or distribution will have associated Federal Geographic Data Committee (FGDC) compliant metadata records completed using ArcCatalog. The FGDC compliant metadata will be available via an NPS GIS Clearinghouse on the web. This documentation of all database tables and fields will be provided to HFBIDP.

Data Archiving Procedures

See SOP 10 for details. A copy of the database is backed up during the automated, nightly and monthly network backup. In addition, archived versions of the database will be created and stored by HFBIDP. Photocopies of field books will be stored at the HFBIDP office, and a set of copies will be stored off-site.

Data Analysis

PACN landbirds vital sign data analysis procedures are detailed in SOP 11, and summarized here.

Data Summaries (Survey Summaries and Abundance calculations)

At the end of each field season, following data entry and verification, the Project/Field Lead will include in an annual report summaries of the surveys conducted in PACN park units and bird status. A more detailed explanation of the data summaries are described in SOP 11, and summarized here. The AMEF database provides a tab for summarizing the survey (list of counters who conducted the survey, list of transects and stations sampled, list of species detected, and naive species abundance estimates). Note: these abundance calculations may be biased and do not account for species detectability. Thus, the naive species abundance estimates are intended for use in quality control. Accounting for species detection probabilities is conducted in the density estimation analyses, below.

All areas surveyed are mapped using GIS software, and GIS layers and metadata are provided following Reporting procedures. GPS waypoints of survey stations and ancillary data (including descriptions of habitats) will be used to produce maps of areas surveyed. Occurrence by species will be plotted and visual comparisons of areas occupied, along with species lists, will be assessed in the long-term trend analysis.

Species Composition Estimation

See SOP 11 for details. Estimation of species composition, or species richness, will be conducted using the free software COMDYN (Hines et al. 1999). In general, new applications of capture-recapture methods can be used for estimating unbiased species richness and assessing trend while accounting for heterogeneous detectability (Nichols et al. 1998, Kery and Schmid 2003). Program COMDYN calculates the species richness for each survey occasion, and for successive years it estimates the trend, disappearance rate, species turnover, and colonization rate.

Density Estimation

See SOP 11 for details. Estimation of bird densities is well developed, and methods using distance sampling are described in Buckland et al. (2001, 2004). Analysis will be conducted using the free software DISTANCE, version 5.0 (Thomas et al. 2005), and the User's Guide and SOP 11 provide analytical procedures. In general, a species-specific detection function is fitted to truncated distance data through a model fitting procedure. From this model, species-specific encounter rates, detection probabilities and density estimates are generated, along with variance and 95% confidence intervals in the "Results" tab of DISTANCE. Survey data can be pooled to increase species-specific sample size (number of detections); however, it would be best to estimate detection probabilities independently for each year and tract. In situations where the numbers of detections are lacking, post-stratification procedures will be used, allowing for calculating survey-specific density estimates when data are pooled across years.

Point-transect data from repeated surveys of the same area or areas with similar habitat characteristics can be combined to increase sample sizes. By combining surveys, it is possible to develop reliable detection probabilities for uncommon species for which insufficient numbers of detections are recorded during a single survey. Numerous studies have shown that differences among counters have a much greater effect on detection distances than other factors (e.g., Kepler and Scott 1981). Advancements in distance sampling analyses however allow for counters to be treated as a co-variable when determining species' detectability. Multiple counters may sample within and among surveys without adversely affecting density estimation.

Long-term Trend Analysis

Every six years, the program will conduct analyses to determine long-term trends for individual species and changes in the composition of bird communities over time. At the same time, there will be a protocol review. Data analysis will follow the methods described in SOP 11, and the protocol will be evaluated to ensure that operating procedures and data gathered are adequate to address the monitoring objectives. Data will be shared following Reporting procedures.

Power to detect trends in landbird densities is low (Appendix D), and, therefore, two analytical procedures are suggested to help elucidate relevant changes, 1) visual inspection for deviations, and 2) equivalency hypothesis testing. Comparison of baseline to later monitoring data can reveal trends in data over many years. Therefore, it is advisable to develop alert limits, or thresholds of change, that trigger more intensive monitoring, research or management actions to be implemented. If changes of a certain magnitude are observed, some action is triggered, for example. Determining and detecting biologically meaningful amounts of change in a relatively short period, especially for programs with low power, is difficult. An alternative, yet complementary, approach is to graph and visually inspect the data, looking for deviations from a pattern, downward trends, wild fluctuations in abundances (either density or population size estimates) or increases in variances. One goal of the annual reporting should be to look for such "red flags" indicating trouble with a species or with a data collection scheme.

It is reasonable to assume that a population will fluctuate over time, even in the absence of trends. An equivalence-testing approach, used in conjunction with traditional trends analysis, distinguishes between cases in which there was not a trend from the inability to statistically detect a trend (Manly 2001, Camp et al. 2008). More specifically, parameters are considered to be equivalent within some pre-specified bounds and test for evidence to falsify this. When considered together the trend and equivalency tests provide complementary information of a change large enough to be of concern. In equivalency tests, "to reject that hypothesis is to infer that the variables being sampled are very unlikely to differ by more than a specified amount (the prescribed interval width) and so may be considered as 'equivalent'. That is, differences *are* expected, but if they are small enough the variables can be considered as equivalent. Note that in this case the significance level (α) protects the consumer's risk, so it is essentially precautionary in nature" (McBride. 2000. Some issues in statistical inference, published on the Internet at http://www.niwa.co.nz/rc/prog/stats/intro/, click on title). Thus, the use of equivalency testing is more conservative, or protective, then simple trends detection. For more information on equivalency and examples for detecting trends, see Camp et al. (2008).

Reporting

PACN landbirds vital sign data analysis procedures are detailed in SOP 11 and project deliverables are detailed in SOP 12, and summarized here.

Reporting

An annual report summarizing the surveys conducted in PACN park units will be produced by the Project/Field Lead. Most additional project deliverables will be generated and delivered within 30 or 45 days after completion of surveying (Tables 4 and 5). The report details survey effort, bird occupancy, and bird density, and is completed at the end of the field season. The figures are formatted in a Microsoft (MS) Excel spreadsheet and can be updated each year and inserted into the report. The report and GIS layers are provided to the PACN and HFBIDP. Specific information, reporting protocols and schedule of deliverables are included in SOP 12. Proper procedures detailing how to treat and disseminate sensitive data are included in SOP 13, how to post and distribute data and products are included in SOP 14, and how to manage photographic images are included in SOP 15.

Table 5. Schedule for project deliverables.

Deliverable Product	Primary Responsibility	Target Date	Destination(s)
Field season report	Project/field lead	30 days after completion of surveying of the same year	Upload digital file in MS Word format to the PACN digital library submissions folder.
Raw GPS data files	Project/field lead	30 days after completion of surveying of the same year	Zip and send all digital files to the GIS specialist.
Processed GPS data files	GIS specialist	30 days after completion of surveying of the same year	Zip and upload raw and processed files to the PACN digital library.
Digital photographs	Project/field lead	30 days after completion of surveying of the same year	Organize, name and maintain photographic images in the project workspace according to SOP 15: Managing Photographic Images.
Certified working database	Project/field lead	delivered 45 days after completion of surveying of the same year, not posted to public sites until June of the following year	Refer to the following section on delivering certified data and related materials.
Certified geospatial data	Project/field lead with GIS specialist		
Data certification report	Project/field lead	45 days after completion of surveying of the same year	Refer to the following section on delivering certified data and related materials.
Metadata interview form	Project/field lead and data manager	45 days after completion of surveying of the same year	Refer to the following section on delivering certified data and related materials.
Full metadata (parsed XML)	Data manager and GIS specialist	March 15 of the following year	Upload the parsed XML record to the Natural Resource Information Portal, and store in the PACN digital library.
Annual I&M report	Project/field lead	60 days after completion of surveying of the same year	Refer to the following section on reports and publications.
Field data forms	Data manager and project/field lead	60 days after completion of surveying of the same year	Scan original, marked-up field forms as PDF files and upload these to the PACN digital library submissions folder. Originals go to the park curator and HFBIDP for archiving.
6-year analysis report	Data analyst, USGS liaison, project/field lead, program manager	Every 6 years by September 30	Refer to the following section on reports and publications.
Other publications	Data analyst, project/field lead, USGS liaison, NPS lead, program manager	as completed	Refer to the following section on reports and publications.

Table 5. Schedule for project deliverables (continued).

Other records	Data manager, NPS lead, project/field lead	review for retention every January	Organize and send analog files to park curator for archiving. Digital files that are slated for permanent retention should be uploaded to the PACN digital library. Retain or dispose of records following NPS Director's Order 19.

Personnel Requirements and Training

Roles and Responsibilities

This protocol requires a Project/Field Lead, one biological technician, and two interns staffed by Cooperators and an NPS Lead, the PACN Program Manager. The Project/Field Lead is the lead biological technician for implementing this monitoring protocol. The Project/Field Lead is responsible for data collection, data entry, data verification and validation, as well as data summary, analysis and reporting. The Project/Field Lead supervises the biological technician and any other field crewmembers (e.g., volunteers and interns). The Project/Field Lead and biological technician are responsible for preparing all field gear and data collection equipment, supplies, and data forms for the field season, and cleaning, repairing, and storing field equipment. The Project/Field Lead and biological technicians should be skilled primary counters. The interns will assist the Project/Field Lead and biological technician in data collection and data entry; however, their primary duty is to meet NPS safety requirements. The interns serve as secondary counters and will record each species detected at the point-transect sampling stations, independent of the primary counter, and in a separate field book. Thus, the secondary counters need to be able to identify birds with skill equal to the primary counters.

Because of the need for a high level of training and consistency in conducting bird surveys, the Project/Field Lead will oversee the hiring and training of the field crews in conjunction with the HFBIDP. In addition, the Project/Field Lead should be one of the persons conducting at least some of the point-transect counts annually. Field crewmembers must be proficient at: (1) identifying birds by sight and sound, (2) distance sampling, and (3) using MS Access. In addition to possessing these skills, the Project/Field Lead needs to be proficient at data analysis and report generation.

The data management aspect of the monitoring effort is the shared responsibility of the Project/Field Lead and the Data Manager, while GPS information is the shared responsibility of the Project/Field Lead and the GIS Specialist (Tables 5 and 6). Table 5 describes who is responsible for producing or processing product deliverables and Table 6 outlines personnel roles and responsibilities.

Table 6. Personnel roles and responsibilities.

Role	Responsibilities	Name / Position
NPS lead	Oversee project oversight and administration Track project objectives, budget, requirements, and progress toward project objectives Facilitate communications between NPS and cooperator(s) Coordinate and ratify changes to protocol Review annual reports and other project deliverables for completeness and compliance with Inventory and Monitoring Program specifications Ensure reports are peer reviewed to appropriate standards Maintain and archive project records	PACN program manager
Principal investigator	Oversee project operations and implementation Hire and supervise Project/Field Lead Assist in training field crews Assist in performing data summaries and analysis, assist interpretation and report preparation Ensure reports, metadata, and other products are complete and delivered according to schedule	Cooperating principal investigator[1]
Project/field lead (counter)	Project operations and implementation Train and ensure safety of field crew Plan and execute field visits Acquire and maintain field equipment Oversee data collection and entry, verify accurate data transcription into database Collect, record, enter and verify data Complete a field season report Certify each season's data for quality and completeness Complete reports, metadata, and other products according to schedule	Cooperating biologist[1]
Data analyst	Perform data summaries and analysis, assist interpretation and report preparation	USGS (Hawaii Forest Bird Interagency Project)
Technician (counter)	Collect, record, enter and verify data	Cooperating technician (1)
Interns (counters)	Collect, record, and verify data	Cooperating interns (2)
Data manager	Consultant on data management activities Facilitate check-in, review and posting of data, metadata, reports, and other products to national databases and clearinghouses according to schedule Maintain and update database application Provide database training as needed	PACN network data manager*
GIS specialist	Consultant on spatial data collection, GPS use, and spatial analysis techniques Facilitate spatial data development and map output generation Work with project lead and data analyst to analyze spatial data and develop metadata for spatial data products Primary steward of GIS data and products	PACN network GIS specialist*

Table 6. Personnel roles and responsibilities (continued).

NPS lead and park biologists	Facilitate logistics planning and coordination Ensure project compliance with park requirements Review reports, data and other project deliverables	PACN program manager, park wildlife biologists and resource managers at HALE, HAVO and NPSA
Park curator	Receive and archive copies of annual reports, 5-year analysis report, and other publications Facilitate archiving of other project records (e.g., original field forms, etc.)	Park curators and collections managers at HALE, HAVO and NPSA
USGS liaison	Consultant on technical issues related to project sampling design, statistical analyses, or other issues related to changes in protocol and SOPs	Research wildlife biologist, USGS-PIERC

*These individuals act as coordinators and primary points of contact for this project. Their responsibility is to facilitate communication among network and park staff and to coordinate the work, which may be shared among various staff to balance work load and to enhance the efficiency of operations.

[1]A cooperative agreement will be established with the University of Hawaii or other cooperating partner to conduct fieldwork and other tasks as detailed

[2]A cooperative agreement will be established with the USGS (Hawaii Forest Bird Interagency Project) to produce density estimation and long-term trend analysis.

Qualifications and Training

The SOP 3 provides details on hiring and training all personnel associated with the PACN Landbirds Protocol. The most essential component for the collection of credible, high-quality data on birds is a competent counter. This cannot be overemphasized. Various studies have shown that counter bias is one of the most noteworthy bias factors in trend analysis of songbird populations (Scott et al. 1986). As well as being able to visually identify birds, counters must be proficient at identifying species by their songs and calls, and making accurate distance estimation. Therefore, recordings of birds in the study area, especially for the less common or unexpected species, will be provided for counters. Counters will be tested frequently on their ability to identify bird calls. Good hearing ability is essential because many birds, particularly in forested habitats, are detected by sound only. Differences in hearing ability between counters may strongly affect survey results.

The quality of the counters will determine the quality of the data. Therefore, each counter is required to participate in a training course before the field season (see SOP 3 for details). Training occurs over a sufficient period to ensure data quality, a minimum of five days of bird identification and distance sampling training. This will require training in the field to become proficient with the use of a laser rangefinder and to gain experience with estimating distances to different species in different habitat types. The Project/Field Lead coordinates the training with close cooperation with the HFBIDP. All members of the bird survey crew will complete this mandatory training before the field season.

The Project/Field Lead and PACN botanists will train the bird crew to conduct habitat monitoring. Counters conducting habitat work should familiarize themselves with the standard cover classes and vegetation requirements described in SOP 8. Prior to the field season, field crews will practice estimating cover and identifying dominant vegetation. If habitat monitoring cannot be practiced prior to the field season, a staff botanist will accompany the bird crew on the first field trip.

Operational Requirements

Annual Workload and Field Schedule

Hawaiian Island Parks

The training period for the field crews will begin no later than 15 January and will include a minimum of five days of bird identification and distance sampling training, and habitat monitoring. The sampling period for breeding birds will begin no sooner than 15 January and end no later than 31 May. This coincides with the seasonal peak in vocalization for most Hawaiian landbirds. Inclement weather and personnel workloads preclude scheduling sampling on specific dates; thus, this schedule is sufficiently flexible to accommodate annual variability. Habitat monitoring should be completed in conjunction with bird surveys, and end no later than 31 May, in order for habitat measures to accurately reflect conditions experienced by breeding birds. At a minimum, fieldwork for monitoring landbirds requires one two-person field crew. The time required for completing sampling depends on the number and location of transects and stations. Regardless of the number of stations to visit in a season each crew will try to complete 12 to 15 point-transect counts (in open habitats) or 10 point-transect counts (in difficult terrain) each field day. Data entry, validation and report generation should follow the project deliverables schedule (Table 5). An outline of each task by project stage for Hawaiian parks is provided in Table 7.

Table 7. Yearly project task list for the Hawaiian parks. This table identifies each task by project stage, indicates who is responsible, and establishes the timing for its execution. Protocol SOPs are referred to as appropriate.

Project Stage	Task Description	Responsibility	Timing
Preparation (SOP 1, 2, 3, 4, and 5)	Complete agreement with cooperators (University of Hawaii for fieldwork, USGS for data analysis)	Program manager	May–Aug
	Initiate announcement for project/field lead position, begin hiring	Principal investigator	Aug–Oct
	Initiate announcements for seasonal technician and internship positions, begin hiring	Principal Investigator	Nov–Jan
	Notify data manager and GIS specialist of needs for the coming season (field maps, GPS support, training)	Project/field lead	by Dec 1
	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	Project/field lead, program manager, park biologists, data manager, and GIS specialist	Dec
	Ensure all project compliance needs are completed for the coming season	Park biologists	by Jan 10
	Provide names of field crew to park biologists	Project/field lead	by Jan 1
	Plan schedule and logistics, including ordering any needed equipment and supplies (SOP 1)	Project/field lead, program manager, and park biologists	by Jan 15
	Inform GIS specialist and data manager of specific needs for upcoming field season	Project/field lead	by Dec 15
	Generate field navigation reports, roster of sample points and coordinates from the database (SOP 4 and 5)	Project/field lead	by Jan 10
	Review and ensure all field staff are aware of safety procedures (SOP 2)	Principal investigator, and project/field lead	by Jan 15
	Prepare and print field maps (SOP 4)	Project/field lead, and GIS specialist	by Jan 15
	Update and load data dictionary, background maps, and target coordinates into GPS units (SOP 4 and 5)	GIS specialist	by Jan 15
	Ensure that project workspace is ready for use and GPS download software is loaded at each park (SOP 4)	Data manager and GIS specialist	by Jan 15
	Implement working database copy	Data manager	by Jan 15
	.Initiate computer access and key requests (may need park-specific dates)	Park biologists	by Jan 15
	Provide field crew email addresses and user	Park biologists	Jan
	Provide database/GPS training as needed	Data manager, and GIS specialist	Jan

Table 7. Yearly project task list for the Hawaiian parks (continued).

	Train field crew in bird identification, distance estimation, sampling protocols, and safety (SOP 3)	Project/field lead	by Jan15
Data Acquisition (SOP 5, 6, 7, and 8)	Examination and certification of field counter qualifications, enter training results into database (SOP 3)	Project/field lead	by Jan 15
	Notify Park Biologist and Project Lead of tour itinerary	Technician/interns	before each tour
	Collect field observations and position data during field trips	Technician/interns	Jan–May
	Review data forms after each day	Technician/interns	daily
	Check in with Park Biologist	Technician/interns	after each tour
	De-brief crew on operations, field methods, gear needs	Project/field lead	after each tour
Data Entry & Processing (SOP 4, 5, 7, 8, 10, and 15)	Download GPS data and email files to GIS Specialist for correction (SOP 4)	Technician/interns	after each tour
	Download and process digital images (SOP 15)	Technician/interns	after each tour
	Enter data into working copy of the database (SOP 10)	Technician/interns	after each tour
	Verification of accurate transcription as data are entered	Technician/interns	after each tour
	Correct GPS data and send screen capture to field lead and project lead for review	GIS specialist	after each tour
	Periodic review of GPS location data and database entries for completeness and accuracy	Project/field lead	bi-weekly
	Merge, correct, and export GPS data. Upload processed and verified coordinates to database	GIS specialist	Jun
Product Development (SOP 12)	Complete field season report (SOP 12)	Project/field lead	Jun
Product Delivery (SOP 12)	Send field season report to Program Manager, Park Biologists, and Data Manager, GIS Specialist (SOP 12)	Project/field lead	by Jun 30
Quality Review (SOP 10)	Quality review and data validation using database tools (SOP 10)	Project/field lead, and data analyst	Jun–Jul
	Prepare coordinate summaries and/or GIS layers and data sets as needed for spatial data review	GIS specialist	by Jul 5
	Joint quality review of GIS data, determine best coordinates for subsequent mapping and field work	Project/field lead, and GIS specialist	by Jul 15
	Identify any sensitive information contained in the data set (SOP 10)	Project/field lead, and data manager	Jun
Metadata (SOP 10)	Update project metadata records (SOP 10)	Project/field lead, and data manager	by Jul 15

Table 7. Yearly project task list for the Hawaiian parks (continued).

Data Certification and Delivery (SOP 12, 13, and 14)	Certify the season's data and complete the certification report (SOP 12)	Project/field lead	by Jul 15
	Deliver certification report, certified data (data sheets), digital photographs, and updated metadata to Data Manager (SOP 12)	Project/field lead	by Jul 15
	Upload certified data into master project database, store data files in PACN Digital Library [1]	Data manager	by Jul 15
	Notify Project/Field Lead and USGS Liaison of uploaded data ready for analysis and reporting	Data manager	by Jul 15
	Update project GIS data sets, layers and associated metadata records	GIS specialist	by Jul 15
	Finalize and parse metadata records, store in PACN Digital Library [1]	Data manager, and GIS specialist	by Mar 15 of the following year
Data Analysis (SOP 11)	Export *Distance* input file from database	Data manager, and data analyst	Feb–Mar
Note: The tasks in this section occur every 6 years.	Import into *Distance* to model detectability functions and estimate density by species and detection class	USGS liaison, and data analyst	Mar–Apr
	Export and reformat *Distance* output for report generation	USGS liaison, and data analyst	Apr
	Analyze park-specific trends for each species, and export and reformat trends output for report generation	USGS Liaison, and Data Analyst	Apr–May
	Export park-specific density and trends estimates for each species, import into database	USGS liaison, data analyst, and data manager	by May 31
	Export automated summary queries and reports from database	Project/field lead, and data analyst	Jun–Jul
Reporting and Product Development (SOP 12, 13, and 14)	Produce park-wide and transect-specific map output for archives	GIS specialist	Jun–Jul
	Generate report-quality map output for reports	GIS specialist	by Jul 15
	Acquire the proper report template from the NPS website, create annual report	Project/field lead	by Jul 30
	Screen all reports and data products for sensitive information (SOP 13)	Project/field lead, and program manager	by Jul 30
	Prepare draft report and distribute to park biologists for preliminary review	Principal investigator, project/field lead, and program manager	by Aug 1
Product Delivery (SOP 12)	Submit draft report to program manager for review	Principal investigator	by Aug 15
	Review report for formatting and completeness, notify Principal Investigator of approval or need for changes	Program manager	by Aug 20

Table 7. Yearly project task list for the Hawaiian parks (continued).

	Upload completed report to PACN digital library [1] submissions folder, notify data manager	Program manager	upon approval
	Deliver other products according to the delivery schedule and instructions	Principal investigator, and project/field lead	upon completion
	Product check-in	Data manager	upon receipt
Posting & Distribution (SOP 12, 13, 14, and 15)	Submit metadata to Natural Resource Information Portal [2]	Data manager	Mar 15 of the following year
	Create Natural Resource Information Portal [2] record, post reports to NPS clearinghouse	Data manager	upon receipt
	Update Natural Resource Information Portal [2] records according to data observations	Data manager	upon receipt
Archiving & records management (SOP 9)	Submit certified data and GIS data sets to Natural Resource Information Portal [2]	Data manager	Mar 15 of the following year
	Store finished products in PACN Digital Library [1]	Data manager	upon receipt
	Review, clean up and store and/or dispose of project files according to NPS Director's Order 19 [3]	Data manager, and project/field lead	by Aug 31
Season close-out (SOP 9)	Inventory equipment and supplies	Project/field lead	by Aug 31
	Conference call to discuss recent field season (close out); discuss who needs to do what to get data ready for analysis	Principal investigator, project/field lead, USGS liaison, data analyst, program manager, data manager, GIS specialist, NPS lead, and park biologists	by Aug 25
	Discuss and document needed changes to analysis and reporting procedures	Principal investigator, project/field lead, USGS liaison, data analyst, program manager, data manager, GIS specialist, NPS lead, and park biologists	by Aug 31

[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 Information Portal is a clearinghouse for natural resource data, metadata, bibliographic records, and park species information (http://nrinfo/Home.mvc/showWelcomePage). Only non-sensitive information is posted to the Natural Resource Information Portal. 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

NPSA

Similar to the Hawaii Islands, except the training period for the bird survey crews will begin no later than 15 June and will include a minimum of five days of bird identification and distance sampling training, and habitat monitoring. Additionally, the NPSA I&M Biotech will serve as a primary counter. The sampling period for breeding birds will begin no sooner than 15 June and end no later than 30 September, coinciding with the peak vocalization for most Samoan landbirds (Freifeld et al. 2004). Habitat monitoring should be completed in conjunction with bird surveys, and end no later than 30 September. Data entry, validation and report generation should follow the project deliverables schedule (Table 5). An outline of each task by project stage for NPSA Park units is provided in Table 8.

Table 8. Yearly project task list for NPSA park units. This table identifies each task by project stage, indicates who is responsible, and establishes the timing for its execution. Protocol SOPs are referred to as appropriate.

Project Stage	Task Description	Responsibility	Timing
Preparation (SOP 1, 2, 3, 4, and 5)	Complete agreement with Cooperators (University of Hawaii for fieldwork, USGS for data analysis)	Program manager	Nov–Feb
	Initiate announcement for Project/Field Lead position, begin hiring	Principal investigator	Feb–Mar
	Initiate announcements for seasonal technician and internship positions, begin hiring	Principal investigator	Apr–May
	Notify Data Manager and GIS Specialist of needs for the coming season (field maps, GPS support, training)	Project/fieldlLead	by May 1
	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	Project/field lead, program manager, park biologists, data manager, and GIS specialist	May
	Ensure all project compliance needs are completed for the coming season	Park biologists	by Jun 10
	Provide names of field crew to Park Biologists	Project/field lead	by Jun 1
	Plan schedule and logistics, including ordering any needed equipment and supplies (SOP 1)	Project/field lead, program manager, and park biologists	by Jun 15
	Inform GIS Specialist and Data Manager of specific needs for upcoming field season	Project/field lead	by May 15
	Generate field navigation reports, roster of sample points and coordinates from the database (SOP 4 and 5)	Project/field lead	by Jun 10
	Review and ensure all field staff are aware of safety procedures (SOP 2)	Principal investigator, and Project/field lead	by Jun 15
	Prepare and print field maps (SOP 4)	Project/field lead, and GIS Specialist	by Jun 15
	Update and load data dictionary, background maps, and target coordinates into GPS units (SOP 4 and 5)	GIS specialist	by Jun 15
	Ensure that project workspace is ready for use and GPS download software is loaded at each park (SOP 4)	Data manager and GIS specialist	by Jun 15
	Implement working database copy	Data manager	by Jun 15
	Initiate computer access and key requests (may need park-specific dates)	Park biologists	by Jun 15
	Provide field crew email addresses and user logins to Data Manager	Park biologists	Jun
	Provide database/GPS training as needed	Data Manager, and GIS Specialist	Jun

Table 8. Yearly project task list for NPSA park units (continued).

	Train field crew in bird identification, distance estimation, sampling protocols, and safety (SOP 3)	Project/field lead	by Jun15
Data Acquisition (SOP 5, 6, 7, and 8)	Examination and certification of field counter qualifications, enter training results into database (SOP 3)	Project/field lead	by Jun15
	Notify park biologist and project lead of tour itinerary	Technician/interns	before each tour
	Collect field observations and position data during field trips	Technician/interns	Jun–Sep
	Review data forms after each day	Technician/interns	daily
	Check in with park biologist	Technician/Interns	after each tour
	De-brief crew on operations, field methods, gear needs	Project/field lead	after each tour
Data Entry & Processing (SOP 4, 5, 7, 8, 10, and 15)	Download GPS data and email files to GIS Specialist for correction (SOP 4)	Technician/interns	after each tour
	Download and process digital images (SOP 15)	Technician/interns	after each tour
	Enter data into working copy of the database (SOP 10)	Technician/interns	after each tour
	Verification of accurate transcription as data are entered	Technician/interns	after each tour
	Correct GPS data and send screen capture to field lead and project lead for review	GIS specialist	after each tour
	Periodic review of GPS location data and database entries for completeness and accuracy	Project/field lead	bi-weekly
	Merge, correct, and export GPS data. Upload processed and verified coordinates to database	GIS specialist	Oct
Product Development (SOP 12)	Complete field season report (SOP 12)	Project/field lead	Oct
Product Delivery (SOP 12)	Send field season report to program manager, park biologists, and data manager, GIS specialist (SOP 12)	Project/field lead	by Oct 31
Quality Review (SOP 10)	Quality review and data validation using database tools (SOP 10)	Project/field lead, and data analyst	Oct–Nov
	Prepare coordinate summaries and/or GIS layers and data sets as needed for spatial data review	GIS specialist	by Nov 5
	Joint quality review of GIS data, determine best coordinates for subsequent mapping and field work	Project/field lead, and GIS specialist	by Nov 15
	Identify any sensitive information contained in the data set (SOP 10)	Project/field lead, and program manager	Oct
Metadata (SOP 10)	Update project metadata records (SOP 10)	Project/field lead and program manager	by Nov 15

Table 8. Yearly project task list for NPSA park units (continued).

Data Certification and Delivery (SOP 12, 13, and 14)	Certify the season's data and complete the certification report (SOP 12)	Project/field lead	by Nov 15
	Deliver certification report, certified data (data sheets), digital photographs, and updated metadata to data manager (SOP 12)	Project/field lead	by Nov 15
	Upload certified data into master project database, store data files in PACN Digital Library [1]	Data manager	by Nov 15
	Notify project/field lead of uploaded data ready for analysis and reporting	Data manager	by Nov 15
	Update project GIS data sets, layers and associated metadata records	GIS specialist	by Nov 15
	Finalize and parse metadata records, store in PACN Digital Library [1]	Data manager, and GIS specialist	by Mar 15 of the following year
Data Analysis (SOP 11) Note: The tasks in this section occur every 6 years.	Export *Distance* input file from database	Data manager	Feb–Mar
	Import into *Distance* to model detectability functions and estimate density by species and detection class	USGS liaison, and data analyst	Mar–Apr
	Export and reformat *Distance* output for report generation	USGS liaison, and data analyst	Apr
	Analyze park-specific trends for each species, and export and reformat trends output for report generation	USGS liaison, and data analyst	Apr–May
	Export park-specific density and trends estimates for each species, import into database	USGS liaison, data analyst, and data manager	by May 31
	Export automated summary queries and reports from database	Project/field lead, and data analyst	Oct–Nov
Reporting and Product Development (SOP 12, 13, and 14)	Produce park-wide and transect-specific map output for archives	GIS specialist	Oct–Nov
	Generate report-quality map output for reports	GIS specialist	by Nov 15
	Acquire the proper report template from the NPS website, create annual report	Project/field lead	by Nov 30
	Screen all reports and data products for sensitive information (SOP 13)	Project/field lead, and program manager	by Nov 30
	Prepare draft report and distribute to park biologists for preliminary review	Principal investigator, project/field lead, and program manager	by Dec 1
Product Delivery (SOP 12)	Submit draft report to network coordinator for review	Principal investigator,	by Dec 15
	Review report for formatting and completeness, notify Principal Investigator, of approval or need for changes	Program manager	by Dec 20
	Upload completed report to PACN Digital Library [1] submissions folder, notify data manager	Program manager	upon approval

Table 8. Yearly project task list for NPSA park units (continued).

	Deliver other products according to the delivery schedule and instructions	Principal investigator, and project/field lead	upon completion
	Product check-in	Data manager	upon receipt
Posting & Distribution (SOP 12, 13, 14, and 15)	Submit metadata Natural Resources Information Portal[2]	Data manager	Mar 15 of the following year
	Create Natural Resources Information Portal[3] record, post reports to NPS clearinghouse	Data manager	upon receipt
Archiving & Records Management (SOP 9)	Submit certified data and GIS data sets to Natural Resources Information Portal[2]	Data manager	Mar 15 of the following year
	Store finished products in PACN Digital Library [1]	Data manager	upon receipt
	Review, clean up and store and/or dispose of project files according to NPS Director's Order 19[3]	Data manager, and project/field lead	by Dec 31
Season close-out (SOP 9)	Inventory equipment and supplies	Project/field lead	by Dec 31
	Conference call to discuss recent field season (close out); discuss who needs to do what to get data ready for analysis	Principal investigator, Project/field lead, USGS liaison, data analyst, program manager, data manager, GIS specialist, NPS lead, and park biologists	by Dec 25
	Discuss and document needed changes to analysis and reporting procedures	Principal investigator, project/field lead, USGS liaison, data analyst, program manager, data manager, GIS specialist, NPS lead, and park biologists	by Dec 31

[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 Information Portal is a clearinghouse for natural resource data, metadata, bibliographic records, and park species information (http://nrinfo/Home.mvc/showWelcomePage). Only non-sensitive information is posted to the Natural Resource Information Portal. 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

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Facility and Equipment Needs

The nature of bird survey work does not require special facilities beyond normal office space, a data management workstation, and field books and equipment storage needs. SOP 1 contains a list of the equipment needed for one team.

Budget Considerations

The budget for this protocol is summarized in Table 9 and detailed in Appendix G. Personnel expenses are based on two crews of two people for each year to conduct the fieldwork, and assist the Principal Investigator with preparation for the field season, training, fieldwork, data entry, and data analysis. Approximately 140 days (mid-January through late May) will be scheduled for training and sampling for each field crew for each year for Hawaiian parks. Approximately 100 days (mid-June through late September) will be scheduled for training and sampling for each NPSA park unit each year. Field costs will vary somewhat from year to year depending on the location of transects and the amount of aircraft support needed to access transects. Salary and contract expenses include salaries of biological technicians and field crew members. Travel costs include travel to field sampling sites and backcountry per diem. Startup cost for equipment include the purchase of equipment and supplies listed in SOP 1, as well as maintenance and or replacement of equipment shared among multiple projects (e.g. GPS units, cameras). About 30% of the total budget will be allocated to analyses/reporting through data entry, verification and editing (~10%), generating field and technical reports (~10%), and analyses completed through the Cooperative Agreement (~15%).

Table 9. Estimated costs to conduct landbird monitoring in PACN parks.

Estimated Costs	HALE	HAVO-old	HAVO-new	NPSA-Tut	NPSA-Tau
Salaries[1]	33,380	39,933	39,933	28,028	30,190
Travel (with per diem)[2]	9,350	13,275	12,150	11,420	15,130
Equipment	500	500	500	500	500
Supplies	500	500	500	500	500
Cooperative Agreement[3]	10,000	10,000	10,000	10,000	10,000
Sub-total	53,730	64,208	63,083	50,448	56,320
Overhead (17.5%)	9,403	11,236	11,039	8,828	9,856
Total	63,133	75,444	74,122	59,276	66,176

[1]Salaries are based on Principal Investigator at a salary of $6,800 monthly, 1 Project/Field Lead at Research Cooperation of the University of Hawaii (RCUH) monthly pay of $3,190,1 biological technician at RCUH monthly pay of $2,162, and 2 interns at $600/month; benefits included. NPSA salaries include I&M GS-7 step 3 biotech and no RCUH biological technician.

[2]HALE surveys includes travel to Maui from Hilo for 4 field crew members at $200 per person and helicopter for 6 hr at $750/hr; HAVO-old surveys includes helicopter to Northwest Kahuku for 2.5 hr at $750/hr; HAVO-new surveys includes helicopter to East Rift Zone for 1 hr at $750/hr; NPSA surveys includes travel from Hilo to Pago Pago and Tau for 4 field crew members at $1,400 and $200 per person. Per diem calculated at $20/day in HALE, and per diem at NPSA as $20/day (field) or $130/day (full).

[3]Partnership with USGS (Hawaii Forest Bird Interagency Database Project) for consultation and analysis of landbird surveys.

Permits, Permissions and Cooperative Agreements

Various research permits and compliance procedures are required to implement this monitoring. As this protocol is implemented, the Principal Investigators (PIs), in cooperation with NPS protocol park leads, will proceed through project compliance as appropriate for each park according to federal as well as state, commonwealth, and territory guidelines, or any other compliance or processes. The PIs, in cooperation with the PACN staff designee, 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 NEPA, Section 106 of the National Historic Preservation Act, Section 7 of the Endangered Species Act, Park research permits, and approved by the compliance specialists. The PACN staff designee will be responsible for ensuring appropriate park permitting contacts are notified. Some specific permits required and identified by this protocol follow with descriptions. The PIs are responsible for following all stipulations identified through the compliance process.

Federal

National Park Service: National Park Service research permits will be obtained, in advance of any field activities, for each park where monitoring occurs. Permits will be evaluated on an annual basis, or other timeframe as stipulated in the permit itself. The research permit review process also includes NEPA compliance documentation, as discussed below. The Principal Investigator (or designee) in cooperation with NPS park leads will maintain all appropriate documentation. NPS applications can be submitted at: http://science.nature.nps.gov/research/ac/ResearchIndex.

NEPA: At present, under the National Environmental Policy Act (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." NEPA compliance review and documentation will occur as part of the NPS research permitting process.

State and Territorial

State of Hawaii: No permits are needed from the state of Hawaii. However, all wildlife activities conducted under the U. S. Fish and Wildlife Service (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).

Territory of American Samoa: The territory requires that a Scientific Study and Collection Permit be submitted through the Department of Marine and Wildlife Resources, American Samoa Government (P.O. Box 3730, Pago Pago, AS 96799; office: 684-633-4456).

Village Permissions

Village permission on Tutuila and Tau Islands, American Samoa, should be obtained by personally contacting each mayor of the village near the Park unit where monitoring may occur (i.e., Afono, Fagalea, Fitiuta, Luma Tau, and Vatia). Counters should describe what the study is about prior to initiating any work, according to park cultural resource staff guidelines. Surveying is typically not allowed in or near villages on Sundays.

Sa, or time for prayer, is observed at dusk (around 1800 hrs), so if entering or traveling through villages via vehicle or on foot at this time, counters must stop until Sa is over. Ringing bells in the villages indicate the beginning and ending of Sa. If counters are on the main roads of Tutuila, it is not necessary to stop. On other islands, it is required that all persons be indoors during the time of Sa.

Cooperative Agreements

The Hawaii Forest Bird Interagency Database Project, and its cooperators, play a very important role in the PACN landbirds monitoring program. A long-term partnership with conservation agencies and the NPS has been developed and maintained, and continuation of this partnership in the future will help ensure the success of the landbirds monitoring program. The HFBIDP is a leader in bird conservation in Hawaii and the Pacific, and its role in this project cannot be overemphasized. This partnership can be maintained using Interagency Agreements and

Cooperative Agreements. Specific tasks HFBIDP could assist with include conducting training and calibration sessions, analyzing data to produce population estimates and trends, and generating reports. In addition, HFBIDP could conduct the monitoring program evaluation.

A cooperative agreement should be developed with the Department of Marine and Wildlife Resources (DMWR) for conducting and sharing surveying data on American Samoa. An initial meeting regarding data sharing was held at DMWR on 17 May 2006; however, further progress to obtain a cooperative agreement has not been pursued.

Procedures for Making Changes to and Archiving Previous Versions of the Protocol

Revisions to the Protocol Narrative and SOPs will be inevitable over time. Explicit documentation of these changes is critical for proper collection, interpretation and analysis of bird-survey data. Procedures for changing the protocol narrative and related SOPs are documented in SOP 16. The Protocol Narrative and all SOPs are labeled with version numbers, and include a Revision History Log. Changes to either document type are to be accompanied by changes in version numbers; version numbers and dates, the changes, reasons for the changes, and the author of the changes are to be recorded in the Revision History Log. The updated version numbers must be recorded in the Landbirds Master Version Table (MVT; see SOP 16) and conveyed to the Data Manager for proper updating of the master version table database. Previous versions of the Protocol Narrative and SOPs must be archived in the PACN Landbirds Protocol Library (X:\Archive\Monitoring_Archive\Landbirds\Protocol_Library\).

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Appendix A. Landbird Monitoring in PACN Park Units

Years of monitoring are shown where known, an "X" indicates intermittent monitoring or monitoring of unknown duration, a "—" indicates survey not conducted in the park unit and "Historic" indicates monitoring that was discontinued by 2006. Common national programs, such as the breeding bird census (BBC), breeding bird survey (BBS) and monitoring avian productivity and survivorship (MAPS), are not conducted in PACN park units.

	National Program	Local Programs	
Park Unit	Christmas Bird Count (CBC): area search	Multiple Species Surveys: distance sampling	Species Specific Surveys
AMME	Historic	—	—
HALE	—	X[1]	Nene
HAVO	X[2]	Historic	Nene
KALA	1998–2005[3]	X[4]	—
NPSA	Historic[5]	X[6]	—
WAPA	—	—	—

[1]The NPS survey was not conducted in 2002, 2004 or 2005, and only a portion of the survey was conducted in 2003.

[2]CBC surveys conducted within the park unit were discontinued; however, the CBC survey has been conducted intermittently in Volcano Village (1973–1994, 1998–2002 and 2004–2005).

[3]CBC surveys were also conducted in 1990, 1991, 1993 and 1994.

[4]Conducted by the State of Hawaii Division of Forestry and Wildlife in 1988, 1995 and 2004.

[5]CBC surveys were conducted only on Tutuila.

[6]American Samoa Division of Marine and Wildlife Resources conducts point-transect sampling surveys for landbirds on the main islands, including stations within the park units.

Appendix B. Terrestrial Avian Species by Park

Tables

Page

Table B.1. Terrestrial avian species of Hawaii, including waterbirds. Presence by island is indicated (E = endangered, I = introduced, M = migrant, Ne = Native endemic, Ni = Native indigenous, V = visitor, and CE = Candidate endangered, -- = not present or presence unknown). Species will be tracked through this protocol (Yes/No or pending further funding), except * indicating species' presence will be recorded (P/A) during the point-transect counts. Sampling methods include distance sampling (DS; methods described herein), rare bird search (RBS; methods described Supplemental Information 1), proportion area occupied (PAO; methods described Supplemental Information 2), monitoring avian productivity and survivorship (MAPS; methods described Supplemental Information 3), and breeding biology research and monitoring database (BBIRD; methods described Supplemental Information 4). It is unlikely that sufficient numbers of detections for specific birds will be made to calculate reliable density estimates; data for those species however can be summarized as presence/absence and either tracked qualitatively or analyzed using PAO methods (analysis dependent on recording detections during bird and habitat sampling; see Supplemental Information 2). Thus, the distance sampling methods described herein will provide the necessary monitoring information for 62 of the 70 Hawaiian birds, and 22 of the 23 American Samoa birds. The taxonomy of families, genera, and species as well as common and scientific names used follow the 7th edition (1998) of the American Ornithologists' Union (AOU) Checklist of North American Birds, including changes made in the 42nd, 43rd, 44th and 45th Supplements to the Check-list, as published in The Auk 117:847–858 (2000); 119:897–906 (2002); 120:923–932 (2003); 121:985–995 (2004).

Table B.1. Terrestrial avian species of Hawaii (continued)

Scientific Name	English Name	Hawaii	Maui	Monitoring	Suggested Method	Comments
Bubulcus ibis	cattle egret	I	--	*	P/A	not in park
Nycticorax nycticorax	black-crowned night-heron	Ni	Ni	*	P/A	rare in park
Branta sandvicensis	Hawaiian goose	Ne	Ne	No	--	E, currently surveyed
Anas platyrhynchos	mallard	Ni	--	*	P/A	migrant species
Anas wyvilliana	Hawaiian duck	Ne	--	*	P/A	E, rare in park
Buteo solitarius	Hawaiian hawk	Ne	--	Pending	BBIRD/MAPS	E, rare in park
Alectoris chukar	chukar	I	I	Yes	PAO	
Francolinus pondicerianus	gray francolin	I	I	Yes	PAO	
Francolinus francolinus	black francolin	I	I	Yes	PAO	
Francolinus erckelii	Erckel's francolin	I	--	Yes	PAO	
Coturnix japonica	Japanese quail	I	I	Yes	PAO	
Gallus gallus	red junglefowl	I	I	Yes	PAO	
Lophura leucomelanos	kalij pheasant	I	--	Yes	PAO	
Phasianus colchicus	ring-necked pheasant	I	I	Yes	PAO	
Pavo cristatus	common peafowl	I	I	Yes	PAO	
Meleagris gallopavo	wild turkey	I	I	Yes	PAO	

Table B.1. Terrestrial avian species of Hawaii (continued)

Scientific Name	English Name	Hawaii	Maui	Monitoring	Suggested Method	Comments
Callipepla californica	California quail	I	I	*	P/A	not in park
Callipepla gambelii	Gambel's quail	I	--	*	P/A	not in park
Fulica alai	Hawaiian coot	Ne	Ne	*	P/A	E, rare in park
Pterocles exustus	chestnut-bellied sandgrouse	I	--	*	P/A	not in park
Columba livia	rock dove	I	I	Yes	PAO	rare in park
Streptopelia chinensis	spotted dove	I	I	Yes	DS	
Geopelia striata	zebra dove	I	I	Yes	DS	
Zenaida macroura	mourning dove	I	I	*	P/A	rare in park
Psittacula krameri	rose-ringed parakeet	I	I	*	P/A	rare in park
Tyto alba	barn owl	I	I	Yes/Pending	PAO/BBIRD/MAPS	nocturnal species
Asio flammeus	pueo	Ne	Ne	Yes/Pending	PAO/BBIRD/MAPS	
Corvus hawaiiensis	alala	Ne	--	No	--	E, extinct in wild
Chasiempis sandwichensis	Hawaii elepaio	Ne	--	Yes	DS	
Alauda arvensis	sky lark	I	I	Yes	PAO	
Parus varius	varied tit	I	I	*	P/A	not in park
Pycnonotus cafer	red-vented bulbul	I	I	*	P/A	not in park
Cettia diphone	Japanese bush-warbler	I	I	Yes	DS	
Copsychus malabaricus	white-rumped shama	--	I	Yes	PAO/DS	
Myadestes obscurus	omao	Ne	--	Yes	DS	
Garrulax canorus	hwamei	I	I	Yes	DS	
Leiothrix lutea	red-billed leiothrix	I	I	Yes	DS	
Zosterops japonicus	Japanese white-eye	I	I	Yes	DS	
Mimus polyglottos	northern mockingbird	I	I	Yes	DS	
Acridotheres tristis	common myna	I	I	Yes	DS	
Sicalis flaveola	saffron finch	I	--	*	P/A	rare in park
Paroaria coronata	red-crested cardinal	--	I	*	P/A	rare in park

Table B.1. Terrestrial avian species of Hawaii (continued)

Scientific Name	English Name	Hawaii	Maui	Monitoring	Suggested Method	Comments
Paroaria capitata	yellow-billed cardinal	I	--	*	P/A	rare in park
Cardinalis cardinalis	northern cardinal	I	I	Yes	DS	
Carpodacus mexicanus	house finch	I	I	Yes	DS	
Serinus mozambicus	yellow-fronted canary	I	--	*	P/A	rare in park
Psittirostra psittacea	ou	Ne	Ne	No	RBS	E
Loxioides bailleui	palila	Ne	--	No	--	E, not in park
Pseudonestor xanthophrys	Maui parrotbill	--	Ne	Yes/Pending	PAO/DS/BBIRD/MAPS	E
Hemignathus virens virens	Hawaii amakihi	Ne	--	Yes	DS	
Hemignathus virens wilsoni	Maui amakihi	--	Ne	Yes	DS	
Hemignathus lucidus affinis	Maui nukupuu	--	Ne	No	RBS	E
Hemignathus munroi	akiapolaau	Ne	--	Yes/Pending	PAO/DS/BBIRD/MAPS	E
Oreomystis mana	Hawaii creeper	Ne	--	Yes/Pending	PAO/DS/BBIRD/MAPS	E
Paroreomyza montana	Maui alauahio	--	Ne	Yes	DS	
Loxops coccineus ochraceus	Maui akepa	--	Ne	No	RBS	E
Loxops coccineus coccineus	Hawaii akepa	Ne	--	Yes/Pending	PAO/DS/BBIRD/MAPS	E
Vestiaria coccinea	iiwi	Ne	Ne	Yes	DS	
Palmeria dolei	akohekohe	--	Ne	Yes/Pending	PAO/DS/BBIRD/MAPS	E
Himatione sanguinea	apapane	Ne	Ne	Yes	DS	
Melamprosops phaeosoma	poouli	--	Ne	No	RBS	E
Passer domesticus	house sparrow	I	I	Yes	DS	
Uraeginthus bengalus	red-cheeked cordonbleu	I	--	*	P/A	rare in park
Estrilda caerulescens	lavender waxbill	I	--	*	P/A	rare in park
Estrilda melpoda	orange-cheeked waxbill	--	I	*	P/A	rare in park
Estrilda troglodytes	black-rumped waxbill	I	--	*	P/A	rare in park
Amandava amandava	red avadavat	I	I	*	P/A	rare in park
Lonchura malabarica	African silverbill	I	I	*	P/A	rare in park

Table B.1. Terrestrial avian species of Hawaii (continued)

Scientific Name	English Name	Hawaii	Maui	Monitoring	Suggested Method	Comments
Lonchura punctulata	nutmeg mannikin	I	I	Yes	DS	
Padda oryzivora	Java sparrow	I	I	*	P/A	rare in park

Table B.2. Terrestrial avian species of NPSA.

Scientific Name	Common Name	Tutuila	Tau	Monitoring	Sampling Method	Comments
Gallus gallus	red junglefowl	I	I	Yes	DS	
Rallus philippensis	banded rail	Ni	Ni	Yes	DS	
Porzana tabuensis	spotless crake	Ni	Ni	*/Pending	P/A/PAO/BBIRD/MAPS	CE
Porphyrio porphyrio	purple swamphen	Ni	Ni	*	P/A	
Columba livia	rock dove	I	--	Yes	PAO	localized distribution
Gallicolumba stairi	friendly ground-dove	--	--	Yes/Pending	PAO/RBS/ BBIRD/MAPS	CE, rare in park
Ptilinopus perousii	many-colored fruit-dove	Ni	Ni	Yes	DS	tracks resource
Ptilinopus porphyraceus	purple-capped fruit-dove	Ni	Ni	Yes	DS	tracks resource
Ducula pacifica	Pacific pigeon	Ni	Ni	Yes	DS	
Vini australis	blue-crowned lorikeet	Ni	Ni	Yes	DS	species clusters
Eudynamis taitensis	long-tailed cuckoo	M	M	*	P/A	migrant species
Tyto alba	barn owl	I	I	Yes/Pending	PAO/BBIRD	nocturnal species
Aerodramus spodiopygius	white-rumped swiftlet	Ni	Ni	Yes/Pending	PAO/BBIRD/MAPS	colonial species, aerial insectivore
Halcyon chloris	white-collared kingfisher	Ni	Ni	Yes	DS	
Pycnonotus cafer	red-vented bulbul	I	--	Yes	DS	human associated
Clytorhynchus vitiensis	Fiji shrikebill	--	Ne	Yes	PAO/DS	E, rare in park
Aplonis atrifusca	Samoan starling	Ne	Ne	Yes	DS	tracks resource
Aplonis tabuensis	Polynesian starling	Ni	Ne	Yes	DS	tracks resource
Acridotheres tristis	common myna	I	--	Yes	PAO/DS	
Acridotheres fuscus	jungle myna	I	--	Yes	PAO/DS	
Myzomela cardinalis	cardinal honeyeater	Ni	--	Yes	DS	
Foulehaio carunculata	wattled honeyeater	Ni	Ni	Yes	DS	tracks resource
Gymnomyza samoensis	mao	Ne	--	No	RBS	probably extinct

Appendix C. Dichotomous Key to Select Population Estimators

(Adapted from Thompson et al. 1998)

1a)	A complete count is possible	2
1b)	A complete count is not possible	3
2a)	All birds can be counted within each plot	Site counts
2b)	All breeding territories, pairs and associated nests can be located within each plot	Total mapping
3a)	Individuals can be caught and uniquely marked	4
3b)	Individuals cannot be caught	10
4a)	Element is mobile (i.e., birds)	5
4b)	Element is immobile (e.g., nests)	7
5a)	Individuals are completely contained within a given plot	6
5b)	Not as above	8
6a)	Time period is short enough to treat population as closed	7
6b)	Not as above	9
7a)	There are at least 100 individuals and capture probability > 0.3	Mark-resight
7b)	Not as above	10
8a)	Individuals can be equipped with radio transmitters	NOREMARK
8b)	Not as above	10
9a)	Population is geographically closed and there is no heterogeneity in capture probability or behavioral response to capture method	Jolly-Seber open population model
9b)	Not as above	10
10a)	Perpendicular distance to bird can be recorded	11
10b)	Not as above	14
11a)	Every individual on line or point can be located	12
11b)	Not as above or methods to adjust for incomplete detection are not feasible	14
12a)	Individuals do not move in response to counter	13
12b)	Not as above	14

Dichotomous Key to Select Population Estimators (continued).

13a)	Adequate numbers of individuals or groups of individuals can be detected for reliable model selection	Distance sampling methods
13b)	Not as above	14
14a)	Only data on species occurrence required	Presence-absence methods
14b)	Uncorrected counts of all individuals detected on a plot	Relative index methods

Appendix D. Power and Sample Size Calculations to Detect Trends in Landbird Densities

Tables

Power

We calculated the sampling coefficient of variation ($\overline{CV_s} = \sqrt{s^2 / \hat{\overline{D}}}$; J. Skalski, pers. comm.) for each species by site (island and study area) from species- and site-specific density estimates (Camp et al. 2009a). An average $\overline{CV_s}$ was calculated among species and sites, and input into the noncentrality parameter equation

$$\Phi_{1,m-2} = \frac{1}{\sqrt{2}} \times \frac{\left|\frac{\Delta}{m-1}\right|}{\sqrt{\frac{\overline{CV_s}^2}{\sum_{i=1}^{m}\left(t_i - \bar{t}\right)^2}}} .$$

The noncentrality parameter for a noncentral F-distribution with 1 and m-2 degrees of freedom was then used to determine the prospective power for the average bird to detect 25% or 50% declines in density (i.e., Δ = -0.50) at α = 0.10, one-tailed, for monitoring durations of 10, 20 or 25 years (Table D.1).

Table D.1. Prospective power to detect moderate and large declines (25% and 50%) for the average bird is marginal (1-$\beta \leq$ 0.40), regardless of study duration.

	Duration of monitoring (yrs)		
Decline	10	20	25
25%	0.22	0.22	0.23
50%	0.25	0.33	0.37

Tracking trends in species with large variability in density estimates is difficult (i.e., low power to detect trends). We calculated the CV_s for native Hawaiian species by site to identify those species where the average bird effort will miss a decline (Table D.2).

Table D.2. Sampling coefficient of variation (CVs) for species by tract. We identified those species with CVs > 0.5 as species where the average bird effort will likely miss a decline (shaded). These species will also require greater sampling effort to produce reliable density estimates and track trends, except for omao in the Olaa and East Rift regions**.**

Island/Tract	Species	$\hat{\bar{D}}$	s^2	CV_s
Maui	amakihi	8.33	17.310	0.4994
Maui	apapane	20.14	71.519	0.4199
Maui	parrotbill	0.15	0.001	0.1997
Maui	alauahio	11.27	14.291	0.3354
Maui	iiwi	4.28	3.703	0.4497
Maui	akohekohe	0.99	0.032	0.1802
Molokai	amakihi	0.32	0.011	0.3389
Molokai	apapane	14.04	36.785	0.4320
Mauna Loa Strip	elepaio	1.69	0.287	0.3164
Mauna Loa Strip	omao	0.03	0.003	1.7308
Mauna Loa Strip	amakihi	4.51	0.986	0.2203
Mauna Loa Strip	iiwi	0.67	0.084	0.4344
Mauna Loa Strip	apapane	2.85	0.253	0.1766
Olaa	elepaio	0.44	0.644	1.8345
Olaa	omao	0.87	0.212	0.5277
Olaa	amakihi	0.06	0.010	1.7757
Olaa	iiwi	0.90	1.802	1.4957
Olaa	apapane	8.77	49.859	0.8051
East Rift	elepaio	0.20	0.080	1.3970
East Rift	omao	0.85	0.236	0.5700
East Rift	amakihi	0.02	0.000	0.9759
East Rift	apapane	6.99	5.996	0.3503
Kahuku	elepaio	0.39	0.015	0.3132
Kahuku	omao	2.84	1.057	0.3621
Kahuku	amakihi	4.56	1.319	0.2518
Kahuku	akiapolaau	0.03	0.002	1.5105
Kahuku	creeper	0.67	0.239	0.7247
Kahuku	akepa	0.83	0.352	0.7150
Kahuku	iiwi	3.51	1.954	0.3983
Kahuku	apapane	16.96	16.357	0.2385

Sample Size

Sample size (i.e., number of stations) was calculated for each species by tract (Table D.3) following methods by Geng and Hills (1989) with equation

$$n \geq 2 \times \left(\overline{CV_s} \big/ \hat{\overline{D}} \right)^2 \times \left(t_{\alpha,df} + t_{\beta,df} \right)^2$$

.

This method uses observed density and variance values, and a *t*-distribution of the desired α and β levels (Type I and II errors, respectively) for a two-tailed test. Sample sizes were calculated for each species by island/tract from density and variance estimates. Because of the limited number of samples, we could not use least squares methods to determine mean square estimates. Instead, $\overline{CV_s}$ was calculated as $\overline{s^2} / \hat{\overline{D}}$ for each species by island/tract. The number of sampling units were calculated to detect a 20% change in the mean density with α = 0.10 and 80% power. In addition, the number of stations needed to produce a 20% CV about the status estimates were calculated using methods described in Buckland et al. (2001;245-246), and equation

$$k = \frac{k_0 \left\{ b + \left[sd(s) \big/ \overline{s} \right]^2 \right\}}{n0 * cv_t^2}$$

.

We assumed a value of 3 for *b*, and sought a CV of 10% using the number of stations sampled (k_0) and individuals detected (n_0). There are no known costs to this sample size estimator based on a thorough reading of Buckland et al. (2001).

There were approximately 100 stations sampled on Molokai and 300 on east Maui, and on Hawaii there were about 130 stations sampled in East Rift, 200 in Kahuku-Kau, 50 in Mauna Loa Strip, and 120 in Olaa tracts of HAVO. A majority of the stations were outside the park units on Molokai and Maui, whereas on Hawaii most of the stations were within HAVO (except in East Rift and Kahuku-Kau).

Table D.3. Species-specific sample size estimates to produce a 20% CV about the density estimates (*k*), or to detect a 20% difference in densities (*n*). *K* increases with uncertainty in the status estimates (imprecise density estimates), whereas, *n* increases with increasing variability among density estimates. Shaded cells indicate the species that may be under-sampled by island or island/tract.

Species	k	n
Island: Maui‡		
akohekohe	84	13
Maui parrotbill	812	15
Maui amakihi	21	94
Maui alauahio	36	43
iiwi	25	76
apapane	9	66
Island: Hawaii; Tract: Olaa‡		
Hawaii elepaio	1,026	1,260
omao	77	105
Hawaii amakihi	5,988	1,180
iiwi	408	838
apapane	29	243
Island: Hawaii; Tract: East Rift‡		
Hawaii elepaio	366	731
omao	35	122
Hawaii amakihi	2,194	357
apapane	12	46
Island: Hawaii; Tract: Mauna Loa Strip‡		
Hawaii elepaio	61	38
omao	444	1,121
Hawaii amakihi	20	19
iiwi	57	71
apapane	16	12
Island: Hawaii; Tract: Kau ‡		
Hawaii elepaio	440	37
omao	32	50
Hawaii amakihi	42	24
iiwi	54	60
apapane	10	22
Hawaii creeper	588	197
Hawaii akepa	208	192
akiapolaau	1,899	854

Table D.3. Species-specific sample size estimates (continued

Island: Hawaii; Tract: Honomalino†		
Hawaii elepaio	429	604
Hawaii amakihi	16	3
iiwi	215	94
apapane	21	5
Island: Hawaii; Tract: South Flank†		
omao	193	121
Hawaii amakihi	67	35
apapane	60	43
Island: Hawaii; Tract: Northwest†		
Hawaii elepaio	1,375	3,107
Hawaii amakihi	12	5
iiwi	81	98
apapane	18	12
Island: Hawaii; Tract: Papa†		
Hawaii amakihi	18	10
apapane	24	10

‡Calculations based on average of surveys.

†Calculations based on a single survey.

The information presented in Table D.3 should be used to provide a guideline for determining the number of sampling units to detect changes in species' range and status. We expect the native species to change over time, however, and these analyses are based on the CVs remaining constant. We expect the CVs to change through time because of changing density estimates (e.g., as density declines the CV may increase) and duration of sampling (i.e., variability usually increases and then levels off or declines slightly through time series surveys). Sample sizes by park or park tract are presented in Table D.3.

Table D.4. Sample sizes by park or park tract. The number stations allocated to the fixed and random panels are presented (see Appendix E, below). Density estimates were not available for NPSA park units (Tutuila and Tau); therefore, we recommend that a large number of stations should be initially sampled and the number of stations be adjusted during the monitoring program evaluation.

Park/ Tract	Sample Size	Allocation (fixed:random)	Rationalization
HALE	150	100:50[1]	Core habitat for range restricted, endangered species (Maui parrotbill and akohekohe), surveys should be coordinated with DOFAW to increase coverage
HAVO: Olaa	100	50:50	Non-core habitat for common species that are not range restricted, fixed stations should include HFBS and subsequent survey sampling points, surveys should be coordinated with DOFAW and the Olaa-Kilauea Partnership to increase coverage
HAVO: East Rift	120	60:60	Same as Olaa, except surveys should be coordinated with DOFAW to increase coverage
HAVO: Mauna Loa Strip	80	40:40	Same as East Rift, except if surveys are conducted in kipukas Ki and Puaulu and an additional 20 stations should be added (10 HFBS and 10 random)
HAVO: Kau	200	100:100	Core habitat for range restricted, endangered species (Hawaii creeper, Hawaii akepa and akiapolaau; fixed stations should use 10 Tweed et al. (2007) survey sampling transects with 10 stations per transect and extend down to 1,500 m elevation), surveys should be coordinated with DOFAW to increase coverage
HAVO: Honomalino	100	50:50	Same as East Rift, except surveys should be coordinated with DOFAW and other land managers to increase coverage
HAVO: South Flank	120	60:60	Same as Honomalino
HAVO: Northwest	100	50:50	Same as Honomalino, except surveys should be coordinated with land managers of the Forest Legacy lands immediately down slope to increase coverage
HAVO: Papa	20	10:10	Same as Honomalino
NPSA: Tutuila	100	50:50	Non-core habitat for common species that are not range restricted (fixed stations should include Engbring and Ramsey (1989) survey sampling points)
NPSA: Tau	100	50:50	Same as Tutuila

[1]A 2:1 fixed to random sampling allocation ratio was chosen instead of the optimal sampling allocation to provide better coverage for two endangered species, allowing for more effort to be allocated to detecting trends.

References

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Appendix E. Allocation of Sampling Units to Panel Members

The correlation of density estimates to years can be used to determine the number of sites to fixed and rotating panels. With greater correlation between years, fewer fixed sampling sites are needed and more sites can be allocated to the rotating panel. Sample a greater number of random sites will help increase status estimate reliability (i.e., increased within year precision).

The optimal proportion of fixed to rotating panels can be estimated from the correlation (*r*) between years within sites with the equation:

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

Only Mauna Loa Strip has been surveyed sufficiently to produce reliable correlation estimates. The interannual adjusted correlation in density for select Hawaiian birds was $\tilde{\rho}$ = 0.632 (Table 13). The correlation ($\tilde{\rho}$) in bird density from one year to the next was calculated, adjusting for measurement error according to the equation:

$$\tilde{\rho} = \frac{Cov\left(\hat{D}_i, \hat{D}_{i+1}\right)}{\sqrt{\left(s^2_{\hat{D}_i} - \overline{Var\left(\hat{D}_i \middle| D_i\right)}\right)\left(s^2_{\hat{D}_{i+1}} - \overline{Var\left(\hat{D}_{i+1} \middle| D_{i+1}\right)}\right)}}.$$

In expectation, $|\tilde{\rho}|$ will be greater than $|\hat{\rho}|$, which is based on empirical variances ($s^2_{\hat{D}}$) and calculates the correlation between density (i.e., *D*, not density estimates[$\hat{D}$]). However, $\tilde{\rho}$ can take on inadmissible values and these should be treated as outliers.

We used $\overline{\tilde{\rho}}$ (i.e., the average $\tilde{\rho}$ of four Hawaiian birds; Table E.1) in place of *r* when allocating sites to panels. There are obvious limitations to applying this correlation estimate to other park units and tracts; however, this serves as a starting point until further data are available. The proportion of fixed to rotating panels was 0.44, or approximately a 1:1 ratio.

The order in which sites are sampled should be randomized. This will avoid bias in the order of visitation and reduce the likelihood of missing areas due to a foreshortened field season. If sites are grouped together to reduce travel costs, measure the “tours” (group of stations that can be measured by a crew in one trip [day or week]) in random order.

Table E.1. Temporal correlation ($\tilde{\rho}$) and interannual variation for Hawaiian birds, Mauna Loa Strip tract (surveys 1986–1994). For five species, the adjusted correlations were either zero or outside of admissible range. From Camp et al. (2009a).

Species	$\tilde{\rho}$	$\bar{\hat{D}}$ †	$s^{2‡}$	CV_s §
Hawaii elepaio*	-2.370	1.8180	0.252	0.276
oiao*	-2.170	0.0160	0.000	0.559
Hawaii amakihi	0.990	4.3200	0.519	0.167
iiwi	0.470	0.0081	0.088	3.370
apapane*	1.210	2.9880	0.192	0.147
red-billed leiothrix**	0	0.2780	0.024	0.563
Japanese white-eye**	0	8.8500	2.023	0.161
northern cardinal	0.756	0.2640	0.002	0.173
house finch	0.943	1.0040	0.147	0.381

†Mean of density estimate.

‡Variance of density estimates.

§Variance coefficient of variation.

*Outlier not used in temporal correlation calculations.

**Adjusted correlation equals zero, not used in temporal correlation calculations.

Appendix F. Spatial Sampling Design

Spatial sampling designs partition the sampling units into grouped or ungrouped categories (i.e., stratified sampling, or unstratified sampling designs, respectively). Both methods are recommended for long-term monitoring (Thompson 2002, McDonald and Geissler 2004). Stratified sampling allocates sampling units into relatively homogenous subgroups before sampling. Unstratified sampling does not partition the sampling units, instead units are located either randomly or systematically (grid) within the sampling frame.

Stratified sampling is a useful design for reducing the overall variance of an estimator (see Thompson 2002). In stratified sampling, the total numbers of sites (N) are partitioned into regions or strata. Variances of estimators by strata are additive because the sample site selection in the different strata are made independently; the major statistical advantage of stratified sampling. The variances of estimators are minimized by the *principle of stratification*, that is, partitioning the sampling units into relatively homogeneous subgroups before sampling. Stratified sampling designs also assure an adequate sample size for less common habitats (if habitats are strata), and allow for optimizing according to costs of sampling (e.g., access costs and establishing sites costs; McDonald and Geissler 2004). Disadvantages of stratified sampling include increased analysis complexity and difficulty in changing strata boundaries. In addition, stratified sampling is optimal when differences among strata variance are substantially different. If too many strata are defined and variance does not differ substantially among strata, gains in precision may not be realized. Overall precision increases only if the loss of degrees of freedom (one for each stratum) is compensated for by the reduction in variance and increased analytic complexity. An additional limitation is that stratification should not be based on biotic features (e.g., biomes or habitat types) as the distribution of these features may change over time.

McDonald and Geissler (2004) state that 1 of 3 conditions need to be met before stratified sampling is recommended. It is recommended to use stratification when (1) density estimates are desired for each stratum, (2) when the cost to sample differs markedly by strata (stratification by cost) and these costs are not expected to change, and (3) variance differs substantially by strata. If parameter estimates are needed for each stratum, stratification will ensure that adequate sampling occurs in uncommon habitat types and in stratum where parameter estimates are imprecise. Under the second condition, stratification allocates less effort into expensive strata, yet reduces the variance for a fixed cost. McDonald and Geissler (2004:12) caution against using stratification procedures for the sole purpose of reducing variance unless there “are very substantial differences in the response variables (e.g., species composition or density) among different areas.” They further caution that the strata should not change throughout the life of the monitoring program and that unchanging features, such as elevation, be used to delineate strata.

“Strata are artificial constructs used to control and distribute sampling,” McDonald and Geissler (2004:17–18). Density estimates are needed by biomes, but not according to abiotically defined strata (e.g., elevation or management units). Travel and sampling costs do not differ among the biomes. The variance among biomes differs substantially; however, reducing variance should not be the sole purpose of using stratification. The distribution of biomes will change over time and if stratification is based on biomes it is expected that variability will also change as populations respond to changes in habitat. Thus, the initial constraints used to define strata (i.e., biome boundaries) will not be applicable later in the long-term monitoring program and parameter estimation will be confounded. Therefore, we could not identify requirements necessitating the use of stratified sampling designs for PACN park units, including HAVO.

Unstratified Sampling

For monitoring using distance sampling methods, Buckland et al. (2001) recommend that the location of sampling stations be chosen using systematic or simple random samples. Unless the sampling stations are to be used for mapping purposes, it is recommended that they be established using simple random samples (preferred design Buckland et al. 2001, 2004; Thomas et al. 2005; J. Skalski pers. comm.). Thus, the 50 random panel point-transect sampling stations should be located using a simple random sampling design instead of an unstratified systematic or grid based approach.

Unstratified sampling designs are easy to implement and analyze. This is especially pertinent to distance sampling methods where model assumptions are best met when stations are located randomly. Estimates can be easily made for subpopulations of interest (i.e., domains). The extent of domains and the stations within each domain are determined after sampling has occurred; thus, changes in biome distributions do not adversely affect the sampling distribution for example. The use of domains to partition biomes (i.e., assigning stations after they have been sampled to relatively homogeneous groups) therefore avoids the limitation of strata being fixed areas that cannot change throughout the life of the monitoring program.

The primary disadvantage of allocating sampling units with an unstratified sampling design is that less common biomes may be inadequately sampled. This may be particularly problematic because only 50 sampling units will be randomly located per park unit or island. If sampling units are randomly allocated (i.e., not distributed on a grid) uniform coverage of the entire population may not be achieved. More specifically, stations may be clumped (a natural outcome of randomly locating stations) and portions of the population may receive little or no monitoring. However, over time, the entire population can be expected to be surveyed and inference is appropriate to the entire population. Furthermore, travel time and costs may be greater with randomly located stations than stations located uniformly or in stratified sampling designs. Several other disadvantages are detailed in the *Stratified Sampling* section as advantages of this approach, below.

Analysis of unstratified sampling designs is straightforward and well developed, see McDonald and Geissler (2004) for an overview. Many introductory sampling texts are available (e.g., Levy and Lemeshow 1991, Lohr 1999), and advanced principles are described in Thompson (2002), including applications for distance sampling methods (specifically line transects).

Stratified Sampling

Although we do not recommend using stratified sampling methods to allocate sampling units, this section was included for completeness.

Of PACN park units only HAVO consists of several strata in which birds can occupy. These strata roughly correspond to land cover type, herein referred to as biomes. Generally, the land cover types can be categorized into biomes barren/lava, grassland, shrubland, forest, sub-alpine, alpine, water, and human dominated types (k = 7 stratum). Statistical inferences cannot be made to any strata that are not sampled. Three biomes (sub-alpine, alpine and water) can be dropped for bird sampling because landbirds do not occur within these biomes, thus k = 4 stratum (sampling to occur in barren/lava, grassland, shrubland, and forest biomes). In addition, statistical inference is precluded from areas that are identified as being too dangerous to sample (e.g., active lava flows, steep slopes or ground cracks and settling), and the extent of these areas should minimized. The number of sampling units (n_i) for each i strata can be determined by the proportion to strata-specific variance to the total variance according to the equation:

$$n_i = F_i * N,$$

where $F_i \propto s_i^2 / \sum_i s_i^2$ is calculated for each i of k stratum and N is the total number of sampling units (not the total area of the strata; thus $\sum n_i = N$). Costs of sampling are assumed constant and fixed across all strata. Therefore, cost was not considered as a factor in this equation. If the cost of sampling differs among strata, the optimal allocation of sampling units can maximize the precision for the available budget (see Thompson 2002, McDonald and Geissler 2004).

We recommend that strata edges and park boundaries are buffered so sampling stations do not fall in mixed strata or outside the park. If however sampling stations occur where strata juxtapose or lie outside the park, they should not be moved or replaced as this unnecessarily complicates the analyses.

Based on the minimum of 2 sampling units per stratum (McDonald and Geissler 2004) and the high level of imprecision in barren/lava, grassland and shrubland biomes (Turner et al. 2006), it may be more advantageous to allocate a fixed number of sampling units to these biomes. For example, after the strata have been delineated in a GIS, 3 or 5 point transect stations could be located using simple random sample procedures in these biomes (3 biomes * 3 stations = 9 of 50 stations, with 41 stations to be allocated in the forest biome). The number of biomes could be reduced further by pooling the grassland and shrubland types together, similar to combining woodland and forestland into a forest biome. This would result in a total of 3 biomes (barren/lava, grass/shrubland and forest) with 3 sampling stations allocated to the barren/lava and grass/shrubland biomes each, and 44 stations allocated to the forest biome.

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Appendix G. Cost Structure of Conducting Point-transect Sampling Monitoring for Landbirds in PACN Park Units

Budget based on I&M covering all expenses**.**

Estimated Costs	**HALE**	**HAVO-old**	**HAVO-new**	**NPSA-Tut**	**NPSA-Tau**
Salaries	33,380	39,933	39,933	28,028	30,190
Travel (with per diem)	9,350	13,275	12,150	11,420	15,130
Equipment	500	500	500	500	500
Supplies	500	500	500	500	500
Cooperative agreement	10,000	10,000	10,000	10,000	10,000
Sub-total	53,730	64,208	63,083	50,448	56,320
Overhead (17.5%)	9,403	11,236	11,039	8,828	9,856
Total	63,133	75,444	74,122	59,276	66,176
Salaries					
Project/field lead[1]	1	1	1	1	1
Duration of service	7	8	8	6	6
Base pay (per month)	2,552	2,552	2,552	2,552	2,552
Base pay w/ benefits	3,190	3,190	3,190	3,190	3,190
Sub-total	22,330	25,520	25,520	19,140	19,140
Biological technician[2]	1	1	1	1	1
Duration of service	4	5	5	3	4
Base pay (per month)	1,730	1,730	1,730	1,730	1,730
Base pay w/ benefits	2,162.5	2,162.5	2,162.5	2,162.5	2,162.5
Sub-total	8,650	10,812.5	10,812.5	6,487.5	8,650
Intern[3]	2	2	2	2	2
Duration of service	2	3	3	2	2
Base pay (per month)	400	400	400	400	400
Base pay w/ overhead	600	600	600	600	600
Sub-total	2,400	3,600	3,600	2,400	2,400
Salary (total)	33,380	39,932.5	39,932.5	28,027.5	30,190
Travel					
Flights[4]	5,300	1,875	750	5600	6,400
Vehicle[5]	2,250	8,400	8,400	1500	2,250
Field per diem[6]	1,800	3,000	3,000	1,200	1,800
Full per diem[7]	0	0	0	3,120	4,680
Travel (total)	9,350	13,275	12,150	11,420	15,130

[1]Project/field lead at RCUH.

[2]Biological technician at RCUH.

[3]Intern at $600/mo.

[4]HALE surveys includes travel to Maui from Hilo for 4 field crew members at $200 per person and helicopter for 6 hr at $750/hr; HAVO-old surveys includes helicopter to northwest Kahuku for 2.5 hr at $750/hr; HAVO-new surveys includes helicopter to East Rift Zone for 1 hr at $750/hr; NPSA surveys includes travel from Hilo to Pago Pago and Tau for 4 field crew members at $1,400 and $200 per person.

[5]$50/day at HALE for 45 days; HAVO-old and -new for 4 months at $2,100 per month; NPSA-Tutuila for

30 days; NPSA-Tau for 45 days.

[6]$20/day at HALE for 45 days; HAVO-old for 75 days; HAVO-new for 75 days; NPSA-Tutuila for 30 days; NPSA-Tau for 45 days; Project/field lead and biological technician only.

[7]NPSA: $130/day; NPSA-Tutuila for 12 days; NPSA-Tau for 18 days; Project/field lead and biological technician only.

Supplemental Materials 1. Rare Bird Searches (RBS)

Introduction to RBS

Although point-transect sampling is recommended as the primary method for large-scale and multi-species landbird surveys, it is not appropriate for all species. Standard methods, including point-transect sampling surveys, provide poor estimates for secretive or extremely rare birds (Buckland et al. 2001). Species whose persistence is questionable may be monitored using area-search methods, specifically those methods developed by Reynolds and Snetsinger (2001).

Goals and Objectives of RBS

Some landbirds are sufficiently rare as to be "missed" during standard monitoring (e.g., BBIRD, MAPS, and point-transect sampling). In some cases, these species are not observed even during presence/absence sampling (e.g., PAO) or general fieldwork, and their persistence is questionable (see Reynolds and Snetsinger 2001). The specific goal of RBS monitoring is to confirm the persistence of the rarest species. In situations where the species was not detected during RBS surveys, subsequent goals are to determine an extinction probability and calculate the amount of sampling required to conclude the species is locally extinct (Reed 1996).

Questions to be Addressed and Hypotheses to be Tested

The RBS is an intensive, localized area-search sampling method for tracking landbirds whose persistence is questionable. The specific question addressed in RBS surveys is to confirm the species' persistence. RBS method allows for statistically valid variance estimates and inference; thus, the method provides information (i.e., extinction probability and sampling effort) necessary to test specific hypotheses. RBS surveys conducted over time (i.e., years) can be combined in a monitoring program framework to track species' persistence.

Experimental Design

Number and Distribution of Search Routes

The species' distribution and detection probability are the main factors influencing the number and distribution of search routes. Although complete coverage of a species' expected distribution is not necessary to conclude the species is absent, searching should be conducted within suitable habitat in the area the species was last detected. Reynolds and Snetsinger (2001:138) determined that 90 to 1,100 hours of searches are needed to confirm extinction for critically endangered Hawaiian forest birds, depending upon the species. For other species, we recommend an operational standard of 3-km of survey transects sampled in 10 hours of good weather (= 1 visit) be used for initiating pilot surveys. Results from the pilot surveys can then be used to determine the amount of surveys that need to be conducted to conclude local extinction at 95% and 99% confidence (see Data Analysis, below).

Selection of Target Species

If implemented, RBS should focus on those species point-transect sampling, PAO, MAPS and BBIRD track poorly. This includes the 'missing' species identified by Reynolds and Snetsinger (2001), and the friendly ground-dove (*Gallicolumba stairi*) in NPSA.

Weather Data

Weather data (cloud cover, precipitation, wind speed and gusts) may influence the detectability of species. Therefore, weather data will be recorded at the start of surveys, and the time and condition of any changes that occur throughout the search period. Standardized conditions and codes are described in point-transect sampling above.

Methods

The RBS methods applied in Hawaii are a modified form of the area-search technique (Ralph et al. 1993, Bibby et al. 2000), whereby transects or search routes are surveyed instead of plots (see Reynolds and Snetsinger 2001). Observers record as many birds as possible of all species while searching for target species along transects, in addition to recording the time spent searching during variable weather conditions. Searches during unsuitable conditions are subtracted from quantified survey effort. Observers are trained to detect and identify target species by studying museum specimens, artist's depictions, voice recordings when they exist, and historical first-hand accounts. A further modification of the survey methodology is to incorporate the use of periodic playbacks of voice recordings for target species (Johnson et al. 1981). Playbacks may attract species that are rare and difficult to observe. Species-specific searches of target areas are based on prior knowledge of habitat preference, historical distribution, and last sightings.

Data Collection

All birds observed during the course of the study will be identified to species, and age and sex, if discernable. The following data will be taken on all birds detected:

1. Species
2. Detection type (audio or visual)
3. Age (if possible) and how aged (if applicable)
4. Sex (if possible) and how sexed (if applicable)
5. Activity
6. Date and time of detection
7. Transect and site description where detected

All data will be taken using standardized codes and forms.

Effort data, the time spent searching and observing birds, and weather conditions will also be collected in a standardized manner. In order to allow constant-effort comparisons of data to be made, the times of changes in weather will be recorded to the nearest minute.

In situations where staffing, or field conditions, or money is at a premium the use of Autonomous Recording Devices (ARU) should be used as a supplemental tool to RBS. If a rare bird is detected acoustically, but not otherwise corroborated, ARU deployment may be an economical means to substantiate detections. The Cornell's Bioacoustics Lab provides detailed information on ARU use.

Computer Data Entry and Verification

The Project/Field Lead will complete the computer entry of all search data. The critical data for each record (listed above) will be proofed by hand against the raw data and any computer-entry errors will be corrected. The Project/Field Lead, using specially designed data entry programs, will complete computer entry of effort and weather data.

All observations will then be run through a series of verification programs as follows:

1. Clean-up programs to check the validity of all codes entered and the ranges of all numerical data
2. Cross-check programs to compare search route, date, and time of observation from the data with those from the summary of effort data

Any discrepancies or suspicious data identified by any of these programs will be examined manually and corrected if necessary.

Data Analysis

A species-specific detection probability, *p*, assuming a randomly distributed population, is calculated with the equation:

$$p = 1 - \left(1 - \frac{a}{A}\right)^{n}.$$

The effective search area, *a*, is the product of the effective detection distance (*EDD*) and the search area, *L* (total length of transects surveyed), using equation $a = 2 * EDD * L$ (Reynolds and Snetsinger 2001). In many situations the *EDD* cannot be determined directly for the species; therefore, an *EDD* from a surrogate species can be used (see Scott et al. 1986, Reynolds and Snetsinger 2001). The last species' range, *A*, is usually a liberal estimate of the current range because of range contractions. The total population size, *n*, is operationally hypothesized to be 10 birds.

The minimum number of visits, N_{min}, needed to ensure a 99% extinction probability (Reed 1996) is estimates as

$$N_{\min} = \frac{\ln(\alpha - level)}{\ln(1 - p)},$$

where $\alpha - level = 0.01$, and *p* is the detection probability from above. A visit is equal to the sampling effort expended, or for predictive purposes can be defined as 3-km of survey transects sampled in 10 hours of good weather.

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Supplemental Materials 2. Proportion Area Occupied (PAO)

Introduction to PAO

Proportion area occupied (PAO) is an analytical methodology applied to point count data that incorporates detection probabilities to estimate the area occupied by a species. Occurrence data (presence and not detection) will be derived from sampling stations for the total area and from repeated counts of a subset of stations to estimate the probability of detecting the species (MacKenzie et al. 2002, 2003). Data analysis is conducted with program Presence (http://www.proteus.co.nz) to produce estimates of the area occupied, accounting for species-specific detection probabilities and sampling covariates (e.g., observer, time of day and weather conditions).

Goals and Objectives of PAO

To meet objectives 1 and 2 for landbirds, PAO can be conducted to determine species distributions and monitor changes in their distributions. This method will be most appropriate for species that are widely distributed but at low densities (i.e., species whose low detection rates preclude robust density estimation). In addition, PAO is useful for monitoring species that may be experiencing rapid range contraction or expansion, especially if sampling is conducted across the species' range at a fine scaled grid.

The specific goal of the PAO monitoring is to provide, for a suite of target species, estimates of species' distributions from systematic, repeated counts. Distribution estimates will be used to determine changes and track long-term trends. They will be used to facilitate comparisons among data obtained from stations located in landscapes subjected to various management practices in order to provide information relating to the effects of management practices on population parameters.

Questions to be Addressed and Hypotheses to be Tested

The PAO is a large-scale, long-term monitoring program. We suggest that estimates of species' distribution be generated with point count data, adjusted for detection probabilities. Thus allowing for statistically valid variance estimates and inference, and avoiding the possible bias associated with using indices (MacKenzie et al. 2002).

PAO becomes maximally useful when the establishment of stations and sampling are designed to address specific questions or test specific hypotheses that will provide information as to the potential proximate causes of community and population change. Monitoring the spatial trends in species' distribution is the primary objective of PAO, and the temporal variation itself varies spatially. Temporal variation (i.e., short-term fluctuations) can obscure the long-term trends at which the questions and hypotheses are addressed. The spatial scale at which questions and hypotheses can be addressed must correspond to the geographic scale over which data from stations are pooled: the landscape scale. Data can be combined with surveys conducted outside the park units to provide regional (or even island) long-term trends.

Experimental Design

An estimate of the area occupied by a species is derived from sampling a grid of stations. A subset of the stations is repeatedly sampled to estimate detection probabilities. PAO monitoring requires estimating the probability of committing a false positive error (capture probability [$\hat{p}$];

designating that the species was absent when it was present). This is accomplished by sampling a subset of the stations several times within the survey period (MacKenzie et al. 2002, 2003).

The number of visits at a site is dependent on the detectability of the species, and MacKenzie (n. d.) recommends "a 70% chance of detecting [the species] at least once." The suggested minimum number of stations sampled is 20 (MacKenzie n. d.). Detection probability may be influenced by many factors including habitat type, observer, and sampling conditions. Therefore, $\hat{p}$ should be estimated for strata (e.g., habitat type) to determine whether the detection probability varies by strata. Until data are available, it may be assumed that $\hat{p}$ is the same across strata. The other factors may be treated as covariates in the analysis. Turner et al. (2006) conducted a PAO pilot study at HAVO, and their recommendations corroborated the sampling effort suggested by MacKenzie.

Number and Distribution of Sites

The sample size necessary to determine species' distribution and proportion of suitable habitats occupied is dependent on the area occupied by a species and the distance among station locations. Discerning the boundary of a species' range requires sampling both within and beyond the current range. Determining the distribution of a species is dependent on the scale, distance between sampling units and duration of sampling. Producing reliable distributions requires uniform sampling to avoid map distortion (Sauer et al. 1995).

The distance between the stations influences the number of stations sampled, the chance of including unoccupied suitable habitats, and the resolution (coarseness) of distribution maps. Widespread placement of sampling units across the region may overestimate species' distribution, especially for species whose distributions are localized or occur in low densities, by including habitats that are unoccupied or unsuitable in the distribution estimate. Ralph et al. (1995) recommend sampling stations be 250 m apart.

Selection of Target Species

The species being monitored are the native and alien landbirds in the study area during the breeding season (see Appendices F and G). Although we will record all bird species seen or heard during the point count surveys, inadequately sampled species will be removed before analyses.

Covariable Data

Program PRESENCE can incorporate two types of covariates: (1) site-specific, and (2) sampling-occasion covariates. Covariates that are constant for a site (e.g., habitat type, or generalized weather patterns such as drought or El Niño years) are site-specific covariates. These covariates remain consistent within a season. Observers and sampling conditions (e.g., weather factors, time of day) are examples of sampling-occasion covariates. These covariates may change with each survey of a site. Adjustments of detection probabilities by covariates are made using logistic models.

Methods

Data Collection

Sampling procedures should follow the recommendations of Ralph et al. (1995). Each station should be sampled once for 8 minutes, this duration is equivalent to distance sampling procedures. The presence of all species detected should be recorded. See Buskirk and McDonald (1995), Lynch (1995), Thompson and Schwalbach (1995), and Welsh (1995) for explanations of why shorter surveys (i.e., 5–10 minutes) are better than longer duration counts. When possible, the distance from the station center point to each bird detected should be estimated and recorded (following distance sampling procedures). For analyses, the birds detected within a 50 m radius of the station center point can be distinguished from those beyond 50 m. Surveys should only be conducted in appropriate weather (following distance sampling procedures), and all data are recorded on a standard form (see appendix A in Ralph et al. 1995 for an example).

Computer Data Entry and Verification

The Project/Field Lead will complete the computer entry. A data entry menu has been incorporated in program PRESENCE, including species and number detected, station location, and covariates. Data could be entered in a separate database and input into PRESENCE. After data have been entered, a two step verification process will be implemented to ensure data quality. This entails line-item checking each record between the field books and database (which is done in the form), and a random spot-checking process to document transcription error rate. Any discrepancies should be corrected promptly.

Data Analysis

Adjusting the occurrence estimate by the detection probability is necessary to produce reliable estimates and account for birds that are present but missed when sampling (MacKenzie et al. 2002, 2003). A subset of the population can be used to determine the detection probability; therefore, the detection probability should be determined from repeated point count surveys from focal sites. The focal locations or sites should be representative of the target population to avoid bias, or multiple sites should be sampled and applied to representative strata. Program PRESENCE (URL: http://www.proteus.co.nz) can be used to evaluate and incorporate covariate variables, evaluate and incorporate stratification where necessary, and calculate the detection probability. MacKenzie and Kendall (2002) describe how the detection probability may be incorporated in estimating a direct measure of the proportion area occupied. Analysis of trends can be accomplished with z-tests for end-point comparisons, and linear or higher order regression analysis for time series data.

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Supplemental Materials 3. Monitoring Avian Productivity and Survivorship (MAPS)

Materials in this supplemental materials were adapted from DeSante (1998. The MAPS Program in Denali National Park. National Park Service, Inventory and Monitoring Program, Denali National Park and Preserve).

Introduction to Maps

Environmental factors and management actions affect primary demographic parameters directly and these effects can be observed over shorter time than detecting the resulting changes in population size or density as measured by census or survey methods (Temple and Wiens 1989, DeSante and George 1994). Thus, a population could be in trouble long before this becomes evident from survey data, and monitoring primary demographic parameters of target species is an important component of any successful long-term inventory and monitoring program.

Established in 1989 by The Institute for Bird Populations (IBP), the Monitoring Avian Productivity and Survivorship (MAPS) program is now a continent-wide network of constant-effort mist-netting and banding stations to provide long-term demographic data on landbirds (DeSante et al. 1995). Although MAPS monitoring has not been used in Hawaii or the South and West Pacific, MAPS stations are run in other National Park units (e.g., Denali, Kings Canyon, Shenandoah, and Yosemite National Parks).

Goals and Objectives of MAPS

The specific goals of the MAPS program are to provide, for a suite of target species:

1. Annual estimates of adult survivorship, adult population size, and recruitment into the adult population from mark-recapture data on adult birds
2. Annual estimates of young, adult and total population size from age specific mark-recapture data on the numbers and capture probabilities birds captured

Based on fulfilling these goals, the long-term objectives of the MAPS program then are twofold. First, to provide annual demographic and population information on target landbird species that can be used to aid in:

1. Identification
    a. Thresholds and trigger points to identify the need for research and/or management actions
    b. Stage(s) in the life cycles at which changes in population dynamics are taking place,
    c. Testable hypotheses regarding the proximate demographic causes of population changes, and
    d. Management actions and conservation strategies to reverse population declines;
2. Evaluation of the effectiveness of the management and conservation actions implemented.

It is envisioned that MAPS programs in the PACN park units will provide one subset of sites for large-scale assessment of identifying demographic and population monitoring on target landbird species. The sampling strategy utilized should be hypothesis-driven and should be integrated with other research and monitoring efforts.

Questions to be Addressed and Hypotheses to be Tested

MAPS is basically a large-scale, long-term biomonitoring program. As such, the basic questions of MAPS are to obtain annual estimates of population and demographic parameters, including estimates of adult population sizes, indices of the numbers of young that reach independence from their parents, indices and/or estimates of productivity (the proportion of young in the catch), estimates of adult survivorship, and estimates of recruitment into the adult populations.

In order for MAPS data to be maximally useful, the establishment of stations and operation of the program should be designed to address specific questions or test specific hypotheses that will provide information as to the potential proximate causes of population change. Estimates of population and demographic parameters should be generated with capture-recapture models that allow for statistically valid variance estimates and inference, thus avoiding the possible bias associated with using indices (Kendall et al. 2004). Thus, information is provided to identify the potential conservation strategies and management actions needed to reverse declining populations (DeSante and Rosenberg in press).

The appropriate spatial and temporal scales are different for productivity than for survivorship considerations. Productivity indices produced by MAPS are landscape-specific, rather than site- or habitat-specific, and are calculated annually. In contrast to productivity indices, adult survival-rate estimates require three (for non-transient Cormack-Jolly-Seber [CJS] models) or four (for transient CJS models that rely on between-year recaptures to assess residency) consecutive years of data to provide an initial estimate. In addition, because the adults whose survival rate is estimated by MAPS are the adults that are resident on the study area (at least during the netting period), MAPS survival-rate estimates are site- or habitat-specific, at least as far as their breeding season survival is concerned.

Questions Addressed at Large (Regional or Island) Scales

MAPS data from a given park can be pooled with MAPS data from outside the park to provide regional (or even island) indices and estimates of (and longer-term trends in) key demographic parameters. Three important types of questions and associated hypotheses can be addressed using MAPS data pooled over regional or island scales:

1. How do productivity and adult survival-rate estimates vary spatially?
2. How does spatial variation in productivity estimates (or adult survival-rate estimates), if any, correlate with spatial variation in population trends?
3. What is the temporal variation (e.g., long-term trends) in productivity and adult survival-rate estimates and how does this temporal variation itself vary spatially?

Questions Addressed at Smaller (Local) Scales

At smaller scales, MAPS data from a given park can provide local estimates of (and longer-term trends in) productivity and survivorship. Several important types of questions and associated hypotheses can be addressed using MAPS data collected at these local scales:

1. How do productivity and adult survival-rate estimates differ between stations in the national park and stations in similar landscapes outside of the national park?
2. How do productivity estimates differ among stations in different landscapes within the national park itself, or among stations in similar landscapes that are subjected to different management actions?
3. What is the temporal variation (e.g., long-term trends) in productivity and adult survival-rate estimates of landbirds within the park and how are these trends affected by park management practices?

Experimental Design

Several considerations unique to MAPS data must be addressed at the outset. First, the estimation of demographic parameters is much more complex than the estimation of population sizes and trends. This is because the methodology requires the actual capture and banding of individual birds (which is always more difficult than the simple recording of distances of bird detected). Second, the models used for estimating demographic parameters (mark-recapture and loglinear poisson or logistic regression) typically are data-hungry, that is they require large sample sizes for adequate precision (Pollock et al. 1990, Lebreton et al. 1992). Given that most landbirds are territorial during the breeding season, very large or multiple sampling areas are required to obtain the requisite sample sizes. Third, the estimation of survival rates using transient models that rely on between-year recaptures to assess residency requires four years of data to obtain an initial survival-rate estimate (Pradel et al. 1997). Thus, even rough estimation of trends in survival rates are likely to require at least 10 years of data and probably more if survival is strongly influenced by annual fluctuations in weather (Rosenberg 1996). Thus, it is obvious that the monitoring of demographic parameters requires effort at multiple stations in the area under consideration, and requires that the effort be sustained over long time periods (i.e., several decades).

Four basic aspects must characterize the experimental design of the MAPS program in a national park. The first is the selection of the basic landscape-level habitat types, management actions, or questions to be addressed by the study design; second is number and distribution of stations; third is the selection of study sites; and fourth is the selection of target species. All four of these aspects must be considered together as they are all interdependent.

Basic Study Design

Productivity estimates generated at a MAPS station are landscape-level measures, rather than site-specific measures of productivity. This is because the young birds captured by the MAPS protocol are dispersing individuals from the surrounding landscape that were not necessarily produced within the boundaries of the 20 ha MAPS station. Thus, it is critical to consider the landscape-level characteristics of the habitat within which MAPS stations are sited. Although management actions occur on a site-specific basis, their effect on bird populations become pronounced only when the specific management actions occur over substantial portions of the landscape. The Project/Field Lead should choose the one (or two) most important broad habitat type(s) that best represent a majority of the area of the park and for which the park can provide "representative control" data for that (those) habitat(s) in the context of a regional or larger-scale monitoring strategy. This will maximize the value of the information obtained as control data for evaluating the affects of management actions. The Project/Field Lead should then determine the specific aspects of this habitat type, or the management actions that occur (or are anticipated to occur) on it, that they intend to monitor and evaluate.

Number and Distribution of Stations

A MAPS study design should then be established that includes either (a) six stations distributed along a gradient of landscape-level habitat types or management actions (e.g., an elevational gradient, a gradient in extent of forested area, or a gradient in the extent of visitor use); or (b) three stations in landscapes containing a given habitat type or management action and three stations in landscapes containing a different (control) habitat type or management action (or lack thereof). Six stations will permit an evaluation of spatial and temporal variation (or differences) in productivity, but not in survivorship. If within-park differences in survivorship are sought, or if interannual differences in survivorship are required, even for the park as a whole, the study design should include at least two sets of six stations each in a treatment-control framework.

The choice of six stations in the study design derives from two sources, the first involving logistic and personnel considerations. Two trained bird banders, by working an average of five days per week, can operate six MAPS stations for one day each in a ten-day period and have one day to make up missed effort caused by inclement weather or other unavoidable and unpredictable delays.

The second reason to choose six stations is because data from clusters of six stations facilitates the analysis of inter-station differences in productivity estimates through a logistic-regression approach (Rosenberg 1996, DeSante et al. 1997, Pyle et al. 1997), especially when these data can be pooled among stations with regard to landscape-level habitat or management characteristics. Furthermore, pooled data from clusters of six stations generally provide the minimum sample sizes of marked adults needed to obtain survivorship estimates with an acceptable degree of precision (about CV=20%; Rosenberg 1996, Pyle et al. 1997).

Locating MAPS Stations

It is also important to consider site-specific habitat characteristics when locating MAPS stations as these can influence the extent to which young birds concentrate at various stations. On the mainland, MAPS stations sited in forest-interior locations tend to produce lower productivity indices for most species than stations sited at locations that contain some forest-edge or scrub habitat (DeSante 1996); however, it is unknown if this pattern is relevant to island birds. Thus, stations should contain some forest-edge or scrub habitat in order to minimize site-specific sources of variation in productivity indices, and maximize landscape-level sources of variation.

Because of the need to operate each MAPS station once in each of six to ten consecutive 10-day periods during the breeding season, a further logistic consideration regarding the location of stations is that relatively easy access to the stations is needed. Thus, stations should be sited within about two km of roads.

DeSante (1998) suggest the following sampling strategy for locating six stations in a single national park:

1. Determine the specific habitat-type or management action (or gradient therein) for which monitoring information is desired.

2. Identify as many specific candidate sites that contain some forest-edge or scrub habitat and are located within about two km of a road.
3. Select the actual sites from the candidate sites by a probabilistic-based sampling strategy (e.g., a stratified random sample).

Selection of Target Species

Because of the need to obtain the required large sample sizes of adult and young birds captured in mist nets, target species must generally be relatively common species whose normal foraging and nesting haunts include the ground, shrubs, and/or lower levels of the canopy. In general, species that forage and/or nest high in the canopy usually cannot be captured in sufficient numbers to permit the indexing or estimation of primary demographic parameters with adequate precision unless nets are suspended in the canopy. Similarly, uncommon or rare species generally cannot serve as useful target species unless substantial effort is allocated to ensure sufficient captures.

It is also important that target species be those that occur in substantial numbers in both of the habitat types (or under both of the management actions) or throughout most of the gradient in habitat type (or management action) being investigated. In this manner, useful analyses can be conducted, for a given species, using landscape-level habitat information or management action as a covariate.

Finally, selection of target species should also include two additional considerations: (a) species which are unique to the individual park or for which the park provides important habitat or a significant proportion of the existing habitat for the species; and (b) species of local, regional, or island concern for which the park can provide important comparative data.

Other Considerations

Two additional ecological variables are of great importance in analyzing and interpreting data from the MAPS Program: (1) habitat characteristics and temporal variation of the immediate and landscape habitat; and (2) temporal variation in the weather (during and immediately prior to data collection) characterizing the landscapes in which the stations are sited. Such data and analyses are crucial for testing meaningful hypotheses regarding spatial (and temporal, if landscape-level habitat characteristics change over time) variation in the demographic parameters indexed and/or estimated by MAPS. Landscape-level information regarding (at least) total forest cover, major land cover types (using National Vegetation Classification Standard [NVCS] or Jacobi [1989] classifications), ages of forest cover, degree of fragmentation (e.g., mean [and variance] of patch size, and mean [and variance] of distance between patches), and management practices used will need to be determined. As such, the Project/Field Lead should plan for the collection of such GIS data.

Weather data are crucial for testing meaningful hypotheses regarding temporal variation in the demographic parameters, as well as hypotheses regarding appropriate information from other biomonitoring programs. It is also important to determine characteristics of (and temporal variation in) the weather associated with the landscapes in which stations or clusters of stations are sited. Examples of appropriate information would include (at least) summary data on the mean temperatures (high, low, and average) and precipitation during the previous breeding and post-breeding (summer and winter) seasons, and the current breeding season; and records of unusual weather events (large storms, high winds, major hot or cold spells). These data must be obtained from standardized weather-data-collection centers located as near as possible to the stations. As such, the Project/Field Lead should plan for the collection of such weather data.

Methods

The operation of each station will follow MAPS protocol, as established for use by the MAPS Program throughout North America and spelled out in the MAPS Manual (Burton and DeSante 1998). An overview of both the field and analytical techniques is presented here.

Data Collection

All birds captured during the course of the study will be identified to species, age, and sex, and, if unbanded, will be banded with a USGS Bird Banding Laboratory numbered aluminum band. The following data will be taken on all birds captured, including recaptures:

1. Capture code (newly banded, recaptured, band changed, unbanded)
2. Band number
3. Species
4. Age and how aged
5. Sex (if possible) and how sexed (if applicable)
6. Extent of skull pneumaticization
7. Breeding condition of adults (i.e., presence or absence of a cloacal protuberance or brood patch)
8. Extent of juvenal plumage in young birds
9. Extent of body and flight-feather molt
10. Extent of primary-feather wear
11. Fat class
12. Wing chord
13. Weight
14. Date and time of capture (net-run time)
15. Station and net site where captured

All data will be taken according to MAPS guidelines using standardized codes and forms. Effort data, the number and timing of net-hours on each day (period) of operation, will also be collected in a standardized manner. In order to allow constant-effort comparisons of data to be made, the times of opening and closing the array of mist nets and of beginning each net check will be recorded to the nearest ten minutes.

For each of the six stations operated, simple habitat maps will be prepared on which major habitat types, as well as the locations of all structures, roads, trails, and streams, will be marked. For each station, habitat information should be collected using the Habitat Data Form (see SOP 8), in addition to completing a habitat map.

Computer Data Entry and Verification

The Project/Field Lead will complete the computer entry of all banding data. All data for each banding record will be proofed against the raw data and any computer-entry errors will be corrected. The Project/Field Lead will complete computer entry of effort and habitat data. All banding data will then be run through a series of verification programs as follows:

1. Clean-up programs to check the validity of all codes entered and the ranges of all numerical data
2. Cross-check programs to compare station, date, and net fields from the banding data with those from the summary of mist netting effort data
3. Cross-check programs to compare species, age, and sex determinations against degree of skull pneumaticization, breeding condition (extent of cloacal protuberance and brood patch), and extents of body and flight-feather molt, primary-feather wear, and juvenile plumage
4. Screening programs which allow identification of unusual or duplicate band numbers or unusual band sizes for each species
5. Verification programs to screen banding and recapture data from all years of operation for inconsistent species, age, or sex determinations for each band number

Any discrepancies or suspicious data identified by any of these programs will be examined manually and corrected if necessary. Wing chord, weight, station of capture, date, and any pertinent notes will be used as supplementary information for the correct determination of species, age, and sex in all of these verification processes.

Data Analysis

Each species captured will be classified upon their breeding or residency status into one of the following five groups:

(B) regular breeder: Positive or probable evidence of breeding or residency within the boundaries of the MAPS station *during all* years that the station was operated.

(U) usual breeder: Positive or probable evidence of breeding or residency within the boundaries of the MAPS station *during more than half but not all of the years* that the station was operated.

(O) occasional breeder: Positive or probable evidence of breeding or residency within the boundaries of the MAPS station *during half or fewer of the years* that the station was operated.

(T) transient: Species was *never* a breeder or resident at the station, but the station was within the overall breeding range of the species.

(M) migrant: Evidence that the station was not located within the overall breeding range of the species.

Data for a given species from a given station will be included in productivity analyses if the species is classified as a regular (B), usual (U), or occasional (O) breeder or a transient (T) at the station. Data for a given species from a given station will be included in survivorship analyses, after collection of four years of data, only if the species is classified as a regular (B) or usual (U) breeder at the station. Data from a station for a species classified as a migrant (M) at the station will not be included in any analyses.

Population-size and Productivity Analyses

The banding data will be used to calculate for each species and for all species combined at each station and for all stations pooled:

1. Numbers of newly banded birds, recaptured birds, and birds released unbanded
2. Numbers and capture rates (per 600 net-hours) of first captures of individual adult and young birds
3. Proportion of young in the catch

Following the procedures pioneered by the British Trust for Ornithology (BTO) in their constant-effort sites (CES) Scheme, the number of adult birds captured will be used as an index of adult population size, and the number of young birds captured and the proportion of young in the catch will be used as indices of post-fledging productivity.

After the collection of two years of data, and then between subsequent years, changes in the indices of adult population size and post-fledging productivity will be calculated and the statistical significance of any changes that occurred according to methods pioneered by the BTO in their CES scheme will be determined. These year-to-year comparisons will be made in a "constant-effort" manner by using the actual net-run (capture) times and net-opening and -closing times on a net-by-net and period-by-period basis to exclude captures that occurred in a given net and given period in one year during the time when that net was not operated in that period in the other year. For species that are captured at several stations, the significance of park-wide annual changes in the indices of adult population size and post-fledging productivity will be inferred statistically using confidence intervals derived from the standard errors of the mean percentage changes. The statistical significance of the overall change at a given station will be inferred from a binomial test on the proportion of species at that station that increased or decreased.

Survivorship Analyses

After the collection of a minimum of four years of data survivorship analyses will be conducted, with time dependence being incorporated after a minimum of five years of data collection. Modified CJS mark-recapture analyses will be conducted using the computer program MARK (White and Burnham 1999) on four years of data from all stations. The species to be selected will be those for which on average at least eight captures of adults for every year of data were recorded at the six stations combined.

Estimates of survivorship parameters for each of the target species will be produced with two models. The non-transient model (SP) calculates maximum-likelihood estimates and standard errors (*SE*s) for adult survival probability (*S*) and adult recapture probability (*P*). Recapture probability is defined as the conditional probability of recapturing a bird in a subsequent year that was banded in a previous year, given that it survived and returned to the place it was originally banded. The non-transient model, however, does not account for the presence of transient adults in the population; this deflates the survivorship and recapture estimates. Four or more years of data allow the application of the transient model (SPG), which provides an estimate and standard error (*SE*) of the proportion of residents (*G*) among newly captured adults. In both models, these estimates are derived from the capture histories of all adult birds for each target species captured at all stations at which they were classified as regular (B) or usual (U) breeders (see above).

Having five years of data available for assessing the transient model will allow for considering both time-constant and time-dependent (variability as a function of time, *t*) models for each of the three parameters estimated in all possible combinations for a total of eight models. Spatial variability will not be explored among stations as individual stations do not produce sufficient data to provide valid estimates. Only models that produced valid estimates for both survival and recapture probability (i.e., estimates that are neither less than 0.1 nor greater than 0.9, which together bound the range of realistic estimates for survival and recapture probability in nature) will be considered. The goodness of fit of the models will be tested by using a Pearson's goodness-of-fit test. Of those models that fit the data, the one that produces the lowest Akaike Information Criterion (AIC) will be chosen as the optimal model; models showing AICs within 1.0 of each other are considered equivalent. The AIC will be calculated by multiplying the log-likelihood for the given model by -2 and adding two times the number of estimable parameters in the model.

Analyses of Trends in Adult Population Size

After the collection of a minimum of five years of data, trends in indices/estimates of adult population size (PSI) for target species that show at least an average of eight adult captures per year at all stations over the five years will be assessed. Constant-effort changes (as defined above) will be used to calculate these indices in each subsequent year by multiplying the proportional change between the two years by the index of the previous year and adding this figure to the index of the previous year, or simply:

$$PSI_{i+1} = PSI_i + PSI_i * d_i$$

where PSI_i is the population size index for year i and d_i is the proportional change in constant-effort numbers from year i to year i+1. A regression analysis will then be run to determine the slope of these indices over the five years. We will use the slope of this regression to provide an estimate of the population trend for the species, which is defined as the average change per year over the five-year period in the index of adult population size as determined from mist netting capture-rate data. If estimates of population size are produced, then variance-weighted log-linear regression will be used to assess population trend (see SOP 11 for detailed methods in calculating density estimates and assessing trends).

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Supplemental Materials 4. Breeding Biology Research and Monitoring Database (BBIRD)

Introduction to BBIRD

Species' presence may not reflect the health of a population. Thus, estimating reproductive success provides a demographic parameter needed to understand population change. Breeding productivity for target species (e.g., threatened and endangered species and birds of special interest) is determined at randomly located, replicate plots by searching for nests and monitoring them through fledging (detailed sampling methods are provided by Martin et al. 1997). The nation-wide monitoring program Breeding Biology Research and Monitoring Database (BBIRD; Martin et al. 1997; http://www.umt.edu/bbird/) provides a standard monitoring protocol. Monitoring programs that use BBIRD in conjunction with MAPS allow for tracking demographic parameters that can illuminate changes and causes in populations before changes become evident from survey data.

Goals and Objectives of BBIRD

Like MAPS, BBIRD monitors demographic parameters on target landbird species and the associated habitat types or management action strata. To quote Martin et al. (1997:6), the specific goals of the BBIRD program are to provide for a suite of target species:

- Monitor breeding productivity and associated habitat to determine status of population health and to provide an early warning signal of population problems.
- Provide baseline data on breeding productivity in healthy environments.
- Identify unhealthy habitats and conditions.
- Use information to implement management solutions to maximize probability of arresting problems early and prior to their becoming irreversible or cost-prohibitive.

Bird breeding productivity is more easily monitored than MAPS methods (which require capturing birds); although BBIRD is a more intensive survey method than distance sampling and PAO. Breeding productivity assesses breeding population health, and can be used to assess habitat suitability and demographic responses to management actions. Furthermore, breeding productivity results can be compared with larger regional patterns derived from other monitoring programs (e.g., distance sampling and PAO).

Questions to be Addressed and Hypotheses to be Tested

The BBIRD monitoring program is a local-scale, long-term monitoring program that provides patterns across broad geographical regions. BBIRD becomes maximally useful when monitoring is designed to address specific questions or test specific hypotheses that will provide information as to the potential proximate causes of population health and vulnerability to habitat change. Specific questions to be addressed are provided by Martin et al. (1997:5) "(1) identification of species' breeding habitat requirements, (2) assessment of current population health based on breeding productivity for a wide range of species throughout their breeding ranges, (3) early detection of population problems or benefits arising from land management programs, habitat change/fragmentation, or global warming, and (4) projection of species vulnerability to habitat disturbance and global climate change. The spatial scale at which questions and hypotheses can be addressed must correspond to the geographic scale over which data from replicate plots are pooled: the landscape scale. Data can be combined with surveys outside the park units to provide regional (or even island) long-term trends.

Experimental Design

BBIRD monitoring includes randomly located replicate plots nested within sites. The size and number of plots is dependent on the objectives and productivity of the habitat. Nests for all target species found within each plot are monitored to provide data on breeding productivity. Martin and Geupel (1993) and Martin et al. (1997) outline the protocols for nest searching and monitoring. Vegetation sampling is also conducted at each plot and for each nest, and is described by Martin and Roper (1988), Martin (1993), and Martin et al. (1997) detail some modification to vegetation sampling. Instead of using point counts in standard BBIRD protocol, to provide an index of population size (Martin et al. 1997), we suggest distance sampling methods, i.e. point-transect sampling, be used to determine population sizes.

Number and Distribution of Sites

At least 20 nests per species per site (geographic location and habitat type) need to be located and monitored (Hensler and Nichols 1981). Site size is dependent on the species, number of strata within sites and monitoring objectives. However, the minimum plot size should be 200 x 200 m (4 ha), and the number of plots should be sufficient to produce reliable variance estimates and avoid site-specific bias. A minimum of 3 sites per strata combination are needed to produce variance estimates, and more variable strata may require substantially more sites to produce reliable estimates.

Selection of Target Species

BBIRD sampling is a labor intensive monitoring program, and, as such, the species being monitored should be carefully selected. Breeding productivity should be assessed for focal native and alien landbirds whose population health is unknown or in jeopardy (see Appendices F and G). BBIRD sampling may be applicable for threatened and endangered species, although sample size may limit reliable parameter estimation, and species that are undergoing rapid population changes (e.g., iiwi contraction in the Central Windward region of Hawaii Island, Gorresen et al. 2005).

Covariable Data

BBIRD relies on two covariates: (1) vegetation, and (2) population size. These are critical elements of a BBIRD monitoring program and we strongly encourage proper protocol procedures. Sampling and recording vegetation covariate data is described in Martin et al. (1997), and literature cited therein. Population size should be determined using point-transect sampling methods (this study).

Methods

Sampling procedures should follow the recommendations of Martin et al. (1997). We recommend one change in the procedures: that point-transect sampling be carried out instead of point count sampling. In general, nests are located and revisited every 2–5 days to monitor clutch size, onset of incubation, date of hatching, and fate of the nest. Several precautions outlined in Martin and Geupel (1993) should be followed to reduce the risk of observer-induced effects on nest success. Concurrent to nest monitoring, point-transect sampling should be conducted to estimate population size. After the nesting period, habitat data should be collected.

Data Collection

The BBIRD Field Protocol (Martin et al. 1997) contains the data collection forms and information on how to properly complete them, detailed methods for establishing study plots, and proper methods for finding and monitoring nests. In addition, the BBIRD Field Protocol provides information on describing nest location and vegetation on the plots. We recommend that these procedures be followed and data collected on the forms provided in the BBIRD Field Protocol.

Computer Data Entry and Verification

The Project/Field Lead will complete the computer entry. A data entry menu and database needs to be created. This database should comply with standards of both I&M and BBIRD (Martin et al. 1997). After data have been entered, a two step verification process will be implemented to ensure data quality. This entails line-item checking each record between the field books and database (which is done in the form), and a random spot-checking process to document transcription error rate. Any discrepancies should be corrected promptly.

Data Analysis

Nests that fledged at least one young are considered successful. Daily survival rates are calculated using the Mayfield (1961, 1975) method and subsequent improvements to the method. Nest success should be calculated separately for the incubation and nestling periods because daily survival rates are often different between the stages. Analyses can be conducted in the program MICROMORT (Heisey and Fuller 1985) and comparisons of Mayfield nest success between plots, years and strata using the program CONTRAST (a Chi-square analysis with multiple comparisons; Sauer and Williams 1989).

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Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 1: Before the Field Season

Version 1.00 (September 2010)

Revision History Log

Prev. 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, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Tables

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Abstract

This SOP outlines the steps to prepare for a field season and ensures that the proper equipment is available prior to the start of monitoring.

Organization Contact Information
National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm.

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Original Author and Affiliation
Peitz, D. G., S. G. Fancy, L .P. Thomas, and B. Witcher. 2002. Bird Monitoring Protocol for Agate Fossil Beds National Monument, Nebraska and Tallgrass Prairie National Preserve, Kansas. Unpublished report. Prairie Cluster Prototype Monitoring Program, National Park Service, U.S. Department of the Interior. Version 1.00 (September 6, 2002).

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Equipment Specification Disclaimer
Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Procedures

Prior to each sampling occasion all observers should review the entire landbirds monitoring protocol, including SOPs. Safety procedures are detailed in SOP #2. Review of bird identification by sight and sound (SOP #3) is particularly important; misidentification of a species is perhaps the most serious error you can make during a bird count. Misidentification is much more serious than errors in estimating distances or double-counting a bird. This SOP also gives a brief description of how bird monitoring should be scheduled at PACN park units. Preseason planning facilitates the completion of both bird surveys and habitat work. All observers should follow the outlined field schedule to avoid double sampling of sites or initiating habitat work on a site prior to it being sampled for birds. 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 forms in Appendix A should be made. All field data forms should be copied to waterproof paper.

General Preparation and Review

Notebooks

Notebooks and trip reports from previous surveys should be reviewed to identify any unique events that may be encountered. A field notebook for the survey year should be prepared with pages for entry of sampling schedules, observer names, field hours and unique happenings that may influence how the data are reported. Trip reports are based on information recorded in field notebooks so it is imperative that they are clearly organized for ease of field note entry.

Compile Species Lists

Prior knowledge of species most likely to be encountered in a park will aid observers in preparing for the birding season. Therefore, species lists from previous birding efforts in a park or local area should be compiled and compared to reference manuals to identify species that have a probability of being detected. Copies of these combined species list should be carried into the field as quick references in helping to identify unknown birds. Appendix B lists terrestrial avian species reported on islands with PACN park units.

Load Waypoints

Waypoints for each point-transect station must be loaded onto the GPS unit prior to the start of the field season. Waypoints are the X and Y coordinates for each point-transect station and are used to navigate to their location. SOP #4 contains information on preparing maps, images and sampling station locations. SOP #5 describes how to use GPS units, including uploading and navigating to waypoints. Copies of waypoint lists should be carried into the field to ensure that each station is located; this is especially relevant for permanent stations (fixed panel sample sites).

Scheduling Field Work

Sampling Dates

Bird surveys will be conducted from January through June for Hawaiian parks, and July through November for NPSA units, periods that coincide with the peak-vocalization for most birds. This allows for approximately 180 days to sample Hawaiian park units and 150 days to sample NPSA units. Inclement weather and personnel workloads will preclude the scheduling of sampling events to specific annual dates. Sampling dates should be scheduled and logistics organized prior to the start of each field season. Completion of habitat monitoring needs to be scheduled for no later than the end of the bird sampling; changing habitat conditions require this in order to correlate bird populations with habitat type.

Crew

Monitoring within each PACN park will require two, two person crews. Ideally the surveyors will collect both birds and habitat data.

Timing and Collection

Ten point-transect station counts should be scheduled for each field day and multiple field trips, up to ten days in length, will be required to complete the bird and habitat surveys within the allocated sampling period. Transects separated by the least amount of distance should be scheduled for completion within the same day and field trip. Determine which stations will be sampled for habitat measures based on the order they will be sampled for birds. Habitat sampling should only be done on stations already sampled for birds and after the morning survey is completed to minimize bird disturbance.

Transportation

Most transects and sampling stations can be reached by vehicles and hiking, however, helicopter transportation is required for HALE and the Northwest unit of HAVO (Table 1). One four-wheel drive field vehicle can be shared between the two crews for each field season.

Organizing Supplies and Equipment

Review Equipment Lists

An equipment list should be compiled, and equipment organized and made ready prior to the field season. Time to make needed repairs and order equipment should be allocated before the fieldwork starts; we suggest at least two months in advance. Table 2 provides a list of field equipment needed for each crew.

Field Data Forms

Copies of the field data forms should be made on waterproof paper (e.g., Rite-in-the-rain waterproof paper). Field forms can be found in Appendix A of this SOP. See SOPs #7 and #8 for examples of how to properly fill out the forms.

Table SOP 1.1. Transportation requirements to reach transect and sampling stations.

Park/Tract	Transportation
HALE	Field vehicle (1 shared between 2 crews) and helicopter transportation
HAVO – Olaa	Field vehicle (1 shared between 2 crews)
HAVO – East Rift	Field vehicle (1 shared between 2 crews)
HAVO – Mauna Loa Strip	Field vehicle (1 shared between 2 crews)
HAVO – Kau	Field vehicle (1 shared between 2 crews)
HAVO – Honomalino	Field vehicle (1 shared between 2 crews)
HAVO – South Flank	Field vehicle (1 shared between 2 crews)
HAVO – Northwest	Field vehicle (1 shared between 2 crews) and helicopter transportation
HAVO – Papa	Field vehicle (1 shared between 2 crews)
NPSA – Tutuila	Field vehicle (1 shared between 2 crews)
NPSA – Tau	Field vehicle (1 shared between 2 crews)

Table SOP 1.2. Field equipment list for bird and habitat sampling, and installing fixed station markers.

Number Req.	Description
	Bird Surveys
1	Bird identification notebook with species separated by parks
1	10 x 48 or better binoculars
1	Rangefinder (1000 yd. range)
1	Tape recorder for recording unknown bird calls
1	Celsius thermometer
1	GPS unit for navigating to sampling sites
1	Altimeter
1	100 m measuring tape
1	Hip-chain and string
	Habitat Work
2	1.27-cm x 1-m PVC pipe for measuring slope
1	English clinometer for measuring slope
1	Densiometer for measuring canopy cover
1	0.15 x 2.0-m horizontal structure board
1	50-m tape
	Both Elements of Bird Monitoring
several	Maps of survey area with survey points and pick-up locations marked
several	Field notebooks and data forms (for both bird and habitat surveys)
2	Compass for direction between plots and to find subplot azimuths and aspects
2	Clip boards for recording data and carrying data sheet
4	Cruising vest for carrying equipment (backpack and hip packs may be substituted)
several	Re-sealable plastic bags or water tight “dry bags”
2	Two-way radios for communication between crews
several	Reference books for bird and plant identification
several	Flagging (florescent pink works well)
several	Pens, pencils and Sharpies or other permanent markers
several	Insect repellent
several	Sunscreen
1	First Aid kit
several	Batteries, and charger if using rechargeable batteries
1	Wrist watch
	Installing fixed station markers
1 / station	1 cm (3/8”) X 0.75 to 1-m stainless steel threaded rod
1 / station	1-m long pvc white pipe with inner diameter of 1-cm and cap
1 tube	Powerfast Epoxy

Table SOP 1.3. Field equipment list for bird and habitat sampling, and installing fixed station markers (continued).

2	2 or 5 lb. Sledge hammer
1 / station	Aluminum tags
-	***Coordinates, compass headings, and maps of station locations***
1	GPS
1	Compass
2	Latex gloves
2	Ball point pen to write on aluminum tags

Reference Manuals

Suggested reference manuals for bird surveys at PACN park units:

Muse, C., and S. Muse. 1982. The birds and birdlore of Samoa. Pioneer Press, Walla Walla, Washington, U.S.A.

Pratt, D. H., P. L. Bruner, and D. G. Berrett. 1987. A field guide to the birds of Hawaii and the Tropical Pacific. Princeton University Press, Princeton, New Jersey, U.S.A.

Wattling, D. 2001. Birds of Fiji and Western Polynesia: Including American Samoa, Jiue, Samoa, Tokelau, Tonga, Tuvala and Wallis-Futuna. Environmental Consultants (Fiji) Ltd., Suva, Fiji.

Suggested reference manuals for habitat surveys at PACN park units:

Jacobi, J. D. 1989. Vegetation maps of the upland plant communities on the islands of Hawaii, Maui, Molokai , and Lanai. Cooperative National Park Resources Studies Unit Technical Report 68. University of Hawaii at Manoa, Department of Botany, Honolulu, Hawaii.

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Appendix SOP 1A. Data Forms for Bird and Habitat Surveys

PACN Landbird Bird Monitoring Data Sheet

ParkCode	Tract		
Obs	Transect	Station	
Date	Start	End	
Temp	Noise	GPS	
Cloud	Rain	Wind	Gust

Pheno										

Bird Sp	Dist	DT	Dist	DT	Dist	DT	Dist	DT	Dist	DT

Comments:

PACN Landbird Habitat Monitoring Data Sheet (continued).

Park Code: ___________ Date (m/d/y) ________________ **Observer(s) Initials: ________________**

Mgmt. Unit: ________ **Transect:** _______ **Station:** _______ **UTM: ___________________________**

PLOT ATTRIBUTES: (50m radius)

Slope (%): ________ **Var:** high med low **Aspect (°):** _______ **Var:** high med low
Topographic position:
level lower-slope mid-slope upper-slope escarpment/face ledge crest depression draw
Road Cover (%): Paved ______ Unpaved ______ **Water Cover (%):** Stream ______ Pool _____

HABITAT ATTRIBUTES: (50m radius)

Canopy Cover: _______ **Canopy Height:** _______ **Canopy Composition:** ___________________
Understory Species Composition: _____________________

DENSITY BOARD:

15-m distance: 0.50 m: _______ 1.0 m: _______ 1.5 m: _______ 2.0 m: _______

Plot Notes: ____

Appendix SOP 1B. Terrestrial Avian Species by Park

Table B1. Terrestrial avian species of Hawaii. Presence by island is indicated (Ne = Native endemic, Ni = Native indigenous, E = endangered, I = introduced, M = migrant, R = resident, and -- = not present).

Table B1. Terrestrial avian species of Hawaii.

Scientific Name	Common Name	Nativity	Hawaii	Maui
Bubulcus ibis	cattle egret	I	R	--
Nycticorax nycticorax	black-crowned night-heron	Ni	R	R
Branta sandvicensis	Hawaiian goose	Ne	R, E	R, E
Anas platyrhynchos	mallard	Ni	M	--
Anas wyvilliana	Hawaiian duck	Ne	R, E	--
Buteo solitarius	Hawaiian hawk	Ne	R, E	--
Alectoris chukar	chukar	I	R	R
Francolinus pondicerianus	gray francolin	I	R	R
Francolinus francolinus	black francolin	I	R	R
Francolinus erckelii	Erckel's francolin	I	R	--
Coturnix japonica	Japanese quail	I	R	R
Gallus gallus	red junglefowl	I	R	R
Lophura leucomelanos	kalij pheasant	I	R	--
Phasianus colchicus	ring-necked pheasant	I	R	R
Pavo cristatus	common peafowl	I	R	R
Meleagris gallopavo	wild turkey	I	R	R
Callipepla californica	California quail	I	R	R
Callipepla gambelii	Gambel's quail	I	R	--
Fulica alai	Hawaiian coot	Ne	R, E	R, E
Pterocles exustus	chestnut-bellied sandgrouse	I	R	--
Columba livia	rock dove	I	R	R
Streptopelia chinensis	spotted dove	I	R	R
Geopelia striata	zebra dove	I	R	R
Zenaida macroura	mourning dove	I	R	--
Psittacula krameri	rose-ringed parakeet	I	R	R
Tyto alba	barn owl	I	R	R
Asio flammeus	pueo	Ne	R, E	R, E
Corvus hawaiiensis	alala	Ne	E	--
Chasiempis sandwichensis	Hawaii elepaio	Ne	R	--
Alauda arvensis	sky lark	I	R	R

Table B1. Terrestrial avian species of Hawaii. (continued)

Parus varius	varied tit	I	R	R
Pycnonotus cafer	red-vented bulbul	I	R	R
Cettia diphone	Japanese bush-warbler	I	R	R
Copsychus malabaricus	white-rumped shama	I	--	R
Myadestes obscurus	omao	Ne	R	--
Garrulax canorus	hwamei	I	R	R
Leiothrix lutea	red-billed leiothrix	I	R	R
Zosterops japonicus	Japanese white-eye	I	R	R
Mimus polyglottos	northern mockingbird	I	R	R
Acridotheres tristis	common myna	I	R	R
Sicalis flaveola	saffron finch	I	R	--
Paroaria coronata	red-crested cardinal	I	--	R
Paroaria capitata	yellow-billed cardinal	I	R	--
Cardinalis cardinalis	northern cardinal	I	R	R
Carpodacus mexicanus	house finch	I	R	R
Serinus mozambicus	yellow-fronted canary		R	--
Psittirostra psittacea	ou	Ne	R, E	R, E
Loxioides bailleui	palila	Ne	R, E	--
Pseudonestor xanthophrys	Maui parrotbill	Ne	--	R, E
Hemignathus virens virens	Hawaii amakihi	Ne	R	--
Hemignathus virens wilsoni	Maui amakihi	Ne	--	R
Hemignathus munroi	akiapolaau	Ne	R, E	--
Oreomystis mana	Hawaii creeper	Ne	R, E	--
Paroreomyza montana	Maui alauahio	Ne	--	R
Loxops coccineus ochraceus	Maui akepa	Ne	--	R, E
Loxops coccineus coccineus	Hawaii akepa	Ne	R, E	--
Vestiaria coccinea	iiwi	Ne	R	R
Palmeria dolei	akohekohe	Ne	--	R, E
Himatione sanguinea	apapane	Ne	R	R
Melamprosops phaeosoma	poouli	Ne	--	R, E
Passer domesticus	house sparrow	I	R	R
Uraeginthus bengalus	red-cheeked cordonbleu	I	R	--
Estrilda caerulescens	lavender waxbill	I	R	--
Estrilda melpoda	orange-cheeked waxbill	I	--	R
Estrilda troglodytes	black-rumped waxbill	I	R	--
Amandava amandava	red avadavat	I	R	R
Lonchura malabarica	African silverbill	I	R	R
Lonchura punctulata	nutmeg mannikin	I	R	R
Padda oryzivora	Java sparrow	I	R	R

Table B2. Terrestrial avian species of NPSA. Presence by island is indicated (Ne = Native endemic, Ni = Native indigenous, E = endangered, I = introduced, M - migrant, R - resident, V - visitor, and -- - not present).

Scientific Name	Common Name	Nativity	Tutuila	Tau
Gallus gallus	red junglefowl	I	R	R
Rallus philippensis	banded rail	Ni	R	R
Porzana tabuensis	spotless crake	Ni	R, CE	R
Porphyrio porphyrio	purple swamphen	Ni	R	R
Columba livia	rock dove	I	V	--
Gallicolumba stairi	friendly ground-dove	Ni	--	--
Ptilinopus perousii	many-colored fruit-dove	Ni	R	R
Ptilinopus porphyraceus	purple-capped fruit-dove	Ni	R	R
Ducula pacifica	Pacific pigeon	Ni	R	R
Vini australis	blue-crowned lorikeet	Ni	V	R
Eudynamis taitensis	long-tailed cuckoo	Ni	M	M
Tyto alba	barn owl	Ni	R	R
Aerodramus spodiopygius	white-rumped swiftlet	Ni	R	R
Halcyon chloris	white-collared kingfisher	Ni	R	R
Pycnonotus cafer	red-vented bulbul	I	R	--
Clytorhynchus vitiensis	Fiji shrikebill	Ne	--	R
Aplonis atrifusca	Samoan starling	Ne	R	R
Aplonis tabuensis	Polynesian starling	Ni	R	R
Acridotheres tristis	common myna	I	R	--
Acridotheres fuscus	jungle myna	I	R	--
Myzomela cardinalis	cardinal honeyeater	Ni	R	--
Foulehaio carunculata	wattled honeyeater	Ni	R	R
Gymnomyza samoensis	mao	Ne	R, E	--

Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 2: Safety Protocol

Version 1.00 (September 2010)

Revision History Log

Prev. 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, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This SOP outlines the steps to prepare for a field season and ensures that the proper equipment is available prior to the start of monitoring.

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm

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Original Author and Affiliation

Kozar, K. 2010. National Park Service, Inventory and Monitoring Program. Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718.

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This SOP was generated and reviewed by PACN staff. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Purpose

This SOP explains safety procedures that all field crew members should follow to ensure optimum safety when working in the field to monitor Pacific Island Network (PACN) focal terrestrial plant communities. Part of this SOP covers material found in Pacific Cooperative Studies Unit (PCSU) field operation SOPs (2010), while other parts cover material from a Wilderness Hiking and Backpacking Training workshop for PACN Inventory and Monitoring employees held in January 2007.

PCSU Procedures

The PCSU is part of the national network of Cooperative Ecosystem Studies Units established to provide technical assistance and research to environmental and resource managers at organizations such as the NPS. Field personnel should 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.

Field Personnel Rules and Regulations

1. 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. The project lead should always be consulted if there are uncertainties regarding someone’s eligibility to accompany the field crew.
2. Field work will be planned ahead of departure and discussed with a supervisor. On a daily basis, park personnel will be notified of the itinerary and destination (including plot location where appropriate) of the field crew and the estimated return time. A contact person should be chosen at the park that will be responsible for notifying a Safety Officer if a field person is injured.
3. Field crew members must avoid working alone and should never traverse difficult terrain without another crew member. If travel by vehicle alone during working hours is needed, the crew member will notify a park contact person or supervisor. Whatever the case, the individual must ensure that someone knows of their location and expected return time. A radio or cellular phone is required when working off the road or in a remote area.
4. When working in the sun, members of the field crew should wear a hat and a pair of sunglasses to protect themselves from harmful ultraviolet rays. Sunscreen should be applied to exposed skin.
5. Be aware of weather forecasts and changes in the weather, and be prepared to alter field work and clothing accordingly.
6. Learn how to lift heavy objects properly. Ask for help when lifting heavy objects.
7. In areas concerning safety of field personnel, the on-site supervisor’s decision is final. However, an individual still may refuse to engage in what they believe is an unsafe operation.
8. 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.

9. 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.
10. Vehicles must be operated safely and in a manner consistent with Standard Operating Procedures for Vehicles for the agency whose vehicle is being utilized. A supervisor should be asked for a briefing on the procedures before any field crew members operate the vehicle for the first time.
11. Know the Emergency Action Plan.

Emergency Action Plan

1. The contact person 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. Thirty minutes after call-in time, an alert is issued. The contact person or another person should stay near the phone in case field personnel call.
3. One hour from call-in time, search procedures should begin. Note: Prior to going into the field, the field leader and park contact person should agree on a time when search procedures should begin, as it may be more appropriate to set an alternate time to begin search procedures.
4. One person should remain near the phone, and one person familiar with the field area should begin tracking the scheduled route.
5. 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.
6. Tracking continues until the person is found or word is received that the field personnel are safe.

Emergency Response Plan

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. Notify any supervisory personnel and provide them with the same information. Notify the local park manager for the relevant national park.

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 unplanned overnight stay in the field.
3. Each field person shall carry water with them 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 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 at least 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 waterproof matches (kept in a sealable plastic bag or waterproof container), a space blanket, a whistle and a flashlight or headlamp in their pack.

Portable Radios

The most important thing that field crew members should know about the Bendix King R-31 (14 channel) portable radio is that it is a communication tool that helps to ensure the safety of staff in the field. Portable radios allow other staff in the park to know the location and status of crew members in the field. Because crew members 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 scientific observations if field crew members are some distance apart. Field crew members should have a working knowledge of the protocols for communicating with the radios, and a basic understanding of how to use them. Procedures for using radios effectively and appropriately are listed below. Note that some of the procedures below relate specifically to HAVO, and may require some modifications when working in other parks. Thus before entering the field in other parks, be sure to discuss current radio SOPs with park personnel.

1. Read and review the user guide, if available. Also review the radio call numbers and radio channels. Field crew members should photocopy the list of radio call numbers and take it with them into the field as a reference.
2. Whenever the portable radio is not in use (i.e., when crew members are back at the office or base yard), 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 office, and should be assigned to field crew members at the beginning of the season.
3. Before going into the field, take an extra battery from a charging unit.
4. Before traveling into the field, park dispatch must be notified. The field leader will inform Dispatch of the field plans and the estimated time of arrival (ETA) back at the departure point. For example within HAVO, you might contact the **Pacific Area Communications Center (808-985-6170)**, tell them you are working at HAVO on Mauna Loa and provide your ETA as 1700 hr at HAVO Visitor's Center. This is important because it provides the dispatch station with your general location in the event of an emergency. Follow the procedures listed below for HAVO:
    - Turn on the radio by turning the on/off volume control dial clockwise, until it is facing about 11 o'clock. The LED indicator should show a green light, indicating that the battery is charged and the unit is on.
    - There are four channels used on the HAVO radio system:

- **Channel 1 –** This is a direct channel, used for short, line of sight distances. It is used for talking to another field crew member close by. Employees in other areas of the park do not hear their conversations using Channel 1.
- **Channel 2 –** The repeater for Channel 2 is located at the Summit of Mauna Loa. This channel is used to reach all areas of HAVO except for some areas located at the Kahuku Ranch portion of the park. Channel 2 is the channel to use most of the time you are using the radio,
- **Channel 3 –** The repeater for Channel 3 is located at the South Point on the Big Island. This channel is used for the Kahuku Ranch area, as well as along the coastal areas of HAVO.
- **Channel 4 –** The repeater for this channel is located on Kulani Cone. This channel is used by field personnel working in remote forests of HAVO.

- Press and firmly hold down the push-to-talk (PTT) button, and speak into the microphone. The LED indicator will show a red light, indicating that the speaker's communications are being broadcast through the radio.
- Inform the dispatcher of travel plans and ETA back at departure point.

5. While in the field, keep the radio on with the volume loud enough to hear and respond to any communications directed at the designated radio call number (TBD).
6. In most situations, it will not be necessary to communicate with anyone while monitoring plant communities. If arrival off-trail will be later than the previously stated ETA, inform dispatch of the revised ETA as soon as possible.
7. If work requires that two paired field crew members to be separated by physical distance, the channel selector dial should be turned to Channel 1 so crew members can freely communicate with one another, while leaving the regular airwaves of Channels 2, 3 and 4 open for park-wide use. Return to Channel 2 when crew members are together.
8. When returning from the field, contact dispatch again to let them know the field crew is safe: for example, "Dispatch, off trail at 2100 hours."
9. After signing off with dispatch, return the radio to the charger unit, and make sure the radio is turned off while charging. Return the extra battery to the battery charger.
10. Follow the protocols listed below as general guidelines for appropriate use of the radio:
    - Each division within HAVO has a series of Call Numbers. Each employee is assigned a Call Number from the series of the Division they are working in. Example: Maintenance employees call numbers all start with 200, 201, 202, etc.
    - When communicating with the radio, always begin by stating the call number of the person you are trying to reach, followed by your own. For example, state: "505, 301", or "Volcano Dispatch, 301." Then the dispatcher will come on the radio and say "301, this is dispatch." Then let the dispatcher know the reason for the radio transmission.
    - After keying the radio, wait a second before speaking into the radio. This prevents the start of the radio communication from being cut off.
    - Be brief and concise when communicating with the radio. This keeps the airwaves clear and saves battery power.

- Speak clearly into the radio's microphone, and press the PTT button firmly while speaking.
- Think about what needs to be relayed before calling on the radio.
- If your transmission is longer than 30 seconds, you must take a "break", which means you must say "break", take a breath, listen for any other traffic and then resume your transmission to dispatch if there is no other traffic. The "break" allows for someone else to interrupt the transmission is there is an emergency.
- Securing the Radio Channel: During park emergencies or certain incidents, the dispatch office will "SECURE THE RADIO FREQUENCY." When this happens, the only traffic on the radio should relate to the ongoing incident. If there is an emergency that happens during an ongoing incident, then use the radio for that. Otherwise, there should be no radio traffic until the original incident is done and then the dispatchers will "RELEASE THE FREQUENCY TO NORMAL TRAFFIC." If you have not been listening to the radio, you might not know there is a situation going on in the park. So, when turning on the radio, give a minute of time to listen for any ongoing radio traffic.

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

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).
5. Be conscious of surroundings – when disoriented, familiar objects can set you on track. Even if you have a GPS, carry a compass, and an area (field) map showing locations of pertinent transects, plots, roads, trails, and other landmarks. These items may prove invaluable especially in fog, rain or darkness.
6. Always be sure someone at the park knows where you are and when you are expected to return.
7. Never overextend your capabilities.
8. Be sure permission is GRANTED before entering private property.
9. Report accidents immediately to your supervisor.
10. Use common sense.

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 downhill, as it will almost certainly go over a waterfall at some time. Do not travel at night.

Hiking and Backpacking Techniques

Worker injuries, in addition to causing physical harm, directly impact projects by reducing personnel and funds available for project research. Although most workers possess a reasonable degree of wilderness hiking knowledge and experience, the hazards of wilderness hiking or backpacking should not be taken for granted. A large number of injuries result from slips, trips, and falls while hiking. Just like any other work activity, hazards must be identified, safe procedures and techniques must be developed, and workers must be trained to perform tasks safely.

The general training material below (taken from the January 2007 training course on Wilderness Hiking and Backpacking) 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.

Section 1: Individual Levels of Physical Conditioning, Knowledge, and Experience for Wilderness Hiking and Backpacking

- Years of experience
- Types of terrain and elevation changes
- Climate and environmental conditions
- Length and duration of hikes
- Types of gear and/or work equipment utilized
- Amount of weight carried
- Types of physical conditioning
- Types of wilderness activities
- Participation in hiking/climbing organizations
- Training and/or certifications from hiking/climbing organizations and/or employers
- Involvement in wilderness work activities requiring hiking (i.e. Resource Management, Hunting, Surveying)

Section 2: Hazards Involved in 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 to include: Lightening, Heavy Rain, Windstorm, Misty /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 3: Procedures and Techniques 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.
- The stations are the sampling units, not the transects; therefore, transects are just a means of locating the sampling stations. Observers do not necessarily need to traverse the transects. For example, if stations are located below a ridge, observers can traverse along the ridge, drop down to the stations, conduct the count, and hike back up to the ridge top before traversing to the next station and dropping down again. This will eliminate the safety concern of traversing difficult terrain.
- High-visibility bright colored clothing is required for all field operations to more readily locate workers in the wilderness. Long and short-sleeved shirts may be 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” (20 cm) 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 one third 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 do not 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 (e.g., 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-foot minimum) to avoid being struck by branches and tools. Stagger spacing when on 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, a native 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 you 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 offs. Appropriate footwear with traction (tabis, (Japanese fisherman’s shoes), 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. Do not drink stream or pond water without first filtering and treating to eliminate harmful organisms, including *Giardia lamblia* and *Leptospira interrogans*.
- 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. Remember that 25% of your body heat is lost through your head, so cover your head. 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. If you are lost, the best action for survival is find or create shelter. Shelter will keep you alive longer than food, water and fire.

- 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.

Travel in Vehicles

Follow the guidelines below for vehicle use:

1. You must have a valid driver's license before driving any vehicle whether on the road or off-road.
2. Persons not experienced in four-wheel driving may require training in off-road driving.
3. Always carry emergency equipment (i.e., first aid and basic survival kit and car jack).
4. Always be sure someone in the park knows where you are going and when you are expected to return.
5. On private land the owners and their workers have the right of way. Drive slowly so as not to kick up dust.
6. Any vehicle being used to reach sampling sites should be inspected prior to use.
7. Report any vehicle problem immediately to the supervisor and maintenance.
8. Report accidents to your supervisor immediately.
9. Use common sense.
10. Obey the rules of the road even when driving off-road.
11. Driving safety policies are listed in NPS Reference Manual 50B, Section 6.0 Motor Vehicles

Travel in Helicopters and on Commercial Flights

If you will be flying in helicopters for work related activities, you are required to take the Basic Aviation Safety Training. See your supervisor for details about participating in the Aviation Safety Program. If you will be flying on commercial airlines, you are not permitted to take any fuel for cook stoves or have it packed in your luggage. All fuel must be purchased at your destination. It is also prohibited to fly commercially with any fuel containers (even if they are empty) or stoves using fuel containers that have previously contained fuel. You can be fined and/or arrested for attempting to bring these items on commercial airlines. For a listing of what is not allowed on commercial airlines, visit the Federal Aviation Administration (FAA 2010) or the Transportation Security Administration (TSA 2010) websites.

Health Concerns

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

Leptospirosis

There is a known risk of contracting leptospirosis in Hawai'i and American Samoa. This is a disease caused by bacteria (*Leptospira interrogans*) that are transmitted from animals to humans. 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. It is inadvisable to drink or swim in potentially contaminated water (i.e., streams and ponds). The last outbreak in American Samoa was reported in 2004, which appeared to be related to contamination of streams from pig farms (Goldberg 2010). Avoid entering freshwater if you have breaks in the skin.

If two to 20 days after working in or around a stream, you experience flu-like symptoms that persist for more than two days, consult a physician and inform him/her that you may have been exposed to *L. interrogans* bacteria. If you come down with any severe fever or disease, ask your doctor to consider whether there are any unusual diagnoses that should be considered because of your fieldwork.

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Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 3: Training Observers

Version 1.00 (September 2010)

Revision History Log

Prev. 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, 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 explains the training procedures that all observers should follow to learn how to identify birds by sight and vocalizations, how to estimate distances in the field, and how to collect habitat description data.

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm

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Original Author and Affiliation

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Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Procedures

Prior to each sampling occasion all observers should review the entire landbirds monitoring protocol, including SOPs. Preseason training of bird identification by sight and sound is of utmost important. All observers should be proficient at distance estimation. To facilitate this, all observers should participate in a pre-survey calibration and training program.

Identification of Birds by Sight and Vocalizations

The most essential component for the collection of credible, high-quality bird data is well-trained and experienced observers. This cannot be overemphasized. Proficient bird observers obtain species estimates within 90% of total species known to be present and estimate abundance within 80% accuracy (Ralph et al. 1993). Various studies have shown that observer bias is one of the most noteworthy bias factors in trend analysis of songbird populations (Kepler and Scott 1981, Baker and Sauer 1995). Before conducting VCP counts, read "Reducing bird count variability by training observers" by Kepler and Scott (1981) for a detailed discussion of training observers to identify birds by sight and sound as well as training them to estimate distances.

1. See SOP 1 Appendix B for a list of bird species likely to be encountered at PACN parks.
2. Prior to the field-season, observers should review and practice bird identification skills (see reference materials below).
3. Observers should pass a minimum proficiency test on the vocalizations and sight ID of bird species likely to be encountered, correctly identifying all common species likely to be encountered and 90% of the less frequently encountered species (i.e. species encountered less than ten times annually).
4. Regardless of skill level, observers should spend time in the field familiarizing themselves with the birds in a park prior to starting a survey.

Suggested reference materials for conducting bird surveys at PACN parks:

- Tapes or CDs of bird songs for species found in PACN parks. These tapes and CDs are produced and available from Cornell Laboratory of Ornithology's Library of Natural Sounds.
- National Audubon Society Interactive CD-ROM Guide to North American Birds. This interactive CD-ROM is an excellent resource for learning calls, site ID and background information. Although their application may be of limited value for Hawaiian and NPSA bird species.
- Bird slides of species likely to be encountered can be obtained from Cornell Laboratory of Ornithology.
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Estimating Distances to Birds Seen or Heard

Read the paper "Reducing bird count variability by training observers" by Kepler and Scott (1981) for a detailed discussion of training observers to identify birds by sight and sound as well as training them to estimate distances. For observers who are already competent at identifying birds by sight and sound, one full day of training is usually all that is necessary to be able to estimate distances within ±10%.

1. Begin by placing flagging at 10 m, 25 m, 50 m and 100 m from a central point and having observers estimate distances to trees, rocks and flagging from the "station". Horizontal distances should be estimated, as if a plumb bob was lowered to the ground from the bird's location.
2. Have each observer place flagging at 4-5 locations visible from the station, and then have everyone in the group record distances to each flag in a field book. Distances should be estimated to the nearest meter. Then, use tape measures to measure the distance to each flag, and have each person compare their initial estimate to the actual distance. A laser rangefinder may also be useful for measuring the actual distances (although the use of rangefinders in tropical forests may be limited). Repeat this exercise at several sites with both open and closed vegetation until observers can consistently estimate distances to within 10% of the actual distance. For objects within 20 m of the station, observers should consistently estimate distances to within 1 meter of the true distance.
3. The majority of birds are usually heard but not seen, and estimating distances to birds that are only heard is often the greatest source of error in bird counts. With all observers at the central point, have each observer estimate the distance to vocalizing birds pointed out by the leader. Observers should visually identify the tree or branch where they think the bird is, and estimate the horizontal distance to an object that they can see directly below where they think the bird is vocalizing from.
4. Half of the group should place themselves at various distances away from the station, and quietly wait until a bird vocalizes near them. Place reference markers at measured distances from the station to help these "spotters" to estimate the distance between the station and birds that vocalize. The other half of the group should remain at the station, and estimate the distance to any birds that vocalize. The observer closest to the bird should then indicate where the bird was vocalizing from, and the distance to the point directly under the bird should be measured from the station using a tape measure. This is a slow but important part of the training, and should be repeated until observers have experience with estimating distances to a number of different species and call or song types.
5. Simultaneous counts: Divide observers into groups and conduct 8-minute counts from the same location. At the end of each count, have the observers compare notes and discuss any

discrepancies in the species detected and the estimated distances to them. Remember that the distance to where the bird was first detected should be recorded, so that if a bird flies towards the station, the distance where it was first heard or seen is recorded, not the closest distance or where it lands. Continue these simultaneous counts until there is consistency among observers in the species and distances recorded (recommend no difference in species identification, and less than 10% difference in distance estimates).

Collecting Habitat Data

Step-by-step instructions for measuring bird habitat composition and structure is provided in SOP 8. At a minimum, bird observers should be able to assess and record habitat cover and structure.

1. Familiarize yourself with the Park specific canopy and understory composition, SOP #8.
2. Spend time prior to the field season practicing estimating and recording habitat information on practice plots.
3. Someone skilled in estimating tree heights, canopy cover and composition, and determining understory density and composition should also assist in training the crew to accurately access and record this information. Instructions for using a clinometer (tree height) and densiometer (canopy cover) accompany each instrument and should be reviewed prior to and followed during field data collection. All members on the survey crew should be trained and proficient in using each instrument; one day of training.

Suggested reference materials for conducting habitat surveys at PACN parks:

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Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 4: Preparing Maps, Images and Sampling Point Location Tables from GIS

Version 1.00 (September 2010)

Revision History Log

Prev. 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, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Figures

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Abstract

This SOP explains the procedure for generating random point locations for bird survey sampling. Random point locations are used for determining population status estimates, and are independent of the fixed sampling stations (see SOP 6).

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm

Recommended Citation:

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Original Author and Affiliation:

Brown, E. National Park Service, Inventory and Monitoring Program. Pacific Island Network, P.O. Box 52, Hawaii National Park, HI 96718.

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This SOP was reviewed by PACN staff, James Agee, Paul Berkowitz, Eric Brown, Guy Hughes, and two anonymous reviewers. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Procedures

Locations for sampling stations will be randomly selected within ARCMap 9.0 using the criteria outlined below. Randomly selected alternative station locations will also be generated in case the initial location is unsuitable with respect to habitat type or possesses conditions that make it unsafe in which to work.

Generating Random Point-transect Stations within ARCMap

1. Open ARCMap, and load the park specific project file and associated layers including park boundary, land cover types and habitats, DEM contours, legacy stations and transects, and other relevant layers (Figure SOP 4.1).
2. Criteria for generating points are as follows.
   - Within the sampling frame
   - Within appropriate land cover types and habitats
3. Generate 50 points with X and Y coordinates, using the following procedure.
   - Select the sampling frame shape files.
   - Load the Hawth's tools from the View-Toolbar menu. Hawth's tools is a free extension that can be downloaded from http://www.spatialecology.com/htools/download.php.
   - Under the Hawth's Tools down arrow button, select the "Sampling Tools-Generate Random Points" option (Figure SOP 4.2).
   - Within the dialog box, select the polygon or raster file, check the "Prevent points from being located in the NODATA cells" box, enter 50 points within the "Generate this number of random points" box, select the tab that spaces the points > 150 m apart, and specify the output filename.
   - Once the points have been displayed then use the Hawth's tools "Table Tools – Add XY to Table (points)" to create X and Y values for each of the random points within the newly created output shape file. Select the Point layer to identify the shape file and label the X and Y Fields within the Add new fields radio button.
4. These points serve as transect origins. Generate a random bearing and randomly select one point, and place 10 stations 150 m apart along that bearing. Terminate the transect if impassable terrain or the park/unit boundary is reached. The transect must include 5 or more stations. Repeat this procedure until the number of randomly located stations for the park or unit is achieved (see Appendix E of the narrative).
5. Use Table Tools to create X and Y values for each station and output into a shape file. Output the XY values into an Excel file for uploading into GPS.
6. Use the same procedure as above for generating a new set of random points for each sampling occasion.

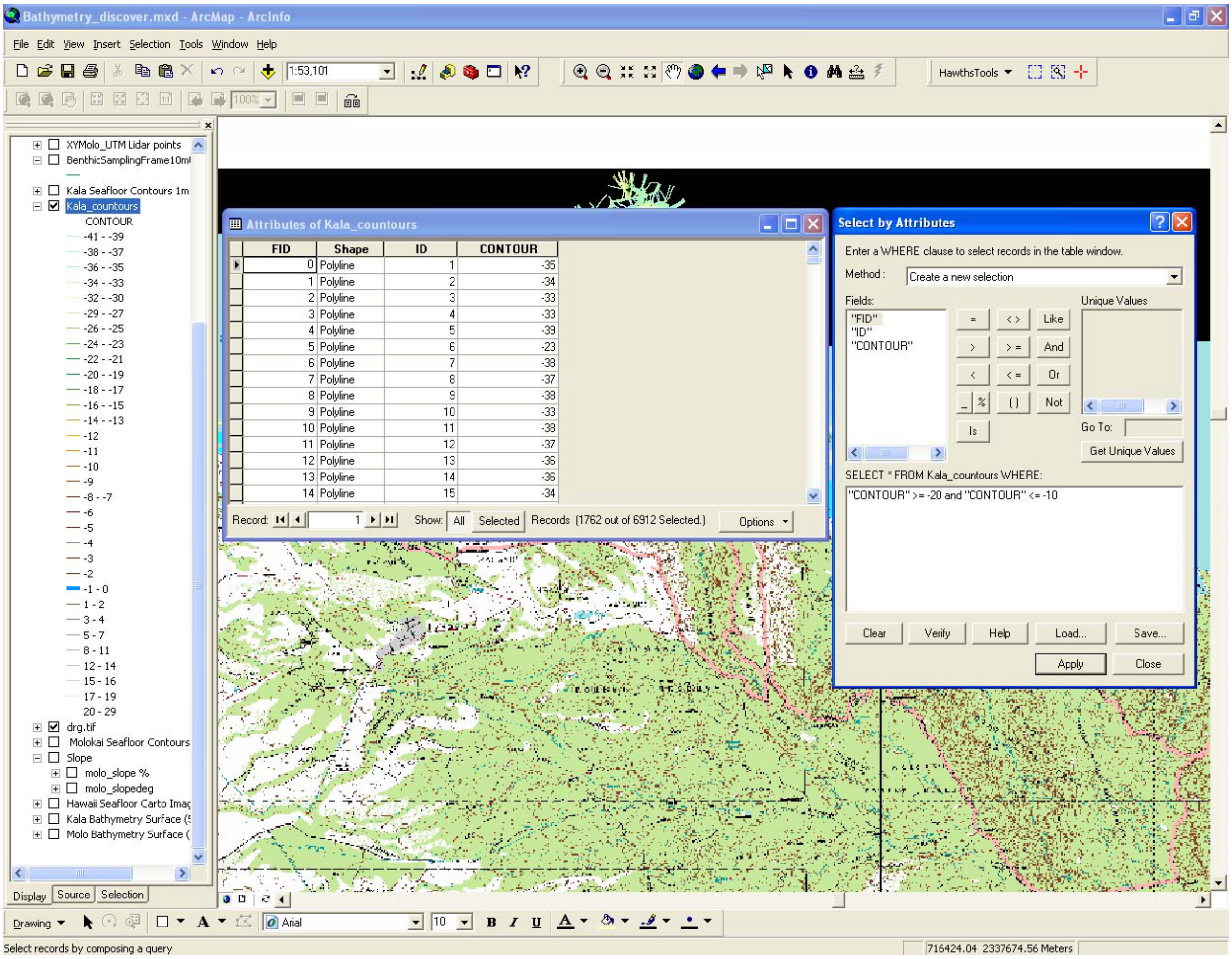

Figure SOP 4.1. Sample screen display for selecting depth contours within a shape file in ARCMap 9.0.

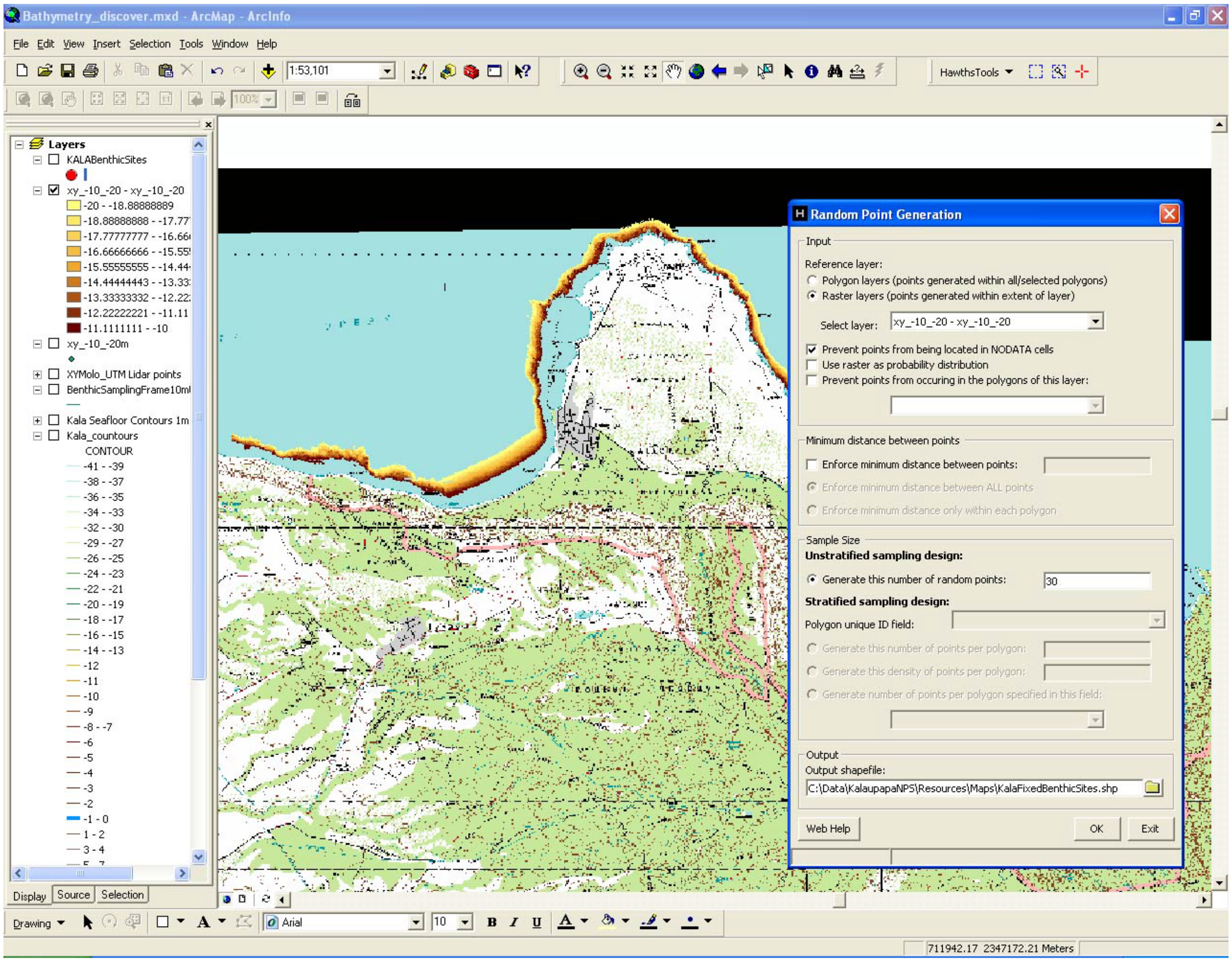

Figure SOP 4.2. Sample screen display for generating 50 random points within a shape file using the Hawth's Tools extension in ARCMap 9.0.

Selection of Random Panel Sampling Stations at HALE

The random panel of the duel panel sampling design provides the probabilistic sampling necessary to eliminate estimator bias and is recommended by I&M. However, HALE has logistical constraints that restrict the establishment of transects. Specifically, there are concerns that establishing new transects will disturb recovering habitat, damage endangered plants, and introduce weeds. We worked with David Schneider (PACN statistical consultant) to develop a sampling design that meets both the I&M requirements and HALE concerns. No changes to the fixed (legacy) panel of the design were necessary, as HALE has regularly surveyed all legacy transects within the park and will continue to do so on future sampling occasions. In order to meet the probabilistic sampling and logistical constraints a grid of points, placed 150-m apart (equal to the distance between sampling stations), was overlaid on the HALE sampling frame. The grid excluded portions that were topographically inaccessible (Figure SOP 4.3). Five (5) points were randomly selected. From these points, a transect was extended to the nearest access corridor, an existing path, trail, transect or road, and continued until 10 stations, the park boundary or a topographical barrier was reached (Figure SOP 4.4). This procedure differs from the standard transect selection process for the random panel by starting at a randomly located point, and extending the transect to the nearest access corridor instead of choosing a random direction for the transect. More specifically, the deviation from probabilistic sampling of the landscape lies in the use of non-random direction.

While this approach meets logistical requirements it introduces a potential bias because not all grid points were within 1,350 m (the distance between 10 stations, 150 m apart) of an access corridor. These grid points would require cutting new trails to reach the transect and so cannot be accessed; therefore, they do not have the same probability of being chosen as points within 1,350 m of a corridor. We calculated the loss rate as the sum of transects that failed to intersect an access corridor, using 250 randomly chosen grid points. The loss rate was acceptably low (8%; 20 of 250 transects) and so will result in no more than a negligible sampling bias.

During sampling it is likely that the random panel transects will be truncated due to topographic barriers not discernable in the GIS map. It is possible that bird numbers may be influenced by the barrier. This could produce a biased estimate if transects with barriers are truncated. We calculated species-specific density per station estimates from previous surveys to test if bird numbers are influenced by barriers. We plotted densities as a function of distance from an edge (cliff or gulch) for 957 density estimates of 12 species (6 native, 6 introduced) from 8 years (1992, 1993, 1996, 1997, 1998, 1999, 2000, 2001, and 2003). Figure SOP 4.5 shows an example of such a graph.

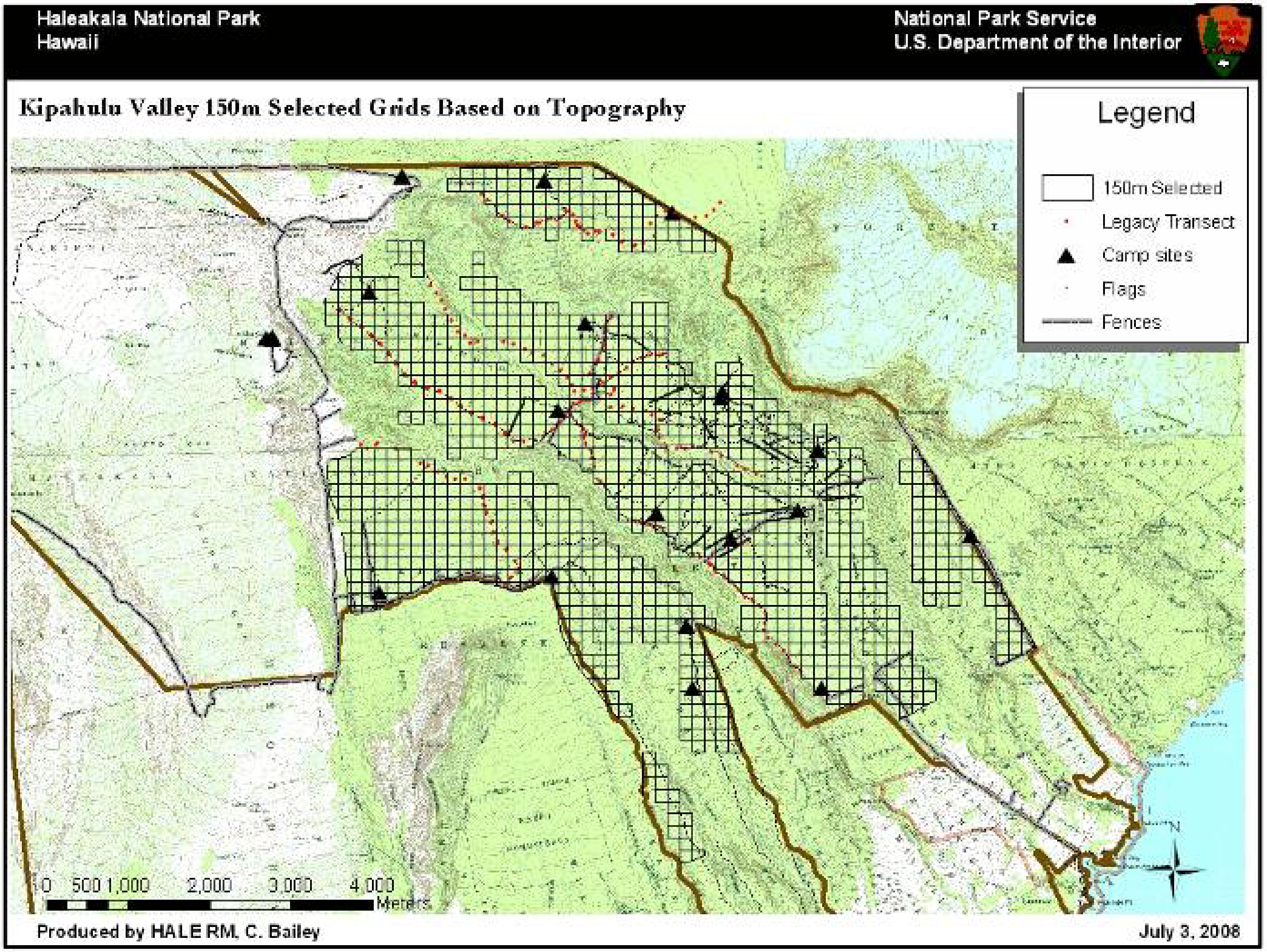

Figure SOP 4.3. 150-m grid overlaid onto HALE sampling frame, excluding topographically difficult areas.

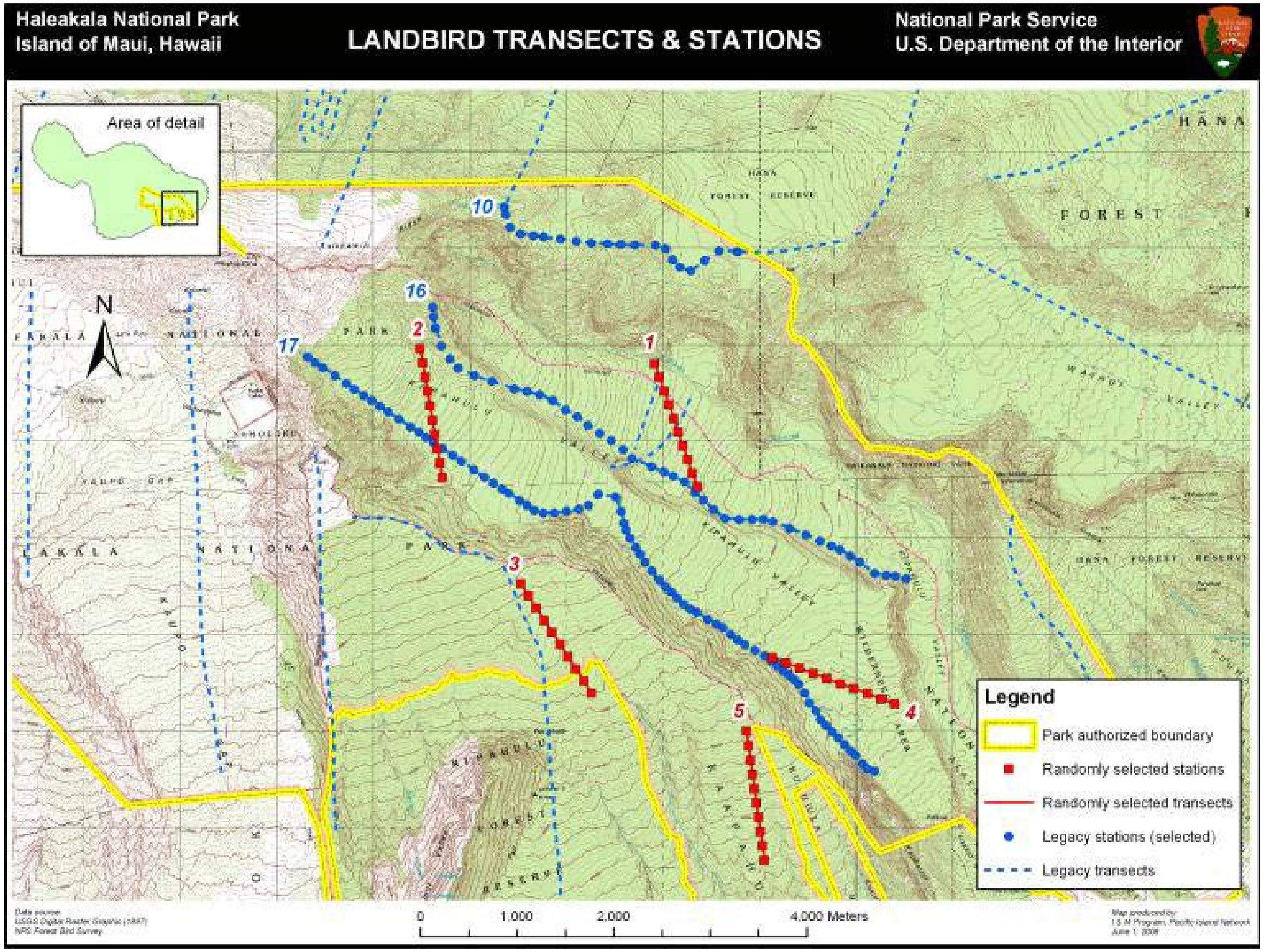

Figure SOP 4.4. Example of random panel transects for surveying landbirds at HALE. Transects were established by selecting five locations randomly from a grid of dots, 150-m apart, and extended to the nearest access corridor.

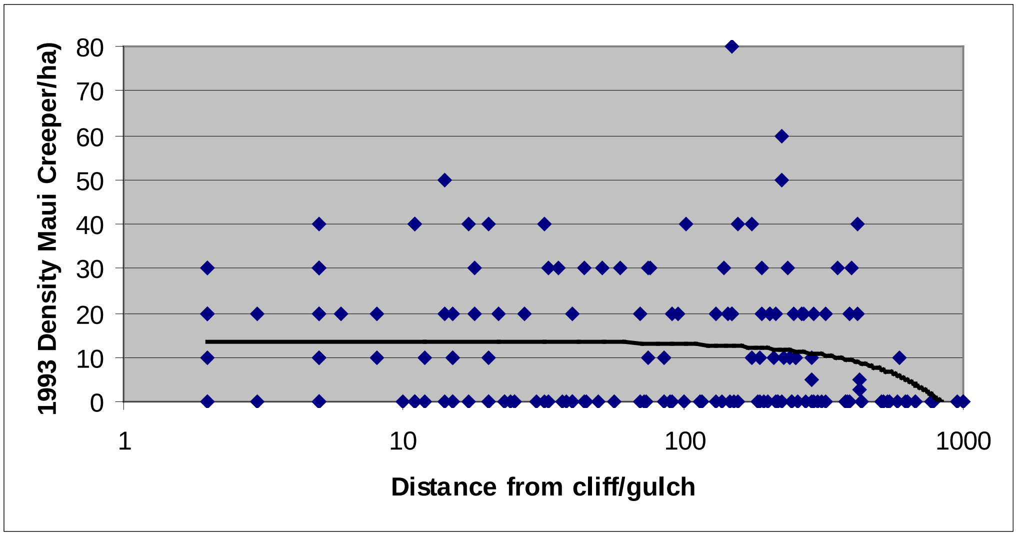

Figure SOP 4.5. Example of densities as a function of distance from an edge. Polynomial trend lines failed to show any consistent reduction or increase near the edge.

Visual comparison of densities near the edge (< 5 m) to densities further away suggested either an increase or decrease in numbers near the edge in some years, but there was never any consistent effect across years in any species. The densities were then combined across years to produce a long term data set, for each species, where the means for each distance category can be considered the decadal scale expectation. Figure SOP 4.6 shows an example of the plot of means with 95% confidence intervals for near stations compared to distant stations (beyond 25 m from the edge).

In some cases the confidence limits extended below zero, indicating that a normal error structure was inappropriate for analysis of the density data. Close stations (2 m and 3 m) were compared to more distance stations (>3 m) using several forms of non-normal error. An acceptable non-normal error structure could not be found, as judged by heterogeneity of the residuals. To address the problem the comparison of near to more distant densities was repeated using the means in each class, weighted by sample size in each class. This addresses the problem because means can be expected to be normally distributed around a parameter estimate, even when observations that make up the means are not. Analysis of 18 means (see Figure SOP 4.6) in two categories (2 m or 3 m versus further away) showed no significant effect of proximity to a topographic barrier (Table SOP 4.1).

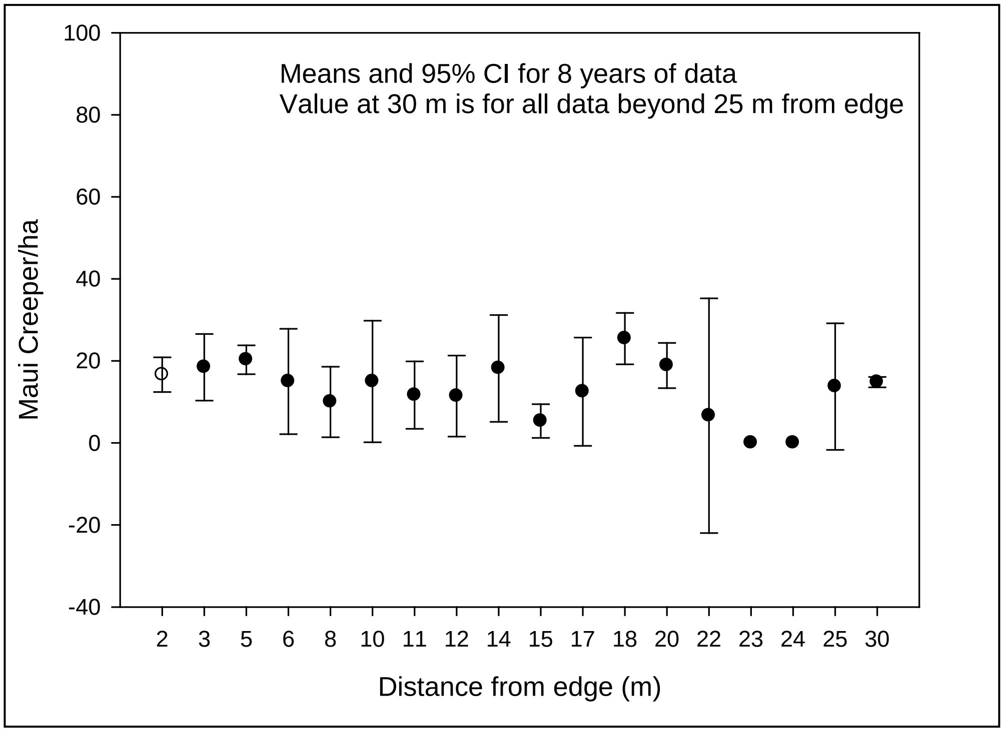

Figure SOP 4.6. Example of the plot of means with 95% confidence intervals for near stations compared to distant stations.

Table SOP 4.1. Analysis of 18 means in two categories (2 m or 3 m versus further away) showed no significant effect of proximity to a topographic barrier.

	Bird/ha				
Species	**near (2m, 3 m)**	**far (> 3m)**	**MS_{error}**	**$F_{1,16}$**	**p**
Apapane	22.630	19.508	211.69	2.748	0.117
Akohekohe (crested honeycreeper)	1.952	1.667	61.57	0.075	0.788
House finch	0.000	0.072	2.10	0.158	0.696
Iiwi	7.031	6.915	40.20	0.019	0.892
Japanese bush-warbler	1.593	1.730	6.61	0.168	0.687
Japanese white-eye	8.513	9.586	195.03	0.355	0.560
Maui alauahio (Maui creeper)	17.021	15.065	559.18	0.409	0.532
Maui amakihi	10.899	10.193	56.18	0.532	0.476
Maui parrotbill	0.135	0.176	0.70	0.148	0.706
Hwamei (melodious laughing-thrush)	0.077	0.059	0.24	0.081	0.779
Northern cardinal	0.078	0.057	0.34	0.079	0.783
Red-billed leiothrix	2.280	2.599	12.00	0.505	0.487

We conclude that there is no barrier effect and hence truncated transects can be expected, in the long run, to yield unbiased estimates of density. We recommend, however, that the contribution of truncated transects to estimates of density be weighted by the length of the transect (equivalently, the number of stations on the transect).

The purpose of the probabilistic sampling is to identify whether the density estimates from the fixed panel are biased. We expect that change detected by the legacy transects will be indistinguishable from the change detected by the probabilistic transects. In the unlikely case that legacy and probabilistic transects differ in the estimate of change, one solution is to use the random transect estimate to correct the bias in the legacy transect estimate. The uncertainty on this estimate could be narrowed under the assumption that the error variance for legacy and random transects are the same. However, we plan to estimate change under the assumption that the error is a function of the magnitude of the estimate of density (i.e. not a fixed value). Within this analytic context, we do not expect the small number of probabilistic samples to have as great an impact on power as in the context of a normal (fixed) error. Consequently we would report the legacy estimate (based on extensive effort) and the probabilistic estimate (based on less effort because of time constraints). The difference between the estimates would be considered useful in a management context, in the same way that estimates of uncertainty (e.g. confidence limits) are considered useful. Because sampling random panel transects is less efficient than sampling the fixed panel transects, the effort allocated to probabilistic transects would be reduced if the legacy and probabilistic estimates did not differ, as assessed at the end of the second year of sampling. Therefore, both fixed and random panels should be assessed for the first two sampling rounds and if the estimates are the same, then random panels would be repeated only every 10^{th} sampling round, not every round. This reduces the environmental impact of (new) probabilistic transects, shifts effort to more efficiently sampled legacy transects, while allowing ongoing assessment of bias.

Printing Coordinates and Maps

1. Print the randomly located point-transect stations
    - Print out X and Y coordinates for the point-transect station locations as successively numbered points in a list. To maximize efficiency in the field, the list should be ordered according to proximity of the transects to each other.
    - Print the GIS map(s) showing the transect locations.
    - Laminate (two-sided: map on one side, list on the other) for field use.
    - Coordinates should be in Universal Transverse Mercator Coordinate System (UTM) format.
2. Enter X and Y coordinates, with transect and station location number into GPS (See SOP 5).

Landbirds Vital Sign Monitoring Protocol – Pacific Island Standard Operating Procedure (SOP)

SOP 5: Using GPS to Navigate and Mark Waypoints

Version 1.00 (September 2010)

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Abstract

This Standard Operating Procedure explains how to use an autonomous, non-differential Garmin GPS receiver and GPS transfer software. This protocol may be used for any Garmin GPS that can average a waypoint and store tracklogs. The GPS transfer process uses DNRGarmin Version 5.1.1. and GIS software.

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm.

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Original Author & Affiliation

Klasner, F. L. National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718.

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This SOP was reviewed by PACN staff, James Agee, Paul Berkowitz, Eric Brown, Guy Hughes, and two anonymous reviewers. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Pre-Field Preparation

Garmin GPS Preparation

1. Load fresh batteries and have extra, charged sets available. Extra batteries should be placed in a water tight "dry bag" or a re-sealable plastic bag.
2. Initialize and download a fresh almanac into a Garmin if more than 1 week has passed since last collection or if the GPS unit has moved more than a straight-line distance of 150 miles. Downloading the almanac takes roughly 20 minutes in open areas - away from buildings, canopy, and obstructions.
3. Delete old waypoints and tracks from memory (download and save data elsewhere if appropriate).
4. Turn off active TrackLog. Set "TrackLog" to the preferred collection method ("Time" is recommended) and an appropriate logging rate for the data collection ("5 seconds" is recommended for most walking collection, but keep in mind the total storage capacity of the GPS).
5. Ensure Simulator Mode is not ON when collecting data.
6. If necessary, transfer data (e.g. background maps) to the GPS unit using DNR Garmin software. See below for DNR Garmin instructions.
7. Set Time and Date on the GPS Unit (note that no PACN parks use daylight savings time, rather the entire PACN is always in 'standard' time).
8. Make sure that "Interface Protocol" is set to Garmin.
9. Make sure that WAAS is enabled.
10. Set the Coordinate System (UTM or LAT/LONG) and Datum to ensure compatibility with any written coordinates you may need to navigate to or map. Recommended settings are:
    - State of Hawaii: NAD83 UTM
    - American Samoa: WGS84 UTM
11. Set Heading to Magnetic or True. If set to True, ensure compass has same declination.
12. If needed, use Trimble Planning Software to ensure best time of day for GPS data collection.
13. Prior to use in the field, ensure the GPS has been placed in a "dry bag" with a desiccant pack.

GPS Transfer Software for DNR Garmin

1. Uninstall any previous versions of DNR Garmin
2. As of Spring 2006, download and install Version 5.1.1 to any computer that will receive GPS data from the Garmin. DNR Garmin can be downloaded from the State of Minnesota Department of Natural Resources website http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html.
3. In DNR Garmin, set projection to ensure compatibility with data stored in GIS.
    - Hawaii Island: ESRI (or EPSG) POSC code of 26905 (NAD83 UTM zone_5N).

- Maui Island: ESRI (or EPSG) POSC code of 26904 (NAD83 UTM zone_4N).
- American Samoa (all islands): ESRI (or EPSG) POSC code of 32775 (WGS 84 UTM zone_55S.

4. In ESRI ArcMap, ensure that Data Frames are set to the appropriate projection.
   - State of Hawaii: UTM, NAD83
   - American Samoa: UTM, WGS84

GPS Field Procedures

Data Collection

Data collection is not anticipated to be a frequent task. Initially, actual data collection locations will need to be documented, relative to sample design specifications. Other data collection needs are not anticipated.

1. Hold GPS unit or antenna at or above your head. Use an external antenna to free hands.
2. Electronically store all data (waypoints and tracks). Write down positions for backup.
3. Note that a Garmin will collect data no matter what the GPS positioning quality is, so you will need to monitor the GPS Satellite Page continuously for anomalies and accuracy. Collect only when “3D GPS” or “3D Differential” is shown. Do not collect data in 2D unless absolutely necessary. 2D Differential should not be used either.
4. Waypoints:
   - Collect all waypoints in “Averaged Position” mode if you are standing still. Obtain a minimum of 10 position points per site, or record for a maximum of 20 minutes at that site. Somewhere in between is enough to generate a quality position in most cases.
   - Collect instantaneous waypoints only when moving.
5. TrackLogs:
   - Use “Stop when Full” or “Fill” Record Mode to prevent overwriting TrackLog points when Active TrackLog becomes full.
   - Begin collecting Active TrackLog when you know where you need to go and immediately begin moving when TrackLog begins collecting.
   - Stop Active TrackLog when stopped.
   - Always stop Active TrackLog when nearing the beginning point of a polygon area you want closed. A line between your last track point and the initial point will automatically be generated in order to close the polygon.
   - Always turn Active TrackLog to OFF when finished collecting. If TrackLogs are turned ON when you are in the office, ugly data will result.
   - NEVER ‘store’ or ‘save’ an active TrackLog unless you need to save space, rather choose to ‘stop’ an active TrackLog. Garmin III+ receivers remove the Active TrackLog,

while modern Garmins merely make a copy of the Active TrackLog. In any case, saved tracklogs degrade original data, whereas a 'stopped' TrackLog retains data quality.

Back in the Office

1. Connect GPS to PC with cable and place GPS in Simulator Mode.
2. Check that TrackLog is OFF! Again, do not save Track!
3. Open DNR Garmin from the desktop (for ArcGIS users) or from within ArcView by loading the extension.
4. Check Projection in DNR Garmin one more time. This will define the projection the GPS file will be stored in.
5. Download Waypoints and Tracks and save to shapefile (if in ArcGIS) or if saving a shapefile from the desktop DNR Garmin, save to projected shapefile. Use naming conventions as below.

- The file-naming convention is to indicate the GPSModel, type of data (Waypoint or Tracks), projection and datum, and date (YYYYMMDD) separated by an underscore (_). For example, a set of waypoints collected with a Garmin GPS76c, using UTM and WGS84 as the projection and datum, on Christmas Day 2005, would be named "GPS76c_waypt_UTMWGS84_20051225".
- If additional notes about GPS collection exist, such as data collected in '2D' mode; create a simple *text* file with an identical filename in the same location which contains this information, with a .text filename extension.

6. Delete all Waypoints and Tracks for the next mapping mission.
7. Turn off the GPS and disconnect cables, returning equipment to its proper storage location.
8. Recharge batteries if appropriate.

Options to Consider

- External antennae, with long cable and pole in order to extend the antennae above a thick vegetated canopy.
- An external beacon, such as the Thales Mobile Mapper Beacon, for DGPS (Differential GPS). This will improve the accuracy of your GPS location.
- Averaging will improve your GPS locations, if and only if, the satellite geometry improves during point collection. Otherwise, averaging can sometimes result in a less accurate position.

Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 6: Marking Permanent Monitoring Points

Version 1.00 (September 2010)

Revision History Log

Prev. 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, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This SOP explains the procedure for marking permanent monitoring points for bird survey sampling. These permanently marked points are comprised of the legacy transect survey stations.

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm

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Original Author and Affiliation

Peitz, D. G., S. G. Fancy, L.P. Thomas, and B. Witcher. 2002. Bird Monitoring Protocol for Agate Fossil Beds National Monument, Nebraska and Tallgrass Prairie National Preserve, Kansas. Unpublished report. Prairie Cluster Prototype Monitoring Program, National Park Service, U.S. Department of the Interior. Version 1.00 (September 6, 2002).

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This SOP was reviewed by PACN staff, James Agee, Paul Berkowitz, Eric Brown, Guy Hughes, and two anonymous reviewers. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Procedures

Within each of the PACN park units bird surveys have been conducted at survey stations on legacy transects (see narrative for a description). Sampling will continue on a portion of these locations; therefore, these stations need to be marked permanently to ensure that observers return to the same location for sampling.

Establishing Fixed Study Sites

These procedures detail establishing sampling point locations for bird monitoring using permanent steel pins to mark the station center point. The UTM locations for each legacy survey point are available in SOP #7.

Before Entering the Field

Collect the equipment necessary to complete all tasks that will be conducted (see SOP #1 for equipment list). Cut pins and pvc pipe to required length. For installing permanent survey sites, pins should be long enough to extend 0.50-m above the ground (approximately 0.75 to 1-m long).

Ensure points have been generated, printed, and downloaded into the GPS.

Ensure that archeological compliance has been completed before any pins are set. Any ground disturbance in a national park has a potential to damage cultural resources or features.

Navigating to Sites

Using a GPS unit in which the survey point locations are already stored, navigate to the location using the GPS's navigation feature (see SOP #5: "Using GPS to Navigate and Mark Waypoints" for information on using a GPS).

When within approximately 3 meters of the site check for existing tags by carefully scanning all trees for flagging and aluminum tags.

Installing Permanent Marking Pins

Install a stainless steel threaded pin into solid substrate by hammering the pin into a crack or crevice with a 2 or 5 pound sledgehammer. Permanently epoxy the pin into a vertical position using a suitable fast-setting two-part epoxy, such as Powerfast. Powerfast is packaged in dual "caulking" or syringe-like tubes, to mix epoxy parts and minimize epoxy handling. Latex gloves should always be worn when handling epoxy. The pins should extend at least 0.5-m above the substrate.

Slip the pvc pipe onto the pin, secure with epoxy and attach cap.

Write station and transect numbers on an aluminum tag and attach the tag to the pipe.

Attach flagging to a nearby tree, and using a Sharpie record the station and transect numbers, and the distance and direction to the pin.

Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 7: Conducting the Point-Transect Count

Version 1.00 (September 2010)

Revision History Log

Prev. 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, 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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Abstract

This SOP gives step-by-step instructions for conducting 8-minute bird counts at PACN park units using the point-transect distance sampling methodology. The SOP describes the procedure for collecting data and filling in the data form "Field Data Form – Point-Transect Station Counts".

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm

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Original Author and Affiliation

Peitz, D. G., S. G. Fancy, L. P. Thomas, and B. Witcher. 2002. Bird Monitoring Protocol for Agate Fossil Beds National Monument, Nebraska and Tallgrass Prairie National Preserve, Kansas. Unpublished report. Prairie Cluster Prototype Monitoring Program, National Park Service, U.S. Department of the Interior. Version 1.00 (September 6, 2002).

Acknowledgements

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Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Procedures

The steps below outline the procedures for sampling landbirds.

- Prior to the day of the counts, determine which stations will be sampled and in which order, and make a list that will be taken into the field of the UTM X and Y coordinates for those stations (Appendix A and B). Upload the coordinates into a GPS unit (see SOP 5).

- Sampling will occur in the morning, beginning as soon as it is light enough to see a distance of at least 200 m, approximately one half hour before sunrise and end no later than 11:00 am. Try to arrive at the first station while it is still dark so that the count can begin as soon as possible. Singing rate for most species is usually highest before or near sunrise, and then declines slowly throughout the morning.

- Do not conduct the count during high winds or heavy rains because these conditions inhibit bird activity and impair your ability to see and hear birds. Counts should not be conducted if wind strength on the Beaufort Scale is a sustained 4 or greater, or if it is raining hard (rain code ≥ 4). If you encounter these conditions, wait until the weather improves or else cancel the sampling for that day and try again on another day.

- Navigate to the coordinates of the next station on the list using the GPS (see SOP 5). Approach the station vigilantly, and if you observe a bird close to the center of the station that flushes as a result of you approaching the station, you should record the initial distance from the station center to that bird on the data form. The reason for this is that a critical assumption of the distance methodology is that any bird directly at (or very close to, e.g., <5–10 m) the station center will always be detected, i.e., $g(0) = 1$. If a bird that otherwise would have been recorded in the station during the count flushes prior to the beginning of the count as a result of the approach of the observer, abundance will be underestimated for that species. The alternative approach is to wait for several minutes after reaching the station before starting the count, but this approach is likely to underestimate bird density near the station because of birds flushing as the observer approaches, and, therefore, should not be used.

- Once you arrive at the station center, begin the count as soon as possible. You should have time to fill in the location, event, and weather conditions information at the top of the form during the count (Appendix C; field form available in SOP #1). If not, these can be filled in at the end of the 8-minute count.

- Set your watch to beep at 8 minutes, and then begin the count recording the species, distance measurement and detection type.

- Use a new page of the “Field Data Form – Point-Transect Counts” for each 8-minute count. Even if no birds are detected at a particular station, there should still be a page for that station (with the first line on the form filled in as explained below under the Species code). As soon as you are able to during or just after the 8-minute count, record the following information at the top of the form:
  - **Park and Tract**: Enter the appropriate ParkCode and tract (e.g., NPSA Tau, HAVO Honomalino).
  - **Observer Initials**: Fill in the three initials of the person conducting the counts using capital letters. If you do not have a middle name, either make one up or put an underscore for your middle initial. Examples would be DGP for David G. Peitz or SGF for Steven G. Fancy. In the database, these initials will correspond to the full name and contact information for that person.
  - **Transect and Station**: This is the transect and station numbers stored in the point-transect database to refer to a particular place on the ground.
  - **Date (mm/dd/yyyy)**: Write in the month (2 digits), day (2 digits) and year (4 digits) in the format shown. Include the forward slash. Examples are 05/02/2007 and 10/23/2007.
  - **Starting and End Time (hhmm):** Write in the time to the nearest minute when the 8-minute counting period begins and ends, using the hour and minute format shown. Use military time (add 12 to the hour beginning with 1 pm through 11 pm). Fill in all four digits. Examples are 0630 (6:30 am), 0802 (8:02 am). Bird sampling should not occur after 1100 hours, but for the habitat form you would record 1:30 pm as 1330 and 8:00 pm would be 2000.
  - **Temperature (C)**: Record the ambient temperature during the 8-minute count in degrees Celsius, to one decimal place or rounded off to nearest degree.
  - **Noise (0–3)**: Record the Noise Code (0–3) from the following Table SOP 7.1 that applies to background noise conditions during the count, as it relates to your ability to hear birds.

Code Descriptions

Table SOP 7.4. Codes used to record level of background noise as it affects observer’s ability to hear birds.

Noise Code	Explanation
0	quiet; normal background noises; no interference
1	low noise; might be missing some high-pitched songs/calls of distant birds
2	medium noise; detection radius is probably substantially reduced
3	high noise; probably detecting only the loudest/closest birds

GPS: Record the UTM location or waypoint of the sampling station.

Clouds (0–100): Record percent cloud cover, rounded off to the nearest 10 percent. This should be a number between 0 (no clouds) and 100 (complete overcast). If there are patches of clouds in different areas of the sky, try to imagine gathering all of them together into one part of the sky and recording what percent of cloud cover that would represent. Cloud cover is recorded because it affects bird activity and singing for many species.

Rain (0–5): Record the rain code (0 through 4) from the following Table SOP 7.2 as it applies to conditions during the 8-min count.

Table SOP 7.5. Codes used to record precipitation codes during bird counts**.**

Rain Code	Explanation
0	no rain
1	mist or fog
2	light drizzle
3	light rain
4	heavy rain; difficult to hear birds

Wind (0–6): Record the wind code (0 through 6) from the following Table **SOP 7.**3 as it applies to the strength of the wind during the 8-min count. Record the average wind condition during the 8 minutes, not the maximum condition (do not record gusts here).

Table SOP 7.6. Codes (Beaufort scale) used to record wind strength during bird counts.

Wind Code	Explanation
0	calm, smoke rises vertically (<2 km/h)
1	smoke drifts (2–5 km/h)
2	light breeze felt on face, leaves rustle (6–12 km/h)
3	leaves and twigs in constant motion (13–19 km/h)
4	small branches move, raises loose paper, dust rises (20–29 km/h)
5	fresh breeze, small trees sway (30–39 km/h)
6	strong breeze, large branches moving, wind whistling (40–50 km/h)

Gust (0–6): Record the gust code (0 through 6) from the following Table SOP 7.4 as it applies to the strength of gusts during the 8-min count. Record the average gust condition during the 8 minutes, not the maximum condition.

Table SOP 7.7. Codes (Beaufort scale) used to record gust strength during bird counts.

Gust Code	Explanation
0	no gusts
1	smoke drifts (2–5 km/h)
2	light breeze felt on face, leaves rustle (6–12 km/h)
3	leaves and twigs in constant motion (13–19 km/h)
4	small branches move, raises loose paper, dust rises (20–29 km/h)
5	fresh breeze, small trees sway (30–39 km/h)
6	strong breeze, large branches moving, wind whistling (40–50 km/h)

Phenology (0–10): Record the Phenology for the stations. The contents of these fields reflect the percentage of bloom (to the nearest 10%) for the closest ten trees to the stations. The values entered into the data field book range from 0 to 10, and a "•", which represents less than 1% bloom.

Once you have started your watch and begun the 8-minute counting period, record all birds heard or seen during the count, regardless of their distance from the center of the station. Do not record birds that flyover (birds that fly above the top of the vegetation canopy, never touch down in your field of view, and do not appear to be foraging, displaying, or behaving in any other way that might suggest a link to the habitat below them).

The distance that you record should be the horizontal distance in meters between the center of the station and the location where you first detected the bird. If the bird is flying directly at you and then lands nearby, record the distance to where you first saw it flying towards you, not the distance to where it landed. For species that occur in clusters or flocks, you will record to the distance from the observer to the center of the flock, plus the flock size. If a bird is high in a tree, imagine dropping a plumb bob from the bird down to the ground, and measure the distance to that spot on the ground (the horizontal distance).

Many birds are heard and not seen. To estimate the distance to a bird that you detect only by sound, you should first try to determine where it is and select some object near where the bird is, such as a tree or rock that you think it is concealed by, and then estimate to that object.

For each bird heard or seen (at any distance) during the 8-minute counting period, record the following information on the "Field Data Form – Point-Transect Counts":

Species: This is the four-character AOU code for the species detected. Examples are APAP for Apapane, WAHE for Wattled Honeyeater and SEOW for Short-eared Owl. These codes are usually easy to determine based on a bird's AOU common name, except where more than one species has the same code and one has to be modified from the convention. Codes for species known to occur at PACN parks are available from the Hawaii Forest Bird Interagency Database Project. If no birds are detected during an 8-minute count, you should complete the header of the form (location through sampling conditions) and record the code NOBI for "No Birds" in the Species column.

Distance (m): Record the horizontal distance in meters between the center of the station, and the location and/or presumed location of the bird where you first detected it. Use a laser range-finder whenever possible to get as accurate a distance as possible. **Do not round off numbers to the nearest 5 meters; estimate the distance to the nearest meter**. If you cannot see the bird, estimate the distance to some object (tree, bush, rock) where you think the bird is located.

DT (Detection Type): Record a number 1, 2, 4, 8 or 9 for the detection type based on the following explanations:
1 = heard first, but not seen (i.e., detected initially by sound) during the 8-min count
2 = seen first (regardless of whether it was later heard or not) during the 8-min count
4 = heard first, but then seen (a DT of 1 can be changed to a 4) during the 8-min count

Two additional Detection Type codes can be used for birds that are not detected during the 8-minute count, but that are detected while traveling between stations or before or after the 8-minute sampling period begins. These data are useful for developing annual checklists of birds occurring in the park and for distribution information:

- 8 = heard, but not during the 8-minute sampling period
- 9 = seen, but not during the 8-minute sampling period

The Detection Type code will be used later in various analyses. For example, distances to birds that are seen (code 2 or 4) are probably more accurate than those to birds that are only heard (DT = 1). Recording the DT makes it possible to develop distance histograms to compare birds seen versus those that are only heard. Also, there are probably different detection functions for birds heard versus seen, and recording the DT makes it possible to analyze data separately if needed.

Flock Size: For most species, each individual bird will be treated independently as a separate observation, but for species that usually occur in clusters or flocks, the appropriate unit is the cluster or flock, and not the individual bird. For example, if Kalij pheasant almost always occur in family groups of 2 to 8 birds, and you observe a group of 4 birds during a count, it is not appropriate to record 4 distances and treat them as independent observations in the analysis. Rather than recording the distance to each individual bird for flocking species, record the distance to the center of the flock (in the Distance field) and the number of birds in the flock (in the Comments field).

Comments: Record any comments that seem appropriate and that might help someone interpret and analyze the data correctly. Note any birds that were already detected from a previous station. Bias caused by repeated counting of the same individual from more than one station is usually small unless repeated counting is common during a survey (Buckland et al. 1993:37) or in cases where a rare bird is counted from multiple stations (Nelson and Fancy 1999). Recording whether a bird is thought to have been counted at a previous station allows the data to be analyzed two different ways, depending on which is most appropriate. Some authorities say that you should not count a bird if you think it was recorded from another station already, whereas other authorities argue that you should always count each bird detected, even if it was probably detected previously. Recording this information will allow the option of analyzing data by either approach. A brief description (<200 characters) of the sampling location referred to by the Location ID should also be recorded in the comments. An example would be "Station 150 m from cattle guard on Mauna Loa Strip road at true bearing 268".

At the end of the day, compare vocalizations with known bird sounds on tapes to identify all unknown bird species recorded in the field. If a species is seen in the field and characteristics recorded but it was not identified, it should be identified at this time using reference materials.

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. 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.
- If possible, edits and revisions should be made in a different color ink to make it easier for subsequent viewers to be able to retrace the edit history.
- 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. On a yearly basis, data sheets are to be scanned as PDF documents and archived (see SOP #12). The PDF files may then serve as a convenient digital reference of the original if needed.

References

Buckland, S. T., D. R Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. Chapman & Hall, London, U.K.

Engbring, J., and F. Ramsey. 1989. A 1986 survey of the forest birds of American Samoa. Regional report. US Fish & Wildlife Service, Honolulu, Hawaii.

Nelson, J. T., and S. G. Fancy. 1999. A test of the variable circular-plot method where exact density of a bird population was known. Pacific Conservation Biology 5:139–143.

Appendix A. Landbird Sampling Stations (Legacy and randomly located transects) in HALE, HAVO and NPSA (Tau and Tutuila units) for the first surveying occasion

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At HALE a 2:1 fixed (legacy transects) to random sampling allocation was chosen instead of the optimal sampling allocation to provide better coverage for two endangered species, allowing for more effort to be allocated to detecting trends. Three legacy transects were randomly selected from the 9 possible HFBS transects in the Kipahulu Valley, which yielded 137 stations (Figure

A.1; Table A.1). An additional 51 stations were selected on 6 randomly located transects in HALE. More stations were selected on the 3 legacy transects than are necessary to sample; therefore, up to 37 stations can be dropped if there is insufficient time to complete the survey. To reduce sampling bias, 3 sets of 10 stations should be randomly selected and dropped instead of subjectively clipping the transect top or bottom. This procedure identified dropping stations 11–20 on transect 16, and stations 41–50 and 61–70 on transect 17 (see Table A.1).

HAVO was separated into old and new (Kahuku acquisition) portions to assign sampling locations. Within the old portion of HAVO all of the stations on transects 14 and 19 in Olaa Koa Unit, 1 and 5 in Olaa Puu Unit, 3 in Olaa Small Track Unit, 1 and 3 in East Rift Zone, and 8 in Mauna Loa Strip tracts were selected from the legacy transects for sampling each survey occasion. In addition, stations 2400–4600 on transect 14 and stations 0–2200 on transect 18 are to be sampled during each survey occasion, which yielded 143 stations (Figure A.2a,b,c,d; Table A.2a,b). A total of 251 legacy stations were selected in the new portion of HAVO and included all stations on transects 2, 7, 12, 17 and 22 in Kahuku, 3 in Mauna Loa South Flank, 1 and 6 in Honomalino, 3, 4, 5, 7 and 8 in Northwest Kahuku, and 1 and 2 in Papi tracts.

For the Tau unit, NPSA, 11 stations on transect 5, in addition to all of the stations on transects 6, 7 and 8 were selected from the legacy transects for sampling each survey occasion. An additional 56 stations on 6 transects were randomly selected for the first survey occasion (Figure A.3; Table A.3).

Only 2 legacy transects (7 and 8) occur within the Tutuila unit, NPSA (Figure A.4). Although stations along the digitized transect 7 occur off the ridge line, survey stations should be established follow the road and ridge line. Engbring and Ramsey (1989) sampled 42 stations on transects 7 and 8. Screen digitizing the stations at 150 m intervals yielded 27 stations on Transect 7. Because of safety concerns, however, only stations within the Tutuila unit will be sampled on Transect 8 (yielding 19 stations).

For the random panel the Tutuila unit was divided into East-West strata, where the stratum dividing line was placed roughly equal distance between the east and west park boundary, and extending from Maugaloa Ridge to Tafeu Cove. The strata are only administrative, not ecological, and the demarcation is only to help balance the sampling effort between the strata. Therefore, substituting stations in one stratum for the other is not a concern. A total of 53 stations were selected on 9 randomly located transects for the first survey occasion (25 stations on 4 transect in the East stratum, 25 stations on 5 transects in the West stratum, and 3 additional stations on Transect 5 were identified as alternatives to stations that pose safety concerns; Figure A.4; Table A.4). The bottom station on Transect 3 may pose a safety concern. If it is deemed to difficult to sample this station, it should be dropped and Station 4 on Transect 5 should be sampled. Likewise, if Stations 3 or 4 on Transect 8 are too difficult to sample they can be switched with Stations 5 and 6 on Transect 5. Transect 6 may be difficult to navigate and pose a safety concern. Transects are just a means of locating stations; transects are not the sampling units. Therefore, observers do not necessarily need to follow the transects. Sampling Transect 6 may require observers to traverse along the ridge, drop down to the stations, conduct the count, and hike back up to the ridge top before traversing to the next station and dropping down again. This will eliminate the safety concern of traversing difficult terrain.

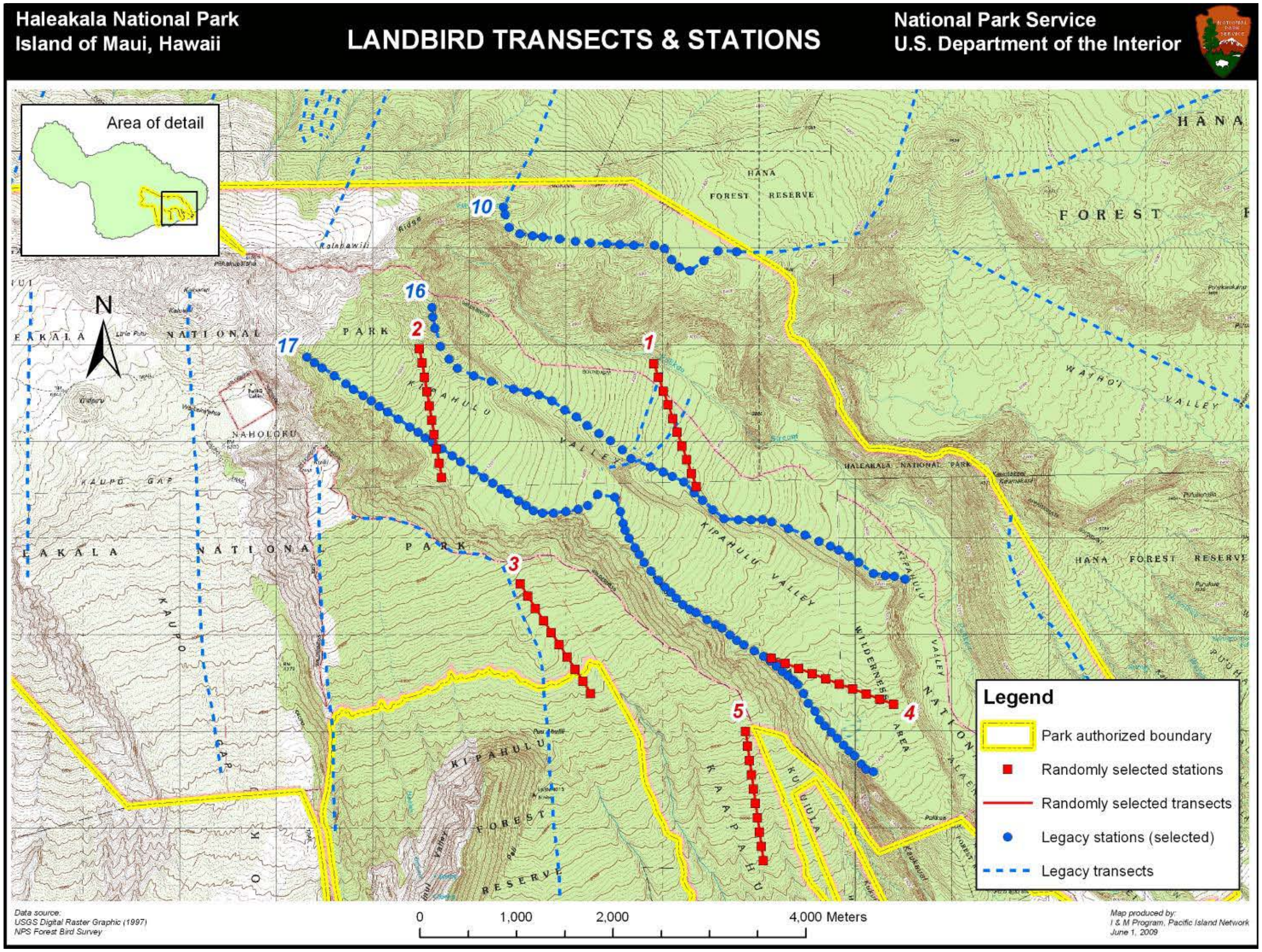

Figure A.1. Location of Landbird sampling stations within HALE. Legacy stations (blue dots) should be sampled on each survey occasion, whereas these random stations (red diamonds) should be sampled only during the first survey occasion.

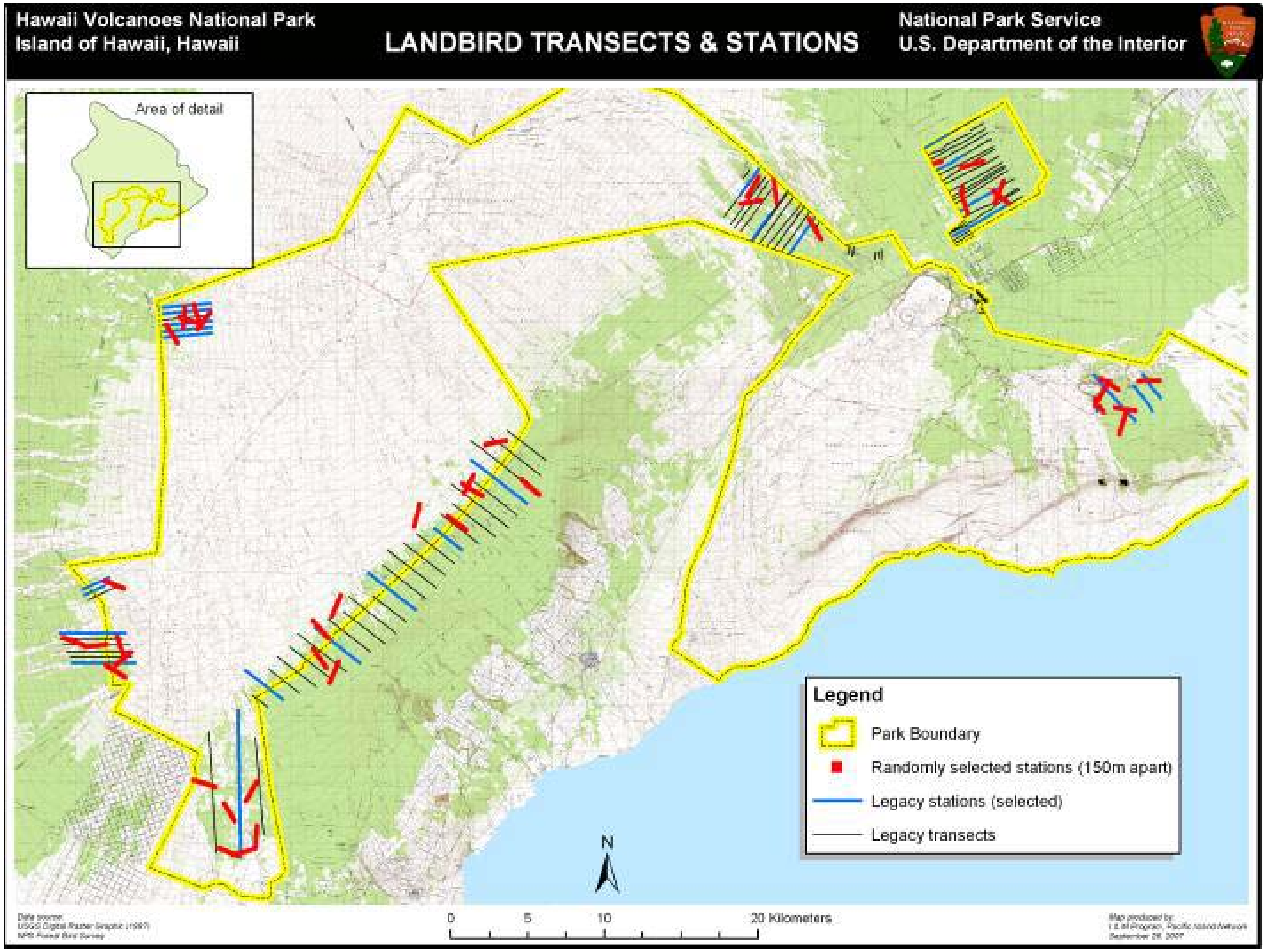

Figure A.4a. Location of Landbird sampling stations within HAVO. Legacy stations (blue lines) should be sampled on each survey occasion, whereas these random stations (red lines) should be sampled only during the first survey occasion. Maps detailing sampling locations are provided for the new acquisition (Figure A.2b), old acquisition (Figure A.2c) and Northwest Kahuku (Figure A.2d).

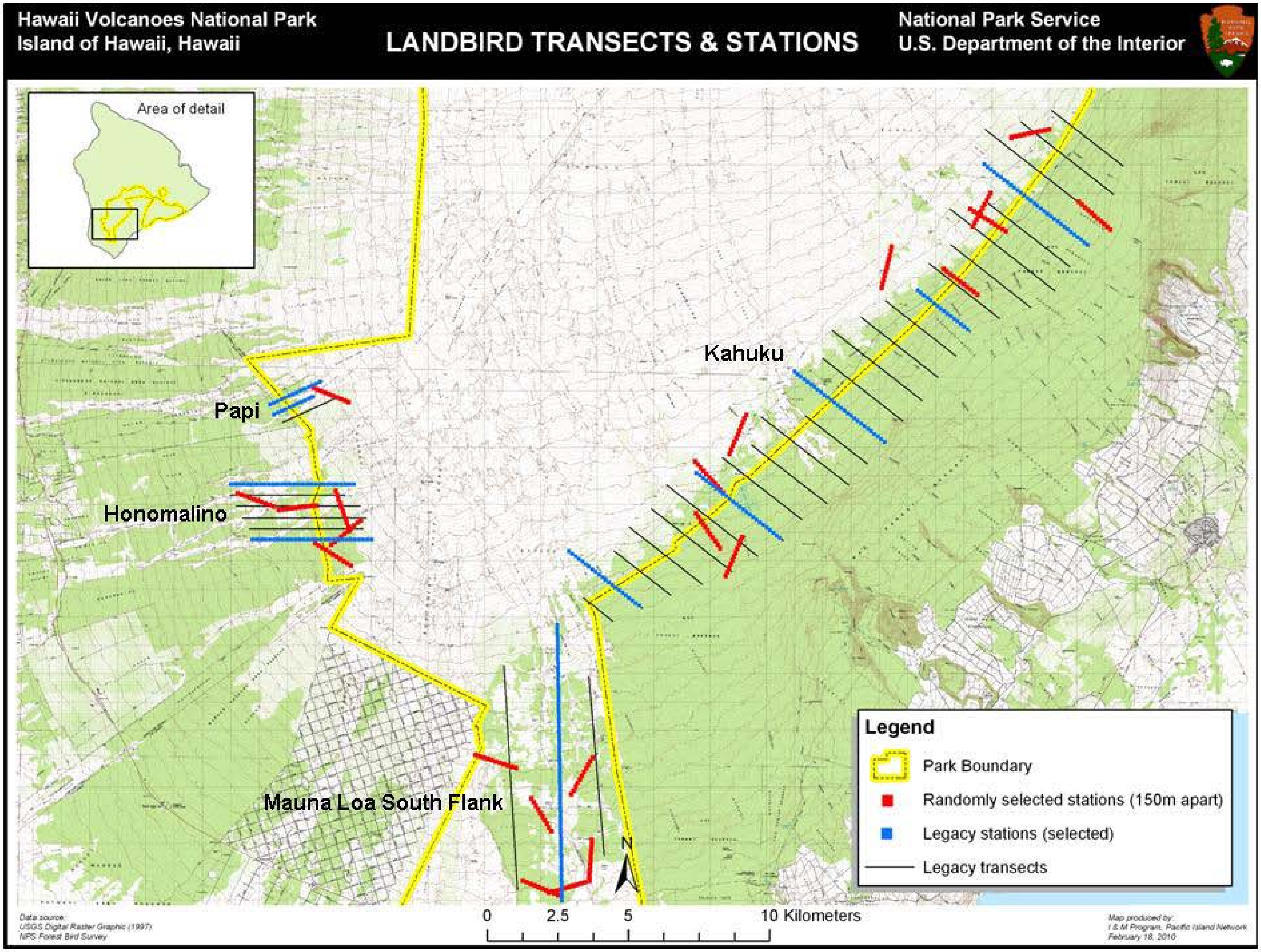

Figure A.2b. Detailed map of sampling locations for the new acquisition.

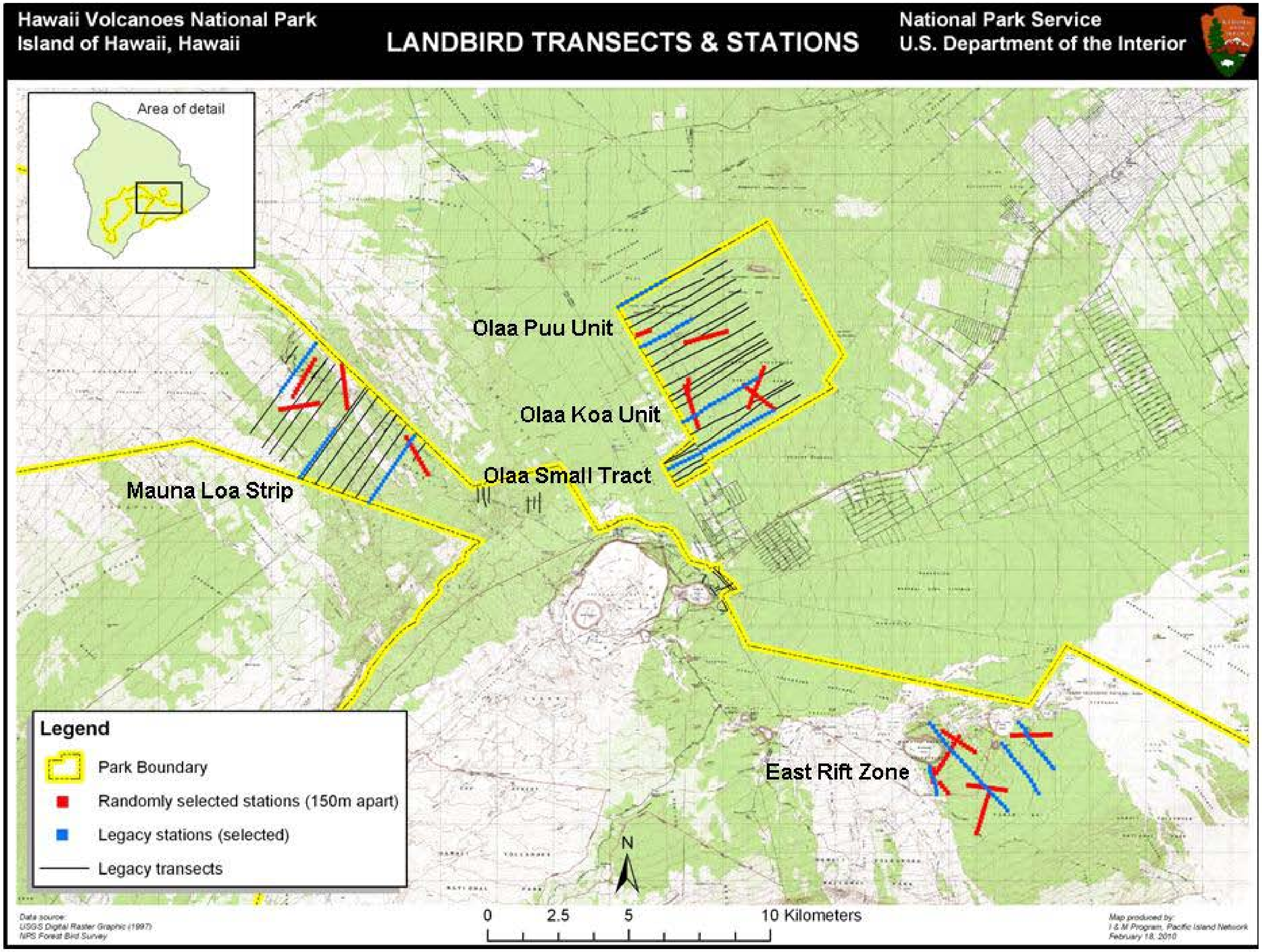

Figure A.2c. Detailed map of sampling locations for the old acquisition.

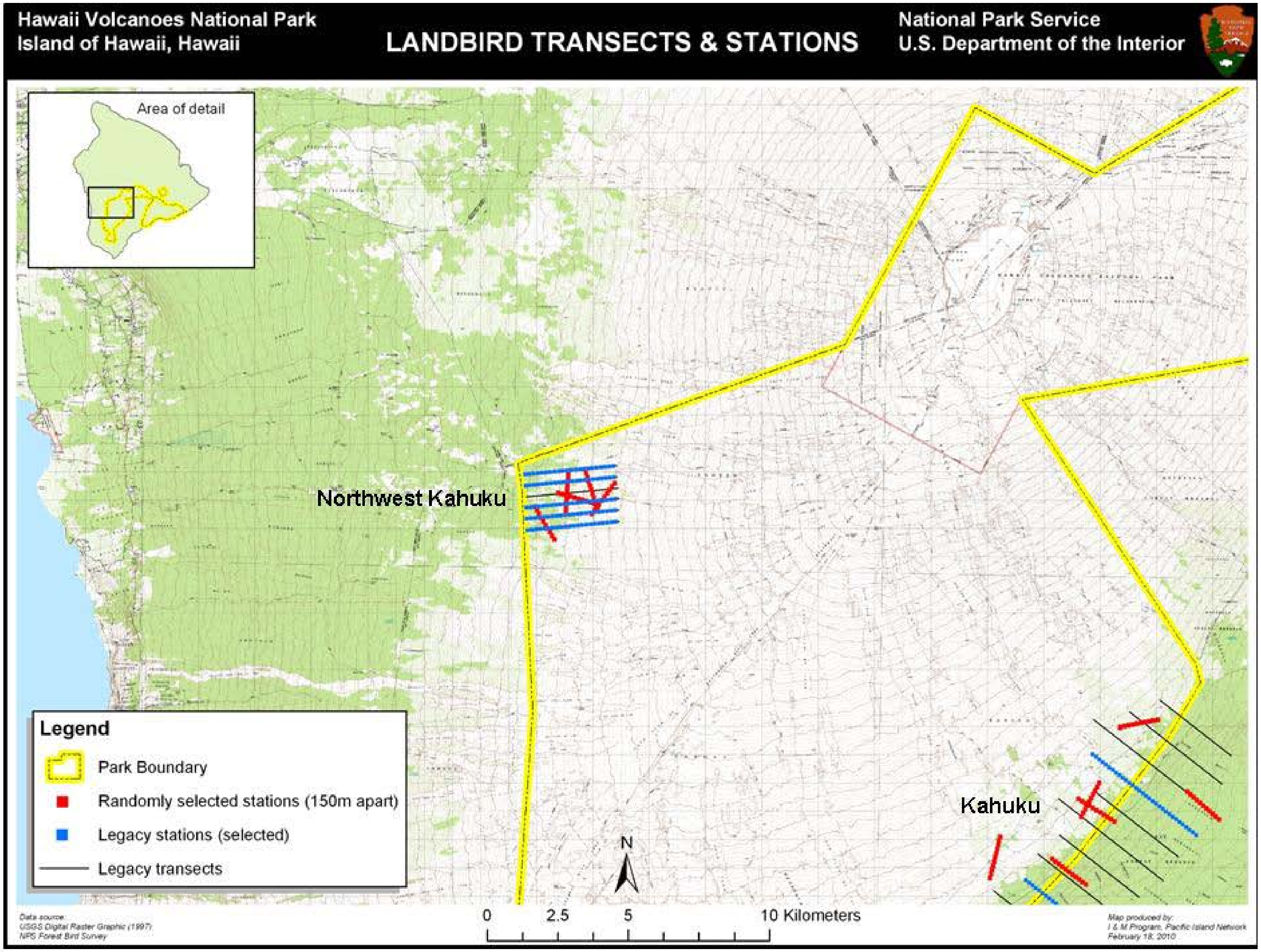

Figure A.2d. Detailed map of sampling locations for the Northwest Kahuku.

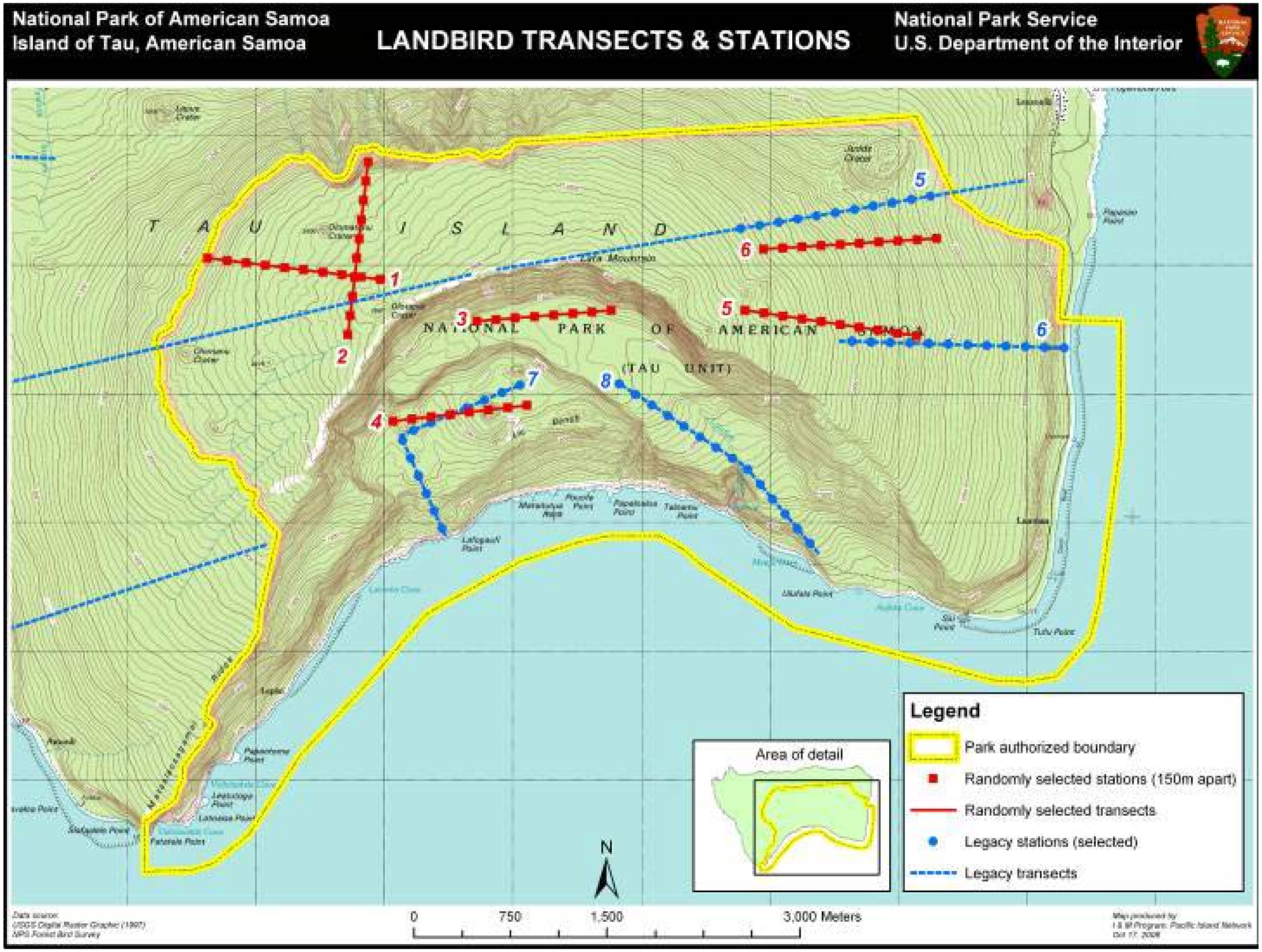

Figure A.3. Location of Landbird sampling stations within NPSA, Tau unit. Legacy stations (blue dots) should be sampled on each survey occasion, whereas these random stations (red diamonds) should be sampled only during the first survey occasion.

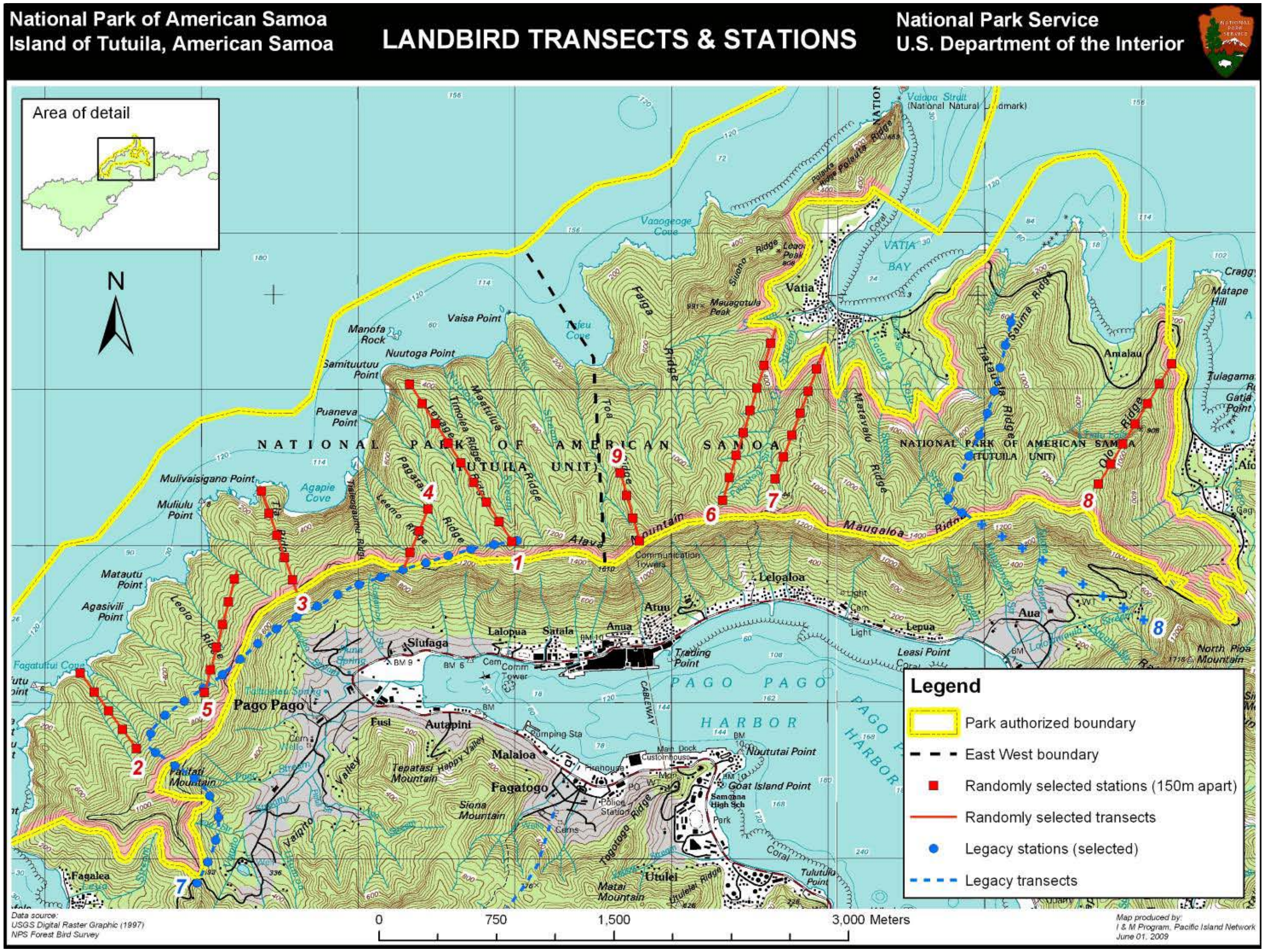

Figure A.4. Location of Landbird sampling stations within NPSA, Tutuila unit. Legacy stations (blue dots) should be sampled on each survey occasion, whereas these random stations (red diamonds) should be sampled only during the first survey occasion.

Table A.1. UTM coordinates (X Coord and Y Coord) for legacy and random stations in HALE**.**

Legacy Stations				Random Stations			
Transect	**Station**	**X_Coord**	**Y_Coord**	**Transect**	**Station**	**X_Coord**	**Y_Coord**
10	1	800361.00	2295420.00	1	1	801916.43	2293800.77
10	2	800377.00	2295344.00	1	2	801965.00	2293658.85
10	3	800417.00	2295213.00	1	3	802013.58	2293516.94
10	4	800528.00	2295144.00	1	4	802062.16	2293375.02
10	5	800662.00	2295126.00	1	5	802110.74	2293233.10
10	6	800766.00	2295112.00	1	6	802159.31	2293091.19
10	7	800942.00	2295092.00	1	7	802207.89	2292949.27
10	8	801103.00	2295068.00	1	8	802256.47	2292807.36
10	9	801261.00	2295052.00	1	9	802305.05	2292665.44
10	10	801430.00	2295043.00	1	10	802353.69	2292527.12
10	11	801566.00	2295034.00	2	1	799514.89	2293807.00
10	12	801708.00	2295026.00	2	2	799540.14	2293659.14
10	13	801924.00	2295026.00	2	3	799565.38	2293511.28
10	14	802027.00	2294994.00	2	4	799590.62	2293363.42
10	15	802102.00	2294879.00	2	5	799615.87	2293215.56
10	16	802178.00	2294798.00	2	6	799641.11	2293067.70
10	17	802289.00	2294763.00	2	7	799489.65	2293954.86
10	18	802434.00	2294865.00	2	8	799666.36	2292919.84
10	19	802583.00	2294970.00	2	9	799691.60	2292771.98
10	20	802775.00	2294961.00	2	10	799717.55	2292624.26
16	1	799620.00	2294385.00	3	1	800531.43	2291523.66
16	2	799627.00	2294287.00	3	2	800611.16	2291397.19
16	3	799649.00	2294171.00	3	3	800691.17	2291271.93

Table A.1. UTM coordinates (X Coord and Y Coord) for legacy and random stations in HALE (continued).

16	4	799708.00	2293983.00	3	4	800773.71	2291144.52
16	5	799795.00	2293850.00	3	5	800935.77	2290895.22
16	6	799881.00	2293753.00	3	6	800854.28	2291020.20
16	7	800052.00	2293677.00	3	7	801017.38	2290769.84
16	8	800234.00	2293617.00	3	8	801099.89	2290641.27
16	9	800463.00	2293543.00	3	9	801181.47	2290516.02
16	10	800600.00	2293511.00	3	10	801262.81	2290391.27
16	11	800728.00	2293480.00	4	1	804398.01	2290278.81
16	12	800862.00	2293419.00	4	2	804257.66	2290331.73
16	13	800992.00	2293325.00	4	3	804117.30	2290384.65
16	14	801111.00	2293252.00	4	4	803976.95	2290437.57
16	15	801225.00	2293163.00	4	6	803836.59	2290490.49
16	16	801347.00	2293080.00	4	5	803696.24	2290543.41
16	17	801466.00	2293005.00	4	7	803555.88	2290596.33
16	18	801591.00	2292910.00	4	8	803415.53	2290649.26
16	19	801681.00	2292822.00	4	9	803275.17	2290702.18
16	20	801881.00	2292736.00	4	10	803134.82	2290755.10
16	21	802012.00	2292682.00	5	1	802886.24	2289848.76
16	22	802108.00	2292635.00	5	2	802906.81	2289700.17
16	23	802227.00	2292578.00	5	3	802927.38	2289551.59
16	24	802336.00	2292469.00	5	4	802947.96	2289403.01
16	25	802422.00	2292390.00	5	5	802968.53	2289254.43
16	26	802528.00	2292292.00	5	6	802989.10	2289105.84
16	27	802642.00	2292198.00	5	7	803009.68	2288957.26
16	28	802790.00	2292188.00	5	8	803030.25	2288808.68

Table A.1. UTM coordinates (X Coord and Y Coord) for legacy and random stations in HALE (continued).

16	29	802923.00	2292188.00	5	9	803050.82	2288660.10
16	30	803044.00	2292190.00	5	10	802865.67	2289997.34
16	31	803138.00	2292168.00				
16	32	803311.00	2292099.00				
16	33	803481.00	2292030.00				
16	34	803625.00	2291966.00				
16	35	803745.00	2291916.00				
16	36	803832.00	2291874.00				
16	37	803941.00	2291810.00				
16	38	804037.00	2291748.00				
16	39	804192.00	2291633.00				
16	40	804312.00	2291613.00				
16	41	804409.00	2291602.00				
16	42	804519.00	2291574.00				
17	1	798323.00	2293871.00				
17	2	798400.00	2293813.00				
17	3	798481.00	2293761.00				
17	4	798607.00	2293677.00				
17	5	798728.00	2293593.00				
17	6	798807.00	2293538.00				
17	7	798908.00	2293469.00				
17	8	798990.00	2293417.00				
17	9	799074.00	2293358.00				
17	10	799158.00	2293301.00				
17	11	799269.00	2293227.00				
17	12	799390.00	2293146.00				

Table A.1. UTM coordinates (X Coord and Y Coord) for legacy and random stations in HALE (continued).

17	13	799474.00	2293092.00
17	14	799550.00	2293037.00
17	15	799627.00	2292985.00
17	16	799721.00	2292924.00
17	17	799829.00	2292850.00
17	18	799916.00	2292790.00
17	19	800047.00	2292701.00
17	20	800158.00	2292625.00
17	21	800247.00	2292568.00
17	22	800336.00	2292506.00
17	23	800407.00	2292459.00
17	24	800518.00	2292385.00
17	25	800595.00	2292334.00
17	26	800669.00	2292284.00
17	27	800765.00	2292257.00
17	28	800879.00	2292259.00
17	29	801007.00	2292272.00
17	30	801133.00	2292299.00
17	31	801232.00	2292336.00
17	32	801333.00	2292452.00
17	33	801511.00	2292420.00
17	34	801570.00	2292274.00
17	35	801597.00	2292151.00
17	36	801620.00	2292082.00
17	37	801662.00	2291998.00
17	38	801721.00	2291901.00

Table A.1. UTM coordinates (X Coord and Y Coord) for legacy and random stations in HALE (continued).

17	39	801765.00	2291830.00
17	40	801817.00	2291746.00
17	41	801886.00	2291655.00
17	42	801963.00	2291561.00
17	43	802091.00	2291437.00
17	44	802031.00	2291492.00
17	45	802150.00	2291378.00
17	46	802215.00	2291311.00
17	47	802286.00	2291262.00
17	48	802353.00	2291227.00
17	49	802466.00	2291156.00
17	50	802558.00	2291104.00
17	51	802622.00	2291069.00
17	52	802706.00	2291000.00
17	53	802775.00	2290943.00
17	54	802847.00	2290897.00
17	55	802955.00	2290832.00
17	56	803054.00	2290776.00
17	57	803121.00	2290726.00
17	58	803187.00	2290672.00
17	59	803247.00	2290622.00
17	60	803306.00	2290573.00
17	61	803358.00	2290529.00
17	62	803410.00	2290484.00
17	63	803466.00	2290393.00
17	64	803516.00	2290292.00

Table A.1. UTM coordinates (X Coord and Y Coord) for legacy and random stations in HALE (continued).

17	65	803585.00	2290208.00
17	66	803629.00	2290119.00
17	67	803689.00	2290057.00
17	68	803755.00	2289990.00
17	69	803815.00	2289929.00
17	70	803881.00	2289859.00
17	71	803941.00	2289798.00
17	72	803995.00	2289746.00
17	73	804066.00	2289662.00
17	74	804118.00	2289608.00
17	75	804190.00	2289585.00

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO.

	Legacy Stations			
Tract	**Transect**	**Station**	**X_Coord**	**Y_Coord**
East Rift Zone	1	1	272515	2141171
East Rift Zone	1	2	272554	2141354
East Rift Zone	1	3	272583	2141537
East Rift Zone	1	4	272522	2141698
East Rift Zone	1	5	272480	2141884
East Rift Zone	1	6	272427	2142067
East Rift Zone	2	1	274703	2140910
East Rift Zone	2	2	274544	2141059
East Rift Zone	2	3	274409	2141213
East Rift Zone	2	4	274260	2141357
East Rift Zone	2	5	274120	2141505
East Rift Zone	2	6	273997	2141663
East Rift Zone	2	7	273719	2141965
East Rift Zone	2	8	273859	2141812
East Rift Zone	2	9	273574	2142111
East Rift Zone	2	10	273437	2142261
East Rift Zone	2	11	273301	2142403
East Rift Zone	2	12	273158	2142540
East Rift Zone	2	13	273013	2142689
East Rift Zone	2	14	272899	2142852

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

East Rift Zone	2	15	272782	2143006
East Rift Zone	2	16	272653	2143156
East Rift Zone	2	17	272540	2143305
East Rift Zone	2	18	272423	2143464
East Rift Zone	2	19	272317	2143612
East Rift Zone	2	20	272450	2143701
East Rift Zone	2	21	272625	2143798
East Rift Zone	2	22	272800	2143895
East Rift Zone	2	23	272975	2143992
East Rift Zone	2	24	273150	2144089
East Rift Zone	2	25	273325	2144186
East Rift Zone	3	1	276183	2141092
East Rift Zone	3	2	276088	2141224
East Rift Zone	3	3	276016	2141394
East Rift Zone	3	4	275909	2141554
East Rift Zone	3	5	275804	2141714
East Rift Zone	3	6	275680	2141857
East Rift Zone	3	7	275571	2142008
East Rift Zone	3	8	275450	2142157
East Rift Zone	3	9	275324	2142287
East Rift Zone	3	10	275207	2142441
East Rift Zone	3	11	275106	2142598
East Rift Zone	3	12	274987	2142746

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

East Rift Zone	3	13	274858	2142879
East Rift Zone	3001	1	276652	2142035
East Rift Zone	3001	2	276546	2142191
East Rift Zone	3001	3	276430	2142337
East Rift Zone	3001	4	276293	2142470
9East Rift Zone	3001	5	276160	2142616
East Rift Zone	3001	6	276069	2142759
East Rift Zone	3001	7	275957	2142918
East Rift Zone	3001	8	275832	2143065
East Rift Zone	3001	9	275740	2143201
East Rift Zone	3001	10	275722	2143365
East Rift Zone	3001	11	275585	2143483
East Rift Zone	3001	12	275460	2143625
Honomalino	1	1	209366	2126707
Honomalino	1	2	209166	2126707
Honomalino	1	3	208966	2126707
Honomalino	1	4	208766	2126707
Honomalino	1	5	208566	2126707
Honomalino	1	6	208366	2126707
Honomalino	1	7	208166	2126707
Honomalino	1	8	207966	2126707
Honomalino	1	9	207766	2126707
Honomalino	1	10	207566	2126707

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Honomalino	1	11	207366	2126707
Honomalino	1	12	207166	2126707
Honomalino	1	13	206966	2126707
Honomalino	1	14	206766	2126707
Honomalino	1	15	206566	2126707
Honomalino	1	16	206366	2126707
Honomalino	1	17	206166	2126707
Honomalino	1	18	205966	2126707
Honomalino	1	19	205766	2126707
Honomalino	1	20	205566	2126707
Honomalino	1	21	205366	2126707
Honomalino	1	22	205166	2126707
Honomalino	1	23	204966	2126707
Honomalino	6	1	210025	2124750
Honomalino	6	2	209825	2124750
Honomalino	6	3	209625	2124750
Honomalino	6	4	209425	2124750
Honomalino	6	5	209225	2124750
Honomalino	6	6	209025	2124750
Honomalino	6	7	208825	2124750
Honomalino	6	8	208625	2124750
Honomalino	6	9	208425	2124750
Honomalino	6	10	208225	2124750

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Honomalino	6	11	208025	2124750
Honomalino	6	12	207825	2124750
Honomalino	6	13	207625	2124750
Honomalino	6	14	207425	2124750
Honomalino	6	15	207225	2124750
Honomalino	6	16	207025	2124750
Honomalino	6	17	206825	2124750
Honomalino	6	18	206625	2124750
Honomalino	6	19	206425	2124750
Honomalino	6	20	206225	2124750
Honomalino	6	21	206025	2124750
Honomalino	6	22	205825	2124750
Honomalino	6	23	205625	2124750
Mauna Loa South Flank	3	1	216602	2121842
Mauna Loa South Flank	3	2	216605	2121642
Mauna Loa South Flank	3	3	216607	2121442
Mauna Loa South Flank	3	4	216610	2121242
Mauna Loa South Flank	3	5	216613	2121042
Mauna Loa South Flank	3	6	216616	2120842
Mauna Loa South Flank	3	7	216619	2120642
Mauna Loa South Flank	3	8	216622	2120442
Mauna Loa South Flank	3	9	216624	2120242
Mauna Loa South Flank	3	10	216627	2120042

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Mauna Loa South Flank	3	11	216630	2119842
Mauna Loa South Flank	3	12	216633	2119642
Mauna Loa South Flank	3	13	216636	2119442
Mauna Loa South Flank	3	14	216638	2119242
Mauna Loa South Flank	3	15	216641	2119042
Mauna Loa South Flank	3	16	216644	2118842
Mauna Loa South Flank	3	17	216647	2118642
Mauna Loa South Flank	3	18	216650	2118442
Mauna Loa South Flank	3	19	216652	2118242
Mauna Loa South Flank	3	20	216655	2118042
Mauna Loa South Flank	3	21	216658	2117842
Mauna Loa South Flank	3	22	216661	2117642
Mauna Loa South Flank	3	23	216664	2117442
Mauna Loa South Flank	3	24	216667	2117242
Mauna Loa South Flank	3	25	216669	2117042
Mauna Loa South Flank	3	26	216672	2116842
Mauna Loa South Flank	3	27	216675	2116642
Mauna Loa South Flank	3	28	216678	2116442
Mauna Loa South Flank	3	29	216681	2116242
Mauna Loa South Flank	3	30	216683	2116042
Mauna Loa South Flank	3	31	216686	2115842
Mauna Loa South Flank	3	32	216689	2115642
Mauna Loa South Flank	3	33	216692	2115442

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Mauna Loa South Flank	3	34	216695	2115242
Mauna Loa South Flank	3	35	216697	2115042
Mauna Loa South Flank	3	36	216700	2114842
Mauna Loa South Flank	3	37	216703	2114642
Mauna Loa South Flank	3	38	216706	2114442
Mauna Loa South Flank	3	39	216709	2114242
Mauna Loa South Flank	3	40	216711	2114043
Mauna Loa South Flank	3	41	216714	2113843
Mauna Loa South Flank	3	42	216717	2113643
Mauna Loa South Flank	3	43	216720	2113443
Mauna Loa South Flank	3	44	216723	2113243
Mauna Loa South Flank	3	45	216726	2113043
Mauna Loa South Flank	3	46	216728	2112843
Mauna Loa South Flank	3	47	216731	2112643
Mauna Loa South Flank	3	48	216734	2112443
Mauna Loa South Flank	3	49	216737	2112243
Mauna Loa South Flank	3	50	216740	2112043
Mauna Loa South Flank	3	51	216742	2111839
Mauna Loa Strip	8	0	253831	2154133
Mauna Loa Strip	8	200	253723	2153975
Mauna Loa Strip	8	400	253616	2153816
Mauna Loa Strip	8	600	253509	2153658
Mauna Loa Strip	8	800	253402	2153500

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Mauna Loa Strip	8	1000	253294	2153341
Mauna Loa Strip	8	1200	253187	2153183
Mauna Loa Strip	8	1400	253080	2153025
Mauna Loa Strip	8	1600	252973	2152866
Mauna Loa Strip	8	1800	252866	2152708
Mauna Loa Strip	8	2000	252758	2152549
Mauna Loa Strip	8	2200	252651	2152391
Mauna Loa Strip	8	2400	252544	2152233
Mauna Loa Strip	8	2600	252437	2152074
Mauna Loa Strip	8	2800	252329	2151916
Mauna Loa Strip	8	3000	252222	2151758
Mauna Loa Strip	8	3200	252115	2151599
Mauna Loa Strip	14	2400	250371	2154282
Mauna Loa Strip	14	2600	250264	2154122
Mauna Loa Strip	14	2800	250157	2153963
Mauna Loa Strip	14	3000	250050	2153803
Mauna Loa Strip	14	3200	249943	2153644
Mauna Loa Strip	14	3400	249836	2153485
Mauna Loa Strip	14	3600	249728	2153325
Mauna Loa Strip	14	3800	249621	2153166
Mauna Loa Strip	14	4000	249514	2153006
Mauna Loa Strip	14	4200	249407	2152847
Mauna Loa Strip	14	4400	249300	2152688

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Mauna Loa Strip	14	4600	249193	2152528
Mauna Loa Strip	18	0	250329	2157491
Mauna Loa Strip	18	200	250215	2157326
Mauna Loa Strip	18	400	250101	2157162
Mauna Loa Strip	18	600	249987	2156997
Mauna Loa Strip	18	800	249873	2156832
Mauna Loa Strip	18	1000	249759	2156667
Mauna Loa Strip	18	1200	249645	2156503
Mauna Loa Strip	18	1400	249531	2156338
Mauna Loa Strip	18	1600	249417	2156173
Mauna Loa Strip	18	1800	249303	2156008
Mauna Loa Strip	18	2000	249189	2155843
Northwest Kahuku	3	1	211586	2147912
Northwest Kahuku	3	2	211785	2147931
Northwest Kahuku	3	3	211984	2147949
Northwest Kahuku	3	4	212183	2147968
Northwest Kahuku	3	5	212382	2147987
Northwest Kahuku	3	6	212581	2148006
Northwest Kahuku	3	7	212780	2148025
Northwest Kahuku	3	8	212979	2148044
Northwest Kahuku	3	9	213179	2148062
Northwest Kahuku	3	10	213378	2148081
Northwest Kahuku	4	1	211609	2147516

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Northwest Kahuku	4	2	211808	2147535
Northwest Kahuku	4	3	212007	2147553
Northwest Kahuku	4	4	212206	2147572
Northwest Kahuku	4	5	212405	2147591
Northwest Kahuku	4	6	212604	2147610
Northwest Kahuku	4	7	212804	2147629
Northwest Kahuku	4	8	213003	2147647
Northwest Kahuku	4	9	213202	2147666
Northwest Kahuku	4	10	213401	2147685
Northwest Kahuku	5	1	211628	2147123
Northwest Kahuku	5	2	211827	2147142
Northwest Kahuku	5	3	212026	2147161
Northwest Kahuku	5	4	212225	2147180
Northwest Kahuku	5	5	212425	2147199
Northwest Kahuku	5	6	212624	2147218
Northwest Kahuku	5	7	212823	2147236
Northwest Kahuku	5	8	213022	2147255
Northwest Kahuku	5	9	213221	2147274
Northwest Kahuku	7	1	211653	2146347
Northwest Kahuku	7	2	211852	2146365
Northwest Kahuku	7	3	212051	2146384
Northwest Kahuku	7	4	212250	2146403
Northwest Kahuku	7	5	212449	2146422

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Northwest Kahuku	7	6	212649	2146441
Northwest Kahuku	7	7	212848	2146460
Northwest Kahuku	7	8	213047	2146478
Northwest Kahuku	7	9	213246	2146497
Northwest Kahuku	8	1	211669	2145946
Northwest Kahuku	8	2	211868	2145965
Northwest Kahuku	8	3	212067	2145984
Northwest Kahuku	8	4	212266	2146002
Northwest Kahuku	8	5	212465	2146021
Northwest Kahuku	8	6	212664	2146040
Northwest Kahuku	8	7	212863	2146059
Northwest Kahuku	8	8	213062	2146078
Northwest Kahuku	8	9	213262	2146097
Northwest Kahuku	8	10	213461	2146115
Olaa Koa Unit	14	1	263625	2154230
Olaa Koa Unit	14	2	263814	2154340
Olaa Koa Unit	14	3	264002	2154451
Olaa Koa Unit	14	4	264191	2154561
Olaa Koa Unit	14	5	264379	2154672
Olaa Koa Unit	14	6	264568	2154782
Olaa Koa Unit	14	7	264756	2154893
Olaa Koa Unit	14	8	264945	2155003
Olaa Koa Unit	19	1	264230	2153159

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Olaa Koa Unit	19	2	264418	2153269
Olaa Koa Unit	19	3	264607	2153380
Olaa Koa Unit	19	4	264795	2153490
Olaa Koa Unit	19	5	264984	2153601
Olaa Koa Unit	19	6	265172	2153711
Olaa Koa Unit	19	7	265361	2153821
Olaa Koa Unit	19	8	265549	2153932
Olaa Puu Unit	1	1	261283	2158302
Olaa Puu Unit	1	2	261455	2158401
Olaa Puu Unit	1	3	261628	2158499
Olaa Puu Unit	1	4	261801	2158597
Olaa Puu Unit	1	5	261973	2158695
Olaa Puu Unit	1	6	262146	2158794
Olaa Puu Unit	1	7	262492	2158990
Olaa Puu Unit	1	8	262664	2159089
Olaa Puu Unit	1	9	262837	2159187
Olaa Puu Unit	1	10	263010	2159285
Olaa Puu Unit	1	11	263183	2159383
Olaa Puu Unit	1	12	263355	2159482
Olaa Puu Unit	5	1	262107	2156857
Olaa Puu Unit	5	2	262288	2156957
Olaa Puu Unit	5	3	262470	2157057
Olaa Puu Unit	5	4	262652	2157157

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Olaa Puu Unit	5	5	262834	2157257
Olaa Puu Unit	5	6	263016	2157357
Olaa Puu Unit	5	7	263347	2157555
Olaa Puu Unit	5	8	263529	2157655
Olaa Puu Unit	5	9	263711	2157755
Olaa Puu Unit	5	10	263893	2157855
Olaa Puu Unit	5	11	264075	2157955
Olaa Puu Unit	5	12	264257	2158055
Olaa Small Track Unit	3	1	264082	2153061
Olaa Small Track Unit	3	2	263950	2152990
Olaa Small Track Unit	3	3	263818	2152919
Olaa Small Track Unit	3	4	263686	2152847
Olaa Small Track Unit	3	5	263554	2152776
Olaa Small Track Unit	3	6	263422	2152705
Olaa Small Track Unit	3	7	263290	2152633
Papi	1	1	208024	2130255
Papi	1	2	207842	2130173
Papi	1	3	207659	2130090
Papi	1	4	207477	2130008
Papi	1	5	207295	2129925
Papi	1	6	207113	2129843
Papi	1	7	206930	2129761
Papi	2	1	207810	2129745

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Papi	2	2	207627	2129663
Papi	2	3	207445	2129581
Papi	2	4	207263	2129498
Kahuku	2	1	216992	2124335
Kahuku	2	2	217150	2124212
Kahuku	2	3	217307	2124089
Kahuku	2	4	217465	2123966
Kahuku	2	5	217623	2123843
Kahuku	2	6	217781	2123721
Kahuku	2	7	217939	2123598
Kahuku	2	8	218097	2123475
Kahuku	2	9	218255	2123352
Kahuku	2	10	218413	2123230
Kahuku	2	11	218570	2123107
Kahuku	2	12	218728	2122984
Kahuku	2	13	218886	2122861
Kahuku	2	14	219044	2122738
Kahuku	2	15	219202	2122616
Kahuku	2	16	219360	2122493
Kahuku	2	17	219523	2122366
Kahuku	7	1	221514	2127102
Kahuku	7	2	221671	2126979
Kahuku	7	3	221829	2126857

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Kahuku	7	4	221987	2126734
Kahuku	7	5	222145	2126611
Kahuku	7	6	222303	2126488
Kahuku	7	7	222461	2126365
Kahuku	7	8	222619	2126243
Kahuku	7	9	222777	2126120
Kahuku	7	10	222934	2125997
Kahuku	7	11	223092	2125874
Kahuku	7	12	223250	2125751
Kahuku	7	13	223408	2125629
Kahuku	7	14	223566	2125506
Kahuku	7	15	223724	2125383
Kahuku	7	16	223882	2125260
Kahuku	7	17	224040	2125138
Kahuku	7	18	224197	2125015
Kahuku	7	19	224355	2124892
Kahuku	7	20	224515	2124766
Kahuku	12	1	224984	2130687
Kahuku	12	2	225141	2130564
Kahuku	12	3	225299	2130442
Kahuku	12	4	225457	2130319
Kahuku	12	5	225615	2130196
Kahuku	12	6	225773	2130073

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Kahuku	12	7	225931	2129950
Kahuku	12	8	226089	2129828
Kahuku	12	9	226247	2129705
Kahuku	12	10	226404	2129582
Kahuku	12	11	226562	2129459
Kahuku	12	12	226720	2129337
Kahuku	12	13	226878	2129214
Kahuku	12	14	227036	2129091
Kahuku	12	15	227194	2128968
Kahuku	12	16	227352	2128845
Kahuku	12	17	227510	2128723
Kahuku	12	18	227667	2128600
Kahuku	12	19	227825	2128477
Kahuku	12	20	227983	2128354
Kahuku	12	21	228139	2128227
Kahuku	17	1	229348	2133562
Kahuku	17	2	229506	2133439
Kahuku	17	3	229664	2133316
Kahuku	17	4	229822	2133193
Kahuku	17	5	229980	2133071
Kahuku	17	6	230138	2132948
Kahuku	17	7	230296	2132825
Kahuku	17	8	230453	2132702

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Kahuku	17	9	230611	2132579
Kahuku	17	10	230769	2132457
Kahuku	17	11	230927	2132334
Kahuku	17	12	231085	2132211
Kahuku	22	1	231716	2138016
Kahuku	22	2	231874	2137893
Kahuku	22	3	232032	2137770
Kahuku	22	4	232190	2137647
Kahuku	22	5	232348	2137525
Kahuku	22	6	232505	2137402
Kahuku	22	7	232663	2137279
Kahuku	22	8	232821	2137156
Kahuku	22	9	232979	2137033
Kahuku	22	10	233137	2136911
Kahuku	22	11	233295	2136788
Kahuku	22	12	233453	2136665
Kahuku	22	13	233611	2136542
Kahuku	22	14	233768	2136419
Kahuku	22	15	233926	2136297
Kahuku	22	16	234084	2136174
Kahuku	22	17	234242	2136051
Kahuku	22	18	234400	2135928
Kahuku	22	19	234558	2135806

Table A.2a. UTM coordinates (X Coord and Y Coord) for legacy stations in HAVO (continued).

Kahuku	22	20	234716	2135683
Kahuku	22	21	234874	2135560
Kahuku	22	22	235031	2135437
Kahuku	22	23	235189	2135314
Kahuku	22	24	235507	2135068
Kahuku	22	25	235347	2135192

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO.

	Random Stations			
Tract	**Transect**	**Station**	**X_Coord**	**Y_Coord**
Kahuku	1	1	232698.59	2138937.25
Kahuku	1	2	232703.09	2138985.38
Kahuku	1	3	232850.33	2139014.00
Kahuku	1	4	232997.57	2139042.62
Kahuku	1	5	233144.82	2139071.24
Kahuku	1	6	233292.06	2139099.86
Kahuku	1	7	233439.31	2139128.49
Kahuku	1	8	233586.55	2139157.11
Kahuku	1	9	233733.79	2139185.73
Kahuku	1	10	233881.04	2139214.35
Kahuku	1	11	234028.28	2139242.97
Kahuku	2	1	222694.03	2127775.69
Kahuku	2	2	222752.64	2127913.77
Kahuku	2	3	222811.25	2128051.84
Kahuku	2	4	222869.86	2128189.92
Kahuku	2	5	222928.47	2128327.99
Kahuku	2	6	222987.08	2128466.07
Kahuku	2	7	223045.69	2128604.14
Kahuku	2	8	223104.30	2128742.22
Kahuku	2	9	223162.91	2128880.30

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Kahuku	2	10	223221.52	2129018.37
Kahuku	2	11	223280.12	2129156.45
Kahuku	3	1	222557.91	2123453.99
Kahuku	3	2	222616.52	2123592.07
Kahuku	3	3	222675.13	2123730.14
Kahuku	3	4	222733.74	2123868.22
Kahuku	3	5	222792.35	2124006.29
Kahuku	3	6	222850.96	2124144.37
Kahuku	3	7	222909.57	2124282.44
Kahuku	3	8	222968.18	2124420.52
Kahuku	3	9	223026.79	2124558.60
Kahuku	3	10	223085.40	2124696.67
Kahuku	3	11	223144.01	2124834.75
Kahuku	4	1	230282.53	2134309.28
Kahuku	4	2	230402.32	2134219.01
Kahuku	4	3	230522.12	2134128.74
Kahuku	4	4	230641.91	2134038.47
Kahuku	4	5	230761.71	2133948.20
Kahuku	4	6	230881.50	2133857.92
Kahuku	4	7	231001.30	2133767.65
Kahuku	4	8	231121.09	2133677.38
Kahuku	4	9	231240.89	2133587.11
Kahuku	4	10	231360.68	2133496.83

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Kahuku	4	11	231480.48	2133406.56
Kahuku	5	1	228444.95	2135091.95
Kahuku	5	2	228408.66	2134946.41
Kahuku	5	3	228372.38	2134800.87
Kahuku	5	4	228336.09	2134655.32
Kahuku	5	5	228299.80	2134509.78
Kahuku	5	6	228263.51	2134364.23
Kahuku	5	7	228227.22	2134218.69
Kahuku	5	8	228190.93	2134073.14
Kahuku	5	9	228154.65	2133927.60
Kahuku	5	10	228118.36	2133782.06
Kahuku	5	11	228082.07	2133636.51
Kahuku	6	1	231949.95	2136997.59
Kahuku	6	2	231879.53	2136865.14
Kahuku	6	3	231809.11	2136732.70
Kahuku	6	4	231738.69	2136600.26
Kahuku	6	5	231668.27	2136467.82
Kahuku	6	6	231597.85	2136335.38
Kahuku	6	7	231527.43	2136202.93
Kahuku	6	8	231457.01	2136070.49
Kahuku	6	9	231386.59	2135938.05
Kahuku	6	10	231316.17	2135805.61
Kahuku	7	1	221468.98	2127503.46

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Kahuku	7	2	221569.35	2127391.99
Kahuku	7	3	221669.72	2127280.51
Kahuku	7	4	221770.09	2127169.04
Kahuku	7	5	221870.46	2127057.57
Kahuku	7	6	221970.83	2126946.10
Kahuku	7	7	222071.20	2126834.63
Kahuku	7	8	222171.57	2126723.16
Kahuku	7	9	222271.94	2126611.68
Kahuku	7	10	222372.31	2126500.21
Kahuku	7	11	222472.68	2126388.74
Kahuku	8	1	232494.42	2135636.42
Kahuku	8	2	232367.21	2135715.91
Kahuku	8	3	232240.00	2135795.40
Kahuku	8	4	232112.80	2135874.88
Kahuku	8	5	231985.59	2135954.37
Kahuku	8	6	231858.38	2136033.86
Kahuku	8	7	231731.18	2136113.35
Kahuku	8	8	231603.97	2136192.84
Kahuku	8	9	231476.76	2136272.32
Kahuku	8	10	231349.55	2136351.81
Kahuku	8	11	231222.35	2136431.30
Kahuku	9	1	236203.60	2135704.48
Kahuku	9	2	236090.39	2135802.89

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Kahuku	9	3	235977.18	2135901.30
Kahuku	9	4	235863.98	2135999.71
Kahuku	9	5	235750.77	2136098.11
Kahuku	9	6	235637.56	2136196.52
Kahuku	9	7	235524.36	2136294.93
Kahuku	9	8	235411.15	2136393.34
Kahuku	9	9	235297.94	2136491.75
Kahuku	9	10	235184.74	2136590.16
Kahuku	9	11	235071.53	2136688.57
Kahuku	10	1	222353.74	2124440.84
Kahuku	10	2	222267.70	2124563.71
Kahuku	10	3	222181.66	2124686.58
Kahuku	10	4	222095.63	2124809.45
Kahuku	10	5	222009.59	2124932.33
Kahuku	10	6	221923.55	2125055.20
Kahuku	10	7	221837.52	2125178.07
Kahuku	10	8	221751.48	2125300.94
Kahuku	10	9	221665.45	2125423.82
Kahuku	10	10	221579.41	2125546.69
Kahuku	10	11	221493.37	2125669.56
Mauna Loa South Flank	11	1	215675.78	2115586.50
Mauna Loa South Flank	11	2	215753.03	2115457.93
Mauna Loa South Flank	11	3	215830.29	2115329.35

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Mauna Loa South Flank	11	4	215907.54	2115200.78
Mauna Loa South Flank	11	5	215984.80	2115072.20
Mauna Loa South Flank	11	6	216062.06	2114943.63
Mauna Loa South Flank	11	7	216139.31	2114815.05
Mauna Loa South Flank	11	8	216216.57	2114686.48
Mauna Loa South Flank	11	9	216293.82	2114557.90
Mauna Loa South Flank	11	10	216371.08	2114429.33
Mauna Loa South Flank	12	1	213688.85	2117123.56
Mauna Loa South Flank	12	2	213831.51	2117077.21
Mauna Loa South Flank	12	3	213974.17	2117030.85
Mauna Loa South Flank	12	4	214116.82	2116984.50
Mauna Loa South Flank	12	5	214259.48	2116938.15
Mauna Loa South Flank	12	6	214402.14	2116891.80
Mauna Loa South Flank	12	7	214544.80	2116845.44
Mauna Loa South Flank	12	8	214687.46	2116799.09
Mauna Loa South Flank	12	9	214830.12	2116752.74
Mauna Loa South Flank	12	10	214972.77	2116706.39
Mauna Loa South Flank	12	11	215115.43	2116660.03
Mauna Loa South Flank	13	1	217812.66	2114124.42
Mauna Loa South Flank	13	2	217802.20	2113974.79
Mauna Loa South Flank	13	3	217791.74	2113825.15
Mauna Loa South Flank	13	4	217781.27	2113675.52
Mauna Loa South Flank	13	5	217770.81	2113525.88

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Mauna Loa South Flank	13	6	217760.35	2113376.25
Mauna Loa South Flank	13	7	217749.88	2113226.61
Mauna Loa South Flank	13	8	217739.42	2113076.98
Mauna Loa South Flank	13	9	217728.96	2112927.35
Mauna Loa South Flank	13	10	217718.49	2112777.71
Mauna Loa South Flank	14	1	216275.60	2112249.96
Mauna Loa South Flank	14	2	216419.79	2112291.31
Mauna Loa South Flank	14	3	216563.98	2112332.65
Mauna Loa South Flank	14	4	216708.17	2112374.00
Mauna Loa South Flank	14	5	216852.36	2112415.34
Mauna Loa South Flank	14	6	216996.55	2112456.69
Mauna Loa South Flank	14	7	217140.74	2112498.03
Mauna Loa South Flank	14	8	217284.93	2112539.38
Mauna Loa South Flank	14	9	217429.12	2112580.73
Mauna Loa South Flank	14	10	217573.31	2112622.07
Mauna Loa South Flank	14	11	217717.50	2112663.42
Mauna Loa South Flank	15	1	216613.01	2112174.98
Mauna Loa South Flank	15	2	216473.93	2112231.17
Mauna Loa South Flank	15	3	216334.85	2112287.36
Mauna Loa South Flank	15	4	216195.77	2112343.56
Mauna Loa South Flank	15	5	216056.70	2112399.75
Mauna Loa South Flank	15	6	215917.62	2112455.94
Mauna Loa South Flank	15	7	215778.54	2112512.13

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Mauna Loa South Flank	15	8	215639.46	2112568.32
Mauna Loa South Flank	15	9	215500.39	2112624.51
Mauna Loa South Flank	15	10	215361.31	2112680.70
Mauna Loa South Flank	16	1	217081.62	2115736.46
Mauna Loa South Flank	16	2	217156.62	2115866.36
Mauna Loa South Flank	16	3	217231.62	2115996.27
Mauna Loa South Flank	16	4	217306.62	2116126.17
Mauna Loa South Flank	16	5	217381.62	2116256.07
Mauna Loa South Flank	16	6	217456.62	2116385.98
Mauna Loa South Flank	16	7	217531.62	2116515.88
Mauna Loa South Flank	16	8	217606.62	2116645.79
Mauna Loa South Flank	16	9	217681.62	2116775.69
Mauna Loa South Flank	16	10	217756.62	2116905.59
Mauna Loa South Flank	16	11	217831.62	2117035.50
Honomalino	17	1	209261.14	2123817.53
Honomalino	17	2	209133.93	2123897.02
Honomalino	17	3	209006.72	2123976.51
Honomalino	17	4	208879.52	2124056.00
Honomalino	17	5	208752.31	2124135.49
Honomalino	17	6	208625.10	2124214.97
Honomalino	17	7	208497.89	2124294.46
Honomalino	17	8	208370.69	2124373.95
Honomalino	17	9	208243.48	2124453.44

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Honomalino	17	10	208116.27	2124532.92
Honomalino	17	11	207989.07	2124612.41
Honomalino	18	1	206517.66	2125916.05
Honomalino	18	2	206376.71	2125967.36
Honomalino	18	3	206235.75	2126018.66
Honomalino	18	4	206094.80	2126069.96
Honomalino	18	5	205953.85	2126121.26
Honomalino	18	6	205812.89	2126172.57
Honomalino	18	7	205671.94	2126223.87
Honomalino	18	8	205530.98	2126275.17
Honomalino	18	9	205390.03	2126326.48
Honomalino	18	10	205249.08	2126377.78
Honomalino	19	1	206700.56	2125800.54
Honomalino	19	2	206849.74	2125816.22
Honomalino	19	3	206998.92	2125831.90
Honomalino	19	4	207148.09	2125847.58
Honomalino	19	5	207297.27	2125863.25
Honomalino	19	6	207446.45	2125878.93
Honomalino	19	7	207595.63	2125894.61
Honomalino	19	8	207744.81	2125910.29
Honomalino	19	9	207893.99	2125925.97
Honomalino	19	10	208043.16	2125941.65
Honomalino	20	1	208577.67	2124558.75

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Honomalino	20	2	208692.58	2124655.17
Honomalino	20	3	208807.49	2124751.59
Honomalino	20	4	208922.39	2124848.01
Honomalino	20	5	209037.30	2124944.43
Honomalino	20	6	209152.21	2125040.84
Honomalino	20	7	209267.11	2125137.26
Honomalino	20	8	209382.02	2125233.68
Honomalino	20	9	209496.93	2125330.10
Honomalino	20	10	209611.83	2125426.52
Honomalino	21	1	209222.63	2125049.69
Honomalino	21	2	209173.80	2125191.52
Honomalino	21	3	209124.96	2125333.35
Honomalino	21	4	209076.13	2125475.17
Honomalino	21	5	209027.29	2125617.00
Honomalino	21	6	208978.46	2125758.83
Honomalino	21	7	208929.62	2125900.66
Honomalino	21	8	208880.79	2126042.49
Honomalino	21	9	208831.95	2126184.31
Honomalino	21	10	208783.12	2126326.14
Honomalino	21	11	208734.28	2126467.97
Papi	22	1	207932.72	2130103.46
Papi	22	2	208071.79	2130047.27
Papi	22	3	208210.87	2129991.08

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Papi	22	4	208349.95	2129934.89
Papi	22	5	208489.03	2129878.70
Papi	22	6	208628.10	2129822.51
Papi	22	7	208767.18	2129766.32
Papi	22	8	208906.26	2129710.13
Papi	22	9	209045.34	2129653.94
Papi	22	10	209184.42	2129597.74
Northwest Kahuku	23	1	211931.74	2146770.68
Northwest Kahuku	23	2	212008.99	2146642.10
Northwest Kahuku	23	3	212086.25	2146513.53
Northwest Kahuku	23	4	212163.51	2146384.95
Northwest Kahuku	23	5	212240.76	2146256.38
Northwest Kahuku	23	6	212318.02	2146127.80
Northwest Kahuku	23	7	212395.27	2145999.23
Northwest Kahuku	23	8	212472.53	2145870.65
Northwest Kahuku	23	9	212549.78	2145742.08
Northwest Kahuku	23	10	212627.04	2145613.50
Northwest Kahuku	24	1	212760.30	2147271.90
Northwest Kahuku	24	2	212903.74	2147228.05
Northwest Kahuku	24	3	213047.19	2147184.19
Northwest Kahuku	24	4	213190.64	2147140.34
Northwest Kahuku	24	5	213334.08	2147096.48
Northwest Kahuku	24	6	213477.53	2147052.62

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Northwest Kahuku	24	7	213620.97	2147008.77
Northwest Kahuku	24	8	213764.42	2146964.91
Northwest Kahuku	24	9	213907.86	2146921.06
Northwest Kahuku	24	10	214051.31	2146877.20
Northwest Kahuku	24	11	214194.76	2146833.35
Northwest Kahuku	25	1	213128.55	2147977.71
Northwest Kahuku	25	2	213118.08	2147828.08
Northwest Kahuku	25	3	213107.62	2147678.44
Northwest Kahuku	25	4	213097.16	2147528.81
Northwest Kahuku	25	5	213086.69	2147379.17
Northwest Kahuku	25	6	213076.23	2147229.54
Northwest Kahuku	25	7	213065.77	2147079.90
Northwest Kahuku	25	8	213055.30	2146930.27
Northwest Kahuku	25	9	213044.84	2146780.64
Northwest Kahuku	25	10	213034.38	2146631.00
Northwest Kahuku	26	1	213957.11	2146525.18
Northwest Kahuku	26	2	214047.38	2146644.97
Northwest Kahuku	26	3	214137.65	2146764.77
Northwest Kahuku	26	4	214227.92	2146884.56
Northwest Kahuku	26	5	214318.19	2147004.36
Northwest Kahuku	26	6	214408.47	2147124.15
Northwest Kahuku	26	7	214498.74	2147243.95
Northwest Kahuku	26	8	214589.01	2147363.74

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Northwest Kahuku	26	9	214679.28	2147483.54
Northwest Kahuku	26	10	214769.56	2147603.33
Northwest Kahuku	27	1	214171.92	2146668.38
Northwest Kahuku	27	2	214125.56	2146811.04
Northwest Kahuku	27	3	214079.21	2146953.70
Northwest Kahuku	27	4	214032.86	2147096.36
Northwest Kahuku	27	5	213986.51	2147239.02
Northwest Kahuku	27	6	213940.15	2147381.68
Northwest Kahuku	27	7	213893.80	2147524.34
Northwest Kahuku	27	8	213847.45	2147666.99
Northwest Kahuku	27	9	213801.10	2147809.65
Northwest Kahuku	27	10	213754.74	2147952.31
Northwest Kahuku	27	11	213708.39	2148094.97
Olaa Koa Unit	28	1	264124.06	2154058.92
Olaa Koa Unit	28	2	264077.71	2154201.58
Olaa Koa Unit	28	3	264031.36	2154344.24
Olaa Koa Unit	28	4	263985.01	2154486.90
Olaa Koa Unit	28	5	263938.65	2154629.56
Olaa Koa Unit	28	6	263892.30	2154772.21
Olaa Koa Unit	28	7	263845.95	2154914.87
Olaa Koa Unit	28	8	263799.60	2155057.53
Olaa Koa Unit	28	9	263753.24	2155200.19
Olaa Koa Unit	28	10	263706.89	2155342.85

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Olaa Koa Unit	28	11	263660.54	2155485.51
Olaa Puu Unit	29	1	262401.99	2157466.69
Olaa Puu Unit	29	2	262261.03	2157415.39
Olaa Puu Unit	29	3	262120.08	2157364.08
Olaa Puu Unit	29	4	261979.13	2157312.78
Olaa Koa Unit	30	1	265749.12	2155526.32
Olaa Koa Unit	30	2	265867.32	2155433.97
Olaa Koa Unit	30	3	265985.52	2155341.62
Olaa Koa Unit	30	4	266103.72	2155249.28
Olaa Koa Unit	30	5	266221.93	2155156.93
Olaa Koa Unit	30	6	266340.13	2155064.58
Olaa Koa Unit	30	7	266458.33	2154972.23
Olaa Koa Unit	30	8	266576.53	2154879.88
Olaa Koa Unit	30	9	266694.73	2154787.53
Olaa Koa Unit	30	10	266812.93	2154695.18
Olaa Puu Unit	31	1	263687.48	2157042.23
Olaa Puu Unit	31	2	263832.37	2157081.06
Olaa Puu Unit	31	3	263977.26	2157119.88
Olaa Puu Unit	31	4	264122.15	2157158.70
Olaa Puu Unit	31	5	264267.04	2157197.53
Olaa Puu Unit	31	6	264411.93	2157236.35
Olaa Puu Unit	31	7	264556.81	2157275.17
Olaa Puu Unit	31	8	264701.70	2157313.99

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Olaa Puu Unit	31	9	264846.59	2157352.82
Olaa Puu Unit	31	10	264991.48	2157391.64
Olaa Puu Unit	31	11	265136.37	2157430.46
Olaa Koa Unit	32	1	265918.90	2154750.18
Olaa Koa Unit	32	2	265972.66	2154890.21
Olaa Koa Unit	32	3	266026.41	2155030.25
Olaa Koa Unit	32	4	266080.17	2155170.29
Olaa Koa Unit	32	5	266133.92	2155310.33
Olaa Koa Unit	32	6	266187.68	2155450.36
Olaa Koa Unit	32	7	266241.43	2155590.40
Olaa Koa Unit	32	8	266295.19	2155730.44
Olaa Koa Unit	32	9	266348.94	2155870.47
Olaa Koa Unit	32	10	266402.70	2156010.51
Olaa Koa Unit	32	11	266456.45	2156150.55
Olaa Koa Unit	33	1	263772.37	2155271.65
Olaa Koa Unit	33	2	263774.99	2155421.63
Olaa Koa Unit	33	3	263777.61	2155571.60
Olaa Koa Unit	33	4	263780.23	2155721.58
Mauna Loa Strip	34	1	251511.68	2156217.58
Mauna Loa Strip	34	2	251529.97	2156068.70
Mauna Loa Strip	34	3	251548.25	2155919.81
Mauna Loa Strip	34	4	251566.53	2155770.93
Mauna Loa Strip	34	5	251584.81	2155622.05

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Mauna Loa Strip	34	6	251603.09	2155473.17
Mauna Loa Strip	34	7	251621.37	2155324.29
Mauna Loa Strip	34	8	251639.65	2155175.41
Mauna Loa Strip	34	9	251657.93	2155026.52
Mauna Loa Strip	34	10	251676.21	2154877.64
Mauna Loa Strip	34	11	251694.49	2154728.76
Mauna Loa Strip	35	1	253791.61	2153682.98
Mauna Loa Strip	35	2	253866.61	2153553.07
Mauna Loa Strip	35	3	253941.61	2153423.17
Mauna Loa Strip	35	4	254016.61	2153293.26
Mauna Loa Strip	35	5	254091.61	2153163.36
Mauna Loa Strip	35	6	254166.61	2153033.46
Mauna Loa Strip	35	7	254241.61	2152903.55
Mauna Loa Strip	35	8	254316.61	2152773.65
Mauna Loa Strip	35	9	254391.61	2152643.75
Mauna Loa Strip	35	10	254466.61	2152513.84
Mauna Loa Strip	35	11	254541.61	2152383.94
Mauna Loa Strip	36	1	249328.77	2154677.41
Mauna Loa Strip	36	2	249476.93	2154700.88
Mauna Loa Strip	36	3	249625.08	2154724.34
Mauna Loa Strip	36	4	249773.23	2154747.81
Mauna Loa Strip	36	5	249921.39	2154771.27
Mauna Loa Strip	36	6	250069.54	2154794.74

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

Mauna Loa Strip	36	7	250217.69	2154818.20
Mauna Loa Strip	36	8	250365.85	2154841.67
Mauna Loa Strip	36	9	250514.00	2154865.13
Mauna Loa Strip	36	10	250662.15	2154888.60
Mauna Loa Strip	37	1	250529.37	2156435.87
Mauna Loa Strip	37	2	250454.37	2156305.97
Mauna Loa Strip	37	3	250379.37	2156176.06
Mauna Loa Strip	37	4	250304.37	2156046.16
Mauna Loa Strip	37	5	250229.37	2155916.25
Mauna Loa Strip	37	6	250154.37	2155786.35
Mauna Loa Strip	37	7	250079.37	2155656.45
Mauna Loa Strip	37	8	250004.37	2155526.54
Mauna Loa Strip	37	9	249929.37	2155396.64
Mauna Loa Strip	37	10	249854.37	2155266.74
Mauna Loa Strip	37	11	249779.37	2155136.83
East Rift Zone	38	1	273699.13	2141383.14
East Rift Zone	38	2	273847.67	2141362.27
East Rift Zone	38	3	273996.21	2141341.39
East Rift Zone	38	4	274144.75	2141320.52
East Rift Zone	38	5	274293.29	2141299.64
East Rift Zone	38	6	274441.83	2141278.76
East Rift Zone	38	7	274590.37	2141257.89
East Rift Zone	38	8	274738.91	2141237.01

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

East Rift Zone	38	9	274887.45	2141216.14
East Rift Zone	38	10	275035.99	2141195.26
East Rift Zone	39	1	273926.54	2142556.58
East Rift Zone	39	2	273800.74	2142638.28
East Rift Zone	39	3	273674.94	2142719.98
East Rift Zone	39	4	273549.14	2142801.67
East Rift Zone	39	5	273423.34	2142883.37
East Rift Zone	39	6	273297.54	2142965.06
East Rift Zone	39	7	273171.74	2143046.76
East Rift Zone	39	8	273045.94	2143128.46
East Rift Zone	39	9	272920.14	2143210.15
East Rift Zone	39	10	272794.34	2143291.85
East Rift Zone	40	1	272471.11	2141956.22
East Rift Zone	40	2	272460.65	2141806.58
East Rift Zone	40	3	272450.18	2141656.95
East Rift Zone	40	4	272439.72	2141507.32
East Rift Zone	41	1	272571.17	2141828.87
East Rift Zone	41	2	272650.66	2141956.08
East Rift Zone	41	3	272730.15	2142083.28
East Rift Zone	41	4	272809.64	2142210.49
East Rift Zone	41	5	272889.12	2142337.70
East Rift Zone	41	6	272968.61	2142464.91
East Rift Zone	41	7	273048.10	2142592.11

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

East Rift Zone	41	8	273127.59	2142719.32
East Rift Zone	41	9	273207.08	2142846.53
East Rift Zone	41	10	273286.56	2142973.73
East Rift Zone	41	11	273366.05	2143100.94
East Rift Zone	42	1	274435.94	2141119.35
East Rift Zone	42	2	274392.09	2140975.90
East Rift Zone	42	3	274348.23	2140832.46
East Rift Zone	42	4	274304.37	2140689.01
East Rift Zone	42	5	274260.52	2140545.56
East Rift Zone	42	6	274216.66	2140402.12
East Rift Zone	42	7	274172.81	2140258.67
East Rift Zone	42	8	274128.95	2140115.23
East Rift Zone	42	9	274085.10	2139971.78
East Rift Zone	42	10	274041.24	2139828.34
East Rift Zone	42	11	273997.38	2139684.89
East Rift Zone	43	1	275254.62	2143138.76
East Rift Zone	43	2	275404.60	2143141.37
East Rift Zone	43	3	275554.58	2143143.99
East Rift Zone	43	4	275704.55	2143146.61
East Rift Zone	43	5	275854.53	2143149.23
East Rift Zone	43	6	276004.51	2143151.85
East Rift Zone	43	7	276154.48	2143154.46
East Rift Zone	43	8	276304.46	2143157.08

Table A.2b. UTM coordinates (X Coord and Y Coord) for random stations in HAVO (continued).

East Rift Zone	43	9	276454.44	2143159.70
East Rift Zone	43	10	276604.42	2143162.32
East Rift Zone	44	1	272689.43	2141465.01
East Rift Zone	44	2	272783.82	2141348.44
East Rift Zone	44	3	272878.22	2141231.87
East Rift Zone	44	4	272972.62	2141115.30

Table A.3. UTM coordinates (X Coord and Y Coord) for legacy and random stations in Tau unit, NPSA.

Legacy Stations				Random Stations			
Transect	**Station**	**X_Coord**	**Y_Coord**	**Transect**	**Station**	**X_Coord**	**Y_Coord**
5	6	669249.54	8426533.08	1	1	663628.30	8426053.93
5	7	669101.63	8426508.16	1	2	663777.17	8426035.55
5	8	668953.71	8426483.25	1	3	663926.04	8426017.17
5	9	668805.80	8426458.33	1	4	664074.91	8425998.79
5	10	668657.88	8426433.42	1	5	664223.78	8425980.41
5	11	668509.96	8426408.50	1	6	664372.65	8425962.03
5	12	668362.05	8426383.59	1	7	664521.52	8425943.65
5	13	668214.13	8426358.67	1	8	664670.39	8425925.28
5	14	668066.21	8426333.75	1	9	664819.26	8425906.90
5	15	667918.30	8426308.84	1	10	664968.13	8425888.52
5	16	667770.38	8426283.92	2	1	664873.74	8426799.50
6	1	670287.52	8425358.75	2	2	664856.27	8426650.52
6	2	670137.59	8425363.24	2	3	664838.80	8426501.54
6	3	669987.66	8425367.74	2	4	664821.32	8426352.56
6	4	669837.73	8425372.24	2	5	664803.85	8426203.58
6	5	669687.79	8425376.74	2	6	664786.38	8426054.60
6	6	669537.86	8425381.24	2	7	664768.90	8425905.63
6	7	669387.93	8425385.73	2	8	664751.43	8425756.65
6	8	669238.00	8425390.23	2	9	664733.96	8425607.67
6	9	669088.06	8425394.73	2	10	664716.49	8425458.69

Table A.3. UTM coordinates (X Coord and Y Coord) for legacy and random stations in Tau unit, NPSA (continued).

6	10	668938.13	8425399.23	3	1	665720.98	8425562.53
6	11	668788.20	8425403.73	3	2	665870.49	8425574.59
6	12	668638.27	8425408.22	3	3	666020.01	8425586.65
7	1	666057.29	8425069.12	3	4	666169.52	8425598.70
7	2	665919.21	8425010.51	3	5	666319.04	8425610.76
7	3	665781.14	8424951.89	3	6	666468.55	8425622.82
7	4	665643.07	8424893.28	3	7	666618.07	8425634.88
7	5	665504.99	8424834.66	3	8	666767.58	8425646.93
7	6	665366.92	8424776.04	4	1	666110.71	8424910.16
7	7	665228.85	8424717.43	4	2	665961.76	8424892.42
7	8	665143.11	8424638.30	4	3	665812.81	8424874.69
7	9	665204.60	8424501.49	4	4	665663.87	8424856.96
7	10	665266.09	8424364.67	4	5	665514.92	8424839.23
7	11	665327.58	8424227.85	4	6	665365.97	8424821.50
7	12	665389.07	8424091.04	4	7	665217.02	8424803.76
7	13	665450.56	8423954.22	4	8	665068.07	8424786.03
8	1	666829.61	8425077.90	5	1	667805.19	8425647.25
8	2	666954.76	8424995.21	5	2	667953.55	8425625.14
8	3	667079.91	8424912.52	5	3	668101.91	8425603.02
8	4	667205.06	8424829.83	5	4	668250.27	8425580.91
8	5	667330.21	8424747.15	5	5	668398.63	8425558.79

Table A.3. UTM coordinates (X Coord and Y Coord) for legacy and random stations in Tau unit, NPSA (continued).

8	6	667455.36	8424664.46	5	6	668546.99	8425536.67
8	7	667580.51	8424581.77	5	7	668695.35	8425514.56
8	8	667705.66	8424499.08	5	8	668843.71	8425492.44
8	9	667826.68	8424411.74	5	9	668992.07	8425470.33
8	10	667923.43	8424297.12	5	10	669140.43	8425448.21
8	11	668020.19	8424182.49	6	1	669296.33	8426206.43
8	12	668116.95	8424067.87	6	2	669146.61	8426197.25
8	13	668213.71	8423953.25	6	3	668996.89	8426188.06
8	14	668310.46	8423838.63	6	4	668847.17	8426178.88
				6	5	668697.45	8426169.69
				6	6	668547.74	8426160.51
				6	7	668398.02	8426151.32
				6	8	668248.30	8426142.14
				6	9	668098.58	8426132.95
				6	10	667948.86	8426123.76

Table A.4. UTM coordinates (X Coord and Y Coord) for legacy and random stations in Tutuila unit, NPSA.

Legacy Stations				Random Stations			
Transect	**Station**	**X_Coord**	**Y_Coord**	**Transect**	**Station**	**X_Coord**	**Y_Coord**
7	1	530970.78	8420843.49	1	1	532981.68	8423025.02
7	2	531037.87	8420977.66	1	2	532900.05	8423150.86
7	3	531088.59	8421118.31	1	3	532818.41	8423276.69
7	4	531107.43	8421265.54	1	4	532736.77	8423402.53
7	5	531050.60	8421398.99	1	5	532655.13	8423528.37
7	6	530956.12	8421511.73	1	6	532573.49	8423654.21
7	7	530830.41	8421593.56	1	7	532491.86	8423780.05
7	8	530706.48	8421678.06	1	8	532410.22	8423905.89
7	9	530676.26	8421800.07	1	9	532328.58	8424031.72
7	10	530766.47	8421916.27	2	1	530584.35	8421703.57
7	11	530887.86	8422003.73	2	2	530494.67	8421823.81
7	12	531011.73	8422088.33	2	3	530404.99	8421944.04
7	13	531133.10	8422176.15	2	4	530315.31	8422064.28
7	14	531245.99	8422274.92	2	5	530225.63	8422184.52
7	15	531358.87	8422373.70	3	1	531380.88	8423347.74
7	16	531475.67	8422467.45	3	2	531430.43	8423206.16
7	17	531605.90	8422541.87	3	3	531479.98	8423064.58
7	18	531738.04	8422612.83	3	4	531529.53	8422923.00
7	19	531869.05	8422685.86	3	5	531579.09	8422781.43
7	20	532003.82	8422750.34	4	1	532444.42	8423232.31
7	21	532145.75	8422798.90	4	2	532387.62	8423093.47
7	22	532287.99	8422846.49	4	3	532330.83	8422954.64
7	23	532431.35	8422890.60	5	1	531017.60	8422061.46

Table A.4. UTM coordinates (X Coord and Y Coord) for legacy and random stations in Tutuila unit, NPSA.

7	24	532574.75	8422934.60	5	2	531055.96	8422206.47
7	25	532719.20	8422975.04	5	3	531094.33	8422351.48
7	26	532865.81	8423005.83	5	4	531132.70	8422496.49
7	27	533013.66	8423031.18	5	5	531171.07	8422641.50
8	1	537015.33	8422523.43	5	6	531209.43	8422786.51
8	2	536886.16	8422599.69	6	1	534325.47	8423290.01
8	3	536756.99	8422675.94	6	2	534369.58	8423433.38
8	4	536627.82	8422752.20	6	3	534413.70	8423576.74
8	5	536498.65	8422828.46	6	4	534457.81	8423720.11
8	6	536369.48	8422904.71	6	5	534501.92	8423863.48
8	7	536240.42	8422981.15	6	6	534546.04	8424006.84
8	8	536111.37	8423057.62	6	7	534590.15	8424150.21
8	9	535982.33	8423134.09	6	8	534634.26	8424293.58
8	10	535853.48	8423210.89	7	1	534661.90	8423425.22
8	11	535767.67	8423300.98	7	2	534714.93	8423565.54
8	12	535832.16	8423436.41	7	3	534767.96	8423705.85
8	13	535899.17	8423570.60	7	4	534820.99	8423846.17
8	14	535966.26	8423704.77	7	5	534874.02	8423986.48
8	15	536016.15	8423846.15	7	6	534927.05	8424126.79
8	16	536063.19	8423988.50	8	1	536726.80	8423392.39
8	17	536098.20	8424134.36	8	2	536804.61	8423520.63
8	18	536132.25	8424280.44	8	3	536882.43	8423648.86
8	19	536165.98	8424426.60	8	4	536960.24	8423777.10
				8	5	537038.06	8423905.34
				8	6	537115.87	8424033.58

Table A.4. UTM coordinates (X Coord and Y Coord) for legacy and random stations in Tutuila unit, NPSA.

	8	7	537193.68	8424161.82
	9	1	533672.14	8423463.69
	9	2	533713.03	8423319.37
	9	3	533753.92	8423175.05
	9	4	533794.81	8423030.73

Appendix B. Driving Instructions to Legacy Transects

Haleakala National Park

Transect 10

This transect is accessed from the Smith landing zone; traverse 180 m at 137 degrees to the eastern most station.

Transect 16

This transect is accessed from the West landing zone; traverse 759 m at 68 degrees to the northwest most station.

Transect 17

This transect is accessed from the West landing zone; traverse 640 m at 247 degrees to the northwest most station.

Hawaii Volcanoes National Park

Mauna Loa Strip

Transect 8

Drive 9493 m up Mauna Loa Strip Road from Hawaii 11 turnoff and park, traverse 408 m at 33 degrees from the Mauna Loa Strip Road along the transect to station 1.

Transect 14

Drive 12688 m up Mauna Loa Strip Road from Hawaii 11 turnoff and park, traverse 1470 m at 215 degrees from the Mauna Loa Strip Road along the transect to station 1.

Transect 18

Drive 16351 m up Mauna Loa Strip Road from Hawaii 11 turnoff and park, traverse 1240 m at 36 degrees from the Mauna Loa Strip Road along the transect to station 1.

Olaa Units

Puu

Transect 1

Drive 4360 m up Wright Road from Hawaii 11 turnoff and park (at 90 degree corner), traverse 5237 m along the fence line to station 1.

Transect 5

Drive 4360 m up Wright Road from Hawaii 11 turnoff and park (at 90 degree corner), traverse 3583 m along the fence line to station 1.

Koa

Transect 14

Drive 4360 m up Wright Road from Hawaii 11 turnoff and park (at 90 degree corner), traverse 537 m along the fence line to station 1.

Transect 19

Drive 3613 m up Wright Road from Hawaii 11 turnoff and park, station 1 is just off the road.

Small Tract

Transect 3

Drive 3613 m up Wright Road from Hawaii 11 turnoff and park, station 1 is just off the road.

East Rift Zone

Transect 1

Traverse either along the Napau Crater Trail or Kalapana Trail to their intersection, traverse 95 m west on the Napau Crater Trail and 51 m at 180 degrees to station 1.

Transect 2

Traverse either along the Napau Crater Trail or Kalapana Trail to their intersection, traverse 848 m east on the Napau Crater Trail and 1189 m along the transect to station 1.

Transect 3

Traverse either along the Napau Crater Trail or Kalapana Trail to their intersection, traverse 2565 m east on the Napau Crater Trail to its end and 772 m at 146 degrees to station 1.

Transect 4

Traverse either along the Napau Crater Trail or Kalapana Trail to their intersection, traverse 2565 m east on the Napau Crater Trail to its end and 772 m at 146 degrees to transect 3 station 1, proceed from this location 954 m at 39 degrees to transect 4 station 1.

Mauna Loa South Flank

Transect 2

Drive 12922 m along the Entrance Road from Hawaii 11 turnoff and park, traverse 939 m at 0 (zero) degrees to station 1.

Kahuku

Transect 2

Drive 1288 m along the Top Road from the Entrance Road – Top Road intersection (gate), traverse 1701 m at 307 degrees to station 1.

Transect 7

Drive 6728 m along the Top Road from the Entrance Road – Top Road intersection (gate), traverse 915 m at 307 degrees to station 1.

Transect 12

Drive 11890 m along the Top Road from the Entrance Road – Top Road intersection (gate), traverse 648 m at 307 degrees to station 1.

Transect 17

Drive 18505 m along the Top Road from the Entrance Road – Top Road intersection (gate), walk 1070 m along pasture road to forest edge, traverse

504 m at 94 degrees to station 1.

Transect 22

Drive 24740 m along the Top Road from the Entrance Road – Top Road intersection (gate), traverse 677 m at 307 degrees to station 1.

Honomalino

Transect 1

Drive 6765 m from Old Mamalahoa Highway on 4x4 road to Halepiula Road intersection (water tank designated on USGS Topo), continue 4153 m up 4x4 road from the 4x4 – Halepiula Road intersection and park, traverse 1215 m at 90 degrees along the transect to station 1.

Transect 6

Drive 256 m on the Halepiula Road from the 4x4 – Halepiula Road intersection and park, traverse 4591 m at 90 degrees along the transect to station 1.

Papi

Transect 1

Drive 6765 m from Old Mamalahoa Highway on 4x4 road to Halepiula Road intersection (water tank designated on USGS Topo), continue 7040 m up 4x4 road from the 4x4 – Halepiula Road intersection and park, traverse 1068 m at 319 degrees to the southwest end of the transect, traverse along the transect to station 1.

Transect 2

From the parking location for transect 1, traverse 723 m at 311 degrees to the southwest end of the transect, traverse along the transect to station 1.

Northwest Kahuku

Transect 1

Drive 16208 m from Old Mamalahoa Highway on Big Camp Road to the first intersection within the Park Boundary, turn right and drive 1320 m and park, traverse 54 m at 82 degrees to the southwest end of the transect, traverse along the transect to station 1.

Transect 2

Turn right at the within the Park Boundary intersection of Big Camp Road and drive 877 m and park, traverse 187 m at 83 degrees to the southwest end of the transect, traverse along the transect to station 1.

Transect 3

Turn right at the within the Park Boundary intersection of Big Camp Road and drive 402 m and park, traverse 10 m at 82 degrees to the southwest end of the transect, traverse along the transect to station 1.

Transect 5

Turn left at the within the Park Boundary intersection of Big Camp Road and drive 403 m and park, traverse 125 m at 263 degrees to the southwest end of the transect, traverse along the transect to station 1.

Transect 6

Turn left at the within the Park Boundary intersection of Big Camp Road and drive 977 m and park at the southwest end of the transect, traverse along the transect to station 1.

National Park of American Samoa

Tutuila

Transect 7

Drive up the Paga Paga – Fagasa Road to the Park Boundary and start of the transect. The transect follows the ridge line 4x4 road, the transect was scanned and approximates the actual survey route.

Transect 8

Drive 598 m up the Aua – Afono Road from Aua and park, traverse 1517 m along the Maugaloa Ridge/park boundary; navigate at 315 degrees NW for 67 m to the first station.

Tau

Transect 5

Travel 275 m from the road intersection at the south end of Leusoalii Village to the Pit Driveway, follow the dirt road/trail 1642 m to station 1.

Transect 6

Continue 1258 m from the Pit Driveway to station 1.

Transect 7

Follow coast trail 4992 m from Tufu Point (end of the road), traverse 81 m at 339 degrees to station 1.

Transect 8

Follow coast trail 1670 m from Tufu Point (end of the road), traverse 296 m at 129 degrees to station 1.

Appendix C. Point-Transect Count: Categories, Definitions and Descriptions

Codes used to record level of background noise as it affects observer's ability to hear birds.

Noise Code	Explanation
0	quiet; normal background noises; no interference
1	low noise; might be missing some high-pitched songs/calls of distant birds
2	medium noise; detection radius is probably substantially reduced
3	high noise; probably detecting only the loudest/closest birds

Codes used to record precipitation codes during bird counts.

Rain Code	Explanation
0	no rain
1	mist or fog
2	light drizzle
3	light rain
4	heavy rain; difficult to hear birds
5	snow

Codes (Beaufort scale) used to record wind and gust strength during bird counts.

Wind/Gust Code	Explanation
0	calm, smoke rises vertically (< 2 km/h); no gust
1	smoke drifts (2–5 km/h)
2	light breeze felt on face, leaves rustle (6–12 km/h)
3	leaves and twigs in constant motion (13–19 km/h)
4	small branches move, raises loose paper, dust rises (20–29 km/h)
5	fresh breeze, small trees sway (30–39 km/h)
6	strong breeze, large branches moving, wind whistling (40–50 km/h)

Codes used to record the type of detection (Detection Type, DT) of birds during a count.

DT Code	Explanation
1	heard first, but not seen (i.e., detected initially by sound) during the 8-min count
2	seen first (regardless of whether it was later heard or not) during the 8-min count
4	heard first, but then seen (a DT of 1 can be changed to a 4) during the 8-min count
8	heard, but not during the 8-minute sampling period
9	seen, but not during the 8-minute sampling period

Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 8: Documenting Landbird Habitat

Version 1.00 (September 2010)

Revision History Log

Prev. 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, 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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Abstract

This SOP gives step-by-step instructions for measuring and describing landbird habitat composition and structure at PACN park units. This SOP describes the procedure for establishing habitat sampling, and describes the procedure for collecting data and filling in the data form "Landbird Habitat Monitoring Data Sheet".

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm

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Original Author and Affiliation

Peitz, D. G., S. G. Fancy, L. P. Thomas, and B. Witcher. 2002. Bird Monitoring Protocol for Agate Fossil Beds National Monument, Nebraska and Tallgrass Prairie National Preserve, Kansas. Unpublished report. Prairie Cluster Prototype Monitoring Program, National Park Service, U.S. Department of the Interior. Version 1.00 (September 6, 2002).

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Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Procedures

1. Prior to conducting habitat measurements, establish a list of which landbird stations will be sampled and in which order. Habitat sampling should only be done at stations already sampled for birds.
2. Sampling will start as soon as the bird sampling for the day has been completed. Or if habitat sampling will not impede bird sampling, habitat sampling can start once the bird observers have progressed ahead by several stations (e.g., 3 or 4 stations). Regardless of when habitat sampling occurs, care should be taken to avoid disturbing the birds. Habitat sampling takes approximately 5-10 minutes to complete. Two-way radios work well to communicate when a station is ready for habitat sampling. A minimum of two people are required for the habitat work.
3. Habitat measurements are taken for a 50-m plot centered on the bird survey point. A list of vegetation references is provided in Appendix A. Note: the goal of the habitat monitoring is to describe the general habitat type and structure at the station, not a detailed vegetation profile. References (bolded) provide a minimum knowledge needed to conduct habitat monitoring.
4. Tree canopy cover, tree height, tree species composition, understory species composition, and horizontal vegetation profile are measured and recorded within the plot.
5. Navigate to the coordinates of the next plot on the list using a GPS unit (see SOP 5) and conduct habitat sampling.
6. Use a new copy of the "Landbird Habitat Monitoring Data Sheet" (SOP 1) for each station. Record the following information on each data sheet:
   - *Park Code:* A four letter alpha code unique to a particular park.
   - *Date:* The month (mm) / day (dd) / year (yy) data is collected.
   - *Observer Initials*: The initials of the first, middle, and last name of each person in the field crew collecting data.
   - *Management Unit:* Name of management unit where the sampling station is located. For example, Kipuhulu Valley, or Afono Ridge (outside the park).
   - *Transect and Station Number:* The transect and station numbers that identify the sampling station (see SOP 7).
   - *Coordinates:* Record the X and Y coordinates of the sampling station in UTM units.

Plot Attributes (50-m radius plot)

Slope (English clinometer): Percent slope of ground across the entire 50-m radius plot. See instructions provided with the Clinometer for detailed use. For slope measurements use two poles of equal length (1 m) to sight between and read slope directly off the left-hand scale (slope) of the clinometer (Figure SOP 8.1). The poles should be positioned at a distance great enough to capture the average slope of the land across the 50-m radius plot.

Var: Circle high, medium or low to describe the up and down variability in the slope across the entire 50-m radius plot.

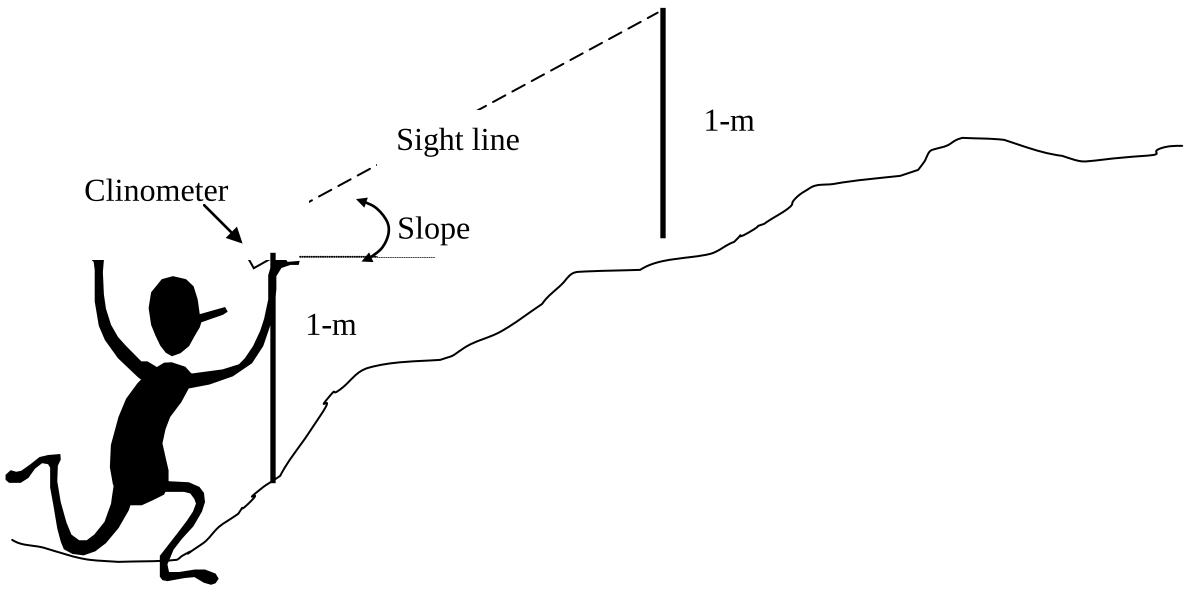

Figure SOP 8.1. Diagram taking slope measurements.

Aspect: The direction in which the 50-m radius plot slope faces. Compass readings will be taken with 0° declination (compass declination is set at 0°). Aspect is recorded from 0° to 359°, with 360° recorded as 0°.

Var: Circle high, medium, or low to describe the variability in the direction of the slope across the entire 50-m radius plot.

Topographic Position: Circle the most descriptive word for the location of the 50-m radius plot relative to its local position on the earth's surface.

Var: Circle level, lower-slope, mid-slope, upper-slope, escarpment/face, ledge, crest, depression, or draw to describe the general topographic position across the entire 50-m radius plot.

Road Cover: An ocular estimate of the percent of ground covered (assessed for 50.0-m radius) by roadway. Although it is unlikely that stations will occur along roadways, it is important to record this information for all stations.

Water Cover: An ocular estimate of the percent of ground covered (assessed for 50.0-m radius) by water. Although it is unlikely that stations will occur along waterways, it is important to record this information for all stations.

Plot Notes: This is a space provided to record comments on the 50-m radius plot.

Habitat Attributes (50-m radius plot)

Canopy Cover (spherical densiometer): The spherical densiometer consists of a concave mirror with 24, ¼-inch squares engraved on the surface. Take four densiometer readings within the 50-m radius plot, one in each of the cardinal directions. Hold the instrument level and 12" to 18" in front of body, at breast height, so that operator's head is just outside of grid area. Assume four equi-spaced dots in each square of the grid and systematically count dots equivalent to quarter-square canopy cover. Remember that there are a total of 96 quarter-squares represented on the mirror. That is, if you count canopy openings rather than canopy closure, subtract from 96 to obtain canopy coverage. The number of dots covered by canopy will be converted to percent canopy coverage and record the tree canopy cover class following Jacobi (1989) criteria, as shown in Table SOP 8.1.

Table SOP 8.1. Tree canopy cover classes (from Jacobi 1989).

Cover Class	Description
c	Closed canopy, most crowns interlocking; >60% cover
o	Open canopy, some or no interlocking crowns; 25–60% cover
s	Scattered trees; 5–25% cover
vs	Very scattered trees; <5% cover

Canopy Height: An ocular estimate of the tree canopy height (assessed for 50.0-m radius). Adapted from Jacobi (1989), the following tree canopy height classes should be recorded (Table SOP 8.2):

Table SOP 8.2. Tree canopy height classes (from Jacobi 1989).

Height Class	Description
1	Low stature trees, monopodial; 2–5 m tall
2	Moderate stature trees; 5–10 m tall
3	Tall stature trees; >10 m tall

Canopy Tree Species Composition: Record the species name abbreviations for all trees composing 25% of the total crown cover. If no species attain this minimum cover value, combine with other tree species (e.g., di – *Diospyros* forest), or list using a tree species association (e.g., nt – native trees; Table SOP 8.3). Following Jacobi (1989) procedures, introduced tree species should be grouped together and indicated by the “xt” association, regardless of their canopy cover. More than one tree species or association may dominate a plot. In these situations, the species or association code should be separated by either a dash, comma, or slash, indicating codominance, dominant with subdominant, or mosaic pattern, respectively (following Jacobi 1989; Table SOP 8.4).

Table SOP 8.3. Tree species composition classes for A) Hawaiian Parks (from Jacobi 1989) and B) American Samoa Park units (from Donnegan et al. 2004).

A) Hawaiian Parks

Class	Species Name or Association
Ac	*Acacia koa* (koa)
Al	*Aleurites moluccana* (kukui)
Ch	*Cheirodendron trigynum* (olapa)
Di	*Diospyros ferrea* (lama)
Ep	*Euphorbia* sp. (akoko)
Me	*Metrosideros polymorpha* (ohia)
Mr	*Myrica faya* (faya tree)
My	*Myoporum sandwicensis* (naio)
nt	Native trees
Psc	*Psidium cattleianum* (strawberry guava)
Sa	*Sapindus saponaria* (soapberry)
So	*Sophora chrysophylla* (mamane)
xt	Introduced trees

B) American Samoa Park units.

Class	Species Name or Association
Cn	*Calophyllum neoebudicum*
Ca	*Cananga odorata*
Cv	*Canarium vitiense*
Co	*Cocos nucifera*
Cy	*Cyathea lunulata* and *C*. spp.
di	*Diospyros* forest (*Diospyros samoensis* and *D*. spp.)
dy	*Dysoxylum* forest (*Dysoxylum naota* and *D. samoense*)
El	*Elaeocarpus ulianus*
Fo	*Ficus oblique*
Fp	*Ficus prolix*
Ga	*Garuga floribunda*
Hi	*Hibiscus tiliaceus*
ma	Mangrove (*Rhizophora mangle*, *Bruguiera gymnorrhiza*, *Xylocarpus moluccensis*
Mo	*Morinda citrifolia*
My	*Myristica fatua*

B) American Samoa Park units (continued).

Class	Species Name or Association
Ne	*Neisosperma oppositifolia*
nt	Native trees
Ps	*Palaquim stehlinii*
pa	*Pandanus* scrub
Pi	*Pipturus argenteus*
pl	*Planchonella* (Pouteria) forest (*Planchonella garberi* and *P. torricellensis*)
po	*Pometia* forest
Re	*Reynoldsia plesosperma*
Rh	*Rhus taitensis*
sy	*Syzygium* forest (*Syzygium inophylloides*, *S. samarangense*, *S. samoense*)
Th	*Thespesia populnea*
xt	Introduced trees

Understory Species Composition: Species association codes are used to describe the understory composition. More than one code can be recorded to describe composition dominance or codominance (e.g., ns-xg, composition dominated by native shrubs and codominated by introduced grasses), following the species dominance format (Table SOP 8.4). Adapted from Jacobi (1989), the following understory codes should be recorded (Table SOP 8.5):

Table SOP 8.4. Procedures to describe species dominance (from Jacobi 1989).

Species Composition[1]	Relative Dominance
A	Only A present
A-B	A and B codominant
A,B	A dominant, B subdominant
A/B	Mosaic with either A or B present
A,B-C	A dominant, B and C subdominant
A-B,C	A and B codominant, C subdominant
A-B-C	A,B,C codominant

[1]substitute the appropriate species name or association abbreviation for the letters A, B, or C.

Table SOP 8.5. Understory species composition classes (from Jacobi 1989).

Class	Description
bg	Structured bog
mf	Matted ferns: *Dicranopteris* spp., *Hicriopteris* spp., *Sticherus* spp.
mg	Mixed native-introduced grasses, sedges, or rushes
ng	Native grasses
ns	Native shrubs

Table SOP 8.5. Understory species composition classes (from Jacobi 1989, continued).

Pm	*Passiflora mollissima* (banana poka)
Sp	*Sphagnum* sp.
tf	Native treeferns: *Cibotium* spp.
xg	Introduced grasses, sedges, or rushes
xh	Introduced herbaceous species
xs	Introduced shrubs
xx	Bare ground (at least 25% of the area without vegetation)

Horizontal Vegetation Profile (density board): Density profile board readings are taken by an observer located 15-m perpendicular to the profile board from the plot center, and at an azimuth direction of 0^{o} (compass declination is set at 0^{o}). Percent coverage of the profile board from 0 – 0.5, 0.5 – 1.0, 1.0 – 1.5 and 1.5 – 2.0 m is read at their respective centered height. A pole with centered heights marked at 0.25, 0.75, 1.25 and 1.75-m above ground should be used when taking readings.

Other Information: This information is recorded to further define the characteristics of the 50-m radius plot. Adapted from Jacobi (1989), the information in Table SOP 8.6 should be recorded when pertinent.

Table SOP 8.6. Other information classes for describing station characteristics (from Jacobi 1989).

Code	Description
bur	Recently burned
clr	Recently cleared or logged
pio	Pioneer vegetation, seral stage on recent lava flow
sng	Many standing dead or defoliated trees

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Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 9: After the Field Season

Version 1.00 (September 2010)

Revision History Log

Prev. 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, 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 explains procedures that all field observers using the Bird Monitoring Protocol for PACN should be familiar with and follow after the field season is completed.

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm.

Recommended Citation

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Original Author and Affiliation

Peitz, D. G., S. G. Fancy, L. P. Thomas, and B. Witcher. 2002. Bird Monitoring Protocol for Agate Fossil Beds National Monument, Nebraska and Tallgrass Prairie National Preserve, Kansas. Unpublished report. Prairie Cluster Prototype Monitoring Program, National Park Service, U.S. Department of the Interior. Version 1.00 (September 6, 2002).

Acknowledgements

This SOP was reviewed by PACN staff, James Agee, Paul Berkowitz, Eric Brown, Guy Hughes, and two anonymous reviewers. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Procedures

1. Clean and repair all equipment prior to returning them to their proper storage areas at the PACN I&M facilities. All field equipment should also be decontaminated. All references manuals should be re-shelved on their appropriate bookshelf. Other reference materials and extra data sheets need to be filed in their appropriate filing cabinet. Clean the insides and outsides of all vehicles used in the field.

2. Organize field data sheets and check that they have been filled out completely. As a rule, all data sheets need to be reviewed for completeness before the crew leaves the field. However, because of the number of field days and crewmembers, some deficiencies in data recording may not be identified until all data sheets have been organized and reviewed as a group (e.g. when habitat work has inadvertently been missed for a plot).

3. Identify and obtain ancillary information (i.e., field notes). It is of critical importance that this data be incorporated into the bird monitoring efforts. First and foremost, knowledge of management efforts in a park for that year (i.e. ungulate control) will be used to assess the effects of these efforts on the habitat and birds present. Secondly, vegetation data collected by other PACN Vital Signs will assist in evaluating habitat types and may give an indication as to why the presence or absence of a bird species was observed. Certain plants may be utilized for food, cover or nesting differently by different birds thus altering the bird communities observed. Climate can also influence bird numbers, both directly and indirect. Excess precipitation can disrupt nesting success while drought conditions may limit plant growth thus food and cover availability for young. Therefore, obtain annual climate data for each PACN park unit (Climate Vital Sign) or from a region wide climatic database on the Internet.

4. At the end of each field trip, file a trip report with the data manager outlining hours worked, field-crew members and their responsibilities on the project, and any unique situations encountered. This information is incorporated in the database and used during data analysis. This information is critical for identifying causes for discrepancies and inconsistencies in the data. The Project/Field Lead is responsible for filing all field reports.

Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 10: Data Management

Version 1.00 (September 2010)

Revision History Log

Prev. 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, 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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Abstract

This SOP documents the database for landbird monitoring and provides instructions for the development, maintenance, and distribution of monitoring data associated with the Landbirds Monitoring Protocol for the PACN. Microsoft Access is the primary software environment for landbird data and the associated metadata. Three separate Access databases were developed for the landbirds monitoring data: (1) Avian Monitoring Entry Database, (2) Hawaii Forest Birds Monitoring Database, and (3) Habitat Monitoring Database. The first two databases were independently developed by HFBIDP and are not consistent with the NRDT design, but these databases have been adapted for I&M purposes. The third database was developed specifically for I&M purposes and is consistent with the NRDT design.

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm

Recommended Citation

Camp, R. J. 2010. Standard Operating Procedure (SOP) 10, Data management, Version 1.00. *In* Camp, R. J., T. K. Pratt, C. Bailey, and D. Hu. 2010. Landbirds Vital Sign Monitoring Protocol – Pacific Island Network. Natural Resources Report NPS/PWR/PACN/NRR—2010/XXX. National Park Service, Fort Collins, Colorado.

Original Author and Affiliation

Brown, E.; National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718.

Acknowledgements

This SOP was reviewed by PACN staff, James Agee, Paul Berkowitz, Eric Brown, Guy Hughes, and two anonymous reviewers. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Data Model

PACN landbird monitoring tracks changes in both avian and habitat data. Sampling for these data are co-located (surveys conducted at the same sampling points), however, the data are managed in separate databases with independent data management structures. The bird data will be combined with the avian monitoring being conducted throughout the Pacific in the Hawaii Forest Bird Monitoring Database, which is managed by the Hawaii Forest Bird Interagency Database Project (HFBIDP). HFBIDP has also developed a separate bird monitoring data entry form in Access, the Avian Monitoring Entry Form. These two databases are not consistent with the NRDT design. The Habitat Monitoring Database is a repository for the habitat data gathered at each bird sampling point. This database was developed by the PACN staff and is consistent with the NRDT design. Combining the data from the bird and habitat databases is essential for effective analysis and interpretation**.**

These three databases consist of files in a front-end and a back-end configuration that can be linked using the Back End Linking Utility included with each database. The back-end files contain the data tables, forms, queries, modules, macros, and reports for the application itself. The front-end files contain switchboards for accessing and processing the data. The front-end, back-end configuration makes it easier to make continual improvements to the database application and the various forms and queries for getting data into and out of the database, without altering the actual data structure or any of the data records**.**

Avian Monitoring Entry Form

The purpose of the Avian Monitoring Entry Form (AMEF) is to provide an easy-to-use entry form to transcribe point-transect monitoring data into a standardized database. Additionally, the AMEF is configured to reduce keying entry errors with format restrictions and drop-down windows, thereby, increasing user efficiency and data accuracy**.** Figure SOP 10.1 shows the relationships among the primary tables in the AMEF database. The table “tblSamples” contains the survey location information for each sampling unit and the conditions during the sample. Linked to this table is “tblObservations”, which includes records of the birds observed during the sample. Several sub-tables link from these data tables and contain more detailed information.

A complete User’s Guide and database dictionary is available from HFBIDP (http://biology.usgs.gov/pierc/HFBIDPSite/database.htm). The database dictionary includes the documentation detailing the structure and relationships of the tables, queries, forms, reports, macros and modules (Camp 2006). Detailed instructions for using the document are found in a separate document, the Avian Monitoring Entry Form User’s Guide (Camp et al. 2005).

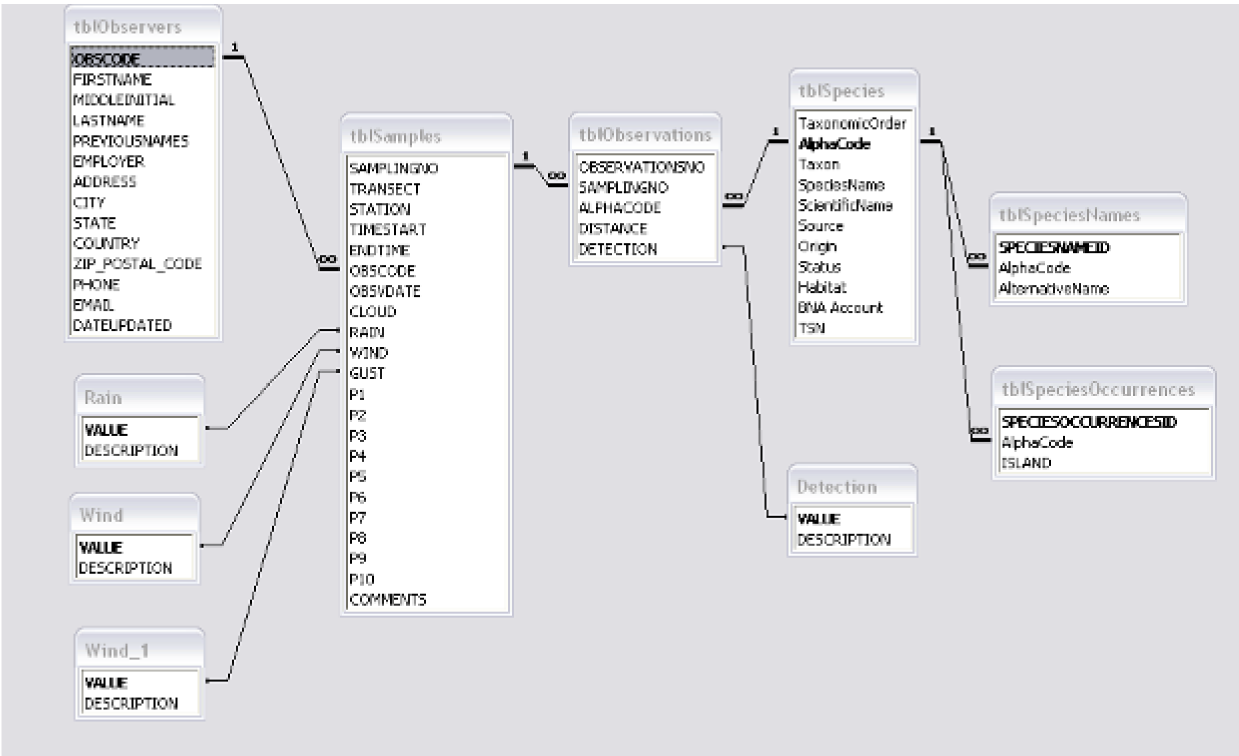

Figure SOP 10.5. Data model for the Avian Monitoring Entry Form database. There are two main data tables: tblSamples and tblObservations.

Hawaii Forest Bird Monitoring Database

The Hawaii Forest Bird Monitoring Database (HFBMD) is a comprehensive inventory of all Hawaiian forest bird census data collected over the last 30 years in a centralized, standardized, relational database. The database also contains data from surveys conducted in South and West Pacific Islands. The function of the HFBMD is data storage, facilitating processing and analysis, not data entry. Data entry should be conducted in the associated Avian Monitoring Entry Form, and appended to the appropriate tables with the Import Data function. Figure SOP 10.2 shows the relationships among the primary tables in the HFBMD. The table “tblSurveyLocation” contains the survey location information for each survey (e.g., island, region, survey area). The table “tblSurveyEvents” describe who and when the survey was conducted, and references the survey metadata. The locations of the sampling units are recorded in the table “tblSamplingLocations”. Linked to the previous two tables is the table “tblSamples”, which contains information on who conducted the count, when the count was conducted, and the conditions during the count. The linked table “tblObservations” records each bird observation during the count. Several sub-tables link from these data tables and contain more detailed information.

A complete User’s Guide and database dictionary is available from HFBIDP (http://biology.usgs.gov/pierc/HFBIDPSite/database.htm). The database dictionary includes the documentation detailing the structure and relationships of the tables, queries, forms, reports, macros and modules (Camp 2006). Detailed instructions for using the document are found in a separate document, the Avian Monitoring Entry Form User’s Guide (Camp et al. 2005).

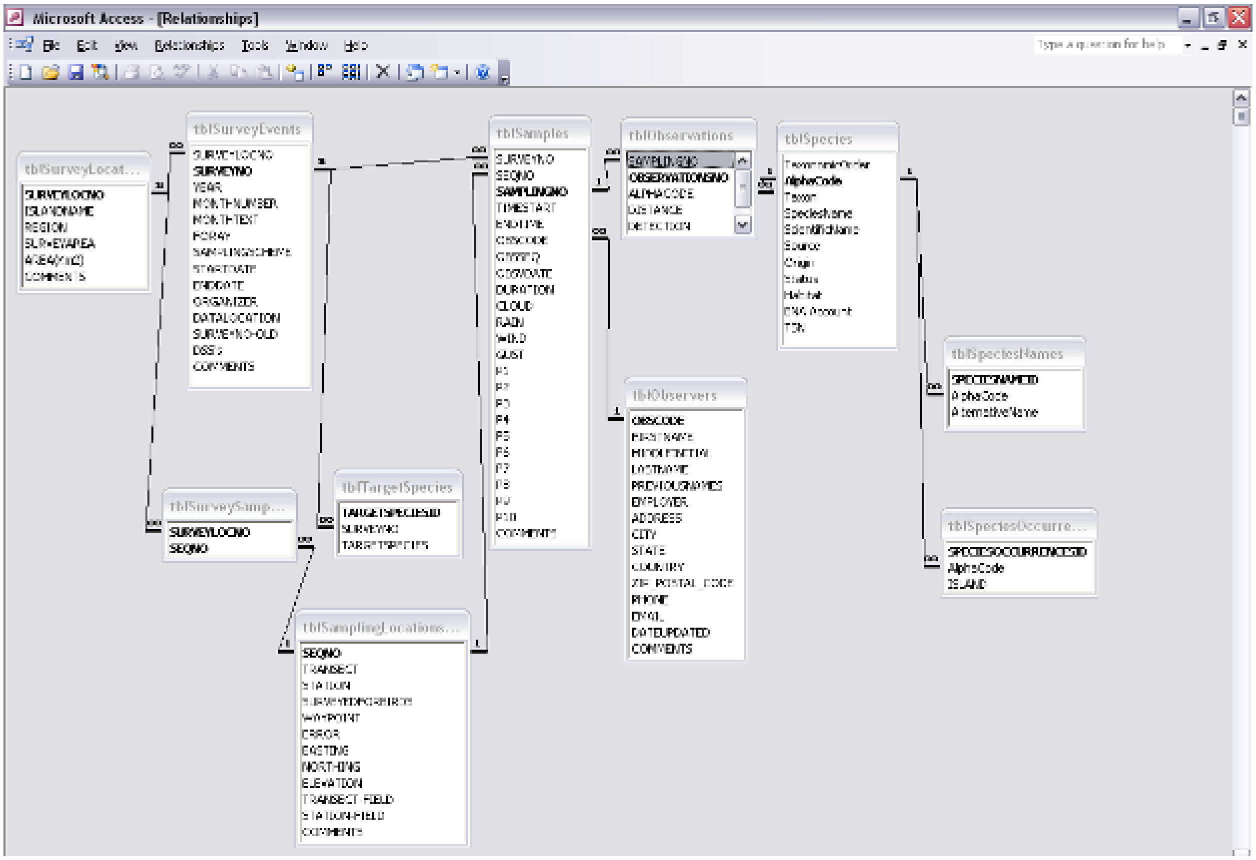

Figure SOP 10.6. Data model for the Hawaii Forest Bird Monitoring Database. There are five main data tables: tblSurveyLocation, tblSurveyEvents, tblSamplingLocations, tblSamples, and tblObservations.

Habitat Monitoring Database

The Habitat Monitoring Database (HMD) and supporting documentation was developed by the PACN. This database is consistent with the NRDT design. Figure SOP 10.3 shows the relationships among the primary tables in the HMD. A complete User's Guide and database dictionary is included in Appendix SOP 10.A.

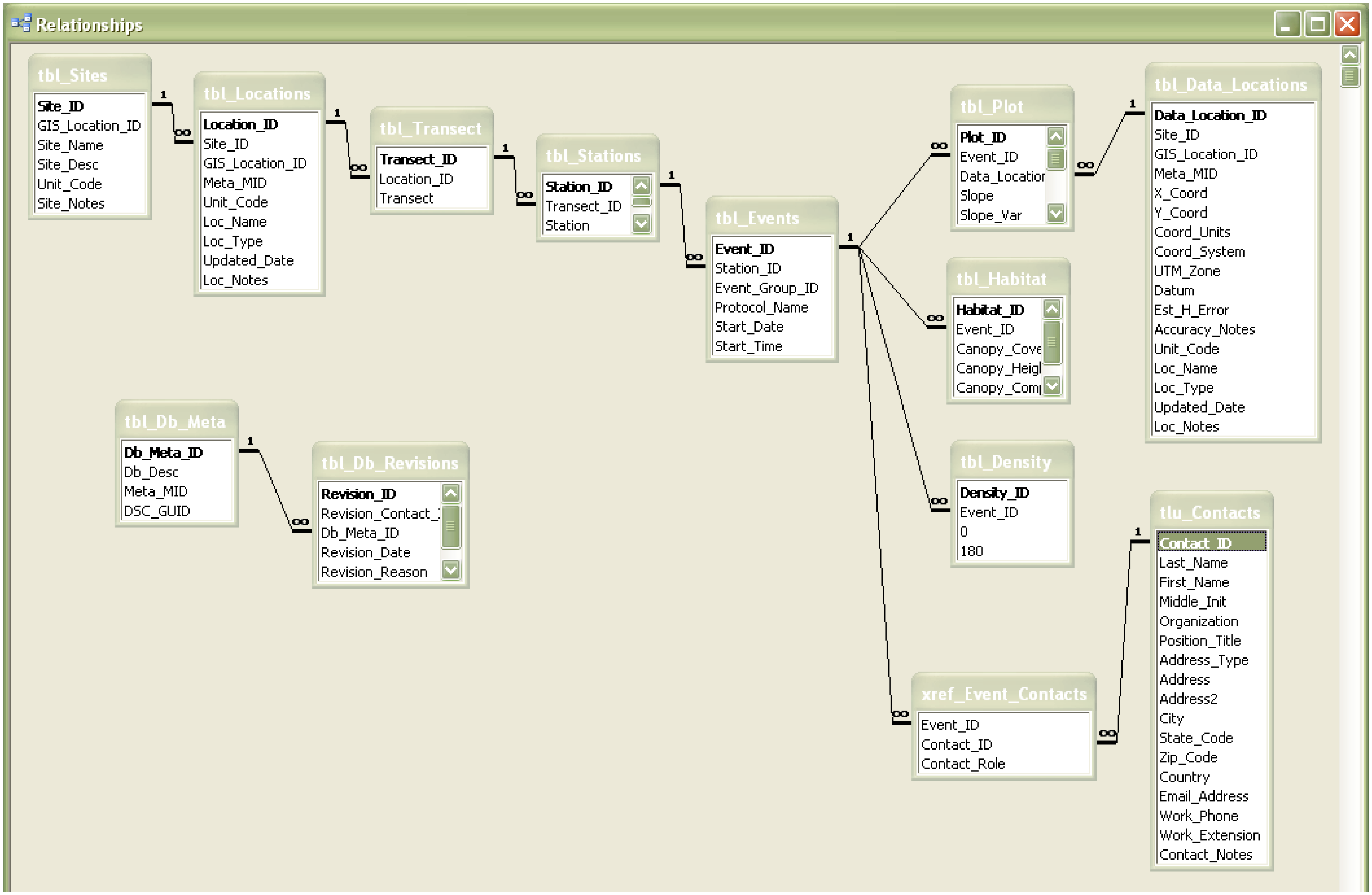

Figure SOP 10.7. Data model for the Habitat Monitoring Database. This database is consistent with the NRDT design.

Database Administration

Database files will be stored on the PACN server in the appropriate I&M project folder, and a read-only version stored on each park's server. Before beginning a data entry session, the user must create a backup of the back-end data files, ensuring that the initial data starting point can be recovered should irreversible errors or problems occur during the data entry session. The backup will be done using a database utility and a prompt will appear at the onset of a data entry session, checking that the back-up has been made. This will not require a name change or revision change. The backup files will be named after the original front end and the current date at the end. Back-up copies are used for the current field season only and will not be archived. Read-only copies of the database should be stored in staff directories, not in project folders, and should be renamed to reflect the date it was copied. Only the current protocol database will be stored in the I&M project folder, and all data entry and/or edits should occur only in this protocol database. Thus, the working copy of the database resides in a single location, avoiding the confusion that would result if multiple working copies were stored in various locations. If a read-only copy is used for exploratory data analysis (i.e., queries and reports are added, and the database copy becomes a working copy), the Principle Investigator must work with the PACN Data Manager to import new queries or reports into the current protocol database. Such changes will be fully documented in the protocol and/or SOP edit logs and reflected in the protocol database filename (e.g., version identifier) and metadata.

Data Entry from Data Forms

Data entry should occur as soon as possible after data collection is completed and before the next observation occurs. Data entry should be administered by the person who collected the data or someone who is familiar with the project and data. The primary goal of data entry is to transcribe the data from paper records into the computer with 100% accuracy.

Database users' manuals are provided in Appendices A and at the web site (http://biology.usgs.gov/pierc/HFBIDPSite/database.htm). Ultimately, it is the Project/Field Lead's responsibility to ensure that all data entry staff understand how to enter data and follow all applicable protocols. Data entry technicians are responsible for becoming familiar with the field data forms, the database software, database structure, and any standard codes for data entry.

Data Maintenance

Any editing of archived data is accomplished jointly by the Project/Field Lead and PACN Data Manager. 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 using this protocol are subject to the following three caveats:

1. Only make changes that improve or update the data while maintaining data integrity.
2. Once archived, document any changes made to the data set through an edit log. At end of each fiscal year, the database manager or a technician will update the central database and will send out read-only versions.

3. Be prepared to recover from mistakes made during editing.

Data Organization

A master copy of the Hawaii Forest Bird Monitoring Database will be stored at the Hawaii Forest Bird Interagency Database Project facilities. In addition, an updated version will be housed at the PACN offices on the I&M server for the monitoring project. Likewise, the Avian Monitoring Entry Form and Habitat Monitoring Database will be located on the I&M server for the monitoring project. No ancillary data files are expected to be retained or archived (e.g., GPS waypoint or image files).

Version Control

Prior to any major changes of a data set, a copy will be stored with the appropriate version number to allow for tracking of changes over time. Versioning of archived data sets is handled by adding a two decimal number to the file name, with the first version being numbered 1.00. 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 recent archived version.

Data Logs and Backups

Once the data are archived, any changes made to the data must be documented in an edit log. Original field forms will not be altered. Field forms can be reconciled to the database through the use of the edit log. Secure data archiving is essential for protecting data files from corruption. Once a data set has passed the QA/QC procedures specified in the protocol, a formal entry is made in the I&M Data Set Catalog. A digital copy is forwarded to the NPS Inventory and Monitoring Program Archive where it is maintained in a read-only format on the PACN I&M server. Backup copies of the data are maintained in a read-only format at each park. A backup of the park data copies should be conducted at least every month.

Verification of Data Entry

Quality control of data is a critical step in data management. Verification of data (ensuring data on field sheets match data entered into a database) is the responsibility of the Project/Field Lead. In addition to archived files, the table “tblSurveyEvents” in the HFBMD serves as a record that the data have been transcribed, proofed and incorporated into the database.
Quantification of transcription errors and data verification is detailed in the AMEF User’s Guide. This process includes:

> The raw data (field notebooks or photocopies of field books) are compared to the electronic version on a line-by-line basis to correct transcription errors. All errors are corrected and rechecked for accuracy. After line-by-line proofing is completed, individual data sets are spot-checked for error rates. Ten percent of the total records for a given data set are randomly selected and proofed to raw data. Records are kept to ensure that error rates are less than one percent (< 1%). Spot-checking error rates are logged in the metadata. If the error rate exceeds

1%, the whole data set will be proofed again using line-item procedures and a new set of random records checked via the spot-checking methods. The person proofing the data will be different than the person who entered the data.

Using built-in queries within the database, data will be examined for outliers and other unusual observations. If unusual points are found, they will be cross referenced against original field data sheets to ensure accuracy. Inaccurate entries will be corrected.

Spatial data will be verified annually. A database utility (query) will compare coordinates with data in GIS and ensure points match up. Verify that points line up with existing data (e.g. park boundary).

File Management

Local Archiving of Files

PACN will work with the park's curatorial staff to meet their archiving desires. HFBIDP will perform an independent archiving of field books (copies or originals) and digital data according to USGS standards.

Digital data

Any time a revision of protocols requires a revision to the database, a complete copy of the database will be made and stored in an archive directory (see Version Control, above). 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 CAKN, which is provided to parks along with the database. These files are saved in the archive directory, with a subdirectory created for each version. At the end of a field season when all data have been entered, verified and validated, an annual archive copy of the front and back ends will be made (see Version Control, above). A copy of all archived data sets, both version archives and annual archives, should be sent to PACN with the annual report.
All archived files should be designated as "read-only." These files must be stored on a server or hard drive that has a regular and secure backup routine that includes off-site storage rotation.

Hard Copies and Originals

Hard copies of all datasheets, maps, and protocols will be archived by the Project/Field Lead. Table SOP 10.1 identifies the processing and disposition of the project data.

Table SOP 10.8. Processing and disposition of project data.

Data Item	Action	Database	Project Binder	Archive
Land bird data forms	Make four copies	Enter data	Park copy	I&M keeps original. Park keeps one copy. HFBIDP keeps two copies
Habitat data forms	Make two copies	Enter data	Park copy	I&M keeps original. Park keeps one copy
Maps	Download GPS data	Enter new location data	Original	Park keeps an annual copy
Protocol update		Create archive copy (both Access and ASCII) before update		Save on backed-up server or hard drive; send copies to PACN
End-of-season verified/validated database		Create archive copy		Save on backed-up server or hard drive; send copy to PACN
Metadata	Complete or update dataset catalog record		Park copy	Send updated record to PACN

References

Camp, R. J. 2006. Hawaii Forest Bird Monitoring Database: Database dictionary. USGS Pacific Island Ecosystems Research Center, Hawaii National Park, Hawaii, U.S.A. Available at http://biology.usgs.gov/pierc/HFBIDPSite/database.htm (accessed 13 October 2010).

Camp, R. J., R. W. Lam, V. A. Matsui, A. Cramer, T. K. Pratt, B. L. Woodworth, and M. Gorresen. 2005. Avian monitoring entry form. Version 2.1. USGS Pacific Island Ecosystems Research Center, Hawaii National Park, Hawaii, USA. Available at http://biology.usgs.gov/pierc/HFBIDPSite/database.htm (accessed 13 October 2010).

Peitz, D. G., S. G. Fancy, L. P. Thomas, and B. Witcher. 2002. Bird Monitoring Protocol for Agate Fossil Beds National Monument, Nebraska and Tallgrass Prairie National Preserve, Kansas. Unpublished report. Prairie Cluster Prototype Monitoring Program, National Park Service, U.S. Department of the Interior. Version 1.00 (September 6, 2002).

Appendix SOP 10A Landbird Habitat Monitoring Database
User's Guide

Version 1.0 (5 June 2007)

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Figures

Page

Introduction

The Landbird Habitat Monitoring Database (HMD) and supporting documentation was developed by the PACN. This database is consistent with the NRDT design. Habitat data are collected from each sampling station to aid in producing a detection function (as a habitat covariate), and understanding potential reasons for trends in bird densities. These potential relationships may have practical applications in the management of habitat. The SOP #8 provides details on how to describe and document habitat, and is summarized here. Integrating habitat data and bird densities will allow us to provide feedback to management, which in turn affects bird community composition and abundance.

Installing the Landbird Habitat Monitoring Database

The user can copy and paste both front and back end database files to a park server that has automatic backups. If some parks lack these resources, store the files on a local computer and employ a backup strategy. The database files should be stored in the appropriate I&M project folder (recommended directory structure: pacn_workspace/data_products/landbirds_habitat_database). Once copied, users will need to re-link the databases (see "Connect Data Tables" below).

At the beginning of each data entry session, the user must create a backup of the back-end data file, ensuring that the initial data starting point can be recovered should irreversible errors or problems occur during the data entry session (see "Back Up Data" below). Back-up copies are used for the current field season only and will not be archived.

Starting the Landbird Habitat Monitoring Database

Double-click on landbirds_habitat_FE_v3.mdb to start the application

.

Features of the Application Startup Form

The startup form is the entry point for the application, and therefore the first thing users will usually see when opening the application.

Double-clicking the unit name at the top left of the form will open the web site for that particular unit. Double-clicking the NPS Arrowhead or the title National Park Service at the top right of the form will open a browser and navigate to the National Park Service web site (www.nps.gov).

Also at the top right of the form is an exit button which can be used to close the application.

A tabbed menu resides at the lower left corner of the form. It contains tabs for the main menu, application defaults, and information about the application. Each of the tabs will be examined in more detail in the sections that follow.

At the bottom center-right of the form is a box that displays the current location of the data file to which the application is linked.

Main Menu

The main menu of the application is what users will see when the application is started (Figure A.1). It provides buttons for entering/editing data, managing lookup tables, viewing the database window, backing up data, and connecting data tables.

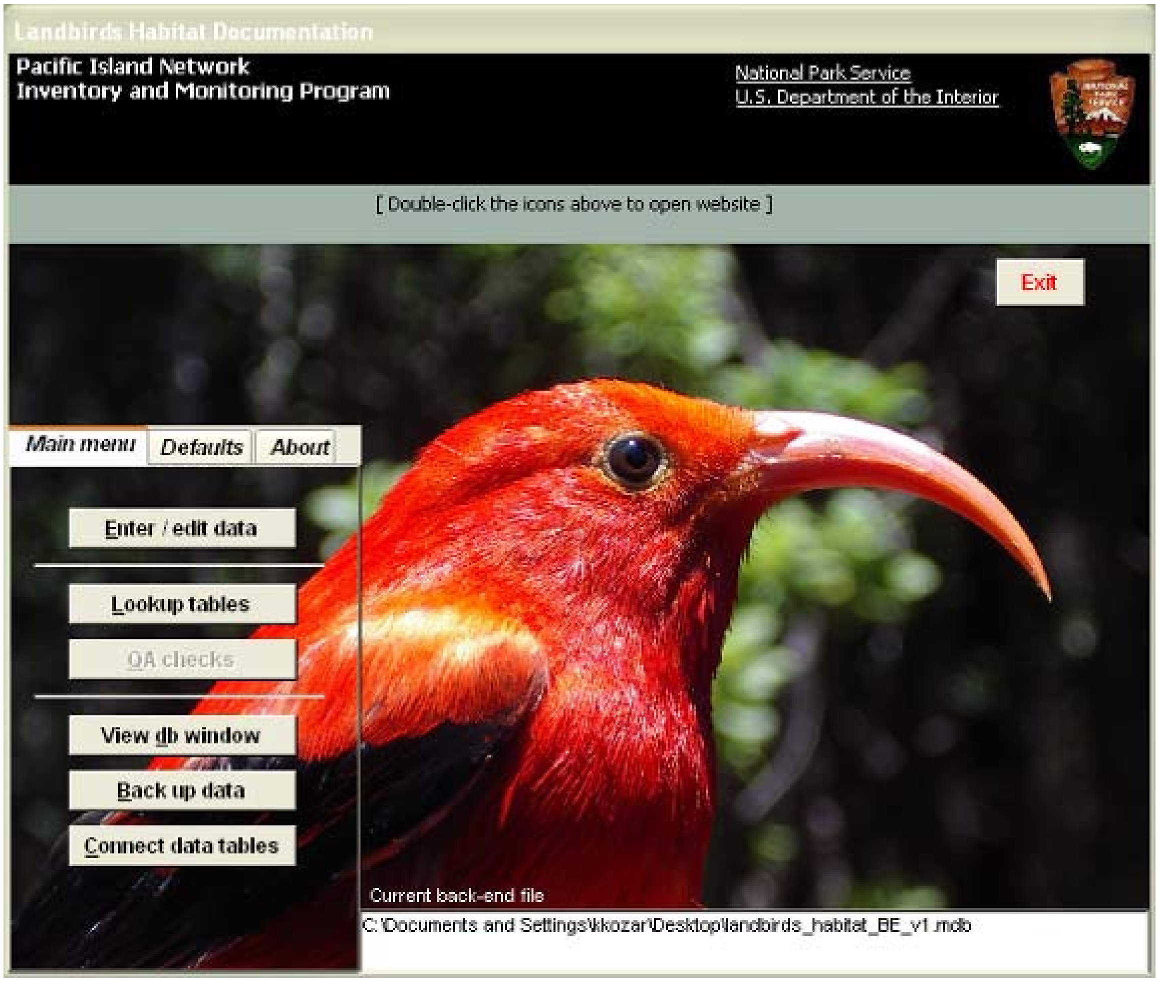

Figure A.1. Main Menu.

Enter/Edit Data

Clicking the Enter / Edit data button will open the Application Defaults form, which can be used to set default values that will be used for new records and to determine which records are initially visible on the Data Gateway form. At a minimum, the user and park must be filled in. These values can be changed later on. See the *Defaults* section of this document for more information on the Application Default form.

Data Gateway Form: Once the Application Defaults form is filled in, the Data Gateway form will be displayed (Figure A.2). This form displays location and event information for each record, and is designed to help the user determine which record to edit/view. By default, the Data Gateway form starts off with a filter (a criteria that limits which records are displayed) for the default park that was selected on the Application Defaults form.

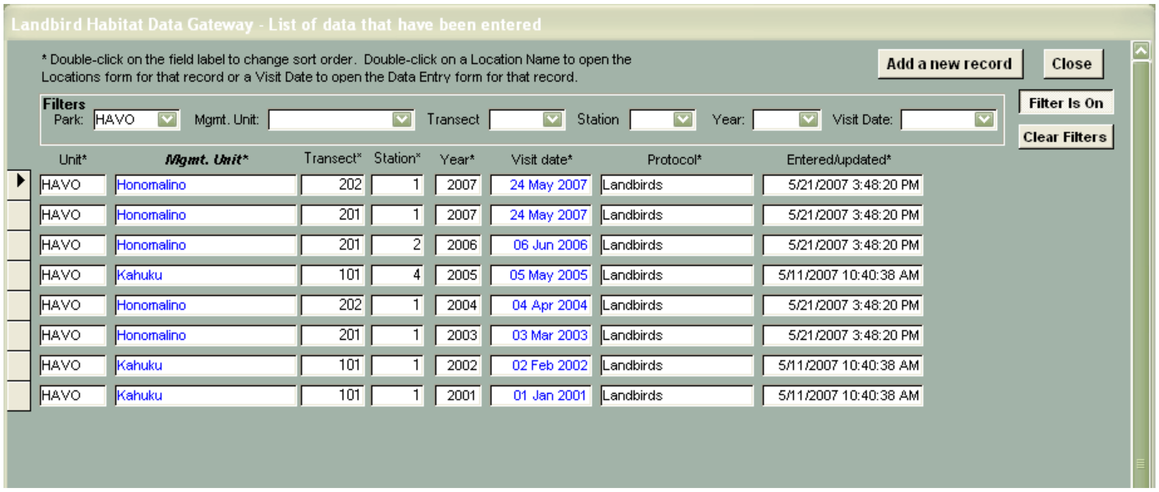

Figure A.2. Data Gateway Form**.**

Additional filters for Management Unit, Transect, Station, Year, and Visit Date can be set by selecting from the drop-down lists at the top of the form in the Filters box. Filters can be removed by clicking the toggle button that says “Filter Is On”. It will toggle up and say “Filter Is Off” when the filter is removed. When the filter is removed, all records will be displayed. Optionally, a specific filter can be removed by deleting the text that is currently displayed in one of the filter controls. To clear all filters of text, click “Clear Filters”.

In addition to filters, there are sorting options for the records on the Data Gateway form. Double-clicking any of the column headings will cause the records to be sorted in ascending order by that column value. The column heading will change to a bold italic format to indicate that it is the column being used to determine sort order. If the same column is double-clicked a second time, the records will be sorted in descending order by that column value.

Double-clicking a Management Unit value will open the Management Unit form for that particular record (see the Management Unit form section that follows). Double-clicking a Visit Date will open the Data Entry (includes Event data) form for that particular record. If an Event record has not been added for a particular location, when that blank Visit Date is double-clicked, a new Data Entry record will be opened.

To add a new data entry record, click the Add a new record button at the top of the Data Gateway form.

Management Unit Form: The Management Unit form is used to enter Management Unit information for a sampling point(Figure A.3). Values entered here include:

- NPS Unit
- Management Unit
- Management Notes
- Transect
- Station
- X & Y Coordinates, Coordinate Units, and Coordinate System
- UTM Zone and Datum
- Estimated Horizontal Error & Accuracy Notes

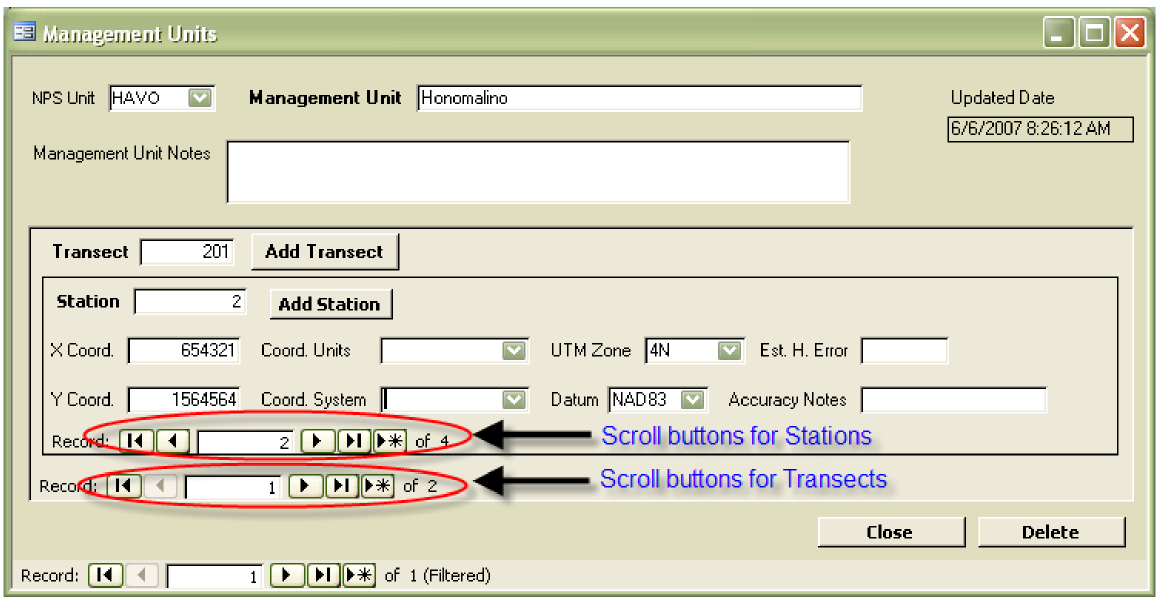

Figure A.3. Management Unit form.

If a transect needs to be added to a Management Unit, either click “Add Transect” or click the  button. If a station needs to be added to a Transect, click “Add Station” or click the  button for Stations. To scroll through transect and stations for a Management Unit, use the  and  buttons (see Management Unit Form above).

Data Entry Form

Data Entry Form: The Data Entry form is used to select a Management Unit, enter event information, enter information about the people who participated in the sampling event, and enter all of the habitat-specific information (Figure A.4).

A Management Unit that was previously entered on a Management Unit form can be selected from a drop-down list, or a new Management Unit can be entered by clicking “Add New”. To edit a Management Unit, or to add Transects and Stations, choose a Management Unit from the drop-down list, then click “Edit”.
Once a Management Unit is chosen, all Transects for that Management Unit will be shown in the Transect drop-down list. Choose a Transect from the drop-down list. All Stations for the chosen Transect will be shown in the Station drop-down list. Choose a Station from the drop-down list. After the Station is chosen, the sampling event subform will be enabled.
Event information entered here includes:

- Protocol Name
- Start Date
- Start Time
- Event Notes

Information about people who participated in the sampling event can be entered in the box at the top right of the form. Contacts can be selected from the Contact drop-down list, and a role can either be typed in to the role box or selected from the drop-down list. If a new contact needs to be entered, click the “Add a person” button to open the Contacts form.

Information collected about the habitat sampling is entered under the headings “Plot Attributes”, “Habitat Attributes”, and “Density Board”.

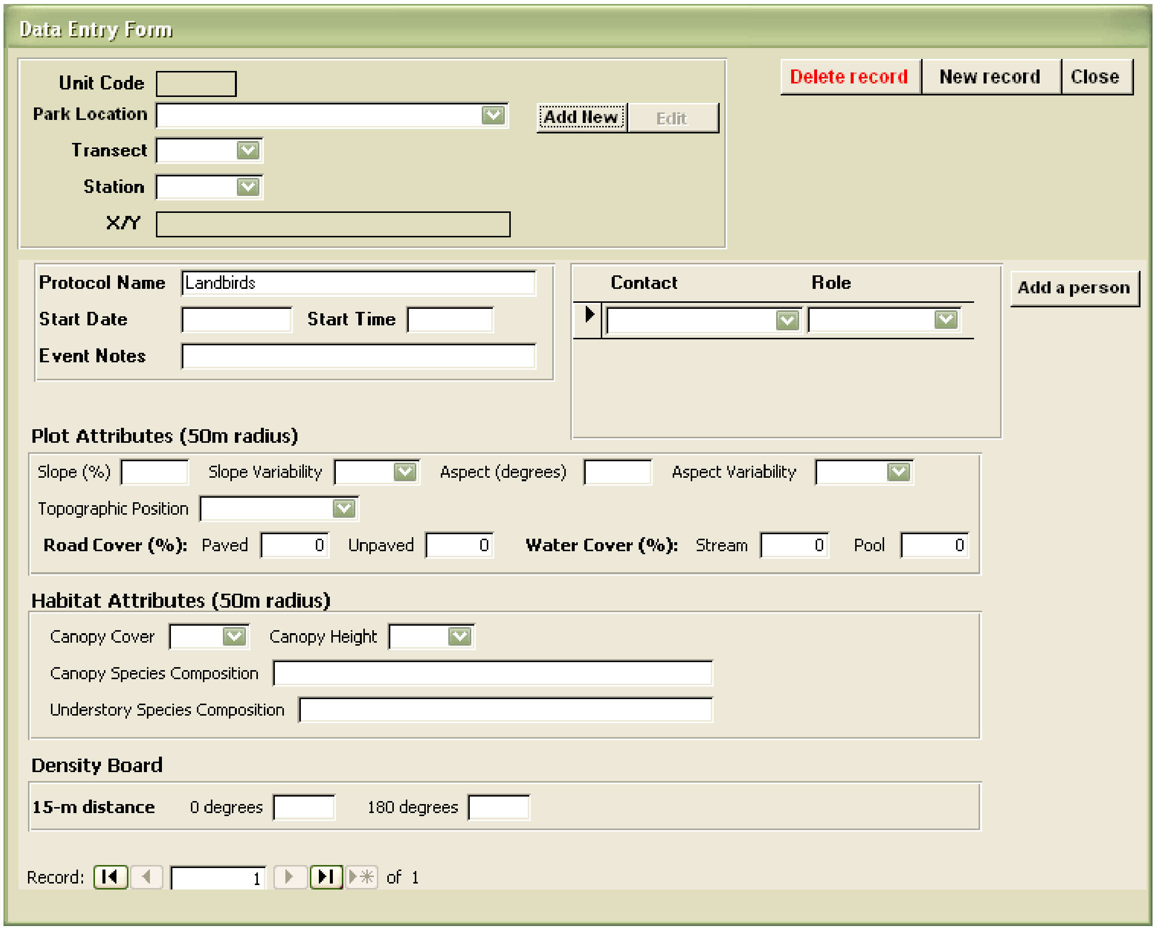

Figure A.4. Data Entry form**.**

If another data entry record needs to be added, simply click the New record button.

Event Group Form

Contact Information Form: The Contact Information form is used to enter details about individuals who participate in data gathering for the protocol and who enter information in the database (Figure A.5). Values entered here include:

- First Name, Middle Initial, Last Name
- Organization
- Position/title
- Work Phone and Extension
- Email Address
- Address Information, including Address Type, Street Address, City, State, Zip Code, and Country
- Comments

Previously entered addresses can be selected from the Address 1 drop-down list, and the associated Street Address, City, State, Zip, and Country values will automatically be filled in.

The Organization and Position/Title drop-down lists will also allow selection from previously entered values or new entries.

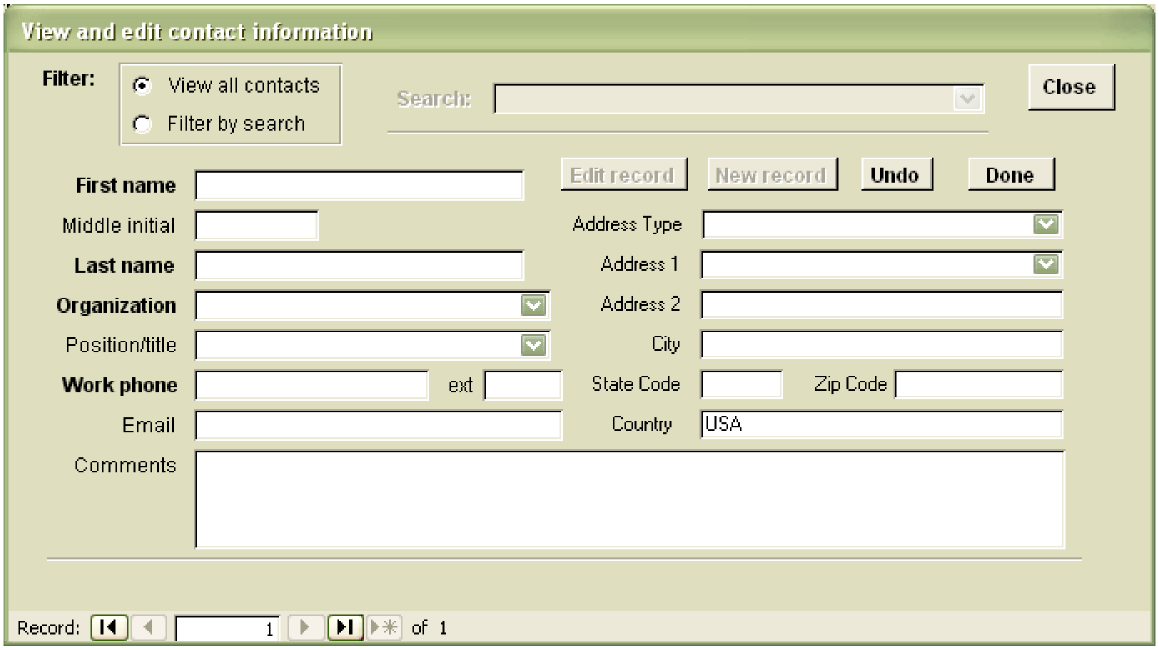

Figure A.5. Contact Information form (new record).

When the Contact Information form is in view mode (click "Done" and the form will then have a grey background, Figure A.6), individual contacts can be shown by selecting from the Search drop-down list at the top right of the form.

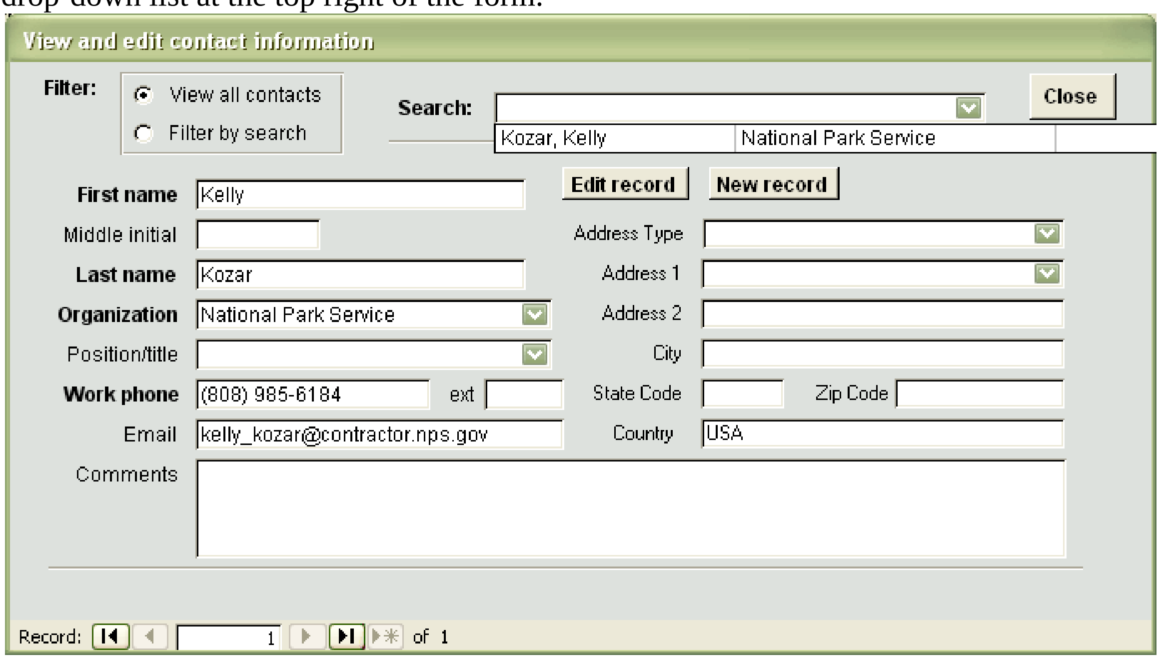

Figure A.6. Contact Information form (view mode).

In view mode, records can only be read, not edited. To enable editing for a record, click the Edit record button.

Lookup Tables

Clicking the Lookup tables button will open the form for managing lookup tables (Figure A.7). On the Other lookup tables tab, lookup tables can be selected from the Tables drop-down list. The values in the lookup table will be displayed in a datasheet below the drop-down list. If the table is listed as "Editable" in the drop-down list, then records can be edited, deleted, or added in the datasheet.

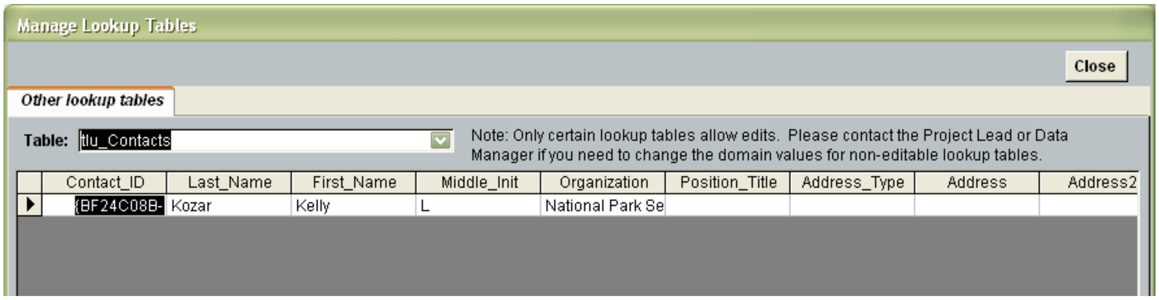

Figure A.7. Lookup Table Management form.

QA Checks

The QA checks button is not currently active in the application.

View db Window

Clicking the View db window button will display the Microsoft Access database window, which lists all of the tables, queries, forms, reports, pages, macros, and modules in the application. It is recommended that you exercise caution when working with objects directly in the database window. To hide the database window once you have opened it, make sure it is selected and select Window > Hide from the menu at the top of the application.

Back Up Data

Clicking the Back up data button will pop up a Yes/No box asking if you would like to make a backup copy of the data. If you select Yes, you will be prompted to select a folder in which to place the backup copy, which has a default name of *[landbirds_habitat_BE_v1_yyyymmdd_hhmm.mdb*. You can rename the file if you would prefer a different name. Clicking the Save button creates the backup file and displays a success message.

Connect Data Tables

The application has a separate front-end (user interface) and back-end (data tables). In order for the application to work properly, the front-end file must be connected to the correct back-end file.

Clicking the Connect data tables button opens the Update Data Table Connections form (Figure A.8), which can be used to establish the link from the front-end to the back-end.

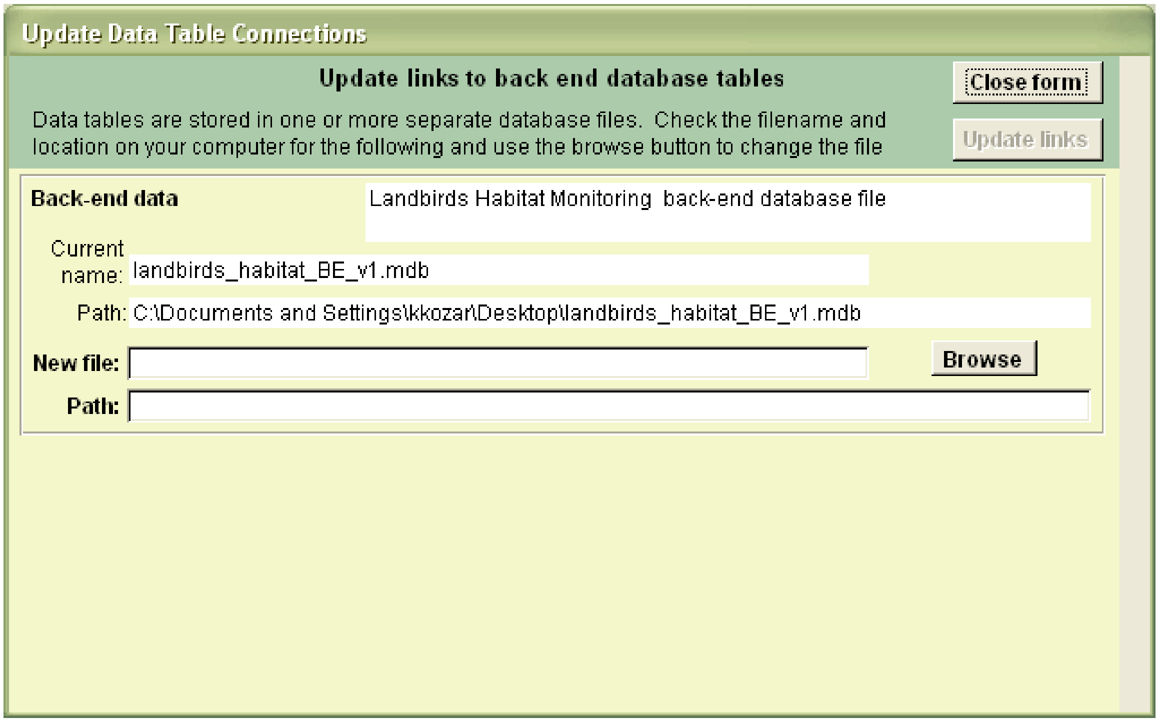

Figure A.8. Update Data Table Connections form.

For each back-end file linked to the front-end, a record will be displayed on the Update Data Table Connections form. The name, path, and file name of the current back-end file are displayed. To change the back-end file connection, click the Browse button, select a new back-end file, and click the Open button. You will be returned to the Update Data Table Connections form and the New file and Path text boxes will be filled in. To make the new connection, click the Update links button. If the connection is made, a success message will be shown and you will be returned to the main menu.

Defaults

The Defaults menu provides feedback on the current default values, and check boxes for automatic backups on startup, backups on exit, data file compaction on backup, and link verification on startup (Figure A.9).

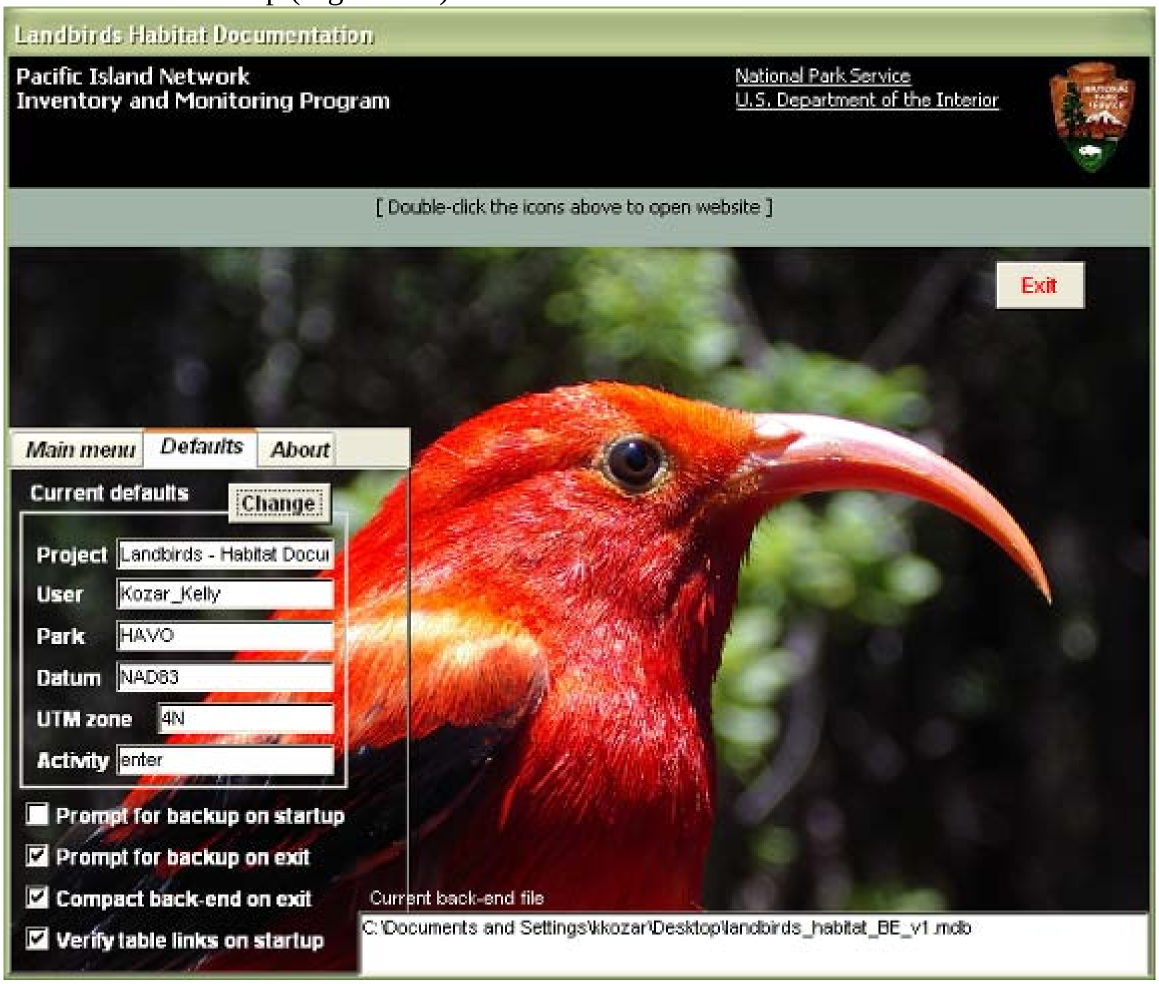

Figure A.9. Defaults.

Current Defaults

The current defaults section of the Defaults menu (Figure A.10) displays values that will automatically be filled in for the following fields when new records are added:

- Project
- User
- Park
- Datum
- UTM Zone
- Activity

To change Project, you should contact the developer of the application (see the About menu in

the next section), since this is set when the application is created.
To change User, Park, Datum, or UTM Zone, click the Change button to bring up the Defaults form. Each value can be selected from a drop-down list. If you are unable to find a User, click the New user button to add a new one (see the Contact Information Form section of this document for more information). When you have finished entering default values, click the OK button to return to the Default menu.

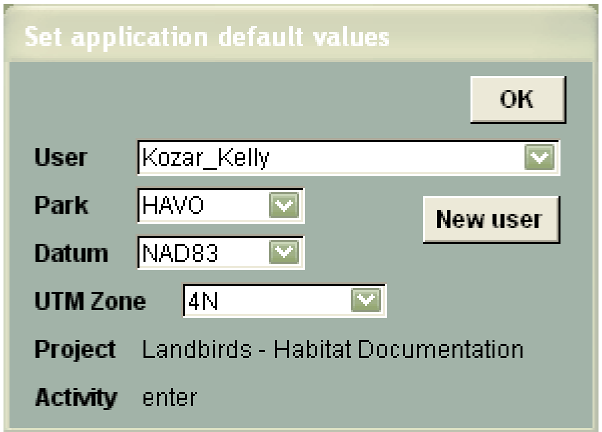

Figure A.10. Application Default form.

Automatic Backups

The application can be set to automatically prompt for backups every time it is started and/or every time it is closed using the Exit button on the main form. Making backups before and after data entry sessions is a good habit to get into, in case of database corruption or data entry mistakes. Backups can also be run manually by clicking the Back up data button on the Main menu.

Compact Back-End on Exit

Compaction is a process whereby Microsoft Access optimizes the organization of the file, making it smaller and quicker to access data. If you check the option to Compact back-end on exit (recommended), the application will compact the data file that is linked to the front-end when the application is closed using the Exit button on the main form.

Verify Table Links on Startup

The application is structured with a front-end (user interface) and a back-end (data tables). In order for the application to work properly, the front-end must be linked to the tables in the back-end. If this check box is checked (recommended), the link to the back-end file(s) will be checked when the application is started.

About

The About menu presents information about the application (Figure A.11), including:

- Version number
- Application author
- Author organization
- Author phone
- Author email (click to email)

Buttons for viewing release history and reporting bugs are also provided on the About menu.

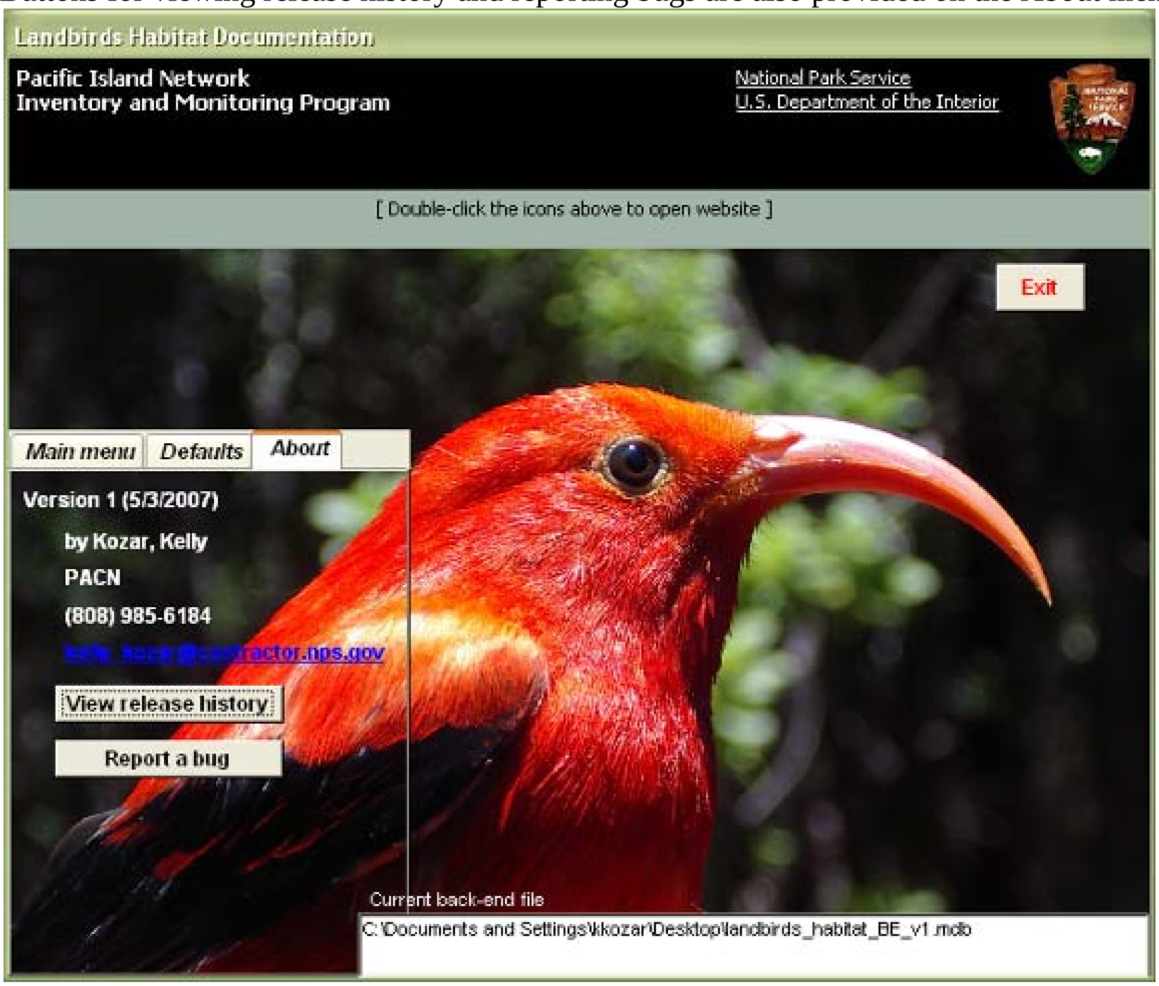

Figure A.11. About.

Release History

Clicking the View release history button opens the Application Releases form (Figure A.12). This form provides information about all of the different versions of the application that have been released. It is filled in by the application developer before the application is distributed and is therefore read-only.

Included in the Application Releases form are title, version, and release information about the application, information about the author of the application, and bug information.

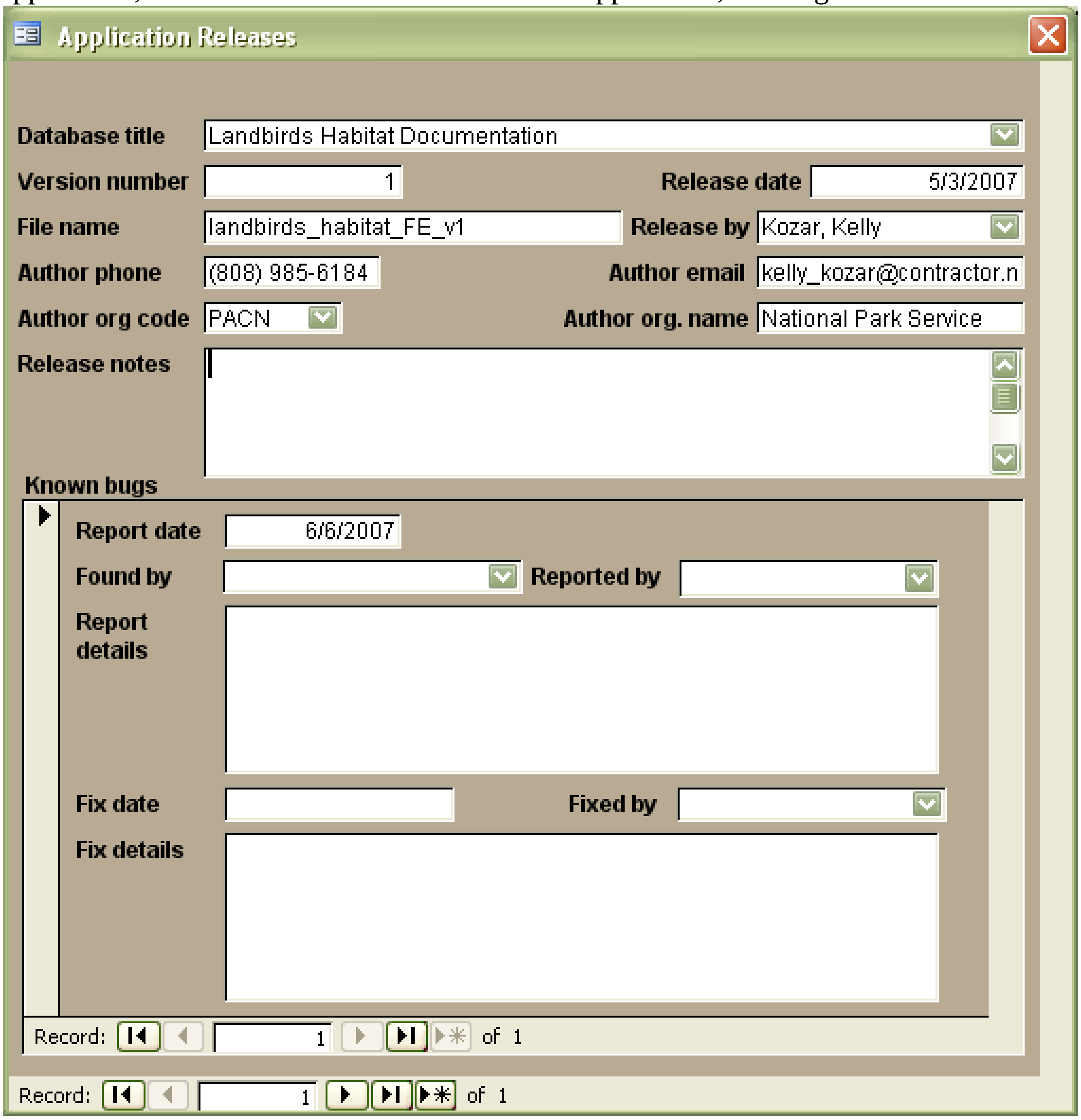

Figure A.12. Application Releases form.

Report a Bug

Clicking the Report a bug button will prompt the user to contact the application developer with the details of the bug. Developer contact information is located above the Report a bug button. The following information is useful when reporting a bug:

- application name
- application version
- name of the form/report you were on when the bug happened
- action, if any, you took right before the bug occurred
- screen capture of any error messages

Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 11: Data Analysis

Version 1.00 (September 2010)

Revision History Log

Prev. 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, 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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Abstract

This SOP describes the process of summarizing survey results, analyzing presence data to assess species composition and trend, and analyzing point-transect distance sampling data and uses data from the Heartland Network bird surveys as examples. In addition, this SOP describes the methods for assessing long-term trends in densities. The methods presented here assume data have been collected following a legitimate probability based sampling design. Note that point-transects are sometimes referred to as variable circular-plots (VCPs), especially in the avian literature. I will continue with the term "point-transect" to be consistent with the current analysis literature Buckland et al. (2001) and avoid confusion with past methods referred to as VCPs which were not as statistically rigorously developed (Reynolds et al. 1980). The SOP is intended to guide data analysis. It is not intended to present the theory of distance sampling. While this SOP describes much of the analysis in detail, the reader should keep in mind that some datasets will require analyses not considered here. For those with more complicated design and analysis problems; please refer to Buckland et al. (2001) and Buckland et al. (2004) for more details.

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm.

Recommended Citation

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Original Author and Affiliation

Lukacs, P. M. 2005. Standard Operating Procedure: Analyzing distance sampling data from point transects. USGS Patuxent Wildlife Research Center, U.S. Department of the Interior. Version 0.01 (May 12, 2005).

Acknowledgements

This SOP was reviewed by PACN staff, James Agee, Paul Berkowitz, Eric Brown, Guy Hughes, and two anonymous reviewers. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Data Summaries

At the end of each field season, following data entry and verification, the Project/Field Lead will include in an annual report summaries of the surveys conducted in PACN park units and bird status. The AMEF database provides a tab for summarizing the survey:

- list of observers who conducted the survey
- list of transects and stations sampled
- list of species detected
- naive species abundance estimates (including frequency of detection and birds per station)

Calculations for determining naive species abundance are provided in the AMEF User's Guide (SOP 10). Note: these abundance calculations may be biased and do not account for species detectability. Thus, the naive species abundance estimates are intended for use in quality control. Accounting for species detection probabilities is conducted in the capture-recapture and distance sampling analyses, below.

In addition to the data summaries, maps of all areas surveyed and metadata should be included in the annual report following reporting procedures (SOP 12).

Species Composition

Detecting trends in species composition, that is, species richness, requires accounting for detectability among species (i.e., imperfect and heterogeneous species detectability because of behavior and abundance) and among years (e.g., variation in detectability due to weather and turnover in observers). Simple enumeration of all recorded species is usually biased because two detectability assumptions are not met (listed above). New applications of capture-recapture methods can be used for estimating unbiased species richness and assessing trend while accounting for heterogeneous detectability (Nichols et al. 1998, Kery and Schmid 2003). Program COMDYN (Hines et al. 1999) calculates the species richness for each survey occasion, and for successive years it estimates the trend (the ratio of species richness for two successive years), disappearance rate (estimated proportion of species from year 1 not present in year 2), species turnover (estimated proportion of species in year 2 that did not occur in year 1), and colonization rate (estimated number of species not present in year 1 but present in year 2). Program COMDYN is available for download at http://www.mbr-pwrc.usgs.gov/software.html#a.

Sampling

Data necessary to calculate species composition and trends is available from the point-transect data and supplemented by additional detections. Multiple visits are needed to create a detection history for each species at each sampling point. Visits can be either separate samples of the stations (such as when conducting bird and habitat surveys) or simultaneous samples from independent observers at the station, such as samples by primary and secondary counters. Combining both types of visits yields three, or more, samples. That is, one sample each from the primary and secondary counters while conducting the point-transect count, and a third (and possible fourth) sample while sampling the habitat. Presence of each species detected (either auditory or visually, or both) at a station is recorded and used to create a detection history. From the point-transect counts the data recorded by the primary counter is reduced to simply a species list by station (i.e., dropping the distance and detection type information). During the point-transect count the secondary counter is required to record each species detected independent of the primary counter, and in a separate field book. Thus the secondary counters need to be able to identify birds with skill equal to the primary counters.

Analysis

Detection history data is a 101 matrix for each species and station, where species A has been detected (1) or not (0). Table 1 shows a hypothetical example of a detection history. Assuming a closed species population (i.e., absence of immigration or emigration of species) during the sampling occasion a conditional probability of detection, *p*, is calculated. Program COMDYN calculates *p* with the Jackknife estimator for model M_h, which allows for heterogeneity among species. See Nichols et al. (1998) for justification using this model.

Table SOP 11.9. Hypothetical example of a detection history for four species at a point-transect sampling station. The columns denote 3 visits during 2007. A detection history is generated for each station to estimate species richness, and successive years are compared for trends.

	Sampling Occasion		
Species	**2007-1**	**2007-2**	**2007-3**
Amakihi	1	0	0
Apapane	0	1	1
Japanese White-eye	1	1	1
Northern Cardinal[1]	0	0	0

[1]Note that the cardinal was not detected at this station, yet it is included in the matrix for analysis as the species occurs elsewhere in the survey.

Information is input into Program COMDYN through a menu (Figure SOP 11.1). Terminology and notation for input data is:

- Sample 1: the first of 2 times over which change is to be estimated
- Sample 2: the second of 2 times over which change is to be estimated
- Subset A: subset of species that were observed in both samples; f(i) and n(i) data come from Sample 2
- Subset B: subset of species that were observed in both samples; f(i) and n(i) data come from Sample 1
- f(i): number of species observed on exactly i occasions
- n(i): number of species observed on occasion i

Note that data for Subset A is from Sample 2 whereas data for Subset B is from Sample 1. Change the number of occasions in the first field. We suggest using the default bootstrap iterations and seed number; however, if desired, set the seed number to 0 for a random seed (it uses the computer date and clock to select a random seed number).

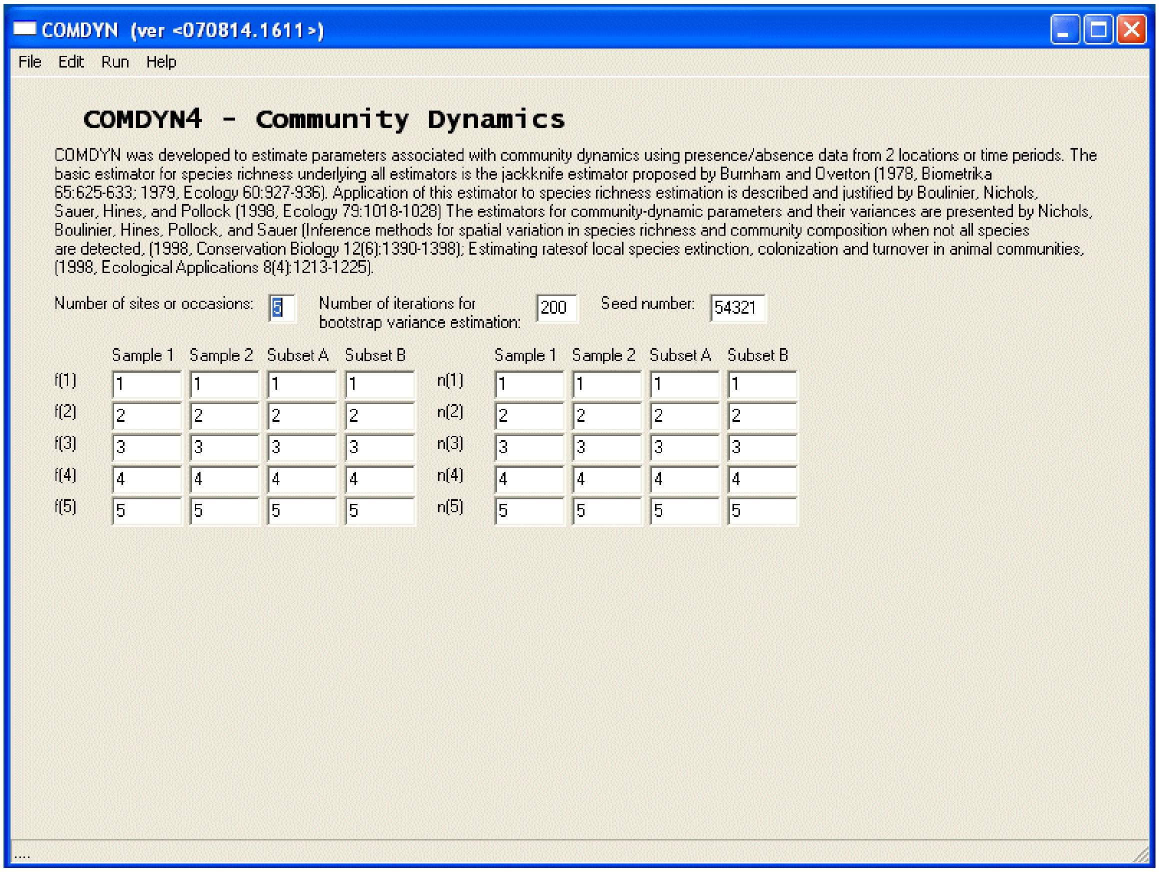


Figure SOP 11.8. Menu of program COMDYN, which is used to input species detection data.

Continuing with the example of three sampling occasions, the number of occasions was set to 3, and the data were input into the appropriate fields (Figure SOP 11.2).

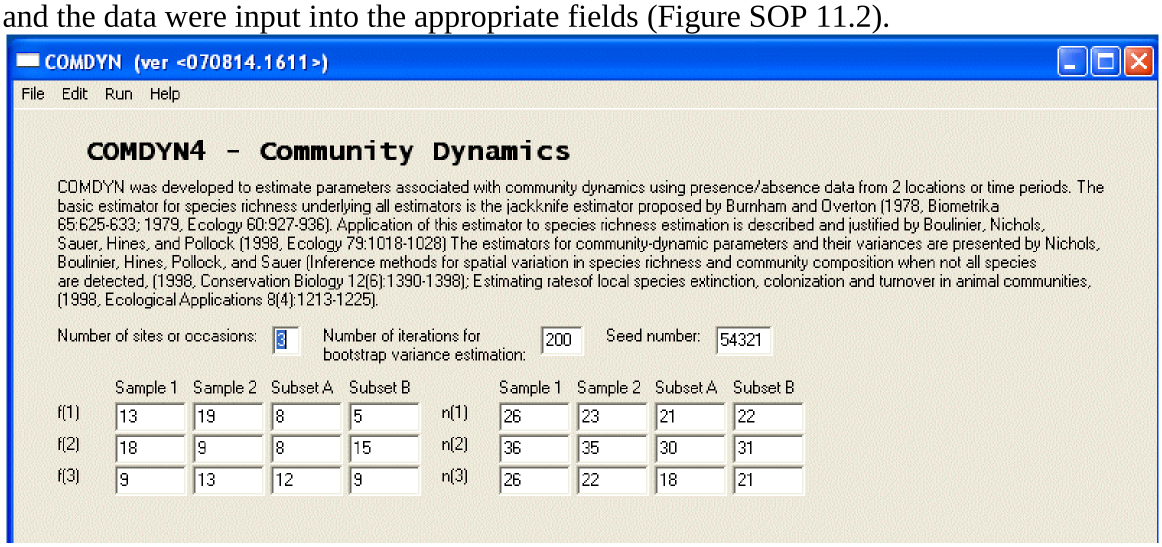


Figure SOP 11.9. Example species detection data input into program COMDYN.

Once the data are entered, compute the estimates by selecting Run and Compute Estimates – COMDYN from the toolbar. The results are output in a text file (comdyn4.txt; Text Box 1); use the Save As function to save the output with your desired file name and location. Species richness estimates are produced for each occasion (from the output in Text Box 1: N(1) = 48, SE(1) = 4.16, and N(2) = 57, SE(2) = 6.37). The rate of change of species richness, trend, is calculated as a ratio of $\hat{T} = \frac{\hat{N}_2}{\hat{N}_1}$, which is an unbiased estimator of the trend because the occasion-specific, species detection probability is incorporated into $\hat{N}$. The estimated species detection probabilities are provided in the output as p(1) and p(2), and we see that the 95% confidence intervals for each species detection probability includes the other species detection probability (from the output in Text Box 1: p(1) = 0.847, 95%CI 0.719–0.983, and p(2) = 0.726, 95%CI 0.587–0.936). From our example the trend (from the output in Text Box 1: lambda = 1.21) in species richness between the two occasions has increased, although not significantly at the levels defined in the monitoring objectives.

Text Box SOP 11.1.

```
*****************************************************
ComDyn4/SpecRich2- Community Dynamics/Species Richness
*****************************************************
bootstrap iterations: 200 seed number: 54321

filename:comdyn4.dat


Sample 1:
==============================
 Total species observed, R(1) = 40
 Observed frequencies, f(i) = 13 18 9

 Species richness estimate, N(1) = 47., SE(N(1) ) = 3.8706162


 M(h) GOF test:
 ==============
 Observed species, n(i) = 26 36 26
 Observed frequencies, f(i) = 13 18 9
 M(h) GOF test: Chi-square = 11.097 df = 2 Prob = 0.0039

 Sample 2:
 ==============================
 Total species observed, R(2) = 41
 Observed frequencies, f(i) = 19 9 13

 Species richness estimate, N(2) = 57., SE(N(2) ) = 6.09780169


 M(h) GOF test:
 ==============
 Observed species, n(i) = 23 35 22
 Observed frequencies, f(i) = 19 9 13
 M(h) GOF test: Chi-square = 11.786 df = 2 Prob = 0.0028

 Test for unequal p's
 ===================
 Observed frequencies, f(i):
 13 18 9
 19 9 13

 After pooling:
 Observed frequencies, f(i):
 13.000 18.000 9.000
 19.000 9.000 13.000
 Expected values:
 15.802 13.333 10.864
 16.198 13.667 11.136

 Total Chi-square: 4.84066546
 Degrees of freedom: 2
 Probability : 0.0888920424
```

Text Box SOP 11.1 (continued).

```
Subset A:Subset of species observed in both samples,
 f(i) and n(i) data come from Sample 2
 ===============================================
 Total species observed, m2(R1) = 28
 Observed frequencies, f(i) = 8 8 12

 Species richness estimate, M2(R1) = 31., SE(M2(R1)) = 3.13636875


 M(h) GOF test:
 ==============
 Observed species, n(i) = 21 30 18
 Observed frequencies, f(i) = 8 8 12
 M(h) GOF test: Chi-square = 19.688 df = 2 Prob = 0.0001

 Subset B:Subset of species observed in Sample 1
 f(i) and n(i) data come from Sample 2
 ===============================================
 Total species observed, m1(R2) = 29
 Observed frequencies, f(i) = 5 15 9

 Species richness estimate, M1(R2) = 30., SE(M1(R2)) = 2.38884878


 M(h) GOF test:
 ==============
 Observed species, n(i) = 22 31 21
 Observed frequencies, f(i) = 5 15 9
 M(h) GOF test: Chi-square = 16.300 df = 2 Prob = 0.0003
 Parameter estimates
 ===================
 data bootstrap standard 95% confide interval
 parameter estimate average error lower upper
 ----------------------------------------------------------------------------
 N(1) 47.04 47.56 4.16 40.40 - 55.49
 N(2) 57.04 57.16 6.37 43.80 - 69.00
 M2(R1) 31.91 31.84 4.40 23.20 - 40.68
 M1(R2) 30.27 30.71 3.41 25.00 - 36.84
 PHI 0.7979 0.7903 0.1133 0.5646 - 1.0000
 GAMMA 0.7383 0.7543 0.1061 0.5578 - 1.0000
 LAMBDA 1.2127 1.2107 0.1709 0.9086 - 1.5856
 altLAMBDA 1.0250 1.0206 0.1061 0.8095 - 1.2368
 B 19.51 19.68 8.84 0.90 - 35.42
 p(1) 0.8504 0.8473 0.0725 0.7192 - 0.9828
 p(2) 0.7188 0.7264 0.0834 0.5874 - 0.9361
```

Text Box SOP 11.1 (continued).

Definitions:
============
R(1) : Number of species observed in Sample 1
R(2) : Number of species observed in Sample 2
f(i) : Observed frequencies - number of species observed at exactly i sites/occasions
f'(i) : Observed frequencies - number of species observed at i sites where sites are in groups of 10
n(i) : Observed species- number of species observed at the ith site/occasion
N(1) : Estimated number of species present in Sample 1
N(2) : Estimated number of species present in Sample 2
M2(R1) : Estimated number of species present in Sample 2 which were observed in Sample 1
M1(R2) : Estimated number of species present in Sample 1 which were observed in Sample 2
PHI : Estimated complement of extinction probability - proportion of Sample 1 species still present in Sample 2
GAMMA : Estimated complement of species turnover -' proportion of Sample 2 species present in Sample 1
LAMBDA : Estimated rate of change of species richness estimated as N(2)/N(1)
altLAMBDA: Estimated rate of change of species richness estimated using alternate method, R(2)/R(1)
B : Estimated local colonizing species - number of species not present in Sample 1, but present in Sample 2
p(1) : Estimated species detection probability in Sample 1
p(2) : Estimated species detection probability in Sample 2

95% confidence interval computed by ordering bootstrap replicate estimates and using the values ranked at 2.5% and 97.5%.

Abundance Estimation

The current, well-tested version of DISTANCE is version 5.0 beta 5 (Thomas et al. 2005). DISTANCE 5.0 is freely available for download at http://www.ruwpa.st-and.ac.uk/distance/. Analysis procedures in this SOP will be based on version 5.0. At the time of writing this SOP, version 5 is in beta release and will likely take over as the primary version of DISTANCE.
This SOP is written as a general guide to the order of actions that should to be taken to analyze point transect data rather than step-by-step instructions. Data analysis procedures are very dependant on the specifics of a dataset and sampling design and will vary through time as monitoring data grow. Therefore, cookbook style instructions would likely be of little value to an analyst and could lead to poor or incorrect analyses. On the same note, I do not provide instructions for importing data because that is dependant on the way each dataset is stored.

Stratification

If the point-transects were placed according to a stratified design, then the area of each stratum must be known and fixed. The area is determined as flat map area, not total area including topography. The area is needed to weight the density of each stratum when determining the total bird density in the entire study area or when converting from density to abundance. Options for stratification are found under the Estimate tab in the Model Definition Properties window. Stratification can be based on geographic area or segment of the population such as males and females. If stratification is based on area, then the global population density is estimated as the mean of the stratum specific density estimates weighted by stratum area. If stratification is by population segment, the total density is the sum of the densities of equal segment, for example total bird density equals the density of males plus the density of females. Options for computing global density are found under the “Estimate” tab of the Model Definition Properties window in DISTANCE 5.0.

Sampling Unit

The first step in analyzing point transect data is to determine the proper sampling unit for the analysis. Actually, the sampling unit should have been determined at the design stage, so hopefully it is already known. The sampling unit will either be an individual point or a group of points along a transect. If all points were randomly placed or systematically placed with a random first starting point, then the sampling unit is the individual point. If transects were randomly placed and sets of points are run from the transects, then transects are the sampling units. When transects are the sampling unit, then the survey effort for that transect is the number of points sampled within each transect.
It is important to correctly determine the sampling unit because the encounter rate of birds and its variance are computed based on the sampling unit. The variance in encounter rate is a function of the spatial distribution of the birds. If individual points are used when transects should be the sampling unit, the variance of encounter rate will be underestimated.
The sampling unit is set in DISTANCE 5.0 when data are imported. The data layer named “Point Transect / Label” will be the sampling unit. Therefore, if transects of points are used, all observations from the points along each transect could be combined and the survey effort would be the number of points along the line.

Data Selection

DISTANCE 5.0 allows a subset of data to be selected from the entire set stored in the file. This is done through some limited SQL statements. Data selection is performed in the "Data selection" tab of the data filter window. Data selection is useful when there are multiple species in the data set, but you only wish to include one species in an analysis. It is also useful if you have multiple years of data and you only wish to analyze one year of data. The data selection process should only be used for fairly simple queries. If you need to do a complex query, that should be done in a database program prior to importing the data into DISTANCE 5.0.

Truncation

Data should be truncated at a distance, *w*, where detection probability (not probability density) drops to approximately 0.1 or where outliers are present for each species. Truncation helps to allow simpler models to be fit to the data without changing the expected density estimate. To determine a truncation distance, run an analysis using a generic detection function such as a hazard-rate with simple polynomial adjustment terms. Examine the histograms of the data. Figure SOP 11.3 shows the histogram for brown-headed cowbird data before any truncation is done. Note the single observation between 360 and 400 m and the four observations between 200 and 280 m. These 5 observations out of 117 pull the entire detection function substantially to the right and are difficult to fit.

Seeing the histogram in Figure SOP 11.3, it appears appropriate to truncate the data at 200 m. Figure SOP 11.4 shows the truncated histogram. Note how the detection function is better centered on the data and outliers are no longer pulling the function and causing an ill fit. The options for truncation can be found in the Data Filter properties within DISTANCE 5.0. Truncation can be done as a percent of the observations or at a specific distance. Typically, truncation is easiest to do at a specific distance.

The discussion above concentrates on right truncation or truncating observations that are far from the observer. DISTANCE 5.0 also offers left truncation. Left truncation is done when the area a zero distance cannot be surveyed, for example from airplane surveys when the observer cannot see directly below the plane. Left truncation is generally not appropriate for point transect data.

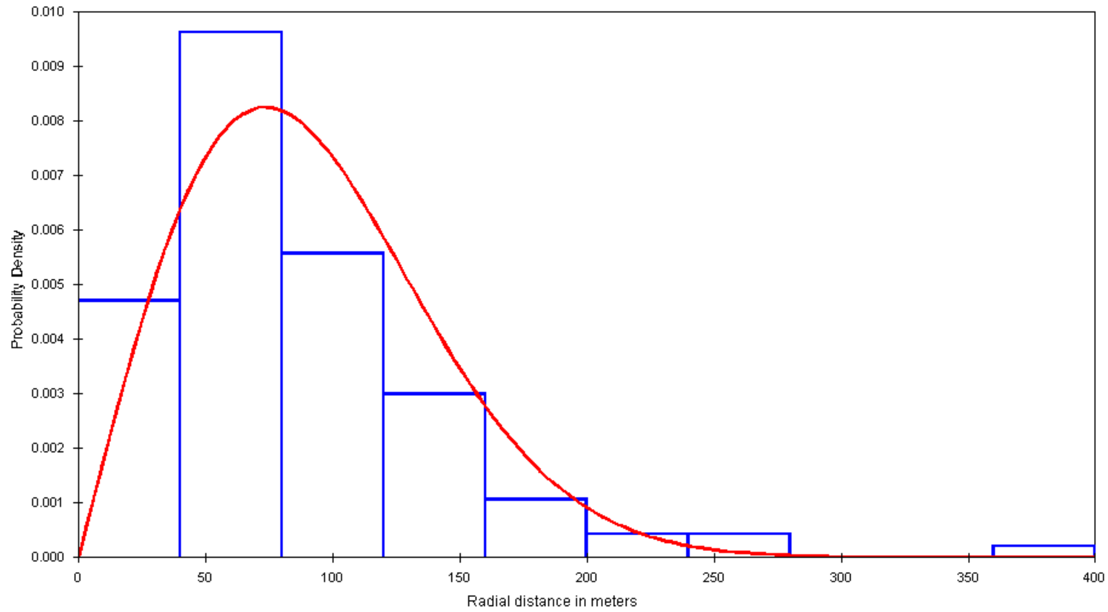


Figure SOP 11.10. Histogram of brown-headed cowbird point transect distance sampling data prior to truncation. The plot represents 117 observations.

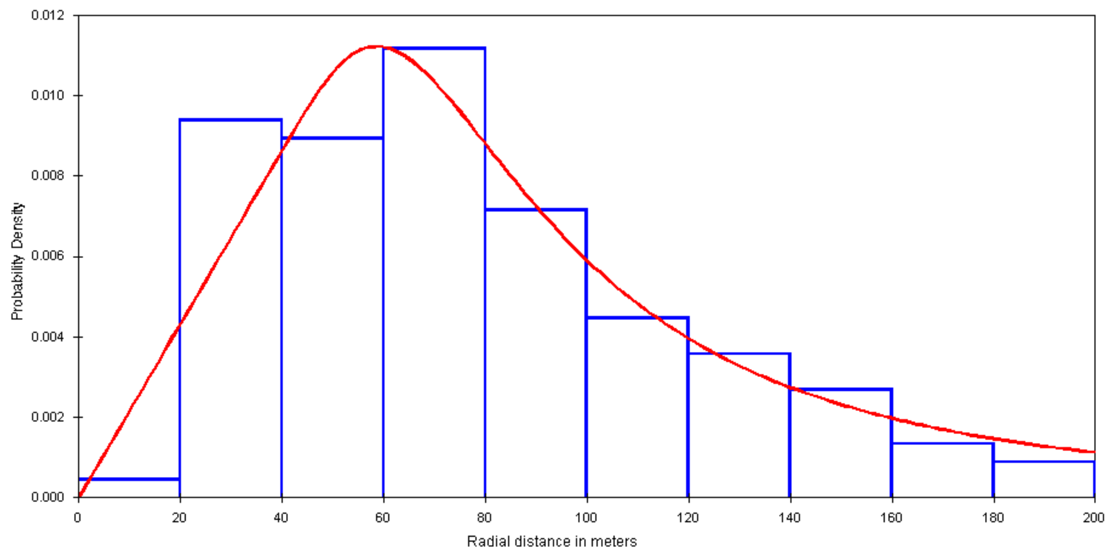


Figure SOP 11.11. Histogram of brown-headed cowbird point transect distance sampling data after truncation of data at 200 m. Five observations were removed; 112 observations remain.

Detection Functions

Once a truncation point is determined, it is now time to move ahead with fitting detection functions. In most cases, the detection functions should be fit to exact distance data. Therefore, I will only describe fits to exact data. If your data are collected in distance groups or you feel they should be grouped, see Buckland et al. (2001) for more details.

Detection functions consist of two parts, the key function and the adjustment terms. Three key functions should be considered for the analysis: 1) the uniform, 2) half-normal, and 3) hazard-rate. These detection functions have been extensively tested, shown to be robust and fit the shape criterion for distance sampling. DISTANCE 5.0 also offers the negative-exponential function. This function does not follow the shape criterion and should not be used in most cases. In addition, adjustment terms should be added if needed. For the uniform detection function, cosine adjustment terms fit naturally. For the half-normal detection function, Hermite polynomials are a good choice. The hazard-rate function performs well with simple polynomial adjustment terms. While these are good choices of adjustment terms, any combination of key functions and adjustment terms can be used. Choices of detection functions can be found in the Model Definition Properties window under the “Detection Function” tab.

Selection of the detection function model is performed using Akaike’s Information Criterion (AIC) in DISTANCE 5.0 (Burnham and Anderson 2002). AIC ranks models based on their relative information losses that result from the use of a model to approximate the true detection process. AIC is a relative measure, therefore it only has meaning when more than a single model have been fit to the data. The AIC selected “best” model is the model with the lowest AIC value. Inference can be made from the best model or by averaging across the model set. Note that AIC can only be used to compare models fit to the same data. Models fit to different truncation points or with different distance groupings are not comparable with AIC.

To ease the model selection process, DISTANCE 5.0 allows several models to be analyzed at one time. Then DISTANCE 5.0 goes ahead and fits each detection function and presents the results for the best fitting model. This makes fitting functions faster and easier, but does not allow the analyst the opportunity to examine all detection functions that were fit.

Once a detection function and adjustment term are selected, the DISTANCE software fits the detection function to the data using maximum likelihood. It sequentially adds adjustment terms until it finds the number of adjustment terms that minimizes AIC (Burnham and Anderson 2002). The user can also select to manually set the number of adjustment terms.

DISTANCE 5.0 offers several diagnostics for model fit. It is important to consider model fit in addition to selecting a model based on AIC because AIC ranks models regardless of fit. Therefore, if all of the models are poor, the top model will merely be the best of the trash. The first tool for assessing fit is the QQ-plot. The QQ-plot presents the empirical distribution function on the *x*-axis versus the fitted distribution on the *y*-axis. The QQ-plot is a useful tool because it does not require any arbitrary grouping of the data before the plot can be generated. Data that fit perfectly will follow a line bisecting the axes. Figure SOP 11.5 presents a QQ-plot where the model fits the data well. Runs on either side of the 45˚ line suggest consistent over- or under-estimation of detection probability. Figure SOP 11.6 shows a QQ-plot where the empirical data are consistently smaller than the fitted model predictions. The QQ-plot is followed up by two formal tests of fit on the ungrouped data. The tests generally do not provide any insight that the graph had not already depicted. The second measure of fit is the chi-squared goodness-of-fit (GOF) test. The GOF test requires grouping data into bins even if exact distance data is used in the analysis. DISTANCE 5.0 will provide three different levels of grouping and their associated

GOF test. Again, the test provides little information beyond what can be seen by plotting a histogram over the fitted detection function. Note that it is important to examine the histogram of the raw distance data unadjusted for area with the probability density function plotted. This prevents the large binomial variance in the first few bins from dominating the appearance of the fit.

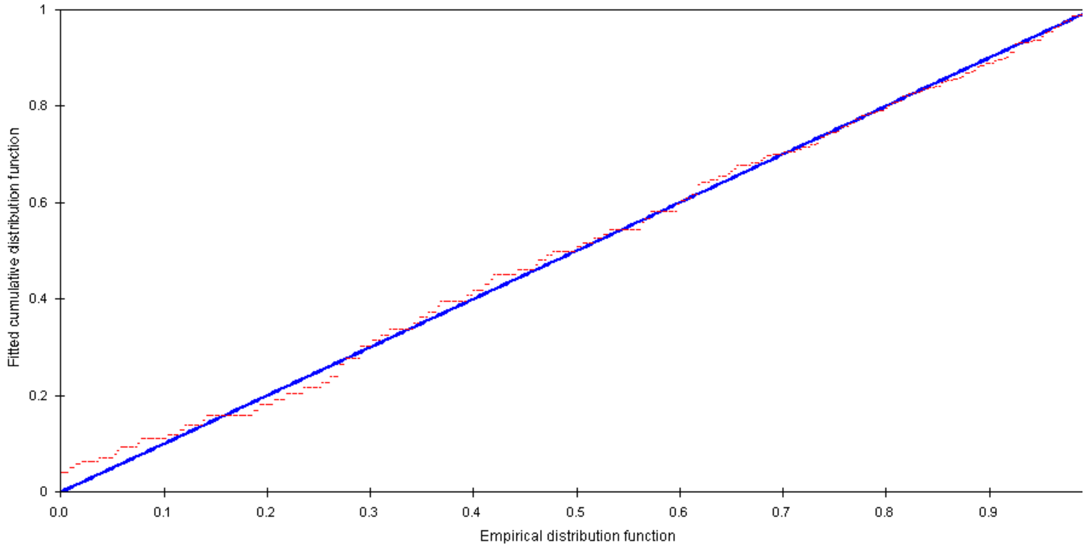


Figure SOP 11.12. A QQ-plot of dickcissel point transect data from the Heartland Network fit with a hazard-rate function. The plot shows a good model fit to the data. Dots represent the data and the diagonal line represents a perfect fit. Note the close association between the dots and the line.

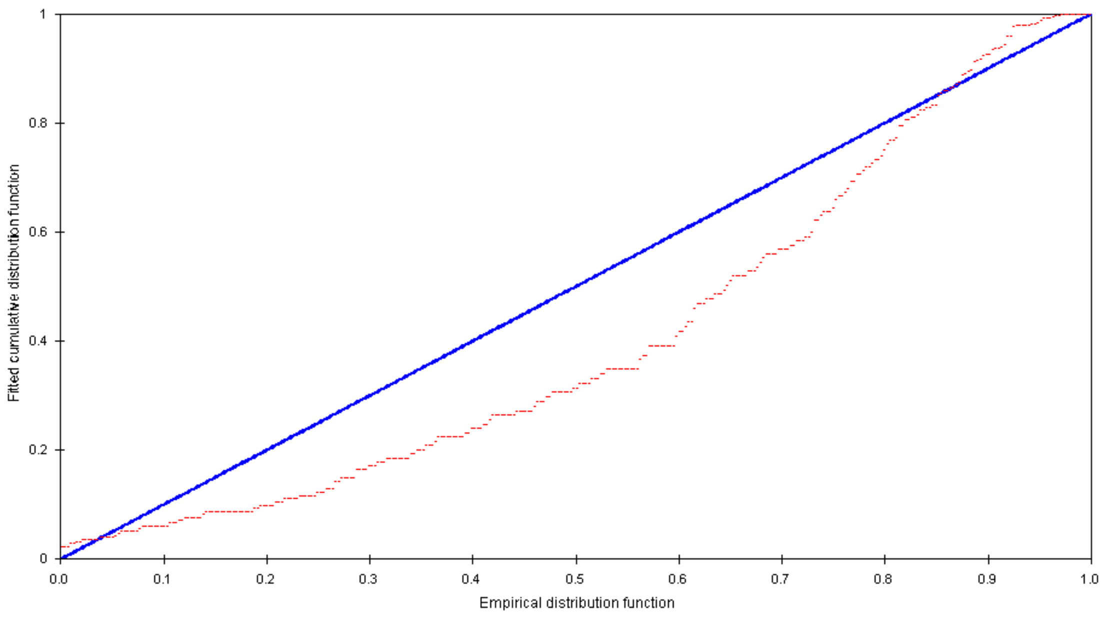


Figure SOP 11.13. A QQ-plot of dickcissel point transect data from the Heartland Network fit with a half-normal key function and Hermite polynomial adjustment terms. The plot shows a poor model fit to the data. Dots represent the data and the diagonal line represents a perfect fit. Note the long run of data that are all well below the diagonal line indicating the model overestimates the observed data.

The grouping process for the GOF tests can be arbitrary and unreliable. For example, consider the dickcissel point transect data again fit with a hazard-rate function with no adjustment terms selected (Figures SOP 11.7, 8, and 9). With the 25.6 m grouping used in Figure SOP 11.7, the detection function fits quite well according to the GOF test (p = 0.948). When the grouping width is decreased to 17.1 m, the fit is shown to be quite poor (p = 0.003, Figure SOP 11.8). Finally, when the group width is further decreased to 12.3 m, the model appears to fit again (p = 0.090, Figure SOP 11.9). The three sets of groupings provide different information about the model fit. At a course scale, the model fits very well, but when looking at a mid-level, the data appear to indicate responsive movement where too many birds are detected in the second interval. Finally, when looking at a fine scale grouping or the exact distance data in the QQ-plot (Figure SOP 11.5), the movement problem does not appear to be too problematic. Thus, GOF tests are helpful for identifying potential problems in the data, but should not be relied on as the sole method of model selection.

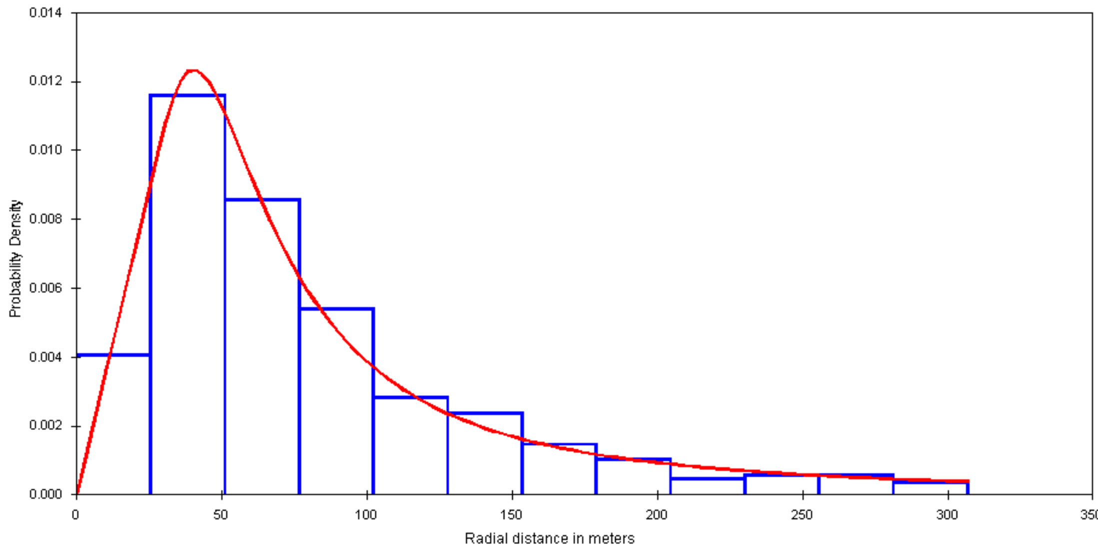


Figure SOP 11.14. Hazard-rate detection function and 25.6 m grouped histogram of dickcissel data from the Heartland Network. Given this grouping width the model appears to fit the data well, p = 0.948.

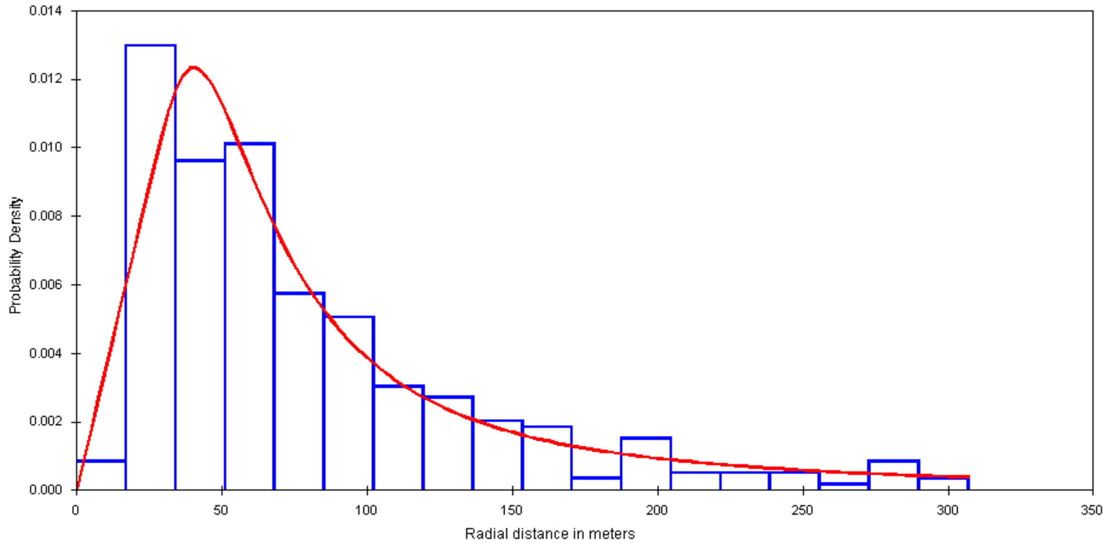


Figure SOP 11.15. Hazard-rate detection function and 17.1 m grouped histogram of dickcissel data from the Heartland Network. Given this grouping width the model appears to fit the data poorly, p = 0.002. Note that too few birds are detected in the first group and too many are detected in the second group. This could be an indication of responsive movement.

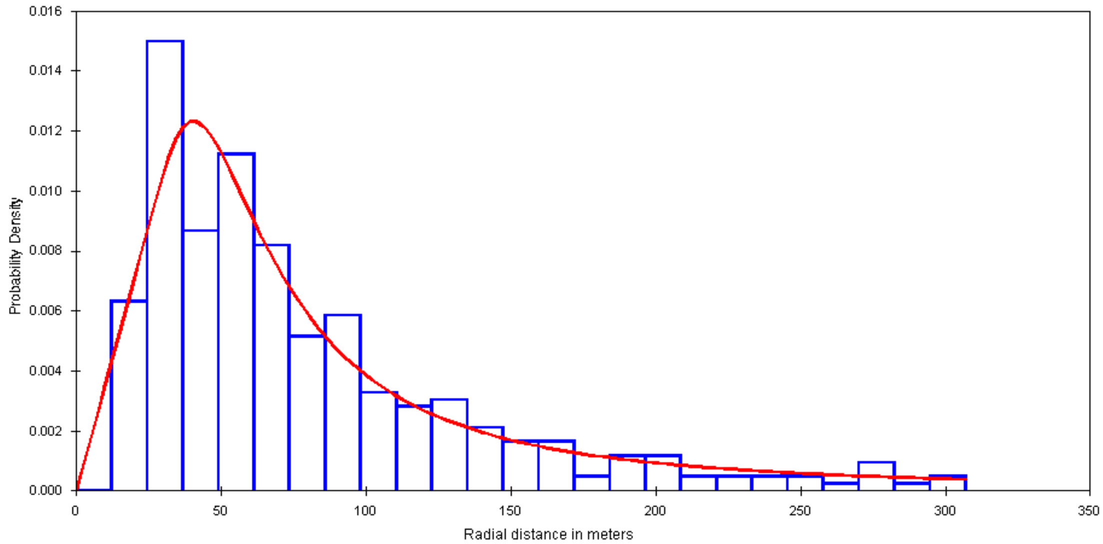


Figure SOP 11.16. Hazard-rate detection function and 12.3 m grouped histogram of dickcissel data from the Heartland Network. Given this grouping width the model appears to fit the data well, p = 0.090. The potential responsive movement remains visible, but not extreme enough to suggest a strong lack of fit.

Encounter Rate

There are several ways to estimate the variance in encounter rate from distance sampling data. The most common method is to use the empirical variance of the counts of birds detected (n_i) at each sampling unit. The variance of $n = \Sigma\, n_i$ within a stratum is

$$\hat{\text{var}}[n] = k\sum_{i=1}^{k}\left(n_i - \frac{n}{k}\right)/(k-1)$$

where k is the number of units sampled. Using the empirical variance of n requires no assumption about the spatial distribution of the animals given points are placed following a random sample. The variance in encounter rate should be estimated separately for each stratum regardless of whether or not the data are pooled to fit the detection. DISTANCE 5.0 uses the empirical variance estimate by stratum as the default method for variance estimation.
In some cases there may be reason to suspect sampling dependence among detections. Birds that occur in loose aggregations are an example of dependant detections. In this situation, a bootstrap estimate of variance can be useful (Efron and Tibshirani 1993). For a bootstrap variance estimate, a sample of size k points or transects of points are selected with replacement from the data collected. The encounter rate is estimated for the sample. The sampling and estimation are repeated a large number of times (≥1,000). The variance of the bootstrap estimates of encounter rate is then an estimate of the variance of encounter rate. DISTANCE 5.0 has the capability to perform a bootstrap analysis.

The final way to estimate the variance in n is to assume the number of encounters follows a Poisson distribution. Generally, this is a poor assumption because animals exist in some form of aggregation. Thus, the Poisson variance is smaller than the actual variance. The Poisson variance option should only be used in the unfortunate case of having only a single transect.

Cluster Size

For species of birds that are found in flocks, distance data are measured to the center of the flock and the size of the flock is recorded. It is often easier to detect large clusters of animals at long distances than small clusters. Therefore, the distribution of clusters detected is not representative of clusters in the population. DISTANCE 5.0 offers size-biased regression methods to account for varying detectability in clusters. For clustered data, the DISTANCE 5.0 default of size-biased regression of the natural logarithm of cluster size on detection probability at distance x is typically a good choice.

Post-stratification

Post-stratification allows density to be estimated for partitions of the data not originally considered in the design or where samples could not be made to be independent. For example, the original design may be a systematic grid of points with a random first start. After collecting the data, we wish to split the density estimate by two habitat types. Simply analyzing the data as if we stratified prior to data collection would lead to underestimated variances on density. Therefore, we should choose to post-stratify.

Post-stratification uses the data partition to estimate detection probability, but encounter rate variance remains estimated from the original design. For the example, there would be a detection probability for each habitat type, but only a single estimate of the variance in encounter rate. Post-stratification is also useful when we would like to have density estimates by year, but the detection function is pooled across years. If we use the same transects each year, there is likely dependence among years in the encounter rate.

Pooling Data

Typically, distance sampling data are collected in several strata and/or across years. While it would be best to estimate detection probability independently for each year and stratum, the number of detections may not make that feasible. Distance sampling data can be pooled across strata or years to better estimate detection probability. Model selection procedures and AIC can help the analyst determine the degree of support for or against pooling data.

Running an Analysis

Once the detection function and the method for estimating the encounter rate variance are selected, we are ready to run the analysis. All analyses in DISTANCE 5.0 are based on a "Data Filter" and "Model Definition" from the "Inputs" tab. DISTANCE 5.0 takes the data from the highlighted data filter and analyzes it with the model in the highlighted model definition. The results are stored in the under the "Analysis" tab. If a problem exists with an analysis it can be deleted or modified and rerun after it is run.

Results

DISTANCE 5.0 provides results of an analysis under the "Results" tab. The results begin with a summary of the input specifications and definitions of parameters. The next page(s) summarizes the model selection procedure. There will be one page for each detection function selected for the analysis. This is followed by detection function parameter estimates, correlations and an estimate of $h(0)$. While these parameters are very important for the inner workings of the distance sampling estimator, they provide the user with little intuitive information. The next two pages are the QQ-plot and fit tests described above. The following nine pages are plots of the detection probability plot, probability density plot and chi-squared GOF test for each of 3 different groupings of data. If the detection function is fit by stratum, there will be a set of these plots and GOF tests for each stratum. After the detection function plots comes a set of summaries of results by stratum. This is followed by summaries of results of encounter rates, detections probabilities and density estimates.

DISTANCE 5.0 also has options to have results sent to a text file. These options can be found under the "Misc." tab in the model definition. The DISTANCE 5.0 help files describe the format of the output text file.

Error Handling and Troubleshooting

DISTANCE 5.0 notifies the user of errors and potential problems through the "Log" tab. If an analysis runs properly, the "Results" tab will appear green. This is a rare event. Typically, the Log tab appears orange indicating the software detected something in the analysis of which the user should be made aware. When the Log tab is orange, the analysis ran, but the information in the Log text should read. Often, the warning is about highly correlated or constrained parameters for a model that was not selected by AIC. Thus, when the Log tab is orange, consider the information that is given knowing most of the occurrences will not affect the analysis results.

When an analysis fails to run the Log tab will appear red. Typically, an analysis fails when the selection methods in DISTANCE 5.0 fail to extract the subset of data you intended to extract. No results are produced when a red error appears in the Log tab.

Assistance in running DISTANCE 5.0 is available. DISTANCE 5.0 has a fairly complete set of help files. In addition, a web-based discussion forum exists that you can post questions to or search past questions and responses, http://www.ruwpa.st-and.ac.uk/distance/.

Long-term Trend Analysis

Every six years, and potentially every year thereafter, the program will conduct analyses to determine long-term trends for individual species and changes in the composition of bird communities over time. Density estimation will follow the methods described above.

Power to detect trends in landbird densities is low; therefore, two analytical procedures will help elucidate relevant population changes, 1) visual inspection for deviations, and 2) statistical trends detection. Comparison of baseline to later monitoring data can reveal trends in data over many years.

Visual Inspection

Determining and detecting biologically meaningful change in a relatively short period, especially for programs with low power, is difficult. However, deviations from a pattern, downward trends, wild fluctuations in abundances (either density or population size estimates) or increases in variances can be seen by inspecting graphed abundances.

Graph species-specific abundance estimates in Excel using the following procedures:

- Input YEAR in Column A.
- Input DENSITY in Column B.
- Input VARIANCE or 95% CONFIDENCE INTERVAL in Column C.
- Use the Graph Wizard to plot the DENSITY and variance measure by YEAR. Make sure to properly label the axis and title each graph according to the species.

Statistical Trends Detection

It is reasonable to assume that a population will fluctuate over time, even in the absence of trends. An equivalence-testing approach, used in conjunction with traditional trends analysis, distinguishes between cases in which there was not a trend from the inability to statistically detect a trend (Manly 2001). More specifically, parameters are considered to be equivalent within some pre-specified bounds and tested for evidence to falsify this. When considered together the trend and equivalency tests provide complementary information of a change large enough to be of concern. In equivalency tests, "to reject that hypothesis is to infer that the variables being sampled are very unlikely to differ by more than a specified amount (the prescribed interval width) and so may be considered as 'equivalent'. That is, differences *are* expected, but if they are small enough the variables can be considered as equivalent. Note that in this case the significance level (α) protects the consumer's risk, so it is essentially precautionary in nature" (McBride 2000). For more information on equivalency and examples for detecting trends, see Camp et al. (in press).

Trends in bird density should be assessed by estimating the posterior probability of a trend within a Bayesian framework. The Bayesian approach provides an intuitive assessment of the trend, and the method is particularly useful for distinguishing between ecologically negligible and meaningful trends (Wade 2000, Camp et al. in press). In contrast, conventional trend analysis is unable to provide conclusive evidence that a trend is near or at zero.

A log-link generalized linear regression model (GLM) calculates the distribution of the posterior probabilities of the slope ($\hat{\beta}$) using WinBUGS (Spiegelhalter *et al*., 2003) in program R. The parameters α and β were given uninformative normal priors, and an uninformative gamma prior was given for τ. The parameter α describes the density at time $t = 0$, β is the rate of change with each unit increase in t, and τ is the precision (1/variance). An uninformative prior distribution was chosen because nothing was known about the population densities except the current data. The first 1,000 iterations were discarded as a burn-in period (chain convergence was achieved within 500 iterations; visual inspection), and the model parameters were estimated from 50,000 iterations for each of the three chains. The three chains were pooled (150,000 samples) to calculate the posterior distribution.

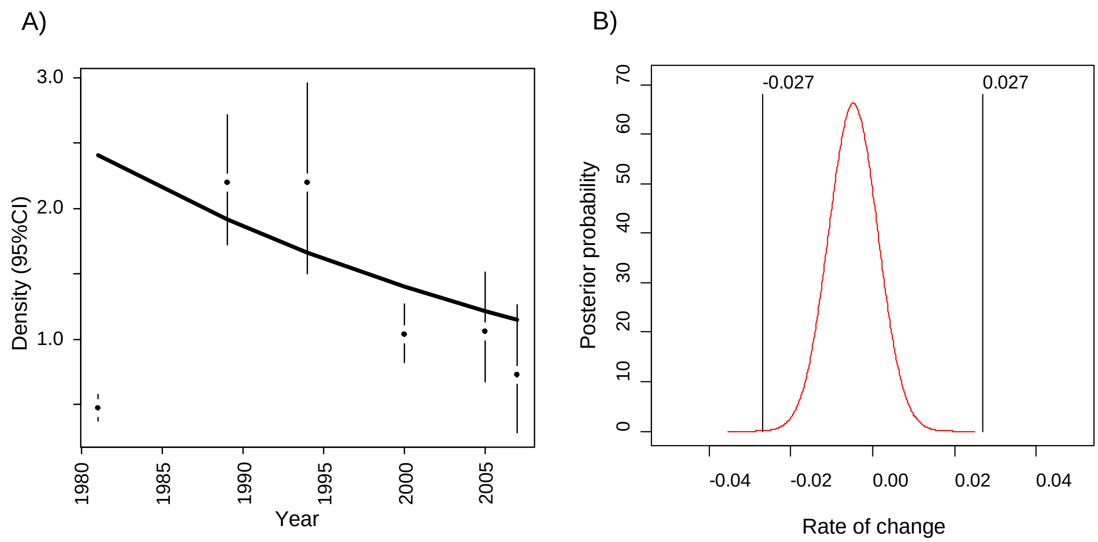
Thresholds for defining the ecological relevance of a trend were based on the North American Breeding Bird Survey annual rate of change (Peterjohn *et al*., 1995). Slopes > 0.0270 or < -0.0270 result in the doubling or halving of a population in 25 years, respectively. Trends were defined as an ecologically meaningful decrease when $\hat{\beta}$ < -0.0270, an ecologically negligible when -0.0270 < $\hat{\beta}$ < 0.0270, and an ecologically meaningful increase when $\hat{\beta}$ > 0.0270 (Wade, 2000).

The plausibility of a trend with four categories of posterior odds (also called Bayes factors): very weak, weak, strong, or very strong evidence for a trend (Wade, 2000). These are based on the posterior probability (*P*) limits of:

- Very weak if $P < 0.1$
- Weak if $0.1 \le P < 0.7$
- Strong if $0.7 \le P < 0.9$
- Very strong if $P \ge 0.9$

In cases where the posterior odds provide weak evidence among all three trend categories, we interpret the trend to be inconclusive (referred to as "no consensus" by Crome *et al*., 1996).

Comparisons of densities using log-link GLM can be made for all species with sufficient sampling duration (e.g., ≥5 surveys; however, analyses with more surveys are more reliable, ≥10 to 15 surveys). Once sufficient sampling occasions have occurred, the R code to conduct trend analyses is provided in Appendix SOP 11.A. An example of the data is provided in Appendix SOP 11.B. Running this code fits a trend through the density estimates (slope and variance), and posterior probabilities of a trend (Figure SOP 11.10).



C)

```
1. Empirical mean and standard deviation for each variable,
   plus standard error of the mean:

       Mean          SD       Naive SE Time-series SE
  -4.733e-03    6.035e-03     4.927e-06      9.429e-06

2. Quantiles for each variable:

     2.5%        5%       95%     97.5%
-0.016552 -0.014659  0.005197  0.007096


>
> problow
[1] 0.000114
> probneg
[1] 0.999886
> probhigh
[1] 0
```

Figure SOP 11.17. R output showing (A) plot of densities and variance, and fitted trend line from the GLM, (B) posterior probability distribution for the trend where the vertical lines represent the threshold limits within which a trend is considered ecologically negligible, and (C) excerpts of the R output detailing the trend slope, variance and posterior probabilities**.**

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Appendix SOP 11A - R Code to Detect Trends Using Log-Link GLM.

Trends are species-specific; therefore, this analysis is conducted for each species individually. The model called in the code is included in the Text Box 1, and must be copied into the analysis path. Annotation in code provides suggested changes for analyses.

```
library(BRugs)


## COPY THE FILE model.txt AND PLACE IN THE ANALYSIS PATH ##


## Acquire and read time series data ##

setwd("C:/Analysis/Kauai/1981-2007 Analysis") # Edit path as needed

#data<-read.table("Bayes-AKEK-SincocksBog-Plot.txt") # File of mean density

data<-read.table("Bayes-AKEK-SincocksBog-DensityByStation.txt") # File of density by station

#names(data)<-c("data","year","density","se","liw","uiw") # Input code with mean density

names(data)<-c("data","year","station","density") # Input code with density by station


## Set up the data for BUGS ##

Y <- data$density

t <- data$year-1980 # Set initial year of time series to 1

N <- nrow(data)


## Create a file with the data ##

data.bugs <- list("Y"=Y,"t"=t, "N"=N)

bugsData(data.bugs,fileName="trend.data.txt")
```

WinBUGS setup

modelCheck(fileName = "model.txt")   # Calls the model file and checks that it is syntatically correct

modelData(file.path("trend.data.txt"))   # read data file

modelCompile(numChains=3)   # compile model with 3 chains

modelGenInits()   # generate the initial values for each chain- this technique just uses a random draw from the prior distribution

Set nodes (parameters to monitor)

samplesSet(c("alpha","beta"))

modelUpdate(1000)

samplesHistory("*") # Run the chains for a short number of iterations to check convergence

modelUpdate(500000) # Run a long set of chains to generate posterior distribution

Set burnin period to 1000, using only the last 500,000 values

samplesSetBeg(1000)

samplesStats("*")

samplesHistory('*')

Plot the posterior distribution for beta

samplesDensity('beta',mfrow=c(1,1),xlim=c(-.05,0.10),ylim=c(0,51)) # Adjust xlim and ylim size as necessary

lines(c(-0.027,-0.027),c(0,50)) # Adjust size as necessary

text(-0.027,51,"-0.027") # Adjust size as necessary

lines(c(0.027,0.027),c(0,50)) # Adjust size as necessary

```
text(0.027,51,"0.027") # Adjust size as necessary


## Calculate the posterior probability, and 90% and 95% credibiltiy interval of beta (i.e.,
the trend) ##

samplesStats("*")

betaMC<-buildMCMC("beta") # "beta" is one of the nodes from the samplesStats, you
can plug in whatever you want here.

summary(betaMC,quantiles=c(0.025, 0.05, 0.95, 0.975))


## Use the sampled distribution to calculate the probability that beta is low, negligible,
or high ##

betaHist<-samplesHistory("beta")

mean(betaHist$beta)

samples<-length(betaHist$beta)

lc<--0.027

uc<-0.027


problow<- sum(as.numeric(as.logical(betaHist$beta<lc)))/samples

probneg<-sum(as.numeric(as.logical(betaHist$beta>lc&betaHist$beta<uc)))/samples

probhigh<-sum(as.numeric(as.logical(betaHist$beta>uc)))/samples


problow

probneg

probhigh
```

Text Box A1. Model statement for the log-link GLM. Copy the contents of the Text Box and place in a file name *model.txt* in the analysis path.

```
model
{
 for(i in 1 : N) {
 Y[i] ~ dgamma(mu[i], sigma)
 }
 sigma ~ dgamma(0.01, 0.01)
 alpha ~ dnorm(0.0,1.0E-3)
 beta ~ dnorm(0.0,1.0E-3)
 for(i in 1 : N) {
 X[i]<-log(t[i])
 }
 for(i in 1 : N) {
 log(mu[i]) <- alpha + beta * X[i]
 }
}
```

Appendix SOP 11B - Example of Input Data to Assess Population Trends.

Data fields are stratum, year, station and density.

Sincock-1981 1981 1135 0

Sincock-1981 1981 1136 0

Sincock-1981 1981 1137 0

Sincock-1981 1981 1138 3.186946

Sincock-1981 1981 1139 1.062315

Sincock-1989 1989 1476 0

Sincock-1989 1989 1477 8.498523

Sincock-1989 1989 1478 0

Sincock-1989 1989 1479 0

Sincock-1989 1989 1480 0

Sincock-1994 1994 1655 0

Sincock-1994 1994 1656 0

Sincock-1994 1994 1657 12.74778

Sincock-1994 1994 1658 0

Sincock-1994 1994 1659 8.498523

Sincock-2000 2000 1774 6.373892

Sincock-2000 2000 1775 0

Sincock-2000 2000 1776 2.124631

Sincock-2000 2000 1777 0

Sincock-2000 2000 1778 0

Sincock-2005 2005 2078 4.249261

Sincock-2005 2005 2079 0

Sincock-2005 2005 2091 0

Sincock-2005 2005 2092 4.249261

Sincock-2005 2005 2093 0

Sincock-2007 2007 2210 0

Sincock-2007 2007 2211 12.74778

Sincock-2007 2007 2229 0

Sincock-2007 2007 2230 8.498523

Sincock-2007 2007 2231 0

Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 12: Reporting

Version 1.00 (September 2010)

Revision History Log

Prev. 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, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This SOP gives instructions for generating annual reports following each season of landbird monitoring. The purpose of the report is to summarize the data for the current year, as well as to provide a comparison with data from previous years. In addition, this document provides details on the process of submitting completed data sets, reports and other project deliverables. Product deliverables should be produced under the direction of the Project/Field Lead.

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm.

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Original Author and Affiliation

Daw, S., S. Ambrose, M. Beer, and M. A. Powell. 2004. American Peregrine Falcon Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network. Unpublished report. Northern Colorado Plateau Network Inventory and Monitoring Program, National Park Service, U.S. Department of the Interior Version 1.00 (December 15, 2004).

Acknowledgements

This SOP was reviewed by PACN staff, James Agee, Paul Berkowitz, Eric Brown, Guy Hughes, and twp anonymous reviewers. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Reporting

This Standard Operating Procedure document 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).

All digital file submissions that are sent by email should be accompanied by a Product Submission Form ([accessed 8/20/2007] http://www1.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Product_Submissions_Form.doc), 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 sensitive information procedures below).

This form can be downloaded from the PACN website or obtained from the Data Manager. Upon notification and/or receipt of the completed products, the Data Manager or GIS Specialist will check them into the PACN project tracking application.

Schedule of Project Deliverables

An annual report summarizing the surveys conducted in PACN park units will be produced by the Project/Field Lead. Most additional project deliverables will be generated and delivered within 30, 45 or 60 days after completion of surveying (Table SOP 12.1).

Table SOP 12.10. Schedule for project deliverables.

Deliverable Product	Primary Responsibility	Target Date	Destination(s)
Field season report	Project/Field Lead	30 days after completion of surveying of the same year	Upload digital file in MS Word format to the PACN Digital Library[1] submissions folder.
Raw GPS data files	Project/Field Lead	30 days after completion of surveying of the same year	Zip and send all digital files to the GIS Specialist.
Processed GPS data files	GIS Specialist	30 days after completion of surveying of the same year	Zip and upload raw and processed files to the PACN Digital Library[1].
Digital photographs	Project/Field Lead	30 days after completion of surveying of the same year	Organize, name and maintain photographic images in the project workspace according to SOP 15: Managing Photographic Images.
Certified working database Certified geospatial data	Project/Field Lead Project/Field Lead with GIS Specialist	delivered 45 days after completion of surveying of the same year, not posted to public sites until June of the following year	Refer to the following section on delivering certified data and related materials.
Data certification report	Project/Field Lead	45 days after completion of surveying of the same year	Refer to the following section on delivering certified data and related materials.
Metadata interview form	Project/Field Lead and NPS Lead	45 days after completion of surveying of the same year	Refer to the following section on delivering certified data and related materials.
Full metadata (parsed XML)	Data Manager and GIS Specialist	March 15 of the following year	Upload the parsed XML record to the Natural Resources Information Portal [2], and store in the PACN Digital Library[1].
Annual I&M report	Project/Field Lead	60 days after completion of surveying of the same year	Refer to the following section on reports and publications.

Table SOP 12.11. Schedule for project deliverables (continued).

Field data forms	Data Manager and Project/Field Lead	60 days after completion of surveying of the same year	Scan original, marked-up field forms as PDF files and upload these to the PACN Digital Library[1] submissions folder. Originals go to the Park Curator and HFBIDP for archival.
6-year analysis report	Data Analyst, USGS Liaison, Project/Field Lead, Program Manager	Every 6 years by September 30	Refer to the following section on reports and publications.
Other publications	Data Analyst, Project/Field Lead, USGS Liaison, NPS Lead, Program Manager	as completed	Refer to the following section on reports and publications.
Other records	Data Manager, NPS Lead, Project/Field Lead	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. Retain or dispose of records following 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]Natural Resources Information Portal is a clearinghouse for natural resource data and metadata (http://nrinfo.nps.gov/Home.mvc). Only non-sensitive information is posted to Natural Resources Information Portal. 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://www.nps.gov/refdesk/DOrders/DOrder19.html.

Procedures

Specific Instructions for Delivering Certified Data and Related Materials

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; and 3) that they 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 SOPs 11, 13, and 14.

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 10 (Data Management).

- *Certified geospatial data*: GIS themes in ESRI coverage or shapefile format.
- *Data certification report*: A brief questionnaire in MS Word that describes the certified data product(s) being submitted. A template form is available on the PACN website at: http://www1.nature.nps.gov/im/units/pacn/data/data_sop.cfm.
- *Metadata interview form*: The metadata interview form is an MS Word questionnaire that greatly facilitates metadata creation. It is available on the PACN website at: http://www1.nature.nps.gov/im/units/pacn/data/data_sop.cfm. For more details, see metadata documentation below.

After the quality review is completed, the Project/Field Lead should package the certification materials for delivery as follows:

- 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., Landbirds_be_2007.mdb).
- Rename the certified back-end file with the project name ("landbirds"), the year or span of years for the data being certified, and the word "certified". For example: landbirds_2007_certified.mdb.
- 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.
- 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.
- 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.
- Upload the compressed file containing all certification materials to the submissions folder of the PACN Digital Library. If the Project/Field Lead does not have access to the PACN Digital Library, then certification materials should be delivered as follows:
- If the compressed file is under 5 mb in size, it may be delivered directly to the NPS Lead and Data Manager by email.
- 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 13. Sensitive Information Procedures for more information).
- Notify the Data Manager and NPS Lead by email that the certification materials have been uploaded or otherwise sent.

Upon receiving the certification materials, the Data Manager will:

- Review them for completeness and work with the Project/Field Lead if there are any questions.
- 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.
- Check in the delivered products using the PACN project tracking application.
- Store the certified products together in the PACN Digital Library.
- Upload the certified data to the master project database.
- Notify the Project/Field Lead that the year's data have been uploaded and processed successfully. The Project/Field Lead may then proceed with data summarization, analysis and reporting.
- Develop, parse and post the XML metadata record to the Natural Resources Information Portal.
- After a holding period of two years, the Data Manager will upload the certified data to the Natural Resources Information Portal. This holding period is to protect professional authorship priority and to provide sufficient time to catch any undetected quality assurance problems. See below for product posting and distribution.

Field Season Reports

A field season report should be written following each season of landbird monitoring. This report is to be submitted to the data manager and outlines the hours worked, field-crew members and their responsibilities on the project, and any unique situations encountered. This information is critical for identifying causes for discrepancies and inconsistencies in the data. The Project/Field Lead is responsible for filing the field report.

Annual Reports

An annual report should be written following each season of landbird monitoring. The purpose of the report is to summarize the data for the current year, as well as to provide a limited comparison with data from previous years. Annual reports should be produced under the direction of the Project/Field Lead.

- Reports should be written following standard NRTR series requirements.
- Reports should include brief summary of the sampling procedures and any data collection or sampling problems encountered in the field that may affect the data or data interpretation.
- Report the following standard survey parameters for the current year, at a minimum:
    - List of observers who conducted the surveys
    - Detail of survey effort (number of fixed and random stations sampled for birds and habitat by park, management unit or biome)
    - List of species detected by park, management unit and biome

- Number of stations occupied by each species (frequency of bird occupancy; number of stations with ≥1 detection/number of stations sampled)
- Naive species abundance estimates (birds per station; number of birds detected / number of stations sampled)
- Maps of stations sampled and bird occurrence by species

- The current-year parameter values should be added to a table that lists similar measures for all monitored years.
- Reports should be accompanied by copies of maps or sketches available. Also, a CD should be included that contains all of the survey data in electronic form, including the database, photographs, and UTM locations of sampling stations.
- Reports and associated data should be completed within two months of completing the field season, and submitted following the schedule outlined in Table SOP 12.1.

Trend Assessments

Trend assessments of population densities should be conducted after five years of monitoring during the sixth year. Trends analyses may be conducted at the individual park unit for each species (see SOP 11). The Data Analyst and USGS Liaison will work closely with the Project/Field Lead and Program Manager to conduct the park-based analysis of trend assessments and report the results in a six-year analysis 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 six 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 the PACN Landbirds Vital Sign Monitoring Protocol narrative.

Specific Instructions for Reports and Publications

Field, annual and analysis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. All reports will use the Natural Resource Report template. Instructions for acquiring a series number and other information about NPS publication standards can be found at: http://www.nature.nps.gov/publications/NRPM/index.cfm. In general, the procedures for reports and publications are as follows:

- 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.
- All reports will be submitted to the Regional I&M Peer Review Manager for final pre-publication review and approval before acquiring a publication series number from the Natural Resource Publications Management Center. The Program Manager will also review all reports for completeness and compliance with I&M standards and expectations.

- Upon completing the peer review, acquire a publication series number from the Natural Resource Publications Management Center.
- Upload the file in PDF and MS Word formats to the PACN Digital Library submissions folder.
- Send a printout to each Park Curator.
- The Data Manager or a designee will create a bibliographic record and upload the PDF document to Natural Resources Information Portal 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., "focal_plants"), network code ("PACN") or park code, and year in the file name.

Examples:

- PACN_focal_plants_2007_Annual_report.pdf
- PACN_focal_plants_2007_Field_season_report.doc

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 ([accessed 8/20/07] http://www1.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Metadata_Guidelines.pdf). The general flow is as follows:

- After the annual data quality review has been performed and the data are ready for certification, the Project/Field Lead (or a designee) updates the PACN Metadata Interview Form ([accessed 8/20/07] http://www1.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Metadata_Interview_Form.doc).
- 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.
- 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.
- 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).
- The Data Manager can help answer questions about the metadata interview form.
- Deliver the completed interview form to the Data Manager.
- 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 ([accessed 8/20/07] http://www1.nature.nps.gov/im/units/pacn/data/data_sop/PACN_Metadata_Guidelines.pdf).

- The Data Manager will post the record and the certified data to the Natural Resources Information Portal, and maintain a local copy of the XML file for subsequent updates. The Natural Resources Information Portal has help files to guide the upload process.
- The Project/Field Lead should update the metadata interview content as changes to the protocol are made, and each year as additional data are accumulated.

Identifying Sensitive Information

Part of metadata development includes determining whether or not 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 NPS Lead and Project/Field Lead should work together to identify any sensitive information in the data after first consulting SOP 13 (Sensitive Information Procedures). Their findings may be documented and communicated to the Data Manager through the metadata interview form.

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:

- Full metadata records will be posted to the Natural Resources Information Portal, which is the NPS clearinghouse for natural resource data and metadata that is available to the public at: http://science.nature.nps.gov/nrdata. Refer to the website for upload instructions.
- A record for reports and other publications will be created in, which is the NPS bibliographic database (http://nrinfo/Home.muc). The digital report file in PDF format will then be uploaded and linked to the Natural Resources Information Portal record. Refer to the Natural Resources Information Portal website for record creation and upload instructions.
- Species observations will be extracted from the database and entered into Natural Resources Information Portal, which is the NPS database and application for maintaining park-specific species lists and observation data (http://science.nature.nps.gov/im/apps/npspp/index.htm).
- These three applications serve as the primary mechanisms for sharing reports, data, and other project deliverables with other agencies, organizations, and the general public.

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 Natural Resources Information Portal) approximately 24 months after they are collected (e.g., data collected in June 2006 becomes generally available through the Natural Resources Information Portal in June 2008). In certain circumstances, and at the discretion of the NPS Lead and Park Biologists, 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 Natural Resources Information Portal 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 13 (Sensitive Information Procedures).
- For quality assurance, only the certified, finalized versions of data sets should be shared with others.

The NPS Lead will handle all data requests as follows:

- 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.
- Notify the Data Manager of the request if s/he is needed to facilitate fulfilling the request in some manner.
- Respond to the request in an official email or memo.
- In the response, refer the requestor to the Natural Resources Information Portal (http://nrinfo.nps.gov/Home.mvc), so they may download the necessary data and/or metadata. If the request can not 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.

- If the request is for a document, it is recommended that documents be converted to PDF format prior to distributing it.
- 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 13 (Sensitive Information Procedures).

After responding, provide the following information to the Data Manager, who will maintain a log of all requests in the PACN Project Tracking database:

- Name and affiliation of requestor
- Request date
- Nature of request
- Responder
- Response date
- Nature of response
- List of specific data sets and products sent (if any)

All official FOIA requests will be handled according to NPS policy. The NPS Lead 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 Project/Field Lead and/or NPS 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 confidentiality agreement is established between NPS and the other organization. Refer to SOP 13: Sensitive Information Procedures for more information.

Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 13: Sensitive Information Procedures

Version 1.00 (September 2010)

Revision History Log

Prev. 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, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number.

Abstract

This SOP gives instructions for disseminating sensitive information. 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, tribal 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 Policies (National Park Service 2006; http://www.nps.gov/policy/mp/Index2006.htm), and in NPS Director's Order 66 (http://home.nps.gov/applications/npspolicy/DOrders.cfm).

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 NPS 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 shall apply if a project is likely to collect and store sensitive information:
    - Random coordinate offsets of up to 2 km for data collection locations
    - Removal of data fields from the released copy that are likely to contain sensitive information

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm.

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Original Author and Affiliation

Kozar, K. 2007. National Park Service, Inventory and Monitoring Program. Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718.

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This SOP was reviewed by PACN staff, James Agee, Paul Berkowitz, Eric Brown, Guy Hughes, and two anonymous reviewers. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Procedures

This Standard Operating Procedure document describes how to disseminating 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 into a publication, then at a later point in time a Hawaiian petrel burrow is observed at that monitoring station, that burrow 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 the case of a small park).

Categorizing Specific Products for Public or Internal Use

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). 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(Angle – 90)), -2)
- Public_UTMN = Round(UTMN_final + (Distance * sin(Angle + 90)), -2)

Sharing Sensitive Information

Note: Refer to SOP 14 (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 NPS 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. Only products that are intended for public/general-use may be posted to public websites and clearinghouses – 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 14. 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.

- 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.

Note: Certain states have sunshine laws that do not have exemptions for sensitive information. NPS should not create confidentiality agreements or share sensitive information with these states without first seeking the advice of an NPS solicitor.

Freedom of Information (FOIA) Requests

All official FOIA requests will be handled according to NPS policy. The NPS Lead 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. Available at: http://www.nps.gov/policy/mp/policies.htm [accessed 4 October 2010].

Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 14: Product Posting and Distribution

Version 1.00 (September 2010)

Revision History Log

Prev. 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, 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 document provides details on the process of posting and otherwise distributing finalized data, reports and other project deliverables. For a complete list of project deliverables, refer to SOP 11 (Reporting).

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm.

Recommended Citation:

Camp, R. J. 2010. Standard Operating Procedure (SOP) 14, Product posting and distribution, Version 1.00. *In* Camp, R. J., T. K. Pratt, C. Bailey, and D. Hu. 2010. Landbirds Vital Sign Monitoring Protocol – Pacific Island Network. Natural Resources Report NPS/PWR/PACN/NRR—2010/XXX. National Park Service, Fort Collins, Colorado.

Original Author and Affiliation

Kozar, K. 2010. National Park Service, Inventory and Monitoring Program. Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718.

Acknowledgements

This SOP was generated and reviewed by PACN staff. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Product Posting and Distribution

Once digital products have been delivered and processed, the Data Manager will post the products to the Natural Resource Information Portal (NR Info)[1]. NR Info is the NPS clearinghouse for natural resource products that are available to the public. The following sets of products are available in NR Info:

1. Full metadata records and datasets will be posted to the References service within NR Info and made available to the public.
2. A record for reports and other publications will be created in the Reference service. The digital report file in PDF format will then be uploaded and linked to the reference record.
3. Species observations will be extracted from the database and entered into the Biology service which is the NPS database and application for maintaining park-specific species lists and observation data.

[1] http://nrinfo.nps.gov/Home.mvc

The Natural Resource Information Portal serves as the primary mechanism for sharing reports, data, and other project deliverables with other agencies, organizations, and the general public.

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., NR Info) approximately 24 months after they are collected (e.g., data collected in June 2006 becomes generally available through the NR Info in June 2008). In certain circumstances, and at the discretion of the Project Lead and Park Biologists, 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 NR Info Portal 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 13 (Sensitive Information Procedures).
- For quality assurance, only the certified, finalized versions of data sets should be shared with others.

The Project Lead 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.
4. In the response, refer the requestor to the NR Info Portal, 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 13 (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 Project Lead 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 Project 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 #13: Sensitive Information Procedures for more information.

Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 15: Managing Photographic Images

Version 1.00 (September 2010)

Revision History Log

Prev. 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, 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 document describes how to process photographic images collected by project staff or volunteers during the course of conducting project-related activities.

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm.

Recommended Citation

Camp, R. J. 2010. Standard Operating Procedure (SOP) 15, Managing Photographic Images, Version 1.00. *In* Camp, R. J., T. K. Pratt, C. Bailey, and D. Hu. 2010. Landbirds Vital Sign Monitoring Protocol – Pacific Island Network. Natural Resources Report NPS/PWR/PACN/NRR—2010/XXX. National Park Service, Fort Collins, Colorado.

Original Author and Affiliation

Kozar, K. 2007. National Park Service, Inventory and Monitoring Program. Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718.

Acknowledgements

This SOP was generated and reviewed by PACN staff. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Procedures

This Standard Operating Procedure document 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.
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
- to document a 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:

- File Structure Setup – Set up the file organization for images prior to acquisition
- Image Acquisition
- 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
- Move into appropriate folders for storage
- Establish database links
- 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: 2007, 2008, etc.
- Processing — Processing workspace
- [Park code] — Arrange files by park: HAVO, NPSA, etc.
- Data — Data images

- [Site_code] or [Date]
    - [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] or [Date]
    - [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] or [Date]
    - [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.

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

Capture images at an appropriate resolution that balances space limitations with the intended use of the images. Although photographs taken to facilitate future navigation to the site do not need to be stored at the same resolution as those that may be used to indicate gross environmental change at the site, it may be more efficient to capture all images at the same resolution initially. A recommended minimum raw resolution is 1,600 x 1,200 pixels (approximately 2 megapixels).

Download and Processing Procedures

Download the raw, unedited images from the camera into the appropriate "_Processing" folder.

- 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.
- Process the images in the _Processing folder. At a minimum, the following processing steps should be performed on all image files:

- 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 alteration or deletion.
  - 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.
- 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 park Digital Image Library. To minimize the chance for accidental deletion or overwriting of needed files, no stray files should remain in the processing folder between downloads.

Depending on the size of the files and storage limitations, contents of the Originals folder may be deleted if all desired files are accounted for after processing.

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 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 locatio (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:

- 20070621_Waihanau_habitat_001.jpg: The habitat at Waihanau Valley taken on June 21, 2007
- 20070518_training_004.jpg 4th photo taken during training on May 18, 2007

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 performed as a batch process which inserts the date and transect number at the beginning of the photo name, and a second step in which 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.

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 11 (Reporting).

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. Upon delivery, the delivered folders should be made read-only to prevent unintended changes.

Landbirds Vital Sign Monitoring Protocol – Pacific Island Network Standard Operating Procedure (SOP)

SOP 16: Revising the Protocol

Version 1.00 (September 2010)

Revision History Log

Prev. 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, 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 explains how to make and document changes to the Landbirds Vital Sign Monitoring Protocol Narrative and associated Standard Operating Procedures (SOPs) for the Pacific Island Network. Anyone editing the Protocol Narrative or any of the SOPs need to follow this outlined procedure in order to eliminate confusion in how data is collected, managed, analyzed, or reported. All observers should be familiar with this SOP in order to identify and use the most current methodologies.

Organization Contact Information

National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718, phone: 808-985-6180, fax: 808-985-6111, http://www.nature.nps.gov/im/units/pacn/index.htm

Recommended Citation

Camp, R. J. 2010. Standard Operating Procedure (SOP) #16, Revising the protocol, Version 1.00. *In* Camp, R.J., T.K. Pratt, C. Bailey, and D. Hu. 2010. Landbirds Vital Sign Monitoring Protocol – Pacific Island Network. Natural Resources Report NPS//PWR/PACN/NRR—2010/XXX. National Park Service Oakland, CA.

Original Author and Affiliation

Frederick L. Klasner; National Park Service, Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawaii National Park, HI 96718.

Acknowledgements

This SOP was reviewed by PACN staff, James Agee, Paul Berkowitz, Eric Brown, Guy Hughes, and two anonymous reviewers. Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Equipment Specification Disclaimer

Use of specific brand-name equipment identified in this protocol and associated SOPs, while shown to be effective, is not intended as an endorsement of any particular manufacturer or model.

Procedures

The Landbirds Vital Sign Monitoring Protocol Narrative and associated SOPs for the Pacific Island Network represents our 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 are 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.

All edits require review for clarity and technical soundness. Small changes or additions to existing methods will be reviewed in-house by Pacific Island Network staff (e.g. version changes by hundredths). However, if a complete or major change in methods is sought, 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 will 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 landbird monitoring in the Pacific Islands will be utilized as reviewers.

1. 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 2nd page of the protocol narrative document. Log changes in the protocol narrative or SOP being edited only. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02, etc.) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0 , etc.). 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.
2. Inform the Data Manager 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.

3. Any changes to associated database design and organization are documented in the Metadata of the project database(s).
4. The appropriate PACN staff is notified of the changes and appropriate level review process initiated as determined in collaboration between the network staff and protocol principal investigator.

Once review comments are received and incorporated, post revised versions on the internet and forward copies to all individuals so they can replace previous version of the effected Protocol Narrative or SOP. 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 XXXXXX, March 2011

National Park Service
U.S. Department of the Interior

Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov

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