Pacific Island Network
Vital Signs Monitoring Plan

Appendix O: Workshop & Scoping Document: Part V-Statistics Workshops

Compiled by Page Else (HPI-CESU)

Pacific Island Network (PACN)

Territory of Guam
War in the Pacific National Historical Park (WAPA)

Commonwealth of the Northern Mariana Islands
American Memorial Park, Saipan (AMME)

Territory of American Samoa
National Park of American Samoa (NPSA)

State of Hawaii
USS Arizona Memorial, Oahu (USAR)
Kalaupapa National Historical Park, Molokai (KALA)
Haleakala National Park, Maui (HALE)
Ala Kahakai National Historic Trail, Hawaii (ALKA)
Puukohola Heiau National Historic Site, Hawaii (PUHE)
Kaloko-Honokohau National Historical Park, Hawaii (KAHO)
Puuhonua o Honaunau National Historical Park, Hawaii (PUHO)
Hawaii Volcanoes National Park, Hawaii (HAVO)

http://science.nature.nps.gov/im/units/pacn/monitoring/plan/

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REPORT ON VITAL SIGNS SAMPLING DESIGN PREPARATORY MEETING WITH STATISTICIANS, HILO, HAWAII, AUGUST 2005.

Note: Individual protocol session reports begin on page 5 of this document. Each session is bookmarked (Edit menu-go to-bookmark "individual protocol abbreviation)

OVERVIEW

Between Monday, August 22, 2005, and Thursday August 25, John Skalski and David Schneider, biometricians contracted by the PACN Inventory and Monitoring Program, met with Principal Investigators (PIs), NPS Leads, and Project Managers who are developing Vital Sign protocols. Dr. John Skalski is a professor at the University of Washington and works with diverse natural resource issues including fisheries and wildlife projects. Dr. David Schneider is a professor and Associate Dean at Memorial University, St. Johns, New Brunswick and has consulting experience with offshore oil work and a variety of other monitoring projects.

Because the PIs are in the preliminary stages of protocol design, these meetings were exploratory and intended to guide the PIs primarily on details of sampling design, with some input on statistical analysis. In addition to answering sampling questions for PIs, information from this meeting will help the I&M program compile data needed for Chapter 4 of the Monitoring Plan, which focuses on sampling design. A final draft is due in mid-December.

There is a wide range of experience in sampling design and statistical implementation among the Principal Investigators for the PACN Monitoring protocols. While PACN had already planned to hire a term biometrician, the statisticians confirmed that further statistical assistance will be necessary. Some PIs planned to discuss allocation of effort and have available data to analyze for temporal and/or spatial variability to assist with sample size calculations (*Eric Brown, Rick Camp, Ann Brasher; Karl Magnacca; Jeff Perreault (AMME groundwater project); Frank Howarth (cave insect counts 1970's to date).* Several other groups had difficulty defining their response variables due to the new research topics, and were hampered by lack of existing data on their topic.

PIs must be able to explain reasons for their choices of sampling design. Temporal precision, observer variability, and spatial variability all affect sampling design. Sample size affects variability; therefore, larger amounts of data provide more degrees of statistical freedom in estimates. In most field conditions, researchers have less control of temporal variability than other sources of variability.

Much of the work accomplished at the Sampling meeting is captured in sampling design of Vital Signs. Discussions with the biometricians helped participants to clarify sampling methods and design, and identify progressive steps toward developing monitoring protocols.

Topics discussed with each PI included: what are the response variables, sampling frame, visitation schedule, and levels of sampling (hierarchy of units). The topic of nested designs occurred many times with the need to define units, the sampling frame, and units within the frame, concepts on which many people needed a refresher. Stratification was discussed frequently, along with allocation by variance, by size of unit, and by risk (for invasive species).

When possible, the PIs were encouraged to measure absolute values, such as performing a complete census or canvassing belts, variable circle plots, or line transects. Another important point of discussion was that the choice between random versus systematic methods was often affected by the improved logistics and ease of access for implementing systematic methods.

The statisticians found that several Vital Sign projects could not be addressed by conventional sampling designs and could only be approximated by indices. While the statisticians were quite familiar with the problems and statistical limitations of indices (indexes can be confounded by other factors that are not being measured), sometimes there seemed to be no other method. It was recommended that studies be designed to assess the problem of index stability and ways to improve the indices [bats, fisheries harvest (catch per unit effort; CPUE); terrestrial invertebrates (CPUE), and seabirds].

The possibility of using panel designs arose with many Vital Sign projects. Initially the PIs thought this was mainly for logistic convenience but John Skalski's discussion demonstrated that panel designs can provide increased precision and reconcile opposing goals of determining status and trends. Re-visitation of fixed sites provides data to assess trends over time, while inclusion of more sites in the rotating panel provides better assessment of status. Panel designs correct first year estimates with additional knowledge gained from the second year, reducing variance. Correlation between years improves precision. The ideal rotational fraction between years can be determined if the correlation is known. The first year's data provides variation and measurement error estimates, which are critical for good sample design. Rotating sites also respond better to reflect changing conditions, since fixed sites over time may become less optimal sampling sites for the variable of interest. Key components of sample designs including panel designs are: measurement error, spatial variability, temporal correlation and variability, and cost (time and money). Much discussion occurred regarding design issues, and it was suggested that researchers lacking data on these parameters should include an implementation study, review literature sources on coefficients of variation, review related research, or give your best guesstimate! The biometricians recommended bracketing the sample size with calculations for the worst and best case scenarios. Limitations of panel designs include (1) lack of common software packages which necessitate assistance from statisticians, (2) don't work well with less than 10 sites, and (3) difficulty with stratified design because a panel is needed for each strata, and logistical issues may occur with accessing randomly generated point locations.

A concluding concern voiced by the biometricians was that many of our Vital Signs will have considerable variability or "noise" in their measurements. Therefore, assistance from statisticians will be necessary to help with sampling, pilot design studies, and analysis for improved redesigns. When monitoring for rare species, it is hard to detect change; maybe the best that can be done is to detect change in overall composition or a systematic shift in species composition. At this point in time, it is not possible to identify which monitoring projects will have problems with identifying change statistically; therefore, further evaluation and discussions must occur. Most projects across the network will not be able to determine population status with precision, and will only identify trends along the order of decades. Those projects listed in the variance table with high variance levels will likely have difficulties in this manner.

Another issue identified by the biometricians regarding PACN sampling is the issue of differing philosophies and approaches to statistical analysis of projects. Although some of the sampling methods discussed were based on infinite sampling, most projects are based on finite sampling, as Drs. Skalski and Schneider believe this approach will work best for most of our projects. However, most statisticians work from infinite sampling theory. This could cause some confusion as we consult with different statisticians; thus we need to choose statisticians who know and can work with both approaches.

Projects identified as having list based sampling frames will be best monitored using finite sampling methods. These include freshwater communities (for both intermittent and perennial stream reaches, anchialine pools); water quality, climate (list of weather stations), caves, frugivorous bats (i.e., list of known colonies), and Hawaiian Petrel (lists of suitable habitat patches).

Another topic at the end of the week was how to best further statistical assistance. The idea of holding a statistics class for PIs received mixed reviews. It was pointed out that we need handcrafted software for some statistical approaches, while there a substantial amount of existing software to perform infinite statistics. It was recommended that I&M hire a quantitative ecologist that has a diverse set of statistical skills that can fill many niches. PACN also needs to anticipate the statistical needs for FY 07 PIs, when there may not be I&M money available to contract statisticians for a workshop.

Another discussion point was the degree of overall integration of our projects.

Another idea was to schedule an intensive work session for protocol write-up, where participants gather for a week, divide the sections, and write an entire protocol.

Another concern is surfacing over the disparate amount of monitoring effort at large versus small parks. Monitoring at smaller parks can not be contingent upon getting more funding, nor should it be delayed for implementation. However, some resources occur only at some parks, with larger parks more likely to sustain larger populations of rare species (with many possibilities for exceptions).

Vital Signs to be initiated in FY06 and FY07:
FY06: benthic marine (Eric Brown, PI), groundwater (Steve Anthony, PI), landuse change (Melia Lane-Kamahele, PI), 2 within park plant projects (Jim Jacobi, PI) , landbirds (Rick Camp, PI), early detection invasives (Lloyd Loope, PI), fresh water perennial streams (Ann Brasher, PI) (includes damselflies for co-location)
(Partially FY06/FY07*:* marine fish (Jim Beets, PI), landuse (Melia Lane-Kamahele, PI), seabirds (David Duffy/Darcy Hu PI), water quality (Aquatic Ecologist TBD), terrestrial invertebrates (David Foote, PI), and terrestrial and frugivorous bats (Leslie HaySmith, PI).
FY07: erosion and deposition (Dwayne Minton, PI), water quality (Aquatic Ecologist TBD), fish harvest (Peter Craig, PI), viewscapes (Laila Tamimi, PI), fresh water intermittent streams and pools (David Foote, PI), cave community (Frank Howarth, PI), terrestrial invertebrates (David Foote, PI).

Next steps for PIs (especially those in FY06 group:

(1) rewrite the sampling design section of study plans, (2) make a list of subsequent steps to follow, (3) follow recommendations from biometricians, and (4) if developing a protocol in FY06, make adjustments to sampling design and plan to meet J. Skalski for a second meeting during the week of October 31-November 4.

MEETING DISCUSSION BY PROTOCOL

Note: Monitoring questions listed in the current PDS (versions were sent 8/5/05) are listed at the beginning of each section as the starting point for the discussion. The discussion notes are divided roughly into three main topics: (a) synopsis & suggestions made by the statisticians, (b) response variable discussions, and (c) sampling design.

BENTHIC MARINE

PIs Eric Brown and Larry Basch

1) What are the changes over time in the composition (e.g., species and/or assemblage) and physical structure (rugosity) of the coral reef benthos?
2) What are the changes over time in reproduction, recruitment, growth, survival and health of target coral assemblage, species, and/or individuals?

This protocol is focused on parks which have marine boundaries and staff to support this monitoring.

Suggestions

- Reconnaissance is needed to properly define the sampling frame (the NOAA benthic habitat map based on remote sensing analysis is not sufficient for all locations).
- When there are multiple responses, they cannot be sampled with the same level of precision, so have to focus on measuring one important response well. Density of coral has lots variability.
- Put more effort into the preliminary survey to have adequate data for sample size calculations.
- Recruitment is a research question, at this point.
- The statisticians advise choosing response variables with less noise (less spatial variability, measurement error), so the statistics are driving the variable choice.

Discussion of response variables:

- Detection level: 10% change in cover
- Percent cover is the focus- it is a world-wide standard, and the public can understand it.
- Possible response variables rank (1) benthic cover, (2) recruitment, (3) growth, (4) disease, and (5) rugosity.
- Growth is measured best by choosing colonies that have discrete boundaries where change in basal diameter can be measured.
- Rugosity is measured by comparing the length of (1) a tight chain between distances with (2) a chain draped over obstacles; thus it is an index of bottom ruggedness or relief.
- Recruitment determines if the reef is alive; rather then in terms of absolute numbers measurements include presence, patterns (frequency of spawning), and abundance (especially reef builders).

Sampling design

- Transects are not perpendicular to shorelines due to potentially unsafe conditions (Guam, some Hawaiian sites) and because the diversity of habitats encountered creates difficulties in sampling and analysis. The near shore habitat is important and parks may have to design their own monitoring programs for those areas (especially NPSA and its lagoons, and areas where algae has increasing dominance).
- The group proposed a split panel design for revisiting transects, which the statisticians thought was a good approach. The design estimates temporal correlation after a couple years of sampling- then the rotational design can be adjusted. Ten fixed sites will be visited every year, with an additional 20 in rotational pattern, 2 year interval, with 50% replacement within rotational group. There would be one visit per year, in the summer for logistical ease. The transect number depends on the contour length but staff workloads limit to 30 transects per park

Sampling Frame: 10-20 m strata in marine realm with hard bottom

Analysis: By measure: route regression, repeated measures ANOVA, ANCOVA (initial area as covariate), chi-square.

GIS needs: shoreline dataset, 10-20 m isobath with hard bottom attribute, generate random points within hard bottom. NOAA benthic habitat map has cloud cover gaps and needs additional groundtruthing

FISH COMMUNITIES

PIs are Jim Beets and Alan Friedlander. Peter Craig and Eric Brown are NPS leads

1. For coral reef fishes, what are long-term trends in the abundance and biomass of key reef slope species of ecological, cultural, or harvest significance at selected sites along an isobath of 10-20 m depth?

Suggestions:

- Fish species to be studied should have park specific criteria based on ecological significance (poorly defined), commercial harvest importance, whether the species can be easily identified, and abundance. Park managers need to be part of the monitoring process rather than an outside expert team.
- This discussion is not a statistical issue as much as a management issue. The protocol objective is to estimate the abundance of large commercial fish and small ecologically important fish. Different methods (both line and plot methods) can be used in different parks if necessary.
- Construct a table of methods and variability, which will help choose the best method.
- Choose one method for most important species. This can vary across parks because they have different species.
- Although the metrics will be same, networks may not like a protocol with different methods as this potentially causes analysis problems.

Response Variables:

- The most informative response variable is change in the shape of the length frequency distribution.
- Total biomass is a derived response variable; it can be computed from abundance and individual biomass, (or length) which are the response variables.
- Biomass is a good variable to compare across locations, but resource managers want to know if species are being lost. Can show them related data but not address that question in design.

Sampling Design

Fish populations may already be declining in size classes and abundance, because ecosystems are heavily altered from natural. This project will use the same sampling sites as benthic marine, but more transects and sampling units may be necessary. Post processing time for fish transects is less than the transect measuring time, which is opposite of benthic transects (may require 30 hours per hour of field work). Not all hard bottoms are equal in habitat value, and can be stratified by type; this increases sample size and precision but is more complicated with panel designs.

Counting fish: Problematic because some fish avoid people, while others are attracted.

Circular plots characterize some elements of a community better than transects and vice versa. They should probably use both, or more methods (like random swim or large width transect).

There will be problems trying to standardize this across network.

For distance sampling methods: need 30 observations per species per transect, which can be hard to get. They can truncate distances within a defined observation space but this makes analysis difficult (Buckland is now suggesting 50-60 observations per transect.)

Sampling Frame: 10-20 m strata in marine realm with hard bottom

Analysis: route regression

GIS needs: shoreline dataset, 10-20 m isobath with hard bottom attribute, generate random points within hard bottom. NOAA benthic habitat map has cloud cover gaps and needs additional groundtruthing

FISHERIES HARVEST

1. What are the annual trends in the species composition, quantity, catch-per-unit-effort, and size of coral reef fishes and invertebrates (e.g., shellfish, octopus, lobster, sea urchins, palolo polychaetes) that are extracted from park waters by traditional, recreational, artisanal, and/or subsistence fishers*?*

NPS has not traditionally addressed this issue; park managers have no effort data while other agencies have a management mandate. There is concern that NPS management has not been proactive enough and park resources are declining. NPS is trying to do this over smaller areas than other agencies, so staff per unit area is greater.

Suggestions

- The Fisheries Protocol is going to take a larger effort than addressed today.
  Comfort monitoring may be important, even if logistics result in a monitoring design with little or no power to detect change. A design capable of detecting change will be beyond agency resources.

- This protocol development will raise visibility of issue.
- Combine participation with creel survey
- Compare length frequency distribution from catch samples with fish transect data
- It is better to rely on just one method.
- Avoid the use of total biomass as an indicator.
- Interview fishermen to understand changing methods, patterns
- If we have compelling data, we can work towards co-management
- Top down management doesn't work with fishermen
- If warranted at park, differentiate between onshore and offshore fisheries
- Consider what needs to be addressed in the protocol and what can be determined later; analysis will be difficult. Management strategy implementation has to be considered in the protocol but will need more work later.

Response Variables

- Need more work on response variables.
- Will still collect biomass info.
- Watch change in length frequency distribution from each data source.
- Creel census is tough, especially when there are numerous access points.
- There is an unequal probability of sampling (longer fisher will more likely get sampled), multiple gear types, and time of sampling (diel) issues.
- Calculate catch per unit effort (CPUE) by gear type, by species group (power per species very low)
- Variability is very high, so sampling error will be large.
- If you pool all species, statistical power might be OK, but that information doesn't help the manager as much.
- Could take a preponderance of evidence approach, correlate CPUE vs. fish assemblage data.
- Managers usually look for trend over time in CPUE. Need CPUE data to get managers to regulate effort
- Can do size distribution of catch which should be more robust variable and is not random because fishermen are selecting for size; then this could be correlated with Fish Community data.
- Use method to compare these length frequency histograms. Could us KS test, there are a number of tests to compare two distributions. Not univariate when comparing over time and space and there are no good statistical tests for that situation. Try to fit curves to histograms and compare which works when curves can be fit well.

Sampling Frame: park shoreline & marine waters (plus buffer?)

Analysis: High variability in measures may limit analysis to descriptive statistics, but otherwise ANOVA & multivariate analysis

GIS needs: shoreline access points, shoreline,

WATER QUALITY

PI: Aquatic Ecologist

1) What are the ranges and variances of the network water quality parameters within selected water bodies?
2) What are the temporal and spatial trends of the network core water quality parameters for individual water bodies or water resource types in each park?
3) How do water quality parameters within park watersheds change with varying land use patterns adjacent to park boundaries?

Limitations: budget, instrumentation, sample analysis, W Pacific has no EMAP funding

Response Variables:

- More challenging: 10 variables: Total discharge, total N, sediment sample, tissue sample, PAR, flow stage level, etc,
- A discharge variable should be measured for some resources.
- Nitrogen and phosphorus are hard to find within existing data; so important to begin gathering measurements on these variables.
- Core water quality parameters (chosen by Water Resources Division)
  Temp, conductivity (salinity), ph, dissolved oxygen (WASO requirements)
- These variables lend themselves to co-location; remote instrumentation

- Frequency of sampling, record every 30 min (15 min better to catch episodic events)
- David Schneider says there will be fluctuation in these parameters in marine waters that can't be characterized with only one point in space (or even 2 or 3) because point variation is driven by larger scale circulation processes. His recommendation is not to expect to be able to monitor trends in marine waters with a few instruments; nonetheless park staff want to know the ranges of these variables.
- To characterize pollution problem, we need more data than one point. A good approach is to monitor as a function of distance from source. This third objective won't be built into the protocol but will have to come from park specific need, and could be land use change driven.

Sampling Design

- Goal: Remove as much bias as possible from site selection.
- Need to develop a list of pools, streams; therefore this is a list-based approach with finite sampling.
- Sampling proportional to size; proportional to area enclosed, need include linear distance, size of pools.
- Within strata is still simple random sample.
- EMAP component is same time frame as rest of Hawaii
- EMAP protocol provides snapshot, one point in time, of water quality conditions.
- EMAP generates new sets of points; David points out appropriate for monitoring status, but inefficient for monitoring trends
- Water Resources Program wants us to use EMAP
- The long-term instruments wouldn't be put out randomly, have to cherry pick from random sites co-located, e.g., FW animals list sites
- Could place instruments in relation to watershed flow structure; a small number of points monitored in a watershed can be highly informative.
- The above methods might not provide an estimate of status. The initial list of sites is random for other vital signs, but if combine lists from all VS, maybe that list is not truly representative because random methodology differs between vital signs.
- Place a small number of instruments at critical points in watershed to monitor trends, rotate others en mass to characterize spatial variation

Sampling Frame: list of all marine waters, perennial streams, pools & ponds w/in WQ area of interest (PACN defined, generally broader than park boundaries); Water quality sampling locations (WRD data set)

Analysis:

- Pick out trends by eliminating small term variation; by using moving averages. Spectral analysis for continuous data is a sophisticated form of moving average but spectral approach requires considerable experience and may not be worth the effort. ARIMA (autoregressive integrated moving average) models might be informative, but also require considerable experience to apply.

a) EMAP procedure

b) Time Series – Begin with simple moving averages

GIS needs: EMAP sampling points, water quality boundary of interest, shoreline, water quality sampling points (available from state agencies and EPA, NPS Water Resources Division), LandUse Change could be trigger for more sampling near new pollution sources.

GROUNDWATER

PI: Jeff Perreault, USGS-WRD NPS Lead: PACN Aquatic Ecologist

The primary objective of the ground-water protocol is to develop procedures for assessing changes in ground-water levels, salinity and discharge.

1. *Is sea-level rise, climate change, and urbanization affecting the PACN park aquifers, and dependent ecosystems and habitats?*

Suggestions

- Don't develop protocol now, learn from pilot studies, then develop
- Become more a part of the aquatic group and land use change

Response variable

- salinity elevation and gradient in well

Sampling Design

- How will surface water sites be chosen, they are variable in space and time, and not well mapped.
- So have to do recon first (including checking out wells), then design probabilistic choice.

- Do discharge measurements
- Would sample repetitively at sites over time, not a rotating panel design.
- Co-location may not be that workable, since well locations are not random sites.
- A monitoring problem could arise over time if well locations cease to reflect conditions of interest.
- Surface water could lend itself to rotating panel, no more sampling but more preparation so more expensive.
- Surface water sampling has more error than well.

Sampling Frame: List of monitoring wells, streams, springs, & wetlands within WQ area of interest/park
Analysis: descriptive statistics, time series analysis if data sufficient
GIS needs: location of sampling wells (USGS data set), park boundaries, surface water bodies, streams, rainfall zones?
LandUse change detection protocol could provide trigger for increased sampling.

EROSION

No PI identified yet. NPS lead: Dwayne Minton

1) What are the changes over time in soil erosion rates and soil quality measurements (e.g., organic matter, pH, infiltration, aggregate stability, soil crusts) at PACN parks?

Parks that have erosion coming from within park, WAPA, KALA, HALE
NPSA not sure, PUHE mostly outside
Suggestions:

- Add survey variables to other protocols
  Soil quality to plants; Soil deposition to benthic habitats, use land use change as sampling trigger
- Need a person (PACN Aquatic Ecologist?) to pull together, perform analytic tasks
- Need more research, talk to USGS folks re methods

Response Variables

- Soil composition would be primary response variable for the terrestrial portion.
- Marine/FW component: turbidity; sediment composition and volume
- Sediment traps provide sediment collection rate, not sedimentation rate.
- Re-suspension is a problem for sediment trap measurements.
- Turbidity would probably be measured by a sensor at a permanent site.

Sampling Design

- Would have to stratify marine area, define frame, distance from source,
- As sediment comes in park, and leaves, take a hydrological approach with discharge measurements at key points in watershed. *I.e.* estimate flux into park (stream or sheet transport), and flux out of park via stream discharge.
- Survey approach: soil quality within park, offshore sediments.
- Can sediment loading on episodic events be measured? Not cheaply, events can wash out sampling gear, hard to catch and sample major events.
- Could focus on hydrological process.
- Sediment loading on benthic transects can be identified but characterizing can be time consuming, and expensive.

Sampling Frame: a) soil quality: same as vegetation? b) sediment: same as WQ? c) turbidity: same as Benthic marine?

Analysis: to be determined
GIS Needs: soils, slope, precipitation (mass wasting model, beyond existing resources), Use GIS to lay out sampling polygons, then do field selection.

LANDSCAPE DYNAMICS

1) What is the current (10 years old or less) land cover / land use within and surrounding PACN parks?
2) What land use changes (and trends) are occurring within and adjacent to the PACN parks?

Suggestions:

- Retain emphasis on land use
- Assess the risks/potentials for defining a finer vegetation class
- Point out invasive species issues

- Continue to work with other groups, erosion, Jacobi x3, early detection
- Be more specific on work with other groups
- Clarify expectations from other groups; can't do GIS for all protocols, random point generation
- Consider both false positives and false negatives in classification, especially for vegetation; consider binomial variance, standard error
- Define frame of park, with criteria, can use same set of watersheds delineated for the water quality VS (used state watershed layer)
- Do a map of frames to ensure park staff and other PI agrees with it
- work with other PI to develop training sets for classification
- Don't be squished into same box as other protocols, this VS is different because it is exhaustive sampling!
- Groundtruthing will be important

Don't need random points, want to reduce classification error by starting with pure pixels if possible. Pure pixel hard to get, for example pixels can have the same species of tree but other factors can vary within pixel, such as understory composition, subspecies of trees, or differing moisture levels)

Response Variables

- This project is mapping activity rather than monitoring defined response variables through time.
- Two types errors in classifying vegetation from remotely sensed data: false negative and false positives.
- Want to minimize both.
- Some habitat or vegetation classes are harder to classify than others.
- Spatial location of error could be important; on perimeter, not all errors are equal (hard to deal with, except through a risk assessment). Think about errors in cases that matter, prioritize vegetation or habitat classes that are critical. Can compute standard error given classification error.
- To deal with long term monitoring as methodology changes, will have to cross-calibrate, normalizing the data, use light ratio signatures to calibrate. In every tile it will be hard to find good calibration pixels for training the algorithm. GPS coordinates of training pixels should be kept as permanent plots. Proportion sampled will be small, training pixels will be a very small fraction of total pixels.

Sampling Frame

- For small parks, the entire parks plus adjacent watersheds. More work needs to be done to define the sampling frame for the larger parks. We also need to define the sampling frame in the marine realm. Even the 4 m cell resolution of Ikonos imagery is not fine enough for coral reef mapping, but it will describe larger features, and harbor construction features, important for parks such as KAHO and PUHE.

Analysis: supervised & unsupervised classification algorithms, change analysis

GIS needs: Image analysis software to be purchased or shared; imagery is already acquired, datasets need to be built

***Related VS*:** Obj. 3 of water quality would be driven by land use change. Groundwater can also use landuse change as signal.

CLIMATE

PI: Fritz Klasner and Karin Schlappa

1. Determine variability and long-term trends in climate for all PACN parks through monthly and annual summaries of descriptive statistics for selected weather parameters.
2. 2. Determine frequencies and patterns of extreme climatic conditions for selected weather parameters.

The Goal is to see that every park has basic climate data available.

Suggestions:

- List known weather stations (note: expect there are more)
- Decide the frequency of updates to website (project has web service goal using partner organizations)
- List the users, park report, investigators, projects
- There is a nice list of potential products; but need to rethink in terms of users. Park might like to compare this year to last, parks will want summary tables, different from what an investigator might like, making data more accessible)
- Rework objectives, clarify value, tasks, (as above pull together….)

- Work with other protocols to identify locations where weather stations or data needed (other projects could be missing critical co-variant)

Response Variables

- Particularly of interest are trade winds, UV (only some stations have those measurements). Extreme events are also of interest. Need to define what are extreme events (default boundary we set, investigator can define, needs temporal criteria)
- With weather data must provide duration, intrinsic time frame, usually measured over hour.

Sampling design

- Sample design within park
- Sample size 1 or more; convenience sampling over time near station, (need to work with climate person to define climate boundaries)

Sampling Frame: list of weather stations (currently incomplete & more are expected to be located)

Analysis: ***Definition of extreme conditions will be based on a time series of 30 years or other standard time frame for climate parameters.***

a) Identification of quantiles for a period of interest, or other user specified outlier range.

b) Time series analysis for patterns and variation.

c) Indices for drought, precipitation, wind, solar radiation.

GIS needs: location of existing climate stations, rainfall zones, temperature and solar radiation zones

VIEWSCAPES

PI: Laila Tamimi. NPS lead: Fritz Klasner. Facilitator: Jean Franklin

1. Determine long-term changes in the visual appearance of selected sites within PACN parks. This objective will allow identification of major physical drivers to viewscapes and responses grouped in four major components: air quality, vegetation, geomorphology, and land use practices.

John asks is this preservation, monitoring of visual resource, or tool that assists other protocols? It was thought park managers intended the former.

Suggestions:

- Focus on the photo documentation aspects and leave the identification of the change drivers to other researchers
- Conduct a pilot study

Sampling Design

- Sampling units: frame: list of old photos that can documented and georeferenced and new sites by criteria (which need to be defined)
- Temporal variability small, Spatial: zero

Sampling Frame: list of old photographs (georeferenced and metadata), list of new sites using criteria established in protocol preparation (cultural, historical, geologic, ecologic [boundaries, gradients, processes, extinction/invasion])

Analysis: GIS viewshed analysis, description and interpretation of natural and anthropogenic changes,

GIS needs: location of photographs, viewshed analysis

FW ANIMALS-PERENNIAL

PI: Anne Brasher. Facilitator: Sonia Stephens

1. What are long-term trends in community composition, population distribution, and abundance of freshwater fish and invertebrates (including snails, crustaceans, and water-associated insects)?
2. How do park management activities (i.e., those that impact aquatic ecosystems) affect the community composition and abundance of freshwater fish and invertebrates (including snails, crustaceans, and water-associated insects)?

Ann has previously sampled many streams, and most within a park will be sampled; so her methods are based on extensive experience.

Suggestions

- Design for streams with a separate design for pools and wetlands
- Put the terrestrial insects portion into a separate protocol, damselflies should be co-located.
- get statistical help on rotation rates in panel design, and consequences
- Habitat variables shouldn't be part of allocation decisions, just get these if easy
- Decide on calculating fish per stream, reach, quadrat

- Need more reaches than quadrats; don't need many quadrats per reach,
- Need more spatial sampling than subsampling
- Specify if targeting seasonal phenomenon
- Need to know inter-year variability, variability between reach, across year variability; then can figure sample size
- Across year variability across locations important

Response variables:
- total abundance, density by species
- Size classes shrimp, fish, shrimp,
- Substrate, water velocity
- Relative abundance (presence/absence) introduced fishes

Sampling Design
- Ann Brasher and David Foote need to design a temporal schedule for streams in parks and islands, rotating or fixed

Sampling Frame: list of all streams (accessibility issues in NPSA, need to discuss)
Analysis: route regression?
GIS needs: streams with segments defined

FW ANIMALS: INTERMITTENT STREAMS AND POOLS

Damselflies
(discussion with D. Foote on damselflies @ lunch)
- visual census or net-mark-recapture
  - mark with permanent marker
- parameter would be abundance/reach or abundance/pool
- weather is highly influential in activity
  - high temporal & spatial variability
  - observing must be budgeted for optimum observing times
- will have to complete an inventory of intermittent streams that would serve as suitable habitat (currently working on this in several parks and are slated to finish in Sept.)
- *density* changes depending on habitat availability (e.g., pools vs. longer lengths of running water), but *abundance* appears to remain fairly constant
- it would also be useful to look at community composition by site

Didn't get to a discussion of site selection, sampling, design, or discuss anything about anchialine pools.
2. Notes from David's presentation on intermittent streams/pools:
- Intermittent streams: need to be sampled. do damselflies & leave off fish, etc.? Have to place quadrats in pools that are perennial & sample them as pools during dry years & as stream sites when wet?
- Anchialine pools: sampling frame is list-based, don't know how funnel traps work with respect to abundance in pools, co-location with marine fish offshore?, potential co-location with caves & landbirds also.
- Information from other VS of use: WQ- issues with stratification, tidal flow, GW.

Sampling Frame: list of intermittent streams, anchialine pools, ponds, seeps
Analysis: to be determined
GIS needs:

LANDBIRDS

PIs: Thane K. Pratt, Rick J. Camp. NPS Leads: Cathleen Bailey, Darcy Hu (NPS)

1. Determine long-term trends in species composition and abundance of native and non-native forest land bird species in PACN parks – AMME, NPSA, KALA, HALE, and HAVO

No previous surveys on woodland and shrubland; don't know how birds use.
Suggestions:
- Move away from grid
- Squeeze panel into each biome tract

- In this setting don't want to compare shrubland, woodland, forest, so panel design would be inappropriate at landscape level to provide answers
- Use level names consistently. Park, biome, tract within biome, grid, transect, stations. Need to know area within each unit, what is area of frame.
- Frame is sum of tracts within biome (not randomly sampling biome; frame is sum of tracts, tracts are cherry picked to be best habitat)
- Sample tract randomly (line or point) or use legacy transect,
- Can't make statistical inferences to the entire park(s) due to sampling limitations, but can make statistical inferences within tracts and biological inferences to the entire park.
- Need to define criteria well for cherry picking tracts
- Develop plans for HALE and HAVO, apply to KALA and Samoa

Response Variables

- Time of day important for certain sp, wind important, cloud cover important for one species, stop surveys when rain, 2 species become more vocal when there is mist.
- Frequency index may be necessary; can't calculate detection index on a few sightings.
- Ricks method assumes no periodicity but don't know if there is.
- Number of samples is the number of lines in grid in woodland
- Have to do point counts in forest, can't traverse and count (both use distance sampling)
- An empirical variance between lines cannot be obtained because rely on a common detection function, so currently are using bootstrap method.
- Within year and between year variance can be pretty large.

Sampling Design

- Park centric study
- Have to do systematic sampling for logistical reasons. Can't defend systematic sampling statistically if litigation.
- It would be OK to use legacy transects as fixed sites for panel. They were set up initially randomly. Can rotate within tracts, and can only infer to individual tracts.
  which would be a better methodology in this case.
- Forest birds are so affiliated with some locations it is biologically ok to cherry pick sampling sites because those areas contain such large percentages of the populations within the parks

Sampling Frame: Frame is sum of tracts within biome, tracts are cherry picked to be best habitat, hence not randomly sampling biome

Analysis: Handcrafted panel design software for analysis within each biome.

GIS needs: vegetation cover (habitat), location of transects and sampling points

SEABIRDS

Co-PIs: David Duffy (PCSU), Darcy Hu (NPS) NPS Lead: Cathleen Bailey (NPS)

1. Seabird monitoring in PACN has a single general objective of monitoring long-term population trends in three groups of seabirds: Endangered Species, Species of special interest (other threatened and rare species), "Common" low-elevation species:

Suggestions

- Need to figure out species composition first, before starting rigorous monitoring, do more inventories and qualitative surveys, work towards a usable measure,
- Birds have to cross shoreline to move from roosts to feeing area so there is a potential measure there
- don't develop all 3 objectives concurrently
- Spatial issue was not addressed in this session, probably cherry picked sites for logistics, need to think through, would need to focus on one or two sp, other sp on wait list
- Common species; shoreline surveys, start with something visible and easy, provides info on difficulties, wait on others

Response Variables

- Special interest birds: call vs. radar, use radar, need to evaluate each species in each park but has logistical issues (hard to lug the radar)
- For special interest birds Can monitor by bird calls only, is index or indicator, monitor route calls/time.

- Call counts are an index confounded with many factors, including hearing acuity, wind, location, duration. Spatial variability, temporal variability, measurement error may be larger than other groups and subject to systematic bias you don't recognize.
- Delineate seasonal cycle so know best single point to visit

Sampling Design

- HI petrel; divide into two strata (known area, exhaustive or subsample), unknown areas do subsample.
- Temporal, one visit/yr burrow count, two/yr for fledgling problematic due to timing, better repeated visits, focus on high strata.
- So stratify by known (100% census) and unknown presence (random subsample) to minimize variability.
- Shoreline survey; what index would be appropriate to use? Will be biased composition, depends on your shoreline position, is fixed bias so easier to deal with than unknown.
- For the third objective on common low elevation birds; Model from seabird inventories at parks, and established routes. Colony counts may be the easiest to collect (although it is only sampling a fraction of the distribution.).

Sampling Frame: a) Hawaiian petrel: known areas & potential habitat b) special interest: to be determined c) park shorelines

Analysis: relative abundance, distribution, for reproductive success tests of independence

GIS needs: shoreline, potential habitat and known areas for Hawaiian petrel,

CAVES

co-PI: Dr. Frank Howarth (Bishop Museum. NPS co-PI: Dr. Jadelyn Moniz Nakamura)

1. What are the principal threats to cave resources in the PACN parks?
2. What are the changes over time in the significant natural and cultural cave resources?

Cave inventory is needed for most parks. Caves on different islands are very different, and at different elevations.

Suggestions

- The definition of frames, units, variables was squishy, it kept changing during this discussion. However, monitoring protocols need to be something others can follow
- Design monitoring program for HAVO & KALA (resources most at danger) HALE have 5 or 6 cave systems but more difficult to access, do later. Then develop frames for other parks.
- Need to sample frequently (within year and among year) until know variation
- There was a concern that the verbal presentation given during this meeting did not match the written documents, suggesting the goals, etc are undefined or still in flux

Response Variables

- 9 measured variables, include cultural, two derived

Number of sp and organisms per cave (derived); Presence/absence rare species, timed counts common obligates, vegetation on transect over cave , % cover, invasives along transect, root distribution, timed counts after baiting, location of cultural artifacts in cave, insect counts/cave (walk through) by species

- Need to describe measured variables and units of measure
- Especially for cultural component, need to describe how to score small amount of vandalism (e.g. one feature out of 200 disappears)
- Need define what is rich site

Sampling Design

- Sites in current program come and go; and so can't be used for monitoring.
- Need to state criteria for fixed site within cave, how choose, what are they?
- State criteria for random sites, need fixed list of sites to be taken from
- For small caves census completely
- For large caves take subsamples
- Could set up known frame to begin work now
- Richest cave are ones where passage shape slows moisture loss
- Set up fixed strata always sampled
- Other strata are random
- Have to keep measuring the fixed sites even if it goes dead.
- Begin developing frames for other parks

- State criteria for visiting caves and temporal schedule for each group.
- Second set of caves have seasonal expectations so sample monthly.
- Define criteria to class caves as seasonal or not.
- Need to be able to define unit of effort to develop a sampling design.
- Should come up with preliminary schedule for caves, which are sampled monthly, annually, or every few years.
- Need criteria to define when monthly sampling no longer needed.
- Part of selection criteria would be to choose caves across an elevational gradient

Sampling Frame: list of known caves with deep zone
Analysis: to be determined; panel design possible
GIS needs: cave locations, cave maps (cave mapping software exists), vegetation cover,

TERRESTRIAL INVERTEBRATES

PI: David Foote (USGS) and Karl Magnacca (David not present for this session, but met briefly after lunch)

1) What are the seasonal and inter-annual patterns in species composition and distribution of selected terrestrial invertebrate communities?

2) How do National Park habitat restoration and alien species control activities affect the species composition and/or abundance of terrestrial invertebrate communities (including earthworms, insects, slugs and snails)?

Highly stratified in terms of habitat; insects particular to certain habitat. Everything is different everywhere.
Currently only checking 2 or 3 taxa in each park. A lot of work has been done before, but hasn't been examined statistically

Suggestions

- Karl has legacy program
- Rethink response variable (CPUE), sometimes can control statistically
- State your levels and reasons for choosing fixed site approach; but rethink that approach. Maybe then could get at spatial issues.
- Think about using a panel design
- Define the reasons for scheduling.

Frame is really small; only this section of forest has pomace flies.
Other insects mentioned are also restricted to small areas
Problem: transects (trails) are established, making a new trail is very labor intensive and trail grows over in year.

Response Variables

- Response variable: # org/bait site, is an index, not an absolute measure so has unknown sources of variation and hence potential bias
- Can get increase in rigor if know that bias is fixed. .
- Karl says can't control weather bias,
- More reliable monitoring when count bugs/transect in different ways.
- Need to know sources of variation and whether variable bias, does it have a temporal component,
- With one trap, CPUE is function of effort and capture probability, so need more traps to sort out confounding factors. Could perform catch-effort study using different size batches of traps (i.e. 1,2, 3, or 4 trap clusters). Catch effort curve could be used to estimate vulnerability and test for consistency. Going to measure catch but have many factors affecting catch, have to sort out, do preliminary studies.
- Karl points out lot of work, lots of analysis,
- catch-effort indices will be of concern to peer reviewers
- Researchers are more conscious of bias issues now.

Sampling Design

- Do within site analysis to see what is controlling hits on trap
- Look at table of groups, methods (indices), transects to create design (remember the Landbird discussion of sampling within frame).
- Karl has several levels; at each level could have cherry picked sites or more rigorous sampling frame.
- Karl going after temporal variation at one fixed site: should identify that in write-up, the inference is to tract only.
- State levels of study: park, Wet forest biome habitat, Tract: (4 for pomace flies)

Grid with transect with subpoints, Fixed point with repeated measurements
- Due to variation between bait sites, best to do CPUE study all within a site
- Need to state reasons for sampling schedule as described in table
- Still have allocation issue in terms of scheduling; move beyond seasonal variation to pick one annual point

Sampling Frame: habitat (tract) of species under study
Analysis: to be determined
GIS needs: vegetation cover for habitat for species under study, existing transect location

BATS (FLYING FOX)

Co PI: Leslie HaySmith, TBD

1. What is the distribution and relative abundance of flying foxes in and near NPSA and WAPA?
2. What habitat types are flying foxes associated with at NPSA & WAPA, and how are populations changing over the long-term (10-20 years) in preferred habitat associations? What potential land management regimes appear to be beneficial or detrimental to the recovery of these species?

Suggestions:

- David suggests need to learn more about biology and how the bats use the landscape A start could be made with a 2 week study to identify key pieces of natural history, to develop measurement protocol.

Response Variables

- For each vista describe amount of obscurement, windy days and non-windy days, develop regression model to see how counts and detectability change
- Might want to stratify by forest type or openness, could do weighted average, could note distance.
- Detection function based on histogram number of sightings with distance
- Need to be aware of detection function and whether it changes.
- Need to be prepared for significant habitat change; i.e. Hurricane impacts

Sampling Design

- Colony: movement from colony is organized in streams to food sources.
- Solitary: move between favorite roost, several feeding sites
- Have to live with serious noise in measurement
- Two units:
    1. Count of colony (must find colony)
    2. Vista count; colonial; proximity to colony is important
        Solitary: not so organized as group, harder to count
       Radio tag; 10 done,
- Vista counts won't work as well for solitary, better for colonial species.
- Systematic vista might work for random movement of solitary animals. Random vista needed for systematic movement to and from colony
- Locate frame of vistas, especially those that are historically important
- Two sampling schemes:

Systematic vista scheme may work for solitary because behavior random at population level even if systematic at individual

Systematic or random vista won't work for colonial; have to be right on vistas, this design fails if flyways change

- Try to count all colonies with colony count or subsample area with colonies in it, need big samples,
- Take probability sample of island without colonies, try to estimate what missed, sample more heavily in strata of habitat type
- Response variable can't be number of colonies cause they re-aggregate so much, bats have site fidelity but move with perturbations
- If can't count at colony maybe could count at emergence pathways
- High tech instrumentation could help
- Change at censusable colonies can be measured , but the cause might be movement to uncensusable colony
- Better to only be concerned about what's happening in park but can't census there, hard topography

Sampling Frame: For colonial species census of known colonies, plus random vista to locate colonies in other suitable habitat. For solitary species: frame would be all vistas of historic importance for observing solitary bats.

Analysis: Depends on measurement variable: presence / absence (binomial) versus count (poisson or overdispersed poisson).
GIS needs:

PLANT COMMUNITIES

Co-PI: Jim Jacobi, Linda Pratt, USGS; NPS lead Steve Anderson

1. What are the long term trends in vascular plant species composition and abundance and community structure in focal communities identified by PACN Network parks?

Suggestions:

- How to choose sample size especially when sampling a range of species
  Three approaches:
  Design around the most variable sp,
  Design by species with most precision,
  Choose species with greatest social or biological imperative, most need to characterize
- Define levels and use words consistently, within park, habitat within park, strata within habitat, sites, subsamples within sites
- Think thru allocation of effort; issues by level, subsampling often pretty cheap,
- how to deal with fragmented habitat, no solutions found today
- revise the sampling as you go: pilot studies, data will help you allocate more effectively
- List response variables with clear operational definitions
- State why the 5 focal communities have been chosen for study and define the sampling frame for each community.
- A panel design might be useful for the rainforest community.

Response Variables

- List response variables for which there is an operational definition.
- Describe why you chose those plant categories

Sampling Design:

- If choose panel design need to define schedule, number of fixed sites, rotational design

Sampling Frame: Frames to be determined within each of 5 focal plant community habitats. The frame might be stratified.
Analysis: handcrafted panel design software for rainforest community?***;*** other communities to be determined
GIS needs: transect and plot locations, vegetation cover

FOCAL PLANT SPECIES

PI: Jim Jacobi, NPS lead Tim Tunison

1. What are the status and long-term trends in distribution, abundance, and demography of endangered, rare and other focal native vascular plant species (e.g., species with cultural significance) in the major native plant communities of the seven PACN parks?

Based on biodiversity and number of rare species, the PACN parks fall into three groups: parks that have high biodiversity and many rare plant species, parks that have low native plant diversity and few rare and focal species, and the two West and South Pacific Parks within PACN.

Suggestions

- Explore adaptive sampling to sample rare species: inference to rest of park is not statistical, will be judgement based
- Define list of species of cultural significance. Need more input from cultural resource managers, esp. Western Pacific parks.
- Identify relationships with other vital signs, e.g. Where a rare plant supports a rare bird or insect.

Response variables

- same as plant community sampling
- Goal: pick up rare species not caught by community sampling; need to define measurement better, goal is to assess how well the species is maintaining, hence extremes more important than means.
- Possibility of Type II errors (false conclusion of no change) large with rare plants; one of biggest challenges.

- Performance measures: distribution, population stability, height, age class, how is community distribution changing, abundance, number of population and total number of individuals,
- Within subset, what is individual status, what is recruitment rate, this is challenging, use size structure as surrogate for age, use stage rather than age
survival; Abundance by life stage, survival of clusters
- Model the probability of survival as function of environmental factors, see what factors driving loss rate.

Sampling Design

- based on locations known to have species, are rare plants maintaining status at those locations? Note: can't use these sites to estimate abundance in park,
- Could use quadrats at beginning, then use adaptive sampling, shift sampling when encounter rare, sample quadrats around plant, when encounter another plant shift quadrats to new plant and sample round
- Random samples outward from known points
- Monitoring known aggregates gives biggest bang for buck.
- Could post-stratify based on animal disturbance, loss of pollinators, etc; not all aggregations will be able to maintain equally well

Sampling Frame: adaptive sampling within known locations or high likelihood habitat; shift the sampling when encounter rare plant?

Analysis: to be determined

GIS needs: locations of known rare plants, vegetation cover, transect and plot locations

INVASIVES WITHIN PARK AND BUFFER

Co-PI: Jim Jacobi, Linda Pratt (USGS); NPS lead Rhonda Loh

1. What are the exotic weeds that threaten native ecosystems in the PACN parks?
2. What are the changes over time in the distribution and abundance of disruptive exotic weeds in the PACN parks?
3. What are the changes over time in recruitment and spread of populations of target disruptive exotic species that are of primary concern to PACN parks?

Only a couple of focal species would be appropriate to sample in small parks.

Suggestions:

- There is a different probabilistic content to the three goals; and they should be defined better in the write-up
- Need to create priority lists of troublesome aliens, ecosystem altering, ones that park can deal with

Response Variables

- Methods and variables will differ when monitoring the status of established invasives compared to detecting incipient invasive populations.
- Status and trends for established invasive species; hectarage over time, is coverage increasing?
- How degraded is area, how is it changing over time, what is the status of invasives.
- Measure frequency of occurrence (fraction of transect with occurrence), abundance (cover within segments, or number of invasive trees). Good to overlap with bird transects on these studies.
- Selected species distribution: think through more, review literature, does probabilistic approach work, otherwise inference based on judgement; performance goal is to understand the population structure of invasives, if the plant is reaching maturity, hence increased reproductive capability within park.
- Incipient: exhaustive sampling along corridor; number of species that made it or got eradicated
Currently record presence of alien in new area and spatial distribution it has.

Sampling Design

- Traditional way of evaluating invasives is to measure with belt transects.
- Have a few permanent transects but not many.
- continuous presence/absence per 10 m segment of transect
- each species will behave differently, need different methods for different species.
- Points of clarification: Belt transects; 5 yr return interval, too much work annually but detection of trends will be delayed by 5-yr sampling scheme, incipients measure at least annually, maybe in a rotating panel
- Goals: status trends established, points plus belts, Jim think panel, 2 yr interval: needs to be determined
- Belts: treat as exhaustive sampling of a lattice of swaths/corridors; systematic sample for detection within each belt, use hot spot theory to calculate probabilities, such as probability of invasive expanding to hit the

lattice, investigate extension to area covered by lattice. (Note similar issues with solitary bat detection discussion yesterday)

- Can't extend inference beyond limits of the lattice. Think of this lattice of corridors as a detection barrier rather than as a representative sample.
- Need to decide if legacy transect good starting point, see what assumptions went into it, might try some simulations on legacy transects. It has some weird geometries but maybe it could be made into usable lattice.
- Doesn't matter if legacy transects were systematic (with random start) now, just assess adequacy of lattice for detection. But will detection within lattice work for trend assessment?
- invasive establishment is the ultimate performance measure
- Schedule for revisiting needs to be thought through more in terms of goals, series of logistic tradeoffs.
- Schedule for one survey might not work for others, there are allocation issues
- Three components: Incipient; overlap on protocols census along corridors; new occurrence along major corridors, tied closely to management response.
- Species not in parks already, or from other portions of park, are of interest
- Spatial overlap: small parks, park itself is corridor
- Distribution of established plants: Belt transects; focusing on movement of invasives.
- Species based approach
- Pick subset of target sp (most dangerous prospects) to more closely monitor, predict invasion potential, assess stage of invasion.
- Change in species abundance or distribution; difference in reporting time, would report immediately (dancing between long term monitoring and tactical monitoring and action)
- Sampling for eradication, does not produce long term datasets for trends, might monitor some for spread, behavior, or monitor management response.
- The trend of interest would how many invasives are caught, how many got away and got established, how many got established and were never detected, for wise allocation of detection effort.
- Complicated by management actions; need for post-stratification
- Overall design going to be compromised
- Can't be as precise when have different levels of management actions affecting different areas
- Habitat related variables can be used for modeling distribution and abundance.
- Modeling presence now, would like to model above, more complicated.
- Need to determine size of buffer adequate to protect a park.

Sampling Frame: ***a) status and trends of established invasives: 5 focal communities in parks b)incipient in park: transport routes (transects, roads, trails, developed areas) c) selected species trends: within park boundaries***

Analysis: hot spot theory (lattice detection); handcrafted panel design analysis software?

GIS needs:

EARLY DETECTION INVASIVES OUTSIDE PARKS

PI: Lloyd Loope (USGS); Facilitator Page Else

1) What and where are the priority incipient infestations of invasive plant species that require and are feasible for rapid response to protect the PACN Parks?

2) Having detected one or more infestations of a "priority incipient plant invasive species," what management actions are warranted for their eradication, based on life history attributes (especially its seed bank), dispersal modes, invasion corridors, vectors of spread, invasibility of areas, and number and size of known locations.

3) What and where are the priority incipient infestations of invasive invertebrate species that require and are feasible for rapid response to protect the PACN Parks?

Suggestions

- Pick out monitoring questions from the described program components and focus on those questions for the I&M program.
- Monitoring questions include the long term performance of the invasive population, and how does the invasion unfold? Spread of the invasion could be mapped or management actions.

- Determine when would a probabilistic approach to sampling would be appropriate.
  Some components are not probabilistic. Identify the components that need a probabilistic approach.
- The probability of missing the species needs to be determined. That parameter affects where to put effort into searching.

Response Variables

- This is really a detection/eradication program
- The performance criteria is the #escapes/eradicated species.
- Mapping spread.
- Id corridors that can be exhaustively surveyed, nurseries, roads
- Exhaustive spatial coverage doesn't mean detected everything
- For exhaustive coverage what is detection rate?
- Lloyd needs to determine how to estimate the detection rate.
- On locations where exhaustive is not possible, must sample, maybe stratify based on risk, sample random units, assign more effort to those strata.

Sampling Design

- Exhaustive canvassing or stratified by risk
- Census is slightly different than canvas, canvas is exhaustive
- Lloyd will need to write description of risk; how is it defined, how units are ranked by risk.
- Allocation of effort is by risk rather than variance

Sampling Frame: a) units that can be exhaustively sampled ***(***nurseries, stretches of road, airports***)*** b) units that can't be exhaustively sample

A***nalysis: calculation of detection rate; risk assessment***

GIS needs: roads, trails, airports, nurseries, GPS gear, coastline, park boundary and buffer

BATS INSECTIVOROUS

PI: Leslie Haysmith

1. What is the distribution of the hoary bat in National Parks of Hawaii? What are the long-term (8-10 years) changes in seasonal occurrence of these bats in native, non-native, and mixed habitats, as well as at high and low elevations?
2. Where do Pacific sheath-tailed bats occur in NPSA and Tinian, CNMI?
3. In what general habitat types are Hawaiian hoary bats and Pacific sheath-tailed bats observed?

Suggestions

- State limits of use of index: if detection probability unknown then assume fixed detection function in order to monitor accurately.
- Study plan needs more write-up on instruments, calibration
- Try correlate with weather station
- Since ignorant of habitat preference could sample proportional to size of spatial unit. Or, could sample where you know insects are. Will probably stratify on riparian, forest, shoreline habitats.
- In first year do roving survey to see what's what. After that could set up fixed stations
- Picking stations that are more likely to have bat activity will stabilize variance in long run

Response Variables

- Variable: passes per minutes at each station (an index).
- Recommend directed study to identify sources of variation in the index; record different methods, total minutes, sources of variation in number of passes counted per unit time.

Sampling Design

- Variable: index, passes per minutes at each station,
- recommend directed study; record different methods, total minutes
- sometimes more than one stratum per park
- fixed equipment sites go to strata with high likelihood occurrence
- Mobile equipment goes to fixed stations allocated according to expected utilization of habitat (habitat definitions should include ecotones (zone between habitats, structural change), zones are ecotones, roads are patrol zones for bats

- If using roads could stratify habitat along road, then relate that habitat sampling proportional to park division of habitat.
- Don't know relation between index and actual behavior/abundance, purpose of directed study is to move beyond hoping index is proportional to abundance.
- Start monthly, locate season with highest activity, then move to annual measurement.

Table
Sample unit: station with unknown sampling area at known time
Sampling frame: in the park
Design: within park: roving survey at fixed stations allocated by expected habitat utilization, plus high use sites with immobile equipment with timed recordings
Sampling Frame: accessible (roads and trails)sites in park (could include entire small park)
Analysis: Generally, basic descriptive stats (mean minutes of activity/unit time, standard deviation, range). Proportion of sites occupied may also be calculated based on presence/absence data.

GIS needs: roads, trails, shoreline, vegetation cover, known bat colonies

REPORT ON FY06 VITAL SIGNS MEETING WITH STATISTICIAN, HAWAII VOLCANOES NATIONAL PARK, HAWAII, OCT 31-NOV 4 2005.

MEETING OVERVIEW

Summary
Between Monday, October 31, 2005, and Friday November 4, 2005, Dr. John Skalski, a biometrician contracted by the PACN Inventory and Monitoring Program, met with Principal Investigators (PIs), NPS Leads, and Project Managers who are developing FY06 Vital Sign protocols. Dr. John Skalski is a Professor at the University of Washington and works with diverse natural resource issues including fisheries and wildlife projects. In August 2005 Dr. Skalski had also met with all PACN VS project teams. The purpose of the second session was to meet with the groups developing protocols in FY06 and focus on sampling design questions and perform example calculations for sample size allocation and effort, and power analyses for trend detection.

This document presents a brief meeting overview of discussion that occurred, organized by Vital Sign.

During the November meetings, it was agreed that several project leaders would compile data and submit it to Dr. Skalski for sample size and power analyses. Landbirds, freshwater animals (perennial), terrestrial plants and invasives, marine benthic, marine fish, and bats protocols all provided data and received analyses.

Concurrently with the statistical sessions, the Benthic Marine Community Vital Sign workgroup met in an intense session to produce a near-ready benthic marine protocol to be submitted for peer review by December 31, 2005. As well as meeting with Dr. Skalski in several sessions for design review, the team wrote and edited detailed standard operating procedures (SOP's) and protocol text. Sessions with Dr. Skalski also discussed the related marine fish community and fisheries harvest vital signs. *Other VS teams should consider intense work sessions prior to their protocol submission dates*

General Remarks on Sample Design
Prior to the meeting, I&M distributed a document written by Dr. Skalski summarizing the more common sampling schemes proposed for our network with the relevant statistical equations (*Document titled "Long-Term Monitoring: Alternative Data Analysis Schemes"****). Dr. Skalski also sent out a set of 8 questions aimed at gathering data for calculating needed sample size, with consideration of costs. Individual protocol sessions reviewed that information and, where data was available, carried out the equation calculations.***

One dominant equation emphasized in several of the sessions was calculations of precision as a function of the sample design sources of variability. In general (counter-intuitive to researchers trained to characterize sites well), Dr. Skalski demonstrated that to make inferences to the broader pre-defined spatial scale, **it is best to sample more intensively at the broader scale and less intensively at the scale of replicates or subunits.**
For instance; for the benthic marine community vital sign, precision (P) is affected by four sources of variability:
N	the number of stations or sites
m	area within sites

g number of transects per area
l replicates per transects

Epsilon is a function of these four sources of variability. The benthic marine community vital sign desired a 10% level for epsilon. Substituting in calculations Dr. Skalski made from example data sets provided by the marine group of variance for each source, the equation appears as:

$$P\left(\left|\frac{\hat{\bar{X}}-\bar{X}}{\bar{X}}\right|<\in\right)=1-\alpha$$

$$\in=Z_{1-\frac{\alpha}{2}}\left[\frac{(1-f_1)(0.6170)^2}{n}+\frac{(1-f_2)(1.2540)^2}{nm}+\frac{(1-f_3)(.3622)^2}{nmg}+\frac{(1-f_4)(0.1056)^2}{nmgl}\right]^{\frac{1}{2}}$$

$$\in=Z_{1-\frac{\alpha}{2}}\sqrt{\frac{\mathrm{Var}\left(\hat{\bar{X}}\right)}{\bar{X}}}$$

(EqBen1_Precision)

Precision is expressed as the desire to have a relative error $\left(\text{i.e.,}\left|\frac{\hat{\bar{X}}-\bar{X}}{\bar{X}}\right|\right)$ in the estimation of population mean $(\bar{X})$ less than ε, $(1-\alpha)$ 100% of the time. The quantities in the bracket are the coefficient of variation (CV) for an error source. The values f_i are the fractions of the nested design sampled at each stage. Because variance is lowest for the last source, replicates within transects, which also has the largest denominator, Dr. Skalski demonstrated to the group that **precision is maximized by spreading out the samples at the largest spatial scale rather than concentrating on the smallest.**
The equation was used again for calculations of precision for recruitment, with three sources of variability, a) the # of locations, b) the # of stakes per location, c) and the # of plates per stake array. Again it was found best to maximize the broadest spatial scale or the number of stations.

In the marine fish session, part of the discussion examined the ratio of fixed sites to rotational, where

$$p_{\substack{rot-\\fixed}}=\sqrt{\frac{1-\rho^2}{1+\sqrt{1-\rho^2}}}$$

EqFish1_PanelDesignFixedRotate

Where ρ is the correlation between years and *p* is the proportion of sites renewed each year.

Using data provided by the benthic marine community vital sign group, it became apparent that to maximize precision for both the benthic and fisheries protocol, half of the sites should be fixed and half rotating.

For this and several other sessions, the increased precision obtained by the second year of the panel design was shown to be important.

$$\tilde{X}_1 = \frac{\frac{1}{\text{Var}\left(\hat{\hat{X}}_1\right)}\hat{\hat{X}}_1 + \frac{1}{\text{Var}\left(\hat{\hat{X}}_1'\right)}\hat{\hat{X}}_1'}{\frac{1}{\text{Var}\left(\hat{\hat{X}}_1\right)} + \frac{1}{\text{Var}\left(\hat{\hat{X}}_1'\right)}} = \frac{\text{Var}\left(\hat{\hat{X}}_1'\right)\cdot\hat{\hat{X}}_1 + \text{Var}\left(\hat{\hat{X}}_1\right)\cdot\hat{\hat{X}}_1'}{\text{Var}\left(\hat{\hat{X}}_1\right) + \text{Var}\left(\hat{\hat{X}}_1'\right)}.$$

Equation 23 of Dr. Skalski's paper, There are two estimates for the year 1 mean $\hat{\hat{X}}_1$, from the first years data, and $\hat{\hat{X}}_1'$, the estimate corrected by information from the second year of sampling The best estimate is a weighted average of these two estimates, shown in the equation above.

Other messages emphasized by Dr. Skalski during the sampling meetings were the importance of obtaining relevant data sets and analyzing them (***Don't collect and neglect!***) for assistance in sample design rather than proceeding on intuition or past methodology. These calculations can surprise researchers and demonstrate that other designs may be superior, and increase efficiency in sample size and design, and power for trend analysis.

It is often difficult to develop monitoring programs for rare species, because the natural variability is high, and measurement precision low, therefore there is not sufficient power to detect trends.

As time allowed, the following more managerial questions posed by the PACN Network Coordinator were discussed in individual protocol sessions.

1. Sampling in Parks-Do you still plan to sample each park proposed in your protocol? If so, have you determined how sampling will be carried out in each park?
2. Data Analysis-Who will do it? Discuss data analysis methods proposed and recommendations provided from last Hilo stat's meetings.
3. Field Sampling/Data Collection-Who will do it? Will you hire through RCUH? USGS? Biotechs, Wildlife Biologist position? At what, or approximate, pay scale?
4. Discuss eight questions regarding sample size posed by Dr. Skalski
5. Further recommendations

Dr. Skalski also reviewed Chapter 4 Sampling Design of the draft PACN monitoring plan. He revised a table to provide more detail on spatial and temporal allocations. He pointed out that our protocols conceivably could allocate in many different ways: Nested, focal, exhaustive, index site sampling, risk based, adaptive sampling, sampling for detection (wave front), creel survey, EMAP, etc.

STATUS OF FY06 VS TEAMS (DETAILED NOTES FROM INDIVIDUAL PROTOCOL SESSIONS WITH DR. SKALSKI ARE AVAILABLE FROM I&M)

BENTHIC MARINE COMMUNITIES

The benthic group is on track to have a draft protocol submitted for review by December 31, 2005. Dr. Skalski analyzed data sets on percent coral cover, growth and recruitment to make sample size allocation calculations. Growth dropped to an optional response variable, both for logistical and statistical reasons. The growth data is so variable that the power to detect trends is rather marginal. A further discussion will occur between the PI and Dr. Skalski during a meeting Thanksgiving Week. Dr. Skalski was pleased the team sent data ahead and had data available during the meeting. The sessions were structured so that he had time to do some numerical calculations and explain the results to the PI in a more educational face to face session.

MARINE FISH

The sampling design issues are somewhat resolved, since this protocol will co-locate the benthic marine protocol. However, additional transects or transect lengthening may be required for adequate sample size. Much of the discussion centered on the availability of historical data for precision calculations. There appears to be a lack of temporal data (revisited sites) that would help the team conduct power calculations for trend analyses. Thus the team is still in the mode of locating and obtaining relevant data, rather than being at a number crunching state. The team is still debating sampling methods, and it is good that they are flexible. The team may be forced to design an implementation study approach since they can't find existing data, which is reasonable since their starting point will be the benthic marine community vital sign methods.

FISHERIES HARVEST

Dr. Skalski expressed concern over the relative cost of the man effort (1.5 man year per park) needed for this project compared with the value of the measurement. Catch is not an indication of fish population size. Due to the difficulties of performing a comprehensive stock assessment, the benthic marine and fish community protocols will be focused on populations within a subset of habitat rather than overall stock. Dr. Skalski raised the possibility that this project would be best implemented in one park in conjunction with a complete stock assessment, to study the population as a result of take. However, that connection would be likely to vary across parks, and I&M is striving for network wide protocols.

WATER QUALITY

Dr. Skalski performed a power analysis on water quality data provided by the team. He felt the protocol was making good progress and would not require further assistance from him.
Data calculations showed that adequate precision could be achieved on all parameters except turbidity. However, the sonde instrument may provide less variable turbidity data than the random samples analyzed for this variability calculation.

FW STREAMS

Dr. Skalski expressed the need for the project to move ahead to identify the necessary sampling level; which may need to be greater than the team currently anticipates to gain sufficient power. The team should move ahead to compile and summarize past data so that Dr. Skalski can make calculations. I&M staff expressed the desire to have the new Aquatic Ecologist able to work with this protocol in its development, given the remote location of the Principal Investigator, which may require a delay in the protocol timeframe.

GROUNDWATER

Principal investigators for this project were unable to attend this meeting, but state they are making good progress on protocol development.

RTE GROUP, STATUS AND TRENDS

This group is making reasonable progress and needs to submit data (Linda Pratt said she could provide). This group also discussed the issue that was apparent with the marine group in wanting to characterize sites well. Dr. Skalski encouraged sampling at the broad spatial coverage level and reviewed the precision equation.

In response to Dr. Skalski's concerns that the area of inference would be small because they're cherry-picking sample sites, the group stressed that there are only a small number of known populations in which to sample for many of the RTE species and that a wider, more randomized sampling strategy would too often simply miss the species of interest. The general consensus was that known populations could serve as a strata with fixed "bell weather" sample sites; while remaining areas could be randomly sampled as a low probability strata (low probability of RTE species presence, that is) thereby providing a probabilistic depiction of conditions outside of the known populations.
With rare species, precision in detecting change is going to be inherently low. John suggested starting with the goal of being able to detect a 20% change, with the caveat that this percent change detectable may need to go up.
With sample data, John will run multiple sample size calculations in order to bracket the group's sampling options. He needs data that will allow characterization of response variable(s) mean value and estimation of the different sources of variance (measurement error, between sample unit variance, etc.), for both the spatial and temporal frames of reference.

EARLY DETECTION OF INVASIVES

This session reviewed some of the sampling design challenges, especially on the Big Island, where only a subset of the likely invasion sites will be able to be sampled, due to logistical costs. While the PI has a well established methodology that has been used on Maui, the rationale and decision process for each step of the search and destroy procedure must be described and documented in a way that will allow future monitoring personnel to carry out an equivalent and comparable process. The PI, Lloyd Loope, and Brad Welsh, the National Invasives Species Coordinator for I&M, participated in the session by phone. Brad volunteered to try to draft a flow diagram of the design process. Lloyd reiterated that his design on the Big Island will need advice of researchers familiar with the locales. There must be objective criteria for subsampling location choices. A risk assessment could be used as a ranking mechanism, with a map of hit locations as an indicator. ***I&M staff could assist Lloyd in producing maps of invasive detection locations***, with a focus of areas with highest number of hits, which may provide a quasi quantitative basis for site selections.
I&M staff will send Lloyd hard copies of completed protocols from other networks so he can get a sense of the documentation required for a protocol. The sampling design must acknowledge the limits on inference created by the logistical limitations on sampling locations. This protocol will be unable to assess the risk of invasions in wildlands.

LANDSCAPE DYNAMICS

This session focused primarily on how accuracy assessments of image classifications are performed. The team had researched common procedures and statistical measures for accuracy computations (primarily involving various comparisons of a generated classification with a reference classification obtained either by ground-truth plots or another classification method). The team had also participated via Internet in a demonstration of an accuracy classification using Ecognition, an advanced object based image classification software.

The statistical review session discussed the potential for establishing long term ground reference sites, and how often the sites would need revisiting. Co-location with the plant people may help with ground-truthing, but the landscape dynamic team needs to establish ground-truthing needs for landscape classes that will not be sampled by other protocols.
Dr. Skalski gave the team a homework assignment to do binomial sample size calculations. If there were 100 sites to classify, what would the error rate be, and what is the error associated with the error calculation? This will be a function of how many ground-truth sites are sampled. The team needs to do further work in researching how much ground-truth data will be necessary to adequately characterizes classes and test the classifications.

LANDBIRDS

The landbirds protocol is making good progress, and have relevant data with some analysis performed before meeting. This protocol has some of the highest research needs for sample design. It is necessary to perform sample size and cost calculations and they may have to revaluate designs due to cost. They will need to contact Dr. Skalski for more formula and statistical assistance. The protocol will use legacy transects as fixed stations in the rotational designs, supplemented with randomly picked transects each sampling session. There will be habitat strata corresponding to various vegetation cover types used differentially by the birds.

SEABIRDS

This team did not meet as the PI was occupied by other meetings.

TERRESTRIAL INVERTEBRATES

This project addresses only a subclass of invertebrates, and is a small subset of all insects that may be park concerns. It is a legacy project and method. Dr. Skalski was concerned with issues of randomization and replication, how representative of the total habitat is the fenced areas of habitat? This project may be a case of pseudo-replication; where the bait sponges are 200 subsamples of one replicate of a treatment. It cannot be determined if fencing is effective because it might work only at that site.

Sample size calculations did show the current sampling precision was quite high. The big issue, though, is that they're only measuring an index, and this provides very limited inference to the population scale, especially since sampling is not being randomly distributed.

This project could be separated into two components; one tracking the more common species and one tracking rare. The later would require highly trained observers to identify some rare species, which will be a serious limitation given the planned departure of one trained individual in May 2006.

The proposed transect sampling scheme would measure an index for the more common species. “Hot spots” along these transects would be identified for sampling for the more rare species. The “hot spots” have even lower inference to population conditions than the transect sampling. However, as the PI stressed, these rare species are hard to find, and it is unrealistic to spread sampling randomly across a very dense and challenging habitat.
One approach would be to use the transect sampling to measure an index for the more common species, and as an experimental evaluation of fencing treatments (although there are several caveats for this treatment evaluation – the design could be seen as a single replicate that would not allow for any inter-replicate analysis; and, as the PI acknowledged, management actions and site conditions are plastic, and changes in actions and/or conditions may negate a treatment analysis). This approach, then, could augment the limited index sampling with a more widespread, randomized sampling at HAVO and other parks, in order to provide some probabilistic estimates for at least some species at multiple parks. However, that may be unlikely to occur given funding and staff constraints.

The PI states that the focus on these species is reasonable, given the difficulties of insect studies in Hawaii. This particular group is well-studied and can be used as an indicator, although it would be of interest to I&M managers to learn what other species could be good invertebrate indicators.

BATS

This team has made progress in compiling and understanding existing data and knowledge on the NPSA flying fox.