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ENDANGERED SPECIES RECOVERY COMMITTEE

15 APRIL 2014 MEETING MINUTES

East-West Center
Rooms 3121 and 3125, John A. Burns Hall
1601 East-West Road, Honolulu, HI 96848

MEMBERS: Scott Fretz (DLNR-Division of Forestry and Wildlife), John Harrison (At-Large Member), Patrick Hart (At-Large Member), Jim Jacobi (US Geological Survey), Greg Koob (US Fish and Wildlife Service), Gordon Tribble (US Geological Survey; in audience).

SPEAKERS: Angela Amlin (DLNR-Division of Forestry and Wildlife), Frank Bonaccorso (US Geological Survey), Joy Browning (US Fish & Wildlife Service), Dawn Bruns (US Fish & Wildlife Service), Mitchell Craig (SunEdison), Reggie David (Rana Biological), Marcos Gorresen (Hawaii Co-operative Studies Unit - UH Hilo), Cris Hein (Bat Conservation International), Dave Johnston (H.T. Harvey & Associates), Ling Ong (SWCA Environmental Consultants), Corinna Pinzari (Hawaii Co-operative Studies Unit - UH Hilo), Diane Sether (US Fish & Wildlife Service), John Vetter (DLNR-Division of Forestry and Wildlife), Ted Weller (USDA - Forest Service),

AGENCY STAFF: Jodi Charrier (US Fish & Wildlife Service), Kirsty Gallaher (DLNR- Division of Forestry and Wildlife), Leila Gibson (US Fish & Wildlife Service), Afsheen Siddiqi (DLNR-Division of Forestry and Wildlife), Jon Sprague (US Fish & Wildlife Service), Katherine Cullison (DLNR-Division of Forestry and Wildlife).

FACILITATOR: Teya Penniman

OTHERS:

Derek Brow (William S. Richardson School of Law - UH Manoa), Matthew Burt (Directorate of Public Works), Paul Conry (H.T. Harvey & Associates), Dave Cowan (SunEdison), Lisa Ferentinos (Ko'olau Mountains Watershed Partnership), Justin Fujimoto (Naval Facilities Engineering Command), Michelle Mansker (US Army Garrison Natural Resources), Lisa Munger (Goodsill Anderson), Allan Nakamura (USDA - Wildlife Services), Ben Okimoto (Honolulu Zoo), Gregory Spencer (H.T. Harvey and Associates), Matt Stelmach (SunEdison), Joel Thompson (WEST, Inc.), Carolyn Unser (SunEdison), Johanna Valente (SunEdison), Marie van Zandt (Auwahi Wind), Eric Vanderwerf (Pacific Rim Conservation), Karen Wattam (SunEdison), Brita Woeck (Tetra Tech).

Chair Fretz called the meeting of the Endangered Species Recovery Committee (hereinafter referred to as the "ESRC" or "Committee" to order at 9:00am.

ITEM 6 **Resource Equivalency Analysis.** ESRC recommendation on the use of the REA model, type of research needed to fill model gaps, and potential for mitigation credit.

Resource Equivalency Analysis (REA) Overview and Gaps (*Ling Ong, SWCA Environmental Consultants*)

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Ong introduced the work that SWCA has done with Resource Equivalency Analysis (REA) to date, and mentioned that this presentation was an abbreviated version of the presentation given to the ESRC in February 2015.

REA is an environmental economic model to quantify the loss of natural resources and to determine the amount of mitigation required to offset the loss. A previous example of the REA being utilized to determine bat mitigation at wind projects is the Pioneer Wind Trail project in Illinois. The current guidance from the US Fish and Wildlife Service and the Division of Forestry and Wildlife on Hawaiian hoary bat mitigation is restoration of 40 acres of forest per pair of bats, which is based on the estimated size of the core feeding range.

Ong introduced the use of the REA for the Hawaiian hoary bat and its assumptions. The currency of measurement used was resource years (or 'bat years'). The analysis included an inherent economic discount rate. Each year of take was discounted by 3%, which is supposed to address resource value today verses future value in the future. REA models used to estimate resource replacement after oil spills employ a discounting rate that will value the resource less in the future, and is said to motivate earlier mitigation, and allow for greater benefits for starting mitigation earlier. However, it was mentioned by a participant there is concern from USFWS staff that this may violate the ESA, because consideration of economic effects in listing decisions indicating that species survival cannot be traded for other benefits. The example model included 39 bats over a 13 year time period. An approximate age distribution of the bat population was required to estimate age-dependent survival rates. Other parameters were estimated as follows:

- Maximum lifespan: 12 years (based on mainland species).
- Juvenile to adult survival rate: 48%, with juveniles maturing at one year of age.
- Annual survival of adults: There was no data for hoary bats (in both Hawaii and the mainland). Surrogate species with a range of adult survival of 55 – 91% were therefore used to estimate adult survival at 85%. A higher survival rate was chosen because it was conservative and allowed mitigation for more bat years.
- Reproduction: Assumed to be the same for replaced populations.
- Resource gain created by the mitigation project: Assumed to be forest conservation maintained for 10 years (years 3 to 12 in the model). This was based on US Fish & Wildlife Service and Division of Forestry and Wildlife estimates that 40 acres of forest could support a pair of bats.

Bonaccorso suggested that 65 acres might be a more appropriate area to support one bat, based on recent research and further stated that bats breed only below 1,000 meters in elevation. Projects such as Kahikinui provide benefits to bats but do not preserve bat breeding habitat.

Ong stated that according to the model, each bat killed would have lived on average another 4.62 years. Similar modelling processes had been carried out for the Indiana bat and Marbled Murrelets, and could be compared to that for the Hawaiian hoary bat. If multiple generations of bats could be protected, mitigation could be increased while protecting a smaller land area. Management consisted of maintaining existing forest or preventing the degradation of existing forest, but not creating a new forest. There were questions about surrogate values (which were conservative), but it was highly unlikely that these values could be obtained from research if this wasn't even available for mainland species.

REA Precedent and Path Forward to Utilizing REA Model (*Diane Sether, US Fish & Wildlife Service***)**

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Sether provided an overview of an REA model the USFWS had developed for the Indiana bat. In this model, the currency was "bat-years" which accounted for lost reproductive services (but did not include pollination or pest management services).

Debits and credits in the model had been based on the median breeding lifespan of the bat. Sether stated that a discounting rate is not appropriate for endangered species, because the Endangered Species Act 'prohibits consideration of economic effects in listing decisions, indicating that species survival cannot be traded for other benefits. Therefore, the value of a listed animal taken does not decrease over time'.

The model for the Indiana bat had a credit side and a debit side, and each side incorporated a demographic model. This is where the survival and breeding rate components were included as credits through mitigation or debits lost through take). The so-called mitigation modules are where the mitigation valuation is included in the form of three models: a summer protection model (maternity colony), winter protection model and summer restoration model. The modules were developed based on data which allowed for significant confidence in them; more modules could be created but this would be dependent on the availability of data of sufficiently high quality so as to make them defendable.

Fundamental assumptions of the summer protection module included the following:

- 46 acres of summer habitat could support one female bat.
- Misestimations of credit gain due to local variation were accounted for in the aggregate, meaning that if a few more or a few less bats are produced by one project versus another, the aggregate of all mitigation should still work out to no net loss.
- Bat take occurred at two years of age.

Overarching conditions of the model included the following:

- All mitigation must have a summer component to account for uncertainty that some of the other modules have (to ensure that enough bats are replaced to account for lost reproductive services).
- Minimum area of 46 acres (enough to produce one female bat).
- The habitat would be permanently protected.

Sufficient funding was available for the study of the Indiana bat therefore there was a high degree of confidence in the life history parameters used in the model.

For the Hawaiian hoary bat, however, parameters on the stationary, declining, and increasing population condition were all lacking. These parameters represented a snapshot of the population condition of that locality in a moment and were important to include in the model as they could affect how quickly the reproductive services are gained or what the effect is when bats are taken.

The point was raised that Hawaiian hoary bats seem to have high site fidelity. It was asked that if bats were being taken at a certain location, could this then be considered a declining condition? This should be kept in mind when formulating future modules for this species. It was also noted that the model was fairly robust for the parameters themselves, but the lambda (or population growth rate) really did have an effect on the number of acres or the mitigation required.

Conditions for the winter habitat protection model included the following: Caves can be used as suitable habitat for mitigation, but there must be evidence that there is a high likelihood of disturbance by humans at that cave (for example, evidence of disturbance and easily accessible to people). The other required information was the number of vulnerable bats in the cave which would have died if not for protection of the cave. But due to high uncertainty (i.e. regarding whether humans would have vandalized the cave in the future), this module couldn't be used alone.

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The conditions for the summer habitat protection model included that there must be an imminent level of threat to the habitat in the next 10 years or there must currently be less than 20% forest cover. The carrying capacity varied significantly depending on what the project was mitigating for or what the action was contributing to (e.g. foraging habitat, roosting habitat).

The summer habitat restoration model assumed the existence of a nursery colony and that the foraging area would increase (thereby gaining credits at a foraging rate). This provided an incentive to select for highly degraded areas.

This model took into account the likely lag time in habitat creation, with zero utility foraging for the first eight years. From years 8 to 25, the model included a stepwise increase in credit (half credit at 25 years and full credit at 50 years).

More information on demographic characteristics is required for the Hawaiian hoary bat, Population growth rates and carrying capacity information would also be required to support the development of robust models. Possible modules included winter protection / summer protection / elevational modules. The model would have to be sufficiently robust to be considered defensible in court.

Gorresen wondered about how the range size had been determined. Sether replied that radio telemetry had been used, specifically looking at nursery colonies.

Cowan asked how acreages had been reconciled. Sether replied that the minimum had been set at 5 acres with a composite of at least 46 acres. If take was set at one bat every 20 years, 46 acres would have to be maintained through, for example, a habitat restoration project. Mitigation would have to be delivered within the permit terms. For example, if take was set at ten bats per year, with a lag time of eight years, many more acres would need to be restored in order to make up the reproductive debit.

Gorresen asked how the effectiveness of mitigation was determined, and how it would be known if bats had been gained over time. Sether replied that this relied upon initial carrying capacity numbers and rates assigned in demographic parameters. Ong asked how difficult it would be to get the required parameters.

Jacobi suggested that validating the parameters would also be a challenge. Craig noted that because the bat was considered endangered, it didn't necessarily mean that populations were currently declining.

Fretz added that the models were based on the assumption that the Hawaiian hoary bat is a habitat limited species.

Vetter asked if credits were one-off or time-dependent. Because the currency of measurement is bat years instead of bats, this effectively makes existing bats more valuable when discount rates aren't included. Protecting bats upfront was therefore still the better strategy, because bat years increased over time. Sether replied that credits were for the time period that the permit was for. The model added a factor of six for mitigation value in highly degraded forest. If populations were declining, the mitigation requirements would be very different than if they were stable.

Conry asked if credit could be used beyond the 50 years. He suggested that mitigation requirements were in perpetuity, and asked if this was always the case.

Sether replied yes, in the case of the bat model, there is the requirement that the mitigation lands be protected in perpetuity. But the perpetuity is not necessarily the proponent's responsibility, so long as the credit outweighs the debits. The eagle model has a 10 year cutoff because mitigation is very different.

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Fretz added that the committee needed to determine the guidance or a resolution on utilizing the REA model. He asked if the public had any comments or questions.

Penniman outlined the key points that had been made thus far. If Resource Equivalency Analysis were to be used in Hawai‘i, there was a lot of uncertainty, including the following questions:

- Which data gaps needed to be filled
- Which variables should be included
- Whether mitigation could fund research.

The current habitat requirements were set by USFWS at 40 acres of forest per pair for the permit duration. Data needs / issues included the following:

- Are bats habitat limited and if so what is the carrying capacity
- Demographic information required including survival and breeding rates
- Size of resource loss
- Degree of suitability of forest cover and composition for bats
- Foraging and roosting requirements
- Prey availability
- Unit of measurement: bats versus bat-years
- Elevation-related habitat needs or use
- Duration of projects
- Predation.

Fretz stated that from an agency perspective, using a similar model might be possible. He said that currently there was a high degree of uncertainty in the model but there is potentially research that could be done to improve the outputs of the model. The model with conservative estimates could be proposed and research undertaken to provide greater confidence in the model.

Hart added that a lot more demographic information on the Hawaiian hoary bat would be required. Bonaccorso added that bat reproduction above approximately 1,000m in elevation had not been recorded. It was known that bats generally moved to the interior highlands in winter (on the Big Island and Maui) because bats were mostly not caught in winter and spring in same locations in the lowlands, but there was little information available on what proportion of bats were vacating the areas. In some areas, it is possible that bats are commuting from the lowlands to the highlands because of a lack of roosting habitat, especially in the higher parts of the Mauna Loa Reserve where there were no suitable roost trees.

Jim Jacobi asked what the limiting factors for bats are. Different islands have different amounts of forest so it is unclear whether distribution is strongly related to habitat. He was uncomfortable with an acreage based model, but thought it was unclear whether another approach could be employed.

Browning stated that the current study showing bats using caves in the winter was funded through a grant dedicated for researching white-nose syndrome. US Fish & Wildlife had looked into obtaining this funding again, but as the Hawaiian hoary bat didn’t seem to meet the criteria for the grant and because there were greater needs on the mainland, it wouldn’t be applied for again.

Amlin compared the REAs for the Hawaiian hoary bat and Indiana bat and asked if it was a goal to obtain the same data upon which the Indiana bat REA was based, for the Hawaiian hoary bat.

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Jacobi added that mitigation should not only consider acreage of habitat maintained but should also consider management of other limiting factors (and attempt to determine what they were). Cowan added that there were different types of forested habitat with different occupancy probabilities; based on this, there were different types of habitat that were more suitable for bat mitigation projects. The same research projects could be used to help answer questions about limiting factors and habitat suitability.

Bonaccorso stated that radio telemetry studies had been done on the windward side of the Big Island. Data had only been obtained for the summer range so far but it revealed bats are using a large range of habitat types including macadamia nut plantations, eucalyptus forests and the Lapahoehoe Natural Area Reserve, suggesting the bat is a habitat generalist (although overall habitat types were primarily wet mesic habitat).

Gorresen added that Hawaiian hoary bat preferences for particular vegetation or landcover types has not been demonstrated; however, this does not mean that it does not exist to some degree. This was known from telemetry data, as the bats seemed to pack into small core use areas in macadamia plantations based on prey availability. The analytical tools available weren't well suited to distinguishing habitat preferences. Areas devoid of forest could be good foraging habitat.

Fretz asked if the area was highly degraded forest with isolated trees, would they roost and breed in them. Gorresen replied that this was possible as a single tree could support a bat. Johnston remarked that the availability of prey species should be added to the information required as this was an important driver for the species.

Weller stated that the model was created by experts, but he was not convinced that the Hawaiian hoary bat was habitat limited. A large scale approach would be required first, with habitat later categorized according to foraging and roosting requirements.

Hart said that the lifespan of the bats was important, as most island species had lower predation and longer lifespans than mainland species. The twelve year estimated Hawaiian hoary bat lifespan seemed like it might be too low.

Fretz added that a basic assumption was that protecting habitat would result in more bats. Landscape heterogeneity and demographic uncertainties made the situation very complex, and the information being provided by the research teams is therefore critical. Fretz added that almost every state-approved HCP that is currently licensed for incidental take for bats will be coming back for amendments of bat take, and will need to be approved by the Board of Land and Natural Resources with a recommendation from the ESRC.

Penniman asked the attendees if REA should be used in Hawaii.

Fretz suggested that applicant could be asked to undertake habitat restoration, and the required monitoring could act as the research to determine if this was having any effect on the bat populations. Jacobi suggested that a power analysis would likely reveal that statistically, but that decisions could not be based off of this information.

Bonaccorso suggested that a potential population difference could be detected. If the population was large too start with, however, changes are less likely to be detected. Gorresen suggested that the occupancy levels at certain sites, for example, Kahikinui, were high enough that a change in population could be detected over a certain number of years.

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Fretz asked if developing a model similar to that for the Indiana bat would be an acceptable approach for the Hawaiian hoary bat, given the degree of uncertainty and whether this could be done in a reasonably conservative way.

Weller gave an example of the impacts of white-nose disease, where population declines for mainland bats were observed even though habitat had not declined.

Charrier stated that the applicants had done restoration and were asking about what the current mitigation recommendations were. It was suggested that now that some restoration had been done, research could be done for the remaining mitigation credits.

Fretz concluded by stating that the potential use of models for the Hawaiian hoary bat would have to be accompanied by monitoring to determine whether this data was accurate.

ITEM 7. Bat mitigation strategies and evaluating mitigation success

Wetland and forest restoration as bat mitigation (Angela Amlin, DOFAW)

Amlin provided an overview of wetland and forest restoration projects which had been undertaken for mitigation credits in state-approved HCPs. The projects were based on agency interpretation of a 2011 US Geological Survey study which found that the mean core area for a Hawaiian hoary bat was 84 acres for males and 41 acres for females (overlapped with males). Bats were assumed to have a 10 year lifespan therefore two pairs were able to use the acreage over a 20 year time period, and so 40 acres per pair of bats was implemented as the mitigation standard. A different interpretation had been used in the Kahuku windfarm HCP, with a core area of 13 acres identified. The USGS study was reinterpreted in 2014 (as it was decided that the median core use area was more appropriate to use than the mean). The median core use area was 20 acres for males and 23 acres for females. The median covers 50% of the core use area, so this was doubled to 40 acres per pair as a conservative measure.

To date, one wetland and three forest restoration projects have been implemented in the state. Two forest projects were located in Kahikinui (on state land in portions of the Nakula Natural Area Reserve and Kahikinui Forest Reserve): Kahuku (the only example of mitigation being implemented on another island than the project area as it was thought that bats were not abundant on Oahu) and Kaheawa Wind Power II (which involved ungulate removal, soil testing and conditioning and plant removal). The third restoration project was implemented by Auwahi Wind in Waihou on Maui.

The wetland restoration project is located at Ukoa pond on Oahu. The site encompasses 80 acres of wetlands and 40 acres of forest. The restoration project includes the removal of aquatic invasive plants and animals, and an increase in forest edge length by creating corridors within the existing forest. This is a combined bat and waterbird mitigation project.

Measures of success for the projects include the following:

- Kahuku: Funds paid to DOFAW and annual reports.
- Kaheawa Wind Power II and Auwahi: Benchmarks at six, 15, and 20 years, including (not in timeline order) fence completion, ungulate removal, forest structure and composition, acoustic monitoring and annual reports.
- Ukoa pond: Acoustic monitoring and thermal imaging, invasive fish and amphibian population decrease, forest edge length, forest composition and bi-annual reports.

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A proposal for a forest preservation project associated with a proposed HCP has also been received, and involves protecting and enhancing existing habitat (relatively intact forest with some invasive species).

Land acquisition was another topic of debate. Some of the questions included whether this would be possible and if so, whether existing habitat would be preferred over potential habitat. Another question was whether land zoned Agricultural, and more likely to be developed, should be a priority for acquisition over land zoned Conservation. It was also unclear whether only acquisition could be done or whether a contingency for management also needed to be included.

Kahikinui baseline acoustic monitoring data (Frank Bonaccorso, USGS)

Bonaccorso presented the results of a study which involved acoustic monitoring across an 8,000 hectare area at Kahikinui Forest Reserve, Maui. Elevational differences between sites were marked, ranging from 1,850 meters to 2,700 meters.

Sampling was done at a variety of habitats including scattered trees with a shrubby understory. Many of the sites were in gulches. The acoustic monitoring devices were mounted on poles, with solar panels for power and the recording unit inside a weather-proof box. The monitoring devices recorded calls, times and temperature data, and were installed by helicopter drop due to the rugged and steep terrain.

The study began in 2012, with the findings indicating higher than expected occupancy at the lower elevations. The study was continued into 2014 to check if the high values were duplicated, but they were not repeated. The reasons for this were as yet unclear, but it was suggested that this could perhaps be related to the removal of ungulates as ungulate waste could potentially impact prey availability (a short-term lag). The long-term benefit of vegetation recovery would still likely result in increases in bat occupancy.

Current methods and analysis (Corinna Pinzari, Hawaii Cooperative Studies Unit, UH Hilo)

Pinzari presented on the equipment, design, and field considerations for acoustic monitoring studies.

The most common acoustic monitoring devices currently being used in Hawaii (Wildlife Acoustics SM2Bat+ and SMX-US Bat Microphone) are solar-powered, and run for a long time. The longest running device so far ran for 2.5 years. The detectors are placed cryptically into the habitat where possible so the bats aren't aware of them. In the experience of the researchers to date, given enough time, bats were detected almost anywhere detectors were placed.

Data obtained was run through filters then visually proofed for accuracy. Data analysis was done using Kaleidescope, CallViewer and Songscope software.

Results included presence and absence data (with ability to distinguish pulses, passes, social behavior, feeding behavior). Carrying out surveys on multiple days made it possible to estimate the probability of bats occurring at the site (occupancy values). Habitat, weather, timing and duration measures could also be included. On Hawaii Island, 22 stations had been used since 2011 with currently only two running. On Maui, 15 stations had been used since 2012, with currently only one running. On Oahu, 31 stations had been used since 2012 with 30 currently running. Kauai had 21 stations with only one currently running. High detections had been obtained on all islands except Oahu (which had a low frequency of occurrence).

The strengths of acoustic monitoring include being able to look at trends, patterns, and behaviors and being able to operate in remote areas over the long term. Limitations include not being able to count individuals (or non-echolocating bats), having an intensive workflow, and the high costs of the equipment. Surveys being done on a project by project basis made comparisons more difficult.

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The five year Big Island study showed that presence correlated with mature forest and seasonal patterns or usage (low elevation in the summer and high elevation in the winter).

Future directions include the development of standardized monitoring protocols. Other data needs for baseline studies are to be determined, and there is the potential to create call libraries, coupling acoustics with video imaging, and creating a database for sharing data.

Craig mentioned that SunEdision had discovered that the speakers slowly lost sensitivity over time although the microphones still appeared to be functioning. Ferentinos said that a relationship between bat presence and mature forest cover had been discussed and asked how this had been defined. Gorresen replied that the information available in the vegetation GIS layer available from the US Geological Survey didn't distinguish between areas with different vegetation structure, only basic landcover types.

Bat Acoustic Monitoring Portal (BatAMP) (Ted Weller, US Forest Service and Corinna Pinzari, Hawaii Cooperative Studies Unit, UH Hilo)

Weller introduced the Bat Acoustic Monitoring Portal, which was first set up in Oregon. It was implemented to monitor bat populations in light of the impacts of wind energy development on migrating tree bats and the effects of white-nose syndrome on hibernating bats. This was measured through remote monitoring of cave entrances using acoustic devices (as white-nose syndrome causes an earlier end to hibernation).

The aim is to capture pulses of hoary bat activity in one area followed by pulses in another area. If there are enough detectors, this can enable tracking of migrations at large scales. To date it has picked up unexpected winter bat activity in Alaska. This could be common or related to white-nose syndrome. Baseline data would be required to confirm whether this was normal behavior, an isolated incident or an indication of white-nose syndrome. The GIS layers built into the system could be used to propose explanations for differences among sites. Detector metadata is required to be added to the system (Data Basin) and there is potential to customize the site for each particular project. However, limited data manipulation would be required and controls are included for the individual uploading the data to designate data to be private, shared with certain individuals only, or seen but not downloaded.

Version two of the site is being planned with interface improvements including improved upload processes, data visualizations and dedicated servers.

A separate subsection of the portal for the Hawaiian hoary bat could be created. It could incorporate fatality data and citizen scientist entries. Many partners were involved in development of the system. Jacobi agreed that it was a great tool for data visualization.

Fretz asked for opinions on what could be defined as mitigation, and whether there was some kind of forest restoration that the committee could agree upon including in HCPs, including the potential to use research to support the mitigation efforts.

Amlin asked if this would apply to current projects as there were existing projects which were ongoing. Jacobi suggested that one approach would be to first identify the aims of the process and then retrofit some of the existing HCPs.

Harrison added that it was fundamental to clarify whether the species is habitat-limited as there are many questions about this. He proposed that some of the research efforts should attempt to illuminate this.

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Jacobi mentioned there are mitigation projects currently underway and there is a need to document whether they have made any difference to bat populations (as well as populations of other affected organisms).

Hart suggested that mitigation could include adding other features (eg. ponds) to increase the supply of food for the bats.

Fretz confirmed that there are many HCPs at varying levels of development. Jacobi suggested a mitigation 'cocktail' that included management and research. Associated questions include how this information is represented spatially. This could be a good opportunity to re-assess projects and determine if the current mitigation efforts are worthwhile to keep pursuing. He foresaw a real opportunity to be very constructive.

Amlin noted that many of the questions already raised during discussion had been identified by DOFAW staff for the discussion section to follow.

Fretz asked if the committee agreed with habitat restoration being used to mitigate take (when combined with good monitoring to determine if restoration was having an effect); the committee agreed.

Cowan added that the definition of management should be kept broad as future mitigation efforts might be beyond what had been contemplated up to that point. Jacobi noted that the requirements for applicants should be very specific.

Koob asked what was specifically meant when habitat was mentioned, as this could include native-dominated or macadamia nut forests, for example. Jacobi agreed that the definition of habitat needed to be narrowed. Fretz replied that habitat would need to be native forest. Cowan suggested that it might be possible to "make bats" by managing units of habitat to ensure that they are restored in a certain way, with a focus on the structural components. Koob agreed that this might be possible for suitable breeding and roosting habitat but wouldn't necessarily apply to food. He wished to see mitigation also benefitting other affected species. Johnston suggested that the two approaches to mitigation (research and habitat restoration) would be complementary and could be assessed on a case by case basis to determine if the management goals of different species were compatible.

Bonaccorso noted that much of the insect fauna in the lowlands had changed (non-native species) but that the Hawaiian hoary bat appeared to have adapted to this. Ferentinos mentioned the need to determine which native plant species supported the species upon which the bats preyed. Bonaccorso replied that the bats did respond to the Koa moth outburst and that Ohia was also probably a good producer of insects.

Weller mentioned that the dominant models for recovery plans usually focused on habitat but that other factors, for example barbed wire and predators, might also influence bat populations. Bruns added that US Fish & Wildlife didn't consider relieving another entity of take (for example, removing barbed wire) as mitigation. Tribble stated that there was a need to synthesize population-scale data as this wasn't currently being done.

ITEM 8. Bridging the gap between science and management: identifying priorities in research as mitigation

Priority research needed to fill in gaps in ecological knowledge (Frank Bonaccorso, USGS and Marcos Gorresen, Hawaii Cooperative Studies Unit, UH Hilo).

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Gorresen highlighted the priority research which was required to determine seasonal distribution and occupancy trends including the following:

- foraging and home range movements,
- seasonal distribution and occupancy trends,
- food habits and links to preferred habitats,
- roost behavior of mothers and pups,
- demography (which was likely to be incredibly difficult to monitor due to low capture rates),
- behavior at wind turbines (including insect abundance relationships at wind turbines, the prevalence of acoustic activity),
- genetic relatedness and diversity,
- inter-island movement,
- pesticide accumulation (which could be impacting populations but was currently unknown), and
- other emerging threats (e.g. crazy ants).

Browning noted that test results on pesticide accumulation were currently being undertaken, using opportunistic sampling and analysis. Pinzari added that when researchers were trying to determine why there was more bat activity in certain areas they had noticed that lights on fields at night drew in insects and bats. This was a potential cause of mortality that needed to be determined. Bonaccorso also raised that invasive ant species (such as fire ants) were a potential cause of mortality of roosting bats which should be investigated.

Priority research to inform recovery and management of the species (Joy Browning, USFWS)

Browning introduced the US Fish & Wildlife Service recovery plan for the Hawaiian hoary bat. Since this plan was developed (1998), newer information and many more questions have come to light. Habitat requirements were not well known at the time, and are still not understood today.

The proposed additions to recovery plan are as follows (additions in italics):

1. *Conduct island wide s*urvey*s* and monitor*ing* on Hawai‘i, Kaua‘i, Maui *& all other main Hawaiian islands.*
2. Determine specific roosting habitat associations *on all main Hawaiian islands.*
3. Determine annual natural history cycle – *habitat use across the year on all main Hawaiian islands.*
4. Determine food habits *& assess the availability of food resources on all Hawaiian islands.*
5. Minimize disturbance and habitat destruction and degradation.
6. Identify predators on ‘Ōpe‘ape‘a *during specific life stages.* Develop and implement control measures.
7. *Identify usage of barbed-wire and its locations in the landscape to assess impacts to ‘Ōpe‘ape‘a.*
8. *Reduce or strategically use barbed-wire if needed.*
9. Determine if pesticide use, introduced insects, or disease are *really* a threat.
10. *Determine impacts and address new threats as they are identified.*
11. *Quantify genetic variation among populations on Hawai‘i, Kaua‘i, Maui, and O‘ahu.*

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12. *Conduct PVA.*

13. *Determine amount and location of areas needed for recovery.*

For example, the impacts of rat predation on bats need to be better understood. Barbed wire, another known threat to bats, is used for many different purposes in Hawaii. Because the Department of Defense is required to use barbed wire, ways of mitigating mortality related to barbed wire might need to be investigated, for example does placement in the landscape influence potential for collisions.

Many of the questions about Hawaiian hoary bats have not been answered due to a lack of funding, and even data from incidental observations observational data is severely lacking. The gathering of basic data by researchers while in the field (in conjunction with gathering data for the actual research question) would assist with this. It was suggested that researchers start looking for and recording observations of potential predators of bats at different life stages, barbed wire locations, and where and when bats were seen, along with what they were doing when seen.

Jacobi noted that HCA safe harbors needed to be brought into the research and management framework.

Koob acknowledged the lack of funding, but also identified the potential to find new sources of funding. For example, nationally pollinators are given preference, and in this case a possible connection could be made that insect production sites have been lost to try and obtain this funding.

Cowan asked if demographic data from all populations or information on the population as a whole was required. Browning noted that for downlisting, populations on Big Island, Maui and Kauai needed to be stable or increasing for at least five years. Due to a lack of information, it is not currently possible to demonstrate that this requirement has been met, although some researchers have stated that they believe population trends, particularly on the Big Island, are stable or increasing. Additions to the recovery plan, in addition to what was proposed during the workshop, could be proposed. Bruns asked if population size data wasn't required to downlist. Sether confirmed that this was the case, and that populations only need to show a stable or increasing trend.

How genetics inform management (Corinna Pinzari, Hawaii Cooperative Studies Unit, UH Hilo)

Pinzari spoke about the potential uses of genetic data to improve knowledge about demographics, population size and structure, and diet / food webs.

Demographic information could be obtained through the sexual identification of bats, which is easier when using live-captured bats. Applications of this data include take calculations in HCPs, REAs, and analysis of seasonal distribution and gene flow in males versus females. It is also possible to genotype the sex of bats from tissue samples and this approach is currently being tested.

Population genetics studies have been undertaken to determine if there are distinct population segments between and within islands. This same study also aimed to answer questions about the effective population size of Hawaiian hoary bats and levels of genetic diversity. Samples from each island were compared to samples from the mainland hoary bat. This data suggested two colonization events, at 10,000 years ago and 800 years ago. Two distinct lineages were found, with the older clade being represented on all islands and the younger clade on Maui and Oahu.

Current research was focusing on assessing the cytochrome oxidase I marker and suite of microsatellite markers. Approximately 204 samples have been obtained from live caught and dead bats since 2009.

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Next generation sequencing is another current research focus. Food web studies could also be done to confirm the hard bodied insects in the bats' diet (identified previously using other, less robust methods) as well as identify soft-bodied insects, frequency of prey items and identify if any seasonal differences in prey items exists. That data could then be related to habitat (prey and host plants).

There is also the possibility of identifying sub-species or sub-populations related to later colonization events through genetic research and the measurement of morphological characteristics.

ITEM 9. Panel discussion: Determining future mitigation scenarios

Fretz opened the panel discussion on the determination of future mitigation scenarios based on the research undertaken to date and remaining research questions. In his opinion, the overriding question was the status of the Hawaiian hoary bat populations on each island (apart from perhaps Big Island), as this could lead to discussions about what populations were most limited by: food or habitat.

Johnston noted that it wouldn't be possible to do a mark-recapture study and make inferences about populations of bats (open systems). Fretz asked if telemetry and demographic information would be sufficient for this purpose. Gorresen mentioned a new technique which might be able to provide a density estimation, which could potentially be extrapolated to habitat and then population size. The number of acres/bat obtained (to feed into the REAs) was a density measure. The advantage of acoustic detection is the ease of deployment, but it provides a very indirect measure for population estimates.

Fretz wondered about the power of acoustics or the new technique to detect differences in populations over five years. Gorresen replied that the trend inferred from the Big Island study was a stable population. Fretz it might be repeatable on the other islands using the same approach. Jacobi asked if there was anything the researchers would do differently if the Big Island five-year study could be redone. Gorresen replied that the funding for the research had been obtained in a piecemeal manner and sampling had been done across a large area. There is the potential to obtain more accurate data on smaller islands. Pinzari added that it wasn't possible to monitor one area for an entire year during the study. Fretz noted that it had only been a five year study and five years of data on multiple islands was required before considering downlisting the species. Weller added that a less opportunistic study with controls would be required for this. Jacobi suggested investigating ways to make the study more robust and then rolling it out to other islands. Hart stated that there is a need to move from population trends to population size estimates.

Fretz said that if the Hawaiian hoary bat population were stable on the Big Island then something is limiting them, likely to be habitat or food availability. He suggested it might be possible to look at habitats that were not being used by bats. Methods could include acoustic data surveys in different habitat types and radio telemetry data (which might also provide information on roosting habits). Koob noted that he would like to see population density studies being done in parallel with genetics work.

Hein suggested a protocol for collecting data could be used as a way to make the process more efficient.

Vetter said that an important part of mitigation is the need to increase the production of young. He suggested the biggest need is therefore to identify pupping habitat and identify predation pressures. Fretz added that there is a need to identify differences between foraging, breeding and roosting habitat. Browning was unsure of the probability of bats moving to restored habitats. Bonaccorso suggested installing cameras to watch breeding sites and monitor survivorship could be a potential mechanism. Weller asked how many breeding sites had been located so far. Bonaccorso replied that a total of about 40 bats had been tracked, with the success rate of finding roosts currently around 60%. Efforts to radio tag

lactating females could be intensified to obtain this information. Hein added that genetic data, fecal pellets and radio data could be obtained from catching bats. Although this might be an expensive approach, it could yield a lot of data.

Amlin stated that the DOFAW staff had hoped to have a list of the top five broad research requirements as an outcome of the workshop that could be provided to applicants.

Fretz summarized the top five research questions based on the discussions during the workshop:

1. Determination of population size and trends, to be achieved by repeating trend studies done on the Big Island on Maui, Oahu, and Kauai, and continuing to study Big Island populations to determine whether inter-island movement affected these metrics
2. Habitat selection and suitability documentation and modelling for foraging, breeding and roosting.
3. Identification of the limiting factors to populations on the Big Island (which appears to be a stable population according to USGS researchers), including prey availability, habitat and predators.
4. Minimization of threats to bats (operational minimization at wind farm, bat deterrents, bat behavior).
5. Monitoring and data analysis of mitigation activities to ensure that researchers are able to statistically detect whether they were effective and ensure that this is required at sites to the highest degree practicable; over 20 years or more.

Weller suggested that genetic data could be used to estimate the population size since colonization but that it might not be the correct level of resolution for this information.

Bonaccorso asked if there was a conflict between mitigating and recovering a species. Koob replied that mitigating is to make sure that recovery is still possible, and presented a more immediate response to an immediate threat, while recovery is to delist species.

Pinzari asked if the entire state could be considered one population; i.e. if the genetic differences mattered. Fretz replied that if populations on each island could be considered subspecies then it did matter legally and if they were genetically different then this had important ecological implications. For this reason mitigation was generally carried out in the area in which the impacts were occurring.

Browning added that without potential subspecies having been identified, it would have to be treated as a single species.

Hein suggested a focus on the minimization of threats, as he didn't see how populations could be grown without this. For the Hawaiian hoary bat, current research might be closer to decreasing threats from wind energy than determining unknown factors in the basic biology of the species. Other threats to the species also needed to be identified. Bruns stated that US Fish & Wildlife Service might not accept the mitigation of other threats as a form of mitigation (deterrence methods). Charrier stated that further discussion of this topic was needed within US Fish & Wildlife Service.

Amlin mentioned that the HCPs already required restoration and asked for the committee's input on whether monitoring would be required as part of this. Fretz replied that applicants were obligated to complete monitoring, but the committee would have to look at what had been asked of applicants before. This requirement should certainly be included for new projects. Ferentinos suggested that the issue might not be clear-cut, but that if the applicant was going to undertake management, monitoring should be occurring.

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Craig stated that many of the research ideas presented required long-term data collection over a 10 or 15 year timeframe, which would require dedicated funding over the long-term. The upfront costs need to be balanced against the longer-term costs. It was suggested that an imagined or real target cost per bat could be used to guide management and research.

Penniman stated that staff were looking for a percentage guidance about how much could be spent on research, for example. While applications would be assessed on a case by case basis, it would be useful to determine what factors staff might want to consider when making this determination. Amlin asked if the mitigation could be 100% research or management, or what the relative contributions of each should be. Fretz replied that in his opinion, both should be required. There are already four habitat management projects on the ground and attention should perhaps be turned to research, while ensuring that those four projects are monitored closely. Hart confirmed that more research is needed to determine whether habitat management is having an effect on the bats.

Jacobi mentioned that a way of determining the degree of research and how it related to future bat production should be investigated. Amlin added that guidance was required on how to implement this and suggested a subcommittee be formed to propose methods for this. Craig suggested the simplest way to determine this would be to determine the price per bat, and then decide how to best spend that particular amount of money. Fretz and Jacobi agreed but noted that the price per bat might increase or decrease based on future information. Any new project which applied may then be subject to the new rules.

Bruns added that the US Fish & Wildlife Service needed to avoid jeopardy. It would be difficult to argue that this was not the case when doing only research as opposed to management.

Harrison added that at this point, it is difficult to confirm that habitat management leads to producing a bat. Bruns noted that it is known that bat densities are higher in forests on the Big Island than in forests on other islands. Harrison asked if this applied to all forests and whether there were certain ancillary environmental features which might also be associated with the preferred forest types.

Craig reminded the committee that windfarms were financial endeavors, therefore not knowing in the future whether the costs would be higher or lower was an issue for applicants. It should be kept in mind that when applicants are determining costs, they must have some sense of what that cost will be. For example, the estimated cost of a bat had changed from $1,000 to $50,000.

Mansker added that protecting the Hawaiian hoary bat was also an issue for the Department of Defense now that it had been detected all over Oahu, and new research was likely to be done as a result of this. She cautioned that the aim would not necessarily be mitigation, but more to show that the bat is not present in particular areas before they could be used for training. The Department of Defense has many barbed wire fences. These fences are regularly inspected and although this is not specifically for bats, no carcasses have been found to date.

Bonaccorso stated that bat mortality on fences is usually related to the tail membrane (or more rarely, the wing membrane) getting snagged and the bats dying of exposure on fences. Bonaccorso stated that he believed smooth wire was therefore not an issue for bats.

Fretz suggested the potential for putting reflective tape or ultraviolet paint on fences, while Bonaccorso added that aluminum plant tags tied to the fence could help. Weller wondered about the relative mortality from barbed wire versus wind farms, which should be determined. Bruns estimated that 15 bats had been discovered snagged on barbed wire fences. Amlin noted that mitigation could be done for any activity that results in bat take.

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Fretz suggested that staff start taking a look at projects that come through and see how much progress can be made with the first few projects that come in. Some of the research is stepwise, and staff would need an indication of the outcomes before reaching the following step. This research has the potential to turn into projects on the ground with monitoring at a later stage. Jacobi added that a database and data collection protocol to provide to applicants should be prepared. This would help to ensure the standardization of data collection. Bruns said that the US Fish & Wildlife Service is very supportive of research in general, but that it is difficult to link to dollar values and include in regulatory language. Conry agreed and added that proposals which were purely research might be difficult to pass through the regulatory environment. A challenge is how to design habitat restoration protocols so as to answer research questions. For example, habitat restoration at high, medium and low elevations.

Amlin asked about what the next step for DOFAW staff should be following the implementation of on the ground conservation measures. Many questions remain, for example, how to identify priority habitats and the protection of relatively intact habitats versus building forests from the ground up.

Jacobi asked how this could be applied on a case by case basis, with new projects versus existing projects. There were also questions on how to determine net benefit.

Fretz asked if DOFAW staff had any idea of the HCP amendments to come. Amlin replied that there were various scenarios.

Craig said that Kawailoa was expected to have 250 to 300 fatalities over the 20 year project. These estimates were based on observed take of ten per year, with another 25 - 50% added for high search areas. Take at Kaheawa Wind Power I could be 50 more.

Fretz suggested that based on these relatively large amounts of take, 100% research should not be allowable for mitigation. Hart added that research could be weighted towards minimization research. Hein said that it didn't necessarily make sense to mitigate in proximity to wind farms where bats could get struck. Amlin added that DOFAW staff agreed with this. The committee members generally agreed to this sentiment, unless it was mitigation involving deterrent research, which could take place onsite at wind facilities. Hein said that as more information about the bat came to light, it could be used to inform siting of new developments.

Ong added that most of the take is occurring on Oahu, where the lower elevations are mostly devoted to agriculture and urban development. This begs the question of how to balance high and low elevation mitigation. Amlin replied that the research component could be flexible in terms of being done on other islands, but the on the ground mitigation should occur on the same island where the take is occurring.

ITEM 10. Wrap up / overview of workshop discussions. Adjournment

Penniman provided an overview of the discussion topics and findings during the workshop. This included the following:

- Curtailment will be a part of minimization strategy to the extent practicable.
  For deterrent technology, there is the recognition of significant uncertainty with acoustic and UV technology, but that research on technologies may be considered mitigation in some cases.

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- Regarding wind take monitoring, the current approach was evidence of absence with an appropriate confidence interval.
- For tree trimming in bat habitat during the pupping season, the current standard was no trimming or harvesting of trees above 15 feet between June and September.
- Regarding forestry applications, it will take time to develop protocols but the Committee will consider proposed protocols to demonstrate no bats are present with the appropriate confidence interval to consider that as a possibility (with other applications to non-timber related activities).
- Resource Equivalency Analysis was discussed and data needs and options identified.
- Discussion of habitat restoration and monitoring with research components.
- Five top priorities for research were identified, including how it might be implemented and allocated and the various considerations associated with this.

Johnston noted that an enormous amount of knowledge had been exchanged during the workshop and wondered if there was a way to continue the dialogue. Jacobi noted that it was encouraging to see so many people contributing to the issue.

Bonaccorso mentioned that there was previously a Hawaiian hoary bat research cooperative which hadn't met in four years. It could be reconstituted and could comprise non-profits to private industries who were interested in meeting to focus on recovering the species. Fretz said that the group had been very helpful in the past but would require someone to coordinate it. The ESRC had an emailing list and website where documents were posted and this formula could be used for the research cooperative.

Amlin stated that the draft guidelines would be provided to the Committee for comment.

Penniman thanked all for their input and attendance and Fretz adjourned the meeting.