ENDANGERED SPECIES RECOVERY COMMITTEE (ESRC) MEETING
Hui ʻŌpeʻapeʻa Bat Workshop
March 6, 2020 Meeting Minutes

Meeting Location: University of Hawaiʻi at Manoa Campus Center, Room 307/308

MEMBERS: David Smith (DLNR), Jim Jacobi (USGS), Michelle Bogardus (USFWS), Melissa Price (UH), Loyal Mehrhoff (At-Large), Kawika Winter (At-Large), Lisa Spain (At-Large)

STAFF: DOFAW: Lauren Taylor, Koa Matsuoka, Afsheen Siddiqi, Lainie Berry, Marigold Zoll, Tiana Bolosan, Lindsey Nietmann, Taylor Garner, Aaron Works

OTHERS: Darren LeBlanc, Lasha-Lynn Salbosa, Adam Vorsino, Rebecca Frager, George Akau, Rachel Moseley, Theresa Menard, Dave Young, Joel Thompson, Amanda Ehrenkrantz, Marie VanZandt, Marcos Gorresen, Kristin Jonasson, Kristina Montoya-Aiona, Corinna Pinzari, Darren LeBlanc, Bob Peck, Tom Snetsinger, John Ugland, Lesley Davidson, Lily Henning, Sarah Howard, Matt Stelmach, Taylor Shimabukuro, Jason Preble, Ilana Nimz

AGENDA

ITEM 8: Monitoring.

SMITH: The agenda is packed and really there's not a lot of time for interaction, which is really unfortunate. There's also tons of really good people and we want to be able to get through everybody and be able to get information out. So I just want people to think of this more as an information gathering and listening session. You're not going to get all your questions answered; just to manage expectations here. From the ESRC side, we're going to have plenty of time to follow up on this. We're not rushing the bat guidance. We don't have to learn everything today. I would like to follow up with another workshop probably within another year. We'll have another one that's structured for more interaction and just following up on the questions that were raised in this one. So I think this workshop is probably going to generate more questions and answers in a lot of ways, but it's also just giving us a whole lot of information that we can work with. So hopefully everybody finds it of value with something that they can use. Then we're going to try set up mechanisms going forward, both within the ESRC, and within the HCP section, where we can have more interaction and the ability to interact with folks here trying to make as many connections as you can here. Get people's contact information so you follow closely with folks and at the end of the day we'll have some time go back and forth for some questions.

LAUREN TAYLOR: Hey, good morning. Welcome back everybody who was here yesterday and thank you for coming. So we're going to start off the first talk. So the format for the workshop for anybody who wasn't here yesterday is we're trying to do sort of a 10 to 15 minute presentation time with a few questions afterwards. We try to let the ESRC deliberate or ask their questions first and then open it up for public comments. If you have something you want to know you can follow up with presenters afterwards. So we will be having another ESRC meeting after we have had time to digest this information. Then we will work on incorporating that into management recommendations with the Hawaiian Hoary Bat guidance document. So we'll set up a period for comments and also for questions. I can relay through to the presenters or you can ask them directly if you can get ahold of them.

Identifying and monitoring insect prey of bats: Bob Peck, U.S. Geological Survey-Hawai'i Cooperative Studies Unit

BOB PECK: My name is Bob Peck. I'm an entomologist with the Hawai'i Cooperative Studies Unit at the University of Hawai'i at Hilo and also the Pacific Island Ecosystem Research Station based in Volcano, Hawai'i. As a researcher, I've been involved with the bat crew on Hawai'i Island. I've been involved with the most recent study on bats and their ecology. As a disclaimer, I'll be sharing some data but just keep in mind this is preliminary data and is meant to be conceptual just to get some points across. So several of those outline all kinds of key questions and considerations that I want to cover. One is could habitats be characterized in terms of insect prey availability? Is there a kind of a community of insects that can be used to kind of describe or characterize particular bat forging habitats? How does prey change in space and time" Is it static or is it not? I wanted to touch on some methods that are commonly used to sample insect prey. Then what do diet samples tell us? They tell us to some extent what bats eat, but is there more information that can be gleaned from diet samples? I don't think I would surprise anybody in this room if I said that insects are not randomly distributed across the landscape. In fact many insects are very closely associated with either particular plant species, a small number of plants, or particular kind of micro habitat. So I just want to give you a couple of examples, and this is with koa. The late great entomologist Wayne Gagne, he identified 111 arthropod species on koa just along the Mauna Loa strip road in Hawai'i Volcanoes National Park. So clearly it's very diverse but there's really only a small subset of insects associated with koa in this example. They are important and those are the insects that keep us up at night literally and figuratively. So just some examples; here are some moths. I think what's important to recognize is that even within these koa associates there's different levels. For example, there's specialist herbivores that really they're only found on koa. There's generalist herbivores that maybe they're on koa and they may spill over on to 'ōhi'a or 'olapa or a few others but generally a fairly small number of other plants they are associated with. Then there's a small number of scavengers. Those are the real generalists and they're feeding on decaying vegetation or fungi they're associated with so there's different levels. Please keep in mind that the focus here is on moths rather than other insects, so when we talk about host plants it's really the caterpillar.

So it's the larval stages that are important, even though the moths are what the bats are eating. Pasturelands are important in Hawai'i. They're loosely made up of a variety of grass species and associated weeds, and there could be a very rich source of moths in the environment. Not so much in a sense of diversity, but in abundance, but that may depend on a variety of factors including grazing levels and things like that, but mostly non-native and as you might expect the insects are associated with mostly non-native too. Then at least in terms of insects an added value to these pasture lands are livestock, in particular cattle. And there's this, kind of a suite, of insects that are often associated with livestock and they can be directly associated with the animal themselves, like some of the flies they can be associated with the cattle dung such as our dung beetles. Then there are aquatic habitats like streams and standing water. And those are important for the larvae of a bunch of different insects. Particularly, Diptera for example, can be very localized but they can also result in very high numbers. Bats certainly forage over wide areas, and then there's urban effects too. There's termites associated with buildings where you get flights of termites. Again a very ephemeral resource that can be very rich for bats that will take advantage of it. Then lights and soccer fields are really not habitats, but they are drawing in bats and habitat is generally in the area. I wanted to characterize foraging habitat and whether or not it's something that we could do and it is a goal that we have and probably a goal shared by others as well. If it's a simple habitat we have maybe just a couple of grass species for example, then it's probably a fairly easy task to characterize that habitat in terms of the insects. But if it's very complex you can have a lot more species and it's a lot more challenging.

So I just kind of want to use our Amaulu study site as an example and I consider this is kind of moderate complexity. It's kind of a mixed orchard at the bottom, there's a grassy area, there's windbreak made up of a single tree. There's up to the Wailuku River and this is just above Hilo. So this is just preliminary data of two nights of collecting insects in the fall of 2019. There's two collecting sites, they are about 150 meters apart. We replicated for two nights. So a total of 14 moth species and here they're kind of lumped into at the family level just for simplicity. If you look at the two pie charts on the right, you see that there are generally three that kind of dominate the samples. Then if you look on the left those are a little bit different. In the pie charts these are relative abundances. See that they're a little bit different. The take home message is that even though you see a little bit of spatial differences, the make up of these samples generally the same across this area. Even though I'm not showing you other sites, at a site a mile down the road in a very different habitat, the moths that would be associated with that would most likely be different. It's important also to think about how moth abundance may change over the course of the night. So as we're sampling we partitioned in the 30 minute sampling period starting at 30 minutes after sunset. Then we collected for three hours. This is the pooled data set; hopefully you can see that there are differences among the taxa. This is family level, but they're dominated by an individual species. If we just look at the Crambid moth, which is the dark blue, you can see that it peaked in abundance at the second sampling period. Then over the course of the night it dropped down to just a few individuals. The night before, which is the yellow one, we can see it was different and it kind of peaked and then dropped down. That's the point—that there can be differences over the course of just a three-hour period—and abundances are the activity of these moths. It could be due to several reasons, we don't really know at this point, but it could truly represent the kind of the evening phenology of the insect or it could be associated with temperature or something like that. At high elevation sites we know it's a real factor.

Another way to look at the data is to look at the size class of the individual moth species and they're not all the same. This moth, which is common, is a smaller size, 5.9 mm. We measured every moth. This moth was 16 mm on average. So this is quite a range in sizes. I think it's important to think about prey size because it may matter to bats. For example, if there's a certain minimum size class that they don't feed on then we don't need to think about them in terms of our analysis and the same goes on the upper size. It is important to think about when you're assessing just how they are distributed by size. Maybe the bats don't really care. Maybe it's about size and not about taxa. The last of this data set we've sampled three times. This is our first of two years. So this is the same site and the same methods over time. We also sampled in June and March and it was approximately the non-breeding and non-pupping season. Then we have the breeding season that kind of shows those windows. This was the dominant time and as you go backwards in time, in June there's some lesser percentage and then March was a very small percentage. In contrast, this is a single Noctuid that was in very high abundance in March, still present in June and then still present in September. So the point here is that at the same site over time you do get differences. That's not surprising. And this is a fairly high number, almost twice as many, and it was driven by this Noctuid species. It's changed over time, not surprising. But what I think the take home message is is that the overall community was similar over time. So that contributes to our being able to characterize what a habitat looks like in terms of moth community.

So now I just want to talk about some methods that are commonly used to trap insects. There's a variety of methods but ultraviolet lights are generally used to attract moths and one common method is a bucket trap and here we have a light and there's a transparent baffle in there and the moth has attracted to the light, it bumps into it, and then it drops down into a funnel and is collected in this bucket. The advantages of this method are that it's battery operated—we can set it up and you can walk away and you come back—and you can use timers, so if you only want to collect during say, three hours. So those are real advantages, but some of the disadvantages are it misses some taxa. Some will come and they just don't effectively fall down into the funnel so it's not a perfect system, but it is very convenient. Another method is hand collecting on a sheet and that's what we use in our study. So we would be there standing at that sheet and we would collect moths, flies, and beetles as they came in. It's highly effective because we feel like we get almost everything. It's also very easy to define time interval so we can get some temporal resolution. So it's very effective at associating with bat guano samples. If you get a guano sample at a certain time then you can say these are the insects that come out during that time; it makes it more valuable and informative. The drawback is it's more labor intensive. You have to have somebody at the sheet monitoring it for that period of time. But overall limitations are that to measure relative abundance it's not absolute abundance so it's hard to say how many individuals there are per area, i.e. moths per hectare. We really don't know how far moths are coming in to the light. So these are the different methodological things that need to be worked out to really maximize the data set. There are trap biases too and it's subject to environmental effects and activities like moon phase and temperature. Other methods are malaise traps that are commonly used to trap insects. The method people don't think about too much probably is hand collecting caterpillars. That can be very effective if there's a particular taxa that you really want to focus on. If you collect the caterpillars, you actually can get density estimate so it can be reflective that way. It's essential for identifying host plants. That's something that we've been doing. If you collect off host plants and barcode it you can figure out what host plant that moth is associated with.

I just want to present some data on diet studies just to talk about what the diet of bats can tell us. So this is just an example. This is the data that were collected by the USGS at the Waihou mitigation area on Maui. So these are diet samples from eight bats that were meta barcoded using Corinna's wizardry and resulted in a set of 24 Lepidoptera taxa. Again, the beetles and flies and other data are not included here, but just focusing on moths. The points of this table are that there's a relatively small number of taxa of that are dominating the samples and to be clear these are numbers of DNA barcodes, but it's not necessarily a number of individuals. But anyway, it allows us to think about the samples and so I used the boxes to highlight the ones that had the most number of breeds. The boxes on the right are host plants that we think those moths were associated with and that information is mostly from the literature for these species. This one is very interesting. This is Eupithecia, this is our native group of predatory caterpillars, although there is one species that is a pollen feeder on ʻōhiʻa. But many of them are predatory, still associated with plants but not necessarily as herbivores. This is Noctuid, made up of several different species and very abundant in samples of DNA. It is found in grasses and various plants. It's habitat is a mix of pastureland and then native plants. So this can tell us the kind of taxa that are identified. Sorry these are identified to different levels. Some to the species level, some to the genus, and some to the family; that's basically restricted by the barcode data. That's our available resolution. But the more we know about the vegetation that they're associated with the more information we can get out of the diet and the better we can link bat forging areas to the availability of the host plants and structure.

In summary, it is possible to characterize habitats to the composition of insects. It's realistic to think that bat foraging areas can be estimated based on diet, but it's going to require more information on host plants and prey assessment methods. It's most informative to coincide the prey sampling with the collection of guano. So if you're trying to interpret the guano, the temporal and spatial components are important. That's what I have for you today.

JACOBI: Time for questions. Bob, you talked about the limitations of the different sampling methods and the advantages of them. Do you think the sampling at the level you were able to do is representative of where the bats are foraging?

BOB PECK: Yeah, it's a limitation of the light. So they're drawn into light in three dimensions. We don't know how far we're drawing in. So we talked about that with mark-recapture types of things to see how far you can draw in moths.

JACOBI: Is there an advantage of trying to do a pilot study to see if you can sample at higher altitudes and see if that's corresponding?

BOB PECK: I think that would be awesome.

DAVE JOHNSTON: What was the reasoning behind not collecting during the winter?

BOB PECK: We are collecting during the winter. And so we partitioned the year up into thirds based on the life history of the bat. And so even though I said March that really spans December… so it did include winter months and we have eight sites that we're moving amongst.

DAVE JOHNSTON: Thank you very much.

Reforestation and habitat enhancement, and insect prey availability: Marcos Gorresen, U.S. Geological Survey-Hawai'i Cooperative Studies Unit

MARCOS GORRESEN: Hi, my name is Marcos Gorresen. I work for the Hawaiʻi Cooperative Studies Unit at UH Hilo in cooperation with the USGS Pacific Islands Ecosystems Research Center (PIERC). I co-lead the bat project with Karen Courtot. We were asked to present on bat monitoring. In general, we were scratching our head a little bit because there’s some good examples of what’s already being done out there such as the WEST study with acoustics. So we came up with several topics that were proposed to the ESRC and answering some of the driving questions in terms of bat impacts and how to alleviate them. The questions that we like to use are reforestation, mitigation assessment, how to estimate bat density and population size, and how to monitor bat activity either at specific sites, such as wind turbines, or in habitats with the thermal video. I’ll follow up with another talk on some of the results of the activity monitoring at the wind turbines on Maui.

So one of the questions that we get a lot is how to offset bat take and does mitigation do that? It’s a difficult question to answer. It’s a little more easy to focus on specific applications, like does reforestation in particular affect habitat quality and to drill down further, how does quality change as a function of insect prey availability and bat roost habitat that is restored? So in general that requires assessing insect biomass compositions such as moths in our current study. We also want to look at bat activity rates and behavior at the sites that are being restored. This approach would need to compare land cover types over space because we don’t have a time machine to look at how a restored area improves over a 20 or 30 year period. It’d also have to be done at a fairly large scale so we don’t have a spillover effect from a small area in a sea of the lesser quality habitat. So that would be done at a landscape scale. As we were thinking about this, we were wondering what areas might be suitable. We are familiar with the east side of Mauna Kea in the Hakalau region just off of Manā road. Which actually has several sites that fall within the same elevation and precipitation range and the same climate zone, and actually has very distinctive land cover types of a suitable size of three to four kilometers in size. There probably are a number of other sites across Hawaiʻi that are equally suitable in terms of having a range of habitats. This area was nice because it has pasture which is a landcover type that is considered for more reforestation.

The other end of the spectrum has mature forests with covered understory within the Pua Kala area of Hakalau. This unit has an area that has been reforested over a 20 to 25 year period and also has another other land cover types in the same climate zone that I that might be a mix, such as pasture with large trees. So here’s the picture for those of you who aren’t familiar with the area within Hakalau that’s been reforested over that 20 to 25 year period. The area is looking fabulous and there’s still a lot of work to be done to bring additional species in. It’s primarily koa-dominated reforestation that’s quickly changing. Then right next door is mature forest. This is a fairly extensive area with some road access which is important for any kind of bat assessments or insect biomass changes. As Bob mentioned, we’ve got a number of techniques for sampling insects. We’ve used a thermal video in the field a lot and we’ve got this cow proof/bullet proof set with a camera on it and a standard acoustic protector. So those methods sample activity and inspect the availability at fairly local and near scales and ranges. But there are other methods that are worth considering. Dr. Pat Hart from UH Hilo contacted me and said it’s part of their seabird tracking radar around Mauna Kea that they were picking up a lot of bats. He’s working with Rob Diehl from the USGS who has developed the algorithms to distinguish between birds, bats, and insects. Here’s a screenshot of what he sent me in the black circle there; you can see these blue trails which are bats in this particular example. Rob Diehl’s algorithms allow them to partition these apart instituting the snapshots this is reporting continuously with time slices throughout the night. You have samples of regular time intervals. Interestingly his truck mount set up is very mobile and the radar can be tipped on the side. So it normally operates like this and you get a horizontal profile of what's flying up here and it's shown on this graph here. But it can also be tipped on its side and it generates a slice through the air and it will take a sample of the vertical profile of everything that is flying up there. Pat, having worked with us for some time said that insects are reliably detected out to at least 500 meters which is a good height to sample insect and bat activity. Larger targets of bats and birds could be looked at least one kilometer further. Just putting it out there that this is a nice site for this kind of research. We want to build in spatial replicates. As Bob said, there's variability locally from site to site so you want to replicate that as best as you can. Probably also over a couple different seasons and depending on the response variables and methods you could use an ANOVA or MANOVA to analyze the data. So that's what I have on this topic. Any questions before I move on to the next?

THERESA MENARD: Is that upper Maulua, that 20 year restoration site in Hakalau?

MARCOS GORRESEN: Yes.

SPAIN: So this is in the initial development stage?

MARCOS GORRESEN: It's not even in the development stage. I was asked to present on how we monitor for bats.

PRICE: You used the term that this could be used to define habitat quality. Can you just define habitat quality?

MARCOS GORRESEN: Yes, this would be gauged by essentially what is available to bats foodwise. It doesn't take into consideration necessarily what those areas were like in terms of like, roost cover. It'd be more like bats would go from where they are roosting into these areas. We're doing some work and are finding that bats are using a variety of these habitats. We know they use them and we're trying to get a handle on relative use over time.

PRICE: So it's a measure of use.

MARCOS GORRESEN: It is. So we'd use thermal video as well as acoustic sampling and radar to get different aspects of bat use in the area.

PRICE: My reason for asking is just because we have to eventually move to defining habitat quality in this context by survival and reproduction. And so I just want to caution with the use of the term habitat quality versus habitat use. We're all familiar with that but in this context I think it's so important to hammer on that.

MARCOS GORRESEN: So the other question that we often hear a lot is how many bats are there? It's a tough one to answer given it's a tree bat that's widely dispersed with low numbers in most areas, and they don't aggregate in ways to easily assess. But there may be some methods to get at this. In general, it would require generating lots of point estimates of local density such as what we already do for say, bird surveys. We look at transect and intervals and sample count the birds we hear or see in the area and then model that based on detectability and density. Then you take those numbers that are accumulated over areas, then extrapolate that area and habitat strata. That's how we generate our Hawaiian bird numbers. So to get more specific into the approach, we're going to be able to generate density estimates through camera trapping techniques. Whether it's thermal video or acoustic detectors there's a model out there call a random encounter model but there's a couple of others like space to event models. What's unqiue about these models is they don't require marking individuals and keeping track of identity like we have to do when we survey for birds on a bird transect. These models don't require identification of individuals and they're robust for multiple detections of the same individual, which is often the case when you have a repeatedly bat using the area. They're kind of based on the ideal gas model which may or may not play very well for bats. But you've got the detector out there, a camera or acoustic detector that is essentially picking up things that are flying by and tallying them. So the inputs are encounter rates over time, the flight speed of bats, which is fairly well known but may vary on habitat type. The sensor with the camera field of view and the sensor detection range, which is pretty well-known. We've actually calibrated bat sized targets at different distances and so we know the volume of airspace that is being sampled. Four years ago, we put in the initial RFP to test this and in our tests we took the video encounter rates of several areas and we generated some estimates of two to eight bats per square kilometer which seems reasonable. But we don't know how true that is. There was a paper that just came out last month that used this very same REM model to generate density estimates from insects and detections of bats from acoustic detectors. I thought the author's validation of it was a little questionable because they took the output from the REM model and compared it to the output of another model and it didn't actually have any field verified truth to evaluate their output. So model validation is a difficult one for this. But I think that if radar sampling was done in the area you could use current video and acoustic sampling and use radar target numbers. If you're getting counts for the number of individual bats in an airspace then that would provide the best index of truth that we can get at.

So the approach in general would be to just identify a variety of habitat strata. These are Jon Price's climate zones. Apply spatially balanced designs which is what WEST has done with the grid design on Oʻahu. Generate a large oversample because you're not going to be able to get to all these points. And pair thermal video and acoustic detection at sites. If we can build up the relationship between what we see relative to what we hear we may be able to eventually move away from the use of thermal video, which is a labor intensive process, and apply these kinds of models to this acoustic sampling. I think what we need to do is look at this relationship. The relationship of how many bats were seen to what we're hearing. We've done that in a macadamia nut field here and it's been done in a study at Kawailoa. We did a similar study at Auwahi on Maui. Those are the three locations where we actually evaluate detection rates of these two different methods. If we can get a better sense of how these correlate and if they differ across different landscapes we might be able to apply this as a corrective factor and get by with just using acoustic only sampling which is a lot easier to get out in the landscape and collect data from than video. So that's what I've got for this topic. Any questions?

DAVE JOHNSTON: How long will you need to do that?

MARCOS GORRESEN: This would be an ambitious study because of the scale of it. You're trying to get at different density estimates representative of different habitat strata. For large islands that's going to be difficult. But I think it could be done in a couple years. If there's a good basis of correlations built between acoustic and video detections it might simplify things a lot. Then you can just blend with a lot more acoustic samples like WEST has done on Oʻahu.

MEHRHOFF: So you have a couple sites you have data from? Were those fairly consistent?

MARCOS GORRESEN: The sites differ quite a bit. The macadamia nut field was essentially paired with cameras with acoustic detectors over some low stature trees. That's quite different from our other two sites where we were actually imaging bat activity around wind turbines. In general, they're similar. At the macadamia nut fields, we'd pick 30 to 40% of bats acoustically that we were seeing on the thermal video. At the wind turbines, it was a little bit less than that and I'll go into that in my next talk.

Video and acoustic monitoring of bat activity and behavior at wind turbines on Maui: Marcos Gorresen, U.S. Geological Survey-Hawaiʻi Cooperative Studies Unit

MARCOS GORRESEN: Alright, so the other topic is video monitoring of bat activity and behavior. We were able to collect thousands of thousands of hours of recordings and get little flight specs and decipher it's a bat by flight behavior. We've got by with frame differencing methods you see in MATLAB. It's worked for a number of years but there's a collaboration with USGS and the National Renewable Energy Laboratory to improve our detection algorithms. We're developing open source software tools for video. This will be made available to the public. It's computer vision programming with machine learning so we feed lots of clips of known bats, insects, and airplanes and machine learning processes this for classifying this automatically in real time. It also generates tracks and automates the counting process. It also does this against backgrounds like moving turbine blades and clouds. Later this year we'll have some results from this. It's very applicable for long-term monitoring and other applications like offshore wind turbine monitoring. Essentially, it does this for us which helps a lot. This is just very basic protection and the output of this is of great use because it generates the data automatically. You don't have to go in there and verify every single speck that flies through. This is another application for the Mariana Swiftlet in a cave in Guam. This measures the number of swiftlets going in and out at dusk. This is very difficult to do by eye. We have this automated and it's been a big improvement for us and will be made available to the public soon. I've got one more talk… any questions?

This next section is not application of video monitoring, it's a study that looked at investigating bat behavior at turbines and relation to bat activity and wind speed. They also looked at the reliability of acoustic monitoring to determine the presence of bats. They have these tower mounted cameras four meters up from the base. The study was at the Auwahi Wind Energy facility and I want to personally thank the folks for your support on this. We monitored four turbines for a four-month period. The sites are about seven km away from any roost habitat. We sampled over 5,000 hours of video and 3,000 hours of acoustics. The acoustic detectors were mounted on a nacelle and they were operating by natural power. The wind speed means were about 7 m/s and 10% of the time they were at 13 m/s. We get a lot of flight behavior that we go through and start collating. We can see there's detections throughout the year with very low mean rates of detection, especially when compared to Kawailoa. You can see there's a pulse in bat occurrence in this video. Starts about one hour after dusk and calibrates that there's no difference in the duration of night. What you note here, which is quite different from other sites, there's not a late-night pre-dawn pulse which we see in many other areas. So this kind of information helps managers decide how to shift curtailment emphasis focus. They might choose to do it in the early part of the night and offset some of the energy loss by changing the curtailment speed later. So there's actually a very low temporal correlation of bats detected one night relative to the subsequent nights. So there's a lot of irregular use of the area and just very moderate spatial use. They occur in the area but not with high frequency or regularity. The detections are very brief. They last in general for about 21 seconds and average about 50 seconds where you have a couple events where they're working the area over and over. The intervals are also long. You can get the detection and an hour will pass before you get the next one. Bat detections made up 2.5 hours of 5,000 hours. That gives you an index of the relative occurrences. This is the number of detections relative to wind speed and turbine RPM. You can see that turbines are curtailed at certain speeds depending on the time of year and since most detections fall to the left of those lines that translates to 82% of detections were near a turbine when it was curtailed. There was no wind. In general, curtailment seems to exclude a lot of the bat activity in the area.

So the last thing we looked at was the reliability of acoustic monitoring on bat presence. An earlier study at Kawailoa was the first time we noticed we were seeing bats but not hearing them. Echolocation and detection is a function of loudness and the frequency at which it is emitted but it's also behavioral traits that hoary bats seem to exhibit. They may fly silently for periods of time and not echolocate. There's also certain artifacts of sampling like the bat mic angle. So for the results of this particular study, we subset the data so that we looked just at the concurrent video and acoustic sampling periods. We had 294 visual detections. And so we looked at for a tentative window of five seconds before or after the video detection, was there an acoustic correlation. That number came out to 12% of the time. We did that for a two hour window, one hour before and after the video detection, and that resulted in only 22% of the time. And 65% of the bats were flying within 15 meters or so of the nacelle, so we feel like the bats would be in the range of the mic of the detector. So this indicates that they're not always echolocating near the nacelle or the rotor-swept zone. That's all I have. I'd like to acknowledge Auwahi Wind Energy. Thanks.

PRICE: If you had to choose between reducing the number of detectors that you had on the landscape to be able to have kind of a cost equivalent use of thermal versus acoustic, do you feel like you could get equivalent power because of being able to actually get counts, density estimates? You know, there's a trade-off obviously between the density of acoustic versus thermal. Can you just speak to that?

MARCOS GORRESEN: I don't have a good sense of how much the higher detection rates of video would allow you to offset the reduced acoustic sampling design. I think that they're going to give you different kinds of data. For one, the video camera will image much higher in the airspace column, for example, if they're aimed up higher than acoustic detectors can reach. Acoustic detectors can reach 30 to 40 meters and our cameras can reach up to 150 meters. So that airspace differs a lot. So I talked to Joel about reevaluating their sampling they could integrate the thermal video into their acoustic sites to help build that correlation to see if that's giving them different numbers.

PRICE: What's the tallest wind turbine being used in Hawaiʻi right now?

MARCOS GORRESEN: I don't know about the tallest but these were about 100 meters at Kawailoa.

PRICE: So the thermal gets you closer to the height of the turbine. And then can you tell the height of the bat from that?

MARCOS GORRESEN: Yes, so Michael is going to talk a bit more about that with some tree modeling. We have to use apparent size so we need to calibrate the apparent size of the bat in the video imaging. So we classify it into broad groups like, it's very near to the camera, or other different categories. When you look at the videos you see the bat going around the nacelle and that gives you a very accurate measure of it's location.

PRICE: Just a quick note, down the road I think you're in the best position to actually make those estimates of the cost effectiveness for the data quality that you get of those two methods and I'd really like to see that in future presentations.

WINTER: I've got a quick question for Bob. It just occurred to me that the white color might be acting as moth attractants and therefore would be attracting bats. Did that ever occur to you?

BOB PECK: Is it the color or just giving off light?

WINTER: Like it's reflecting moonlight or something. I don't know.

BOB PECK: It is possible. Sorry I don't know if I have a good answer to your question.

DAVE JOHNSTON: I can comment. There's some semi-serious talk about painting them purple, but also the texture can be important. So there's a lot of studies particularly in Europe which show that the turbines reflect like water and there's some places where you can see behavior that's like drinking. Marcos, can you comment more on that?

MARCOS GORRESEN: Yeah, it was Amanda Hail with TCU. Their project basically had observations of bats that were skimming the surface of the turbine. They tried a texture study. Not sure what the results are but I provide those to the group.

LAUREN TAYLOR: Thank you very much for the presentation Marcos.

Thermal imaging software: Michael Schirmacher and Kristin Jonasson, Bat Conservation International

MICHAEL SCHIRMACHER: Here's a little bit about our development of a 3D software. We worked with Marcos for awhile using 2D software. This has specific applications that I think can be used to calibrate the 2D system to really help us. And so some of the issues that I see here: basically you have fatalities that are occurring and reduction strategies are needed. Then there's challenges just how to quantify basically the reduction and taking some of these strategies that are out there. Traditional surveys may give you that information but it takes a very long time and so Marcos has shown that from videos we're showing more detections than acoustics. So we developed thermal video software to basically help us with understanding deterrents and how bats were interacting with them. It has other applications, for instance to understand where that bat is in space, you know, the behavior of the bat. I'll show a video here. It's really important where that is when the bat is doing certain behavior to help us interpret what that behavior might be.

I was tasked with: what's the bat doing and how are they responding to acoustic deterrents? And you know, there's some information that I could get from here, like is it flying through the blades, or is it above or below the turbine? Is it windward or leeward and where exactly is it spending its time? Which is just very difficult to interpret. So I have contacted Todd Hedrick, a professor at UNC Chapel Hill. He donated his time to create this and it allows us to understand where the bats are, where they're spending time, and what they're actually doing there. How many times they're crossing the blade plane. You can also get measurements on the speed and a number of different things that really help us to understand what the bats are doing up there. There's additional requirements that you have to do for this. You have to have multiple cameras or lenses. You have to synchronize the camera; that's something we learned is very important. The targets also have to occur in these multiple overlapping views. Camera calibration, using the scene to kind of find where your objects are in space. We worked on methodology and then also the software to be able to use this. So I was an expert on this 3D stuff. Then Eric said, here's what I want. I don't want to have to subjectively say where I think the bat is or what I think the bat's doing. I want software that gives me the XYZ coordinate and it's in relation to the turbine. And also allow me to export that data so that I can easily do statistics on it.

And so we were able to generate that and so here's a case study of how we've used it in the past. So this is with acoustic deterrents and we sampled this data that's based on 17 nights on one turbine. We alternated between control and deterrent nights with a similar number of tracks based on some of the work that we did with USGS. We found that there are differences in how bats were interacting with the turbine when the turbine was on versus off. We make sure that we separated behavior and examined that. There were very few observations when the turbine was off. But there were a lot more observations when the turbines were turned on and that's when the risks present. That's really when we want to understand behavior. So basically what we found was when the turbine was off the deterrents were working great. We see a lot less time bats were spending around the turbine when the deterrent was active. You see a lot less crosses through the rotor plane and this is great. Then we did when the turbine was actually on and that is when we started to see some issues. So there's really no difference between your control and treatment. We looked at track length. We looked at the number of times bats are crossing the rotor swept area and we're seeing actually a higher proportion with deterrents, but you know, it wasn't significantly different. This gives us more information on what's going on. When it's showing that it's effective when the turbines off. We don't see a behavioral difference between on and off, suggesting that this was likely related to how the deterrents are position and oriented. So it allowed us to basically inform the next steps for this type of technology. It was very valuable because when we first did a deterrent test in Pennsylvania we just did a fatality survey. Basically what we came away with that was we're not sure if it's effective or not. We had no next steps. This allowed us to have information to help move forward.

Another thing we looked at was the proportion of times the bats are spending within five meters of the turbine blade. Basically we see two times more activity for deterrents that you do with the control. I think some of this is just basically orientation, the bats just aren't getting exposed. We had a lot of windward approaches which was unusual. Some of the earlier data suggests that bats were spending most of their time in the leeward. This was when the actual blades were spinning and so we saw this different behavior and actually quantified them crossing through the blade plane and really see what was going on with their behavior and give some suggestions on how to improve. And so it's kind of a proof of concept and that was probably a year of my lifetime grinding through all this. We came back and said we got some good data. People were happy with what they saw and were able to get support from the National Renewable Energy Laboratory and the Department of Energy. Basically make some improvements to the software so that it can be a more cost effective tool. So proving the 2D detection and also tracking as well, because one thing you have to do with 3D is basically digitize the coordinates. So if we have good detection that'll actually do it for us. With field methods we actually figured out a way to use the turbine structure itself over time and take the points on the turbine, like the turbine blade tips, then actually calibrate the cameras. So use everything there that basically gives the information that we need to make it easy for everyone to use. Kind of an additional goal is to use metrics related to 3D such as light speed and target size so that you can filter bats, birds, or insects; whatever you're interested in. And so this would be applicable to other taxa.

I was curious, if we wanted to test the effectiveness of deterrents for Hawai‘i, what amount of effort would we need? Michael Woodley from BCI generated power analysis based on data that Marcos provided just to kind of see what that might look like. We wanted to quantify the effectiveness that you would need and also chances to maybe improve the orientation and placement of the device. So the power on your y-axis, 80% is usually what people go with. Up here at the top, we don't know what the reduction is for deterrents. And so we just put 20%, 25%, 30%, 50%, and 75% reduction and then looking at the number of turbines it would take. We did that for a randomized block design and a Tilley randomized design, which one of them just requires changing the treatment nightly. You can see here some of these results for 30, 60 and 90 days. You can see the longer you sample you're going to get more power to be able to assess how effective it is. We attempted one of these studies before and we didn't have the power to answer this question. The last thing we want to do is waste our time and waste other people's time saying we can do something that we can't. So using data from a site in Hawai‘i, we're able to generate that we can get to this. If the effectiveness is high we're going to get to it very quickly. We're talking about 30 days on four turbines. So I was surprised when the results came out. So I'd say right now, the effectiveness of deterrents is unknown for hoary bats. You have traditional methods that will let us know eventually if it's effective or not, but it's going to take the same amount of time to learn if it's good or if it's bad. We have the 3D thermal video tool that we're eventually going to make available. It takes some technical training be able to use it and so we're still figuring out how to roll that out, if it's workshops or it's beta testing, but we're going to put it out there so people can do it. But you know, it can provide a number of advantages, with using this technology particularly for a minimization strategy that affects behavior and we really need to understand what’s going on. Are we pushing then out to the blade tips or are we sending them somewhere else to go forage? We can see an effect with four turbines over 30 nights and we can buffer that to make sure that we’re going to get an answer over time. There’s a number of applications for this. Thank you.

PRICE: Do you mind talking about how your results compared to like the Illinois study that found that acoustic deterrents deterred hoary bats? Like how do your results compare to theirs as far as proportion deterred, that kind of stuff?

MICHAEL SCHIRMACHER: Yes, at our site, I think it was aligned with the orientation and placement. We didn’t see an effect for hoary bats. So that wasn’t there, but they might’ve seen an increase in red bat fatality. I have to look back and see. This was kind of lessons learned on what we don’t want to see from the deterrents…at our site.

PRICE: Sorry, I’m talking about the published 2019 study in Illinois. I was just wondering if you compared your results to that one? It was the GE study.

MICHAEL SCHIRMACHER: Yeah, so we were working with NRG Systems on their deterrent and I have seen some of the results. I’m going to have to look at the paper. Was there a specific question on the effectiveness of…?

PRICE: I was just curious because across the bat species they compared, hoary bats were consistently deterred each year. It gets compared to other species that weren’t necessarily deterred every year of the study. So I was just curious…

MICHAEL SCHIRMACHER: We didn’t see that at our site. But lower frequency bats, 20 kilohertz, are typically deterred. I think the same system did see an effect down in Texas. There’s another project out there in Ontario where I don’t think they saw an effect. And so there’s a lot of variation on the effectiveness and so I think that it’s basically understanding what the bats are doing, and it could be really just orientation and understanding that. So there’s some lesson to be learned.

Acoustic monitoring data at Hawai’i wind farms, patterns, and regression analysis: Matt Stelmach, TetraTech

MATT STELMACH: Hi, my name is Matt Stelmach with TetraTech. I’ll be talking about acoustic monitoring at wind farms in Hawai‘i. So overall the goal of risk monitoring and wind farms has been to inform minimization. So look at some of the observations that we’ve seen. But overall, this data set represents monitoring from five sites. We have over 20,000 calls. Our data represents 13 consecutive years. We have a lot of data and the generalization can be useful for assessing patterns and I’ll show site-specifics where they would differ from the generalization.

So the seasonality of bat observations at wind farms. This figure shows the mean number of nights with bat detections in relation to observed fatalities. So we see the blue is the mean number of nights with detections and orange is the observed fatalities. So we see a bimodal peak in acoustic activity. We see a pronounced peak in August and September for observed fatalities.

That peak in fatalities kind of corresponds with the post-lactation fledging period. We know that's a period of high energetic demand and fledging is a high-risk period. When we do a regression analysis on the correlation, we see that there's a lot of the variation that is explained by acoustic activity. So if you look at the changes over time here, we have the pass rate per detector night by a year. I show this as a boxplot to show the variation. So this data represents data just from August. I chose a single month so that we would expect similar rates as opposed to having introduced seasonal variation. I chose a high activity period because we're more likely to detect changes. Overall, we see that interannual variability is very high and we have little of that variation that is explained by a linear model. That variability is an inherent property of the data. We have over 3,500 detector nights here. So we just see changes from year to year. When we look at activity by time of night, I have multiple sites represented here. And then on the x-axis we have the time from sunset. We have the median and then quantiles. So we see that the peak in activity occurs early in the night with the concentration of acoustic activity being in the first six hours of the night and the timing and intensity of that peak in activity varies by site. This is consistent with other research. I have Frank's 2016 high altitude data shown here for comparison. And we see a similar temporal pattern where acoustic activity is concentrated in the first six hours of the night. Because the timing of fatalities is not known we can't correlate this acoustic activity with risk. So there's a limitation there. When we look at the relative abundance for wind speed, here we have a histogram of the wind speeds at which bat acoustic detections were recorded. On the left is the Hawai‘i data with the kernel density estimate overlaid. And then we have examples from Europe and the mainland for comparison. We see similar patterns in Hawai‘i. Wind speed predicts a large portion of acoustic activity and three patterns emerge. Overall, acoustic activity is negatively correlated with wind speed. The relationship between wind speed and bat activity is not linear. We have many more detections occurring at low wind speeds. Wind speed does not predict all bat activity. At low wind speeds we may not have bats present and at high wind speeds we may still have bats present.

There's a number of challenges with using acoustic detectors. First of all, many of the presenters have discussed it requires echolocating. We know bats are not always echolocating and have to be in range of the detector. Second, we know that detection probability can vary. Detection can change with behavior. So behavior and detectability can change with habitat, and additionally habitat can bias sampling. So fewer detectors and placed in difficult to access areas. Finally, we can have short term responses, you know, detectability and behavior can be impacted by rain and wind speed negatively and insect abundance positively. I touched on the challenges with assessing trends because of the interannual variability which makes it hard to assess if changes are within normal variation. For applying the minimization measures based on acoustic data, we have this challenge that we don't know the exact timing of fatalities. And so you can tend to generalize either the search interval which can vary but seven days is a common search interval. So I've shown here, wind speed and directions from a seven day interval at 15-minute intervals. You can see the wind speed varies from 0 to 15 m/s and the wind direction comes from all 360 degrees. So the generalization of these longer periods can mask the specifics of the time of a collision. Finally, the method of acoustic detection is typically delayed. So normally you deploy a detector, you wait a period of time, you collect and analyze which can lead to days, months or longer for the detection to be incorporated into your minimization scheme. So I really like this statement. We have to begin with the end in mind and that the experimental design reflects the question asked. There's been varying purposes for acoustic detection in Hawai'i and for minimization in particular it can inform low wind speed curtailment.

But I wanted to take a second to look at some of the goals outlined in the draft ESRC guidance. I'm really optimistic about the use of occupancy analysis. You have the potential for analyzing trends and potentially using it for habitat correlations under the right experimental designs. We have lot of people collecting acoustic data in Hawai'i, but we have no cohesion between stakeholders. If we had consistent methods in a centralized system it could be used like forest bird surveys and have a standard method to evaluate those populations. Aggregating multiple stakeholders under a framework with similar methods, the same experimental design, and the central data collection system, we would improve our understanding of the bat which can be a valuable tool for both agencies and applicants. Here I show Marcos's 2013 publication data. The occupancy analysis has been used to demonstrate the downlisting criteria were satisfied on Hawai'i island. Joel demonstrated some occupancy analysis occurring on O'ahu as well. In the long-term, occupancy analysis is the only real means that we have of documenting the success criteria outlined in the USFWS recovery plan.

I also wanted to talk about somethings that I'm concerned are set up for failure. The prediction of fatality rates. We know that pre-construction acoustic monitoring cannot predict bat fatality rates. Typically baseline surveys are used for HCPs to identify covered species. However, in Hawai'i even in the absence of acoustic data, I think it would be unlikely to predict the absence of bats. And so I would just suggest that we assume new wind sites would have bat activity and use appropriate surrogates to estimate take and not a requirement for mandatory baseline monitoring. For documenting downed wildlife, acoustic activity has limited application and usually post construction monitoring is used. And then for evaluating those interactions with turbines we've seen a lot of good examples of that today. Acoustic activity has been documented both in Hawai'i and on the mainland, but it's application for understanding bat interactions with turbines is limited. Typically our understanding is improved through other research methods and those have been necropsy, thermal, and diet studies. So I wanted to think about where we can go as a community in regard to performing acoustic monitoring uses and research in the future. For informing low wind speed curtailment, which is in theory, that's what we're using acoustic monitoring for at wind farms. The typical metric is that 50% reduction in fatalities is assumed over manufacturer's cut-in speed which means that there's 50% of the variation that is unexplained. There may be room for incremental gains depending on your cut-in speed but we're talking about a small portion of the variation leaving a large portion unexplained by wind speed alone. Understanding that variation is more likely to lead to new minimization or better models for minimization.

There's a few unexplored avenues that I think are promising. In the upper right here, I show a figure from Marcos Gorresen's 2015 publication that shows bat activity in relation to insect activity. A number of studies have shown bat activity and insect activity are correlated and if we had a means of real time detection of insect activity hourly, we may be able to improve our predictive models for bat activity or occurrence at wind turbines. Similarly, there's a few rare but potentially impactful changes. In Banko's 2014 publication, there was a Koa Moth outbreak that was documented at Hakalau National Wildlife Refuge. And the description is that the bats responded to the abundance of moths by compressing active foraging to the first three hours of darkness after presumably reaching a digestive bottleneck. Fire is another potential example. On the bottom here we have data from a poster that Kristina presented at HCC. And this is the before and after pictures of one of the long-term effects of monitoring sites where they documented a decrease in foraging activity in response to a fire. Similarly on Maui, in 2016, 14,000 acres burned and in 2019, 25,000 acres burned. Those same years are associated with higher observed fatalities at wind farms on Maui. We don't know if this is correlation or within the normal variation, but it's rather worthy of further research. Additionally, a few studies have looked at storms and barometric pressure and found varying results. But multiple researchers described bats seeking shelter from storms leading to periods of higher activity either before or after. Understanding how that variation affects risk could be important to minimization. Lastly, understanding the risk to juvenile versus adults could be critical to our assessment of the impacts. The peak and observed fatalities correlate to the post fledging or post lactation period. We currently assume the worst case scenario that all impacted individuals are reproductive adults, but that may not be the case and so understanding relative risk to juveniles versus adults could aid in our assessment of impacts. I think that the ESRC has a large role to play in the direction of future research and the recommendations of the ESRC as guidance could be either in forming new minimization measures or represent a significant opportunity cost. Overall, we need to identify our study question before we get to our experimental design. I think that integrating the acoustic monitoring results of multiple stakeholders has the potential for assessing long-term trends. Collecting additional data on questions we know well is unlikely to yield valuable data. Some potential research topics could help to inform minimization measures. That's all I have.

PRICE: So you mentioned the 2013 study that the pre-construction monitoring doesn't correlate with bat fatalities. There's the 2017 study that shows that bat flight height monitored from wind mass can predict mortality risk of wind farms which suggests that it's a height issue, right? So, can you talk about the height of the typical acoustic monitoring that's used compared to the height of the blade?

MATT STELMACH: In Hawai'i, there have been studies that use both nacelle and ground-based monitoring. There are a number of studies that show that there are differences in activity from ground-based detectors versus nacelle height detectors. One of the things that we'll have to think about going forward is as sites deploy acoustic deterrents you'll be unable to do the nacelle height monitoring, so that may influence our understanding going forward.

PRICE: The thing that's important to me is that by the time something gets to ESRC, the siting has been through a ton of processes. And so there's a huge amount of investment on the part of the wind farm before it even gets to us. And so if there are studies like the 2017 study suggesting that siting, you know, really should consider not just plain old acoustic monitoring but the height of the monitoring that took place prior to selecting a construction site, that would be before it ever got to us. So I just wanted to put that point in because I know that that's something that you at TetraTech do is helping with site selection. Thank you for the broad descriptions and suggestion at the end.

LASHA-LYNN SALBOSA: Thank you, Matt. Couple questions and maybe some comments. I know your presentation covered quite a bit. I just wanted to highlight a couple of notes there. As it currently stands, you're absolutely right. All of the wind farms right now are required to conduct acoustic monitoring of the site, but as it currently stands it’s not being used to predict curtailment efficacy. So that’s something to keep in mind. That’s very difficult to do, if not impossible. But you’re absolutely right. Right now, we do need to find a better use and applicability of the acoustic monitoring. There’s acoustic monitoring that’s being required by all of the wind farms to conduct. That’s a large amount of data and we need to better understand the use of that data. I think it’s very interesting what Matt brought up in terms of pairing it with thermal imagery so that we can actually obtain the information we need and better use it. I also caution, you discussed a bit about using acoustic monitoring at the wind farm site to get some type of occupancy and population indices. I caution with that because there’s a lot of bat behavior interactions that are occurring that we just talked about in the other presentation that could influence any type of characterization of local population at that level. I have a question, you made a statement that of all the sites that you provided that the acoustic monitoring is just making a baseline presence or absence. You mentioned that the acoustic monitoring differs by site. You made that statement, but it’d be interesting to see your thoughts on how that acoustic monitoring data differed by site. You didn’t really talk about that aspect of it. It would be interesting if you could speak to that a bit.

MATT STELMACH: Do you mean the quantity or monitoring protocol at different sites or do you mean the results of monitoring?

LASHA-LYNN SALBOSA: The results of monitoring. You made a statement that in your findings of your analysis that the acoustic monitoring when you looked at the four sites, they differed somehow by site.

MATT STELMACH: I was principally talking about the time of night. So if I showed the aggregated time of night data, you would see very little variation because of the timing and peak intensity of activity differs from site to site. So if you aggregate those data sets, each of the peaks masks another and it would look similar across the night.

LASHA-LYNN SALBOSA: It would be great to drill down further and look at how we can better use this trove of acoustic monitoring that’s being done at the wind farm sites. It is useful, but as our knowledge and our technology grows, I’d like to better be able to use that data for our collective purposes. Have you noticed any change in comparing different height turbines because each turbine seems to get larger and larger and if we have to redo the data every time we get a new turbine, is there a way of just analyzing the relationship between acoustic activity and size?

MATT STELMACH: You can use turbine size as a covariate in an analysis, but I haven’t done that myself.

Implications of reduced echolocation: Ted Weller, Forest Service Pacific Southwest Research Station

TED WELLER: Hi, I’m Ted Weller from the Forest Service’s Pacific Southwest Research Station. We looked at bats flying through this flight arena here. How the bats are interacting with the mist nets and how the bats react to echolocation playback. So we have these four very high resolution microphones out and then three thermal cameras and it’s all kind of hooked up to this desktop computer here. And then the end result is we're able to know the bats' locations in three dimensions. So in this video each time the bat echolocates the location is plotted. So this is how it looks if you follow along. So just looking at graphs in the flight path we recorded 78 different times the hoary bats redirect in the way of these microphones. There were six occasions where they used their normal echolocation calls. Here you can see what an echolocation call looks like. You see expanded intensity, then what you might see is traditional output from traditional bat detectors. So they're long duration, high intensity calls. The surprising thing that we found was that the bats were using what we're calling micro calls. So very short duration call, high frequency call—the type of calls that maybe you would expect from a fruit eating bat or something like that to use. So very different from anything that we're used to seeing from hoary bats. It's frankly something that in both cases a typical bat detector would screenout as background noise.

Then there's the screening part; you know, where about half the time the bats flew over we weren't able to record additional calls. So we were capturing bats and releasing them into the flight arena and having them fly over. Those bats were always making normal calls. So we were determining the micro call detection and trying to learn more about whether the bats were trying to echolocate or not. We had first determined at what distance and direction should we expect to find these micro calls that are very low intensity and high frequency calls. So there was some kind of acoustic theory where we get better results when the bat's mouth is oriented directly towards the microphone, and then looking at the various distances that the bats could be away. We dealt with the micro detection call model for basically this little red circle over here where if a bat was aimed here 95% of the time we would expect to record a micro call. Then in these other areas we wouldn't expect to record any micro calls. When bats are making normal echolocation calls no matter where they are, they're detected because hoary bats are just that loud normally. Here's the same information from the flight trajectory of all these bats and how they are flying directly over all these microphones. Here's the plot of all their calls including when they're flying in an area where we'd expect to not record a micro call.

Now I'll play the videos just to show an example of what we're seeing. So here we have a bat flying directly over the microphone not making any calls. Then at the last second just before he hits the net he turns on the echolocation calls. You can see the sensitivity of the microphone because you can hear the sound of the net being hit by the bat. Here's another video showing the interaction between two bats. So at first you see there are no sounds; then you'll hear the sound of the bat. We saw the bat come in from the left and there was no sound at all. Once they detect each other they start to echolocate and you can even hear the collision of the bats or the bats with vegetation there. Then at the end of the video even when they're way up here and very far from the microphone we're still hearing their echolocation calls. Once the bats start interacting then they were always calling with each other during these 13 interactions that we were able to record.

Then finally the final experiment that we had was a response to playback. So we had a little ultrasonic emitter down here. It's playing either the calls of a hoary bat or a big brown bat. Basically they responded the same no matter which species we used. We'll see how the bats react to that in the video. You can see these bats are very interested in these playbacks. When they're flying over the microphone they for the most part are not making their normal calls. So out of the 29 approaches that we saw, in 23 of those the bats were using the micro calls. The very short, low duration calls. In three cases they were using normal calls and in three cases no calls were detected and you can see the microphones are very close.

So the question is, why are the bats doing something like this? We went through a number of different hypotheses. One is that maybe echolocation calls are very expensive. The other reason is we know that bats use quieter echolocation calls when they're flying near to an object. When they're getting close to an object they may lower the intensity of their echolocation call. The other hypothesis is that they use micro calls to sneak up on their prey. However, most of the hoary bats at our sites don't seem to be feeding. We hold the bats for an hour and we don't see them produce any guano. So we assume they're not feeding. So we think that's not a major reason for this. This could also be something like a social interaction with the bats. All this work we've done during the fall period is when they're mating or making some pre-mating behavior. So maybe there's some reason for them to sneak up on the opposite sex. This is still an open question that we're trying to figure out. We also don't know if they're doing it at other times of the year. As you know we did this during the time when bats are colliding the most with wind turbines during the fall. So there seems to be a strong tie here with all these concepts. When we first released this information some were saying we shouldn't use echolocation to detect the presence of hoary bats. I would strongly caution against that because here is some data from the same exact study area. We can still see that during the late spring and fall this is actually when we capture hoary bats. We don't capture hoary bats during the summer. So this is reflective of the echolocation activity that we're measuring at the site.

So it's kind of a question of scale. Some of these behavioral considerations are out there. They may not be echolocating all the time during the fall. This level of activity would be useful to compare among sites. So we know that there are calls that are not very detectable which has implications for bat detectors that may not detect all the calls if they're flying in silence. It does bring up issues about acoustic monitoring at wind turbines. So there's a number of open questions. We don't know for sure why they're using these micro calls or not calling. We're assuming now that it has something to do with mating. The last thing I'll say is that there was some push back from some of the hardcore echolocation folks saying that they didn't believe it. They said that somehow we might've just missed the echolocation calls of these bats even though we could see from videos how close the bats were. So in 2018, we were using a technique with "onboard" microphones which is a tiny microphone that we put directly on the bat. Then we also glue a radio transmitter to that so when the bat detector fell off of the bat we could then go find it in the forest. We had success with that. We're now looking at the analysis and we are finding that there is some evidence of bats flying without echolocating. It's important to note is that this is not a common behavior that they're using.

FRANK BONACCORSO: Hi Ted, this is Frank. I'd throw out an additional hypothesis, not mutually exclusive with your others but about stealth mode. This is an idea taken over long ago from the 70s in fruit bats, in which scouting behavior is described due to insect abundance in space and time being ephemeral. These bats might be in stealth mode to explore new feeding patches that might be coming available and perhaps just using the micro calls might help them evaluate that. What do you think of that idea?

TED WELLER: I agree, I think that makes a lot of sense. The reason I don't think that's going on here is because we see a lot of interactions among the bats so it just seems like a less likely explanation given most of the bats are not feeding. But if potentially insect abundance is low; maybe that's when they're not feeding and they would have to use stealth. Again it's an open question and I think we will be able to repeat doing something like this in a different location.

Bat Acoustic Monitoring Visualization Tool: Ted Weller, Forest Service Pacific Southwest Research Station

TED WELLER: So this is just something that is available on the web. You can go and find it at visualize.batamp.databasin.org. This is the site we set up for sharing echolocation records. The format of the data is very simple, there's instructions for how to upload. There's a number of other tools here.

This is looking at mainland hoary bats in 2014. Here's a look at the data. We can see a number of hoary bat detections at a specific site. Here's a graphing tool if we're only interested in the Great Lakes area. So this is Great Lakes area and then when during the year they were detecting hoary bats, and how many they're detecting, and etc. So all these tools are still available so you can them for free. The limitation we have is that it's really hard to show patterns over time in a specific species. So then we transition into a new data visualization tool. So this is the way it looks when you choose species occurrences or an individual species occurrence. Then we see the map of all the places of folks that are contributing data including Hawai‘i. You can zoom in and see more resolution on a lot of these things, i.e. the number of species detected. Then you can choose some of these sites. On the left you can see specific information on this particular site, like what are the species detected. Then you can look at the seasonality of the detections or choose one and look at the information at this particular site, like information about the individual detector. For example, what its coordinates were, how high off the ground it is, what kind of detectors they're using. So what we're able to do is, choose for example the little brown bat in the mainland, look at seasonal patterns, and where people were trying to find these particular species and how many they were finding. So if we go through by year we can see for brown bats there's not much activity but surprisingly there is some activity in the Northern parts of the continent, etc.

So if we go to Hawai‘i we can see a bunch of data for the Hawaiian Hoary Bat. We can see there are 239,000 detections for Hawaiian Hoary bat and 5,000 different nights they were detected and from 32 different detectors. So I know Corinna shared some information and the point is that if more people share information this tool becomes even more useful. So you can see where hoary bats occurred and areas where detectors were but hoary bats weren't detected. You can see seasonality of these detections and the year of the data so far. If we had more data in here we could see these patterns becoming increasingly clear and real to us. Then we can ask other questions like habitat associations and modeling the data behind the scenes at an elevational gradient. I'm just throwing out possible things that we can use the system to look at. All the data is accumulated, then we can tap into those data to learn more about the basic ecology like habitat associations and presence or absence in certain places. I talked to the program developer about using the system here not only for acoustic detections but then also add in capture data, siting data, etc. We could represent those with different symbols to try and gather a pattern. The acoustic monitoring portion is here; all it takes is the desire for folks to go in and contribute their data. It would be cost-effective to include all the different types of data. There is concern about privacy with private landowners. So one could go in and specify a certain latitude and longitude but instead we use the North American Bat Monitoring Program's system and rather than disclosing the exact location of the acoustic monitoring you can put in a particular group cell. But that doesn't look like it works very well for Hawai‘i. That's what I have on that and I'd be happy to take any questions.

LASHA-LYNN SALBOSA: I have a couple questions. Maybe you he mentioned this but I didn't catch it. I'm sorry. What are some of the QAQC rules of putting data in here? My concern is that you know, this is a great house for this type of data, but are there requirements to do analysis of calls per minute or temporal correlation before you input data here. I guess I'm interested in the use of it. So for instance if applicants or agencies or someone pulls this up, what are some of the gains that we can get at? Is it just looking at pretty areas of where bats are at? You know, because I'm just wondering what are some of the QAQC rules if any that can be put in place here for such a great tool?

TED WELLER: I get this question a lot. I actually thought this would be a micro concern at least in Hawai‘i about the species identification part of it. The behind the scenes data that goes into it is just a summary of the number of call events per night. It's not by minute, it's not by time of night, it's just summarized daily because this design gets a larger spatial and temporal pattern. If we wanted to switch the system and have it be reflective of minutes within the night I think that could be done but it would take a dedicated person to do that. I just wanted to demonstrate the ease of it. In mainland areas we're accepting all the data the folks have. In this case, I have three of Corrina's data releases from Hawai‘i where they use Kaleidoscope but they went in and hand verified each of the individual call events. Then there are other places on there where people say they don't have any skills and they just export the Kaleidoscope output. So we have to decide if we want to include these. That's a place we haven't gotten to yet. Maybe later we can discuss what that might look like for the Hawaiian Hoary Bat.

ITEM 9. Bat take avoidance and minimization at wind farms. Acoustic deterrents: John Ugland, NRG Systems

JOHN UGLAND: I'm John Ugland with NRG systems. I'm here to speak about bats, wind turbines, and acoustic deterrents. I am probably the newest or most neophyte in the room. I've been in my job now for about six weeks. I'm the product manager for our bat deterrent program. I'm not a biologist and I have not spent much time in the wildlife space. So this has been really a unique opportunity for me to sit here and listen to everybody speaking with such knowledge and passion on bats. The reason I'm here is I took this role because I've been involved in renewable energy for more than a decade over on the operations and maintenance side of things and most of my career has been trying to enable more renewable energy. So I've done maintenance and tried to improve best practices. The last several years I've been in technical sales selling upgrades to make wind turbines produce more renewable energy. So I think my perspective on this problem and issue is a little bit different from everybody in the room. But when I learned that wind turbines and bats were interacting such that bats were being killed and wind turbines are being taken offline, I felt like it was a space that I can really make a difference. NRG Systems is a small company in Vermont; we're a technical solutions provider. We have about 120 employees. We've been in the wind resource assessment space for more than 35 to 40 years. So most of wind projects, especially in North America, have been developed with NRG Systems technology at some point. Over the last couple years, we've branched out into solar monitoring, solar resource assessment, atmospheric solutions, and then our wildlife space is our newest branch.

So I have this slide here. I don't think I need to really get into the issue too much; it's been well covered. But really the issue is wind turbines are an impact to bats, and bats are impacted by wind turbines and they're preventing the generation of renewable energy. I'll talk about the impact to renewable energy that the current strategy has. The existing solution in this space is curtailment.

So what we're looking at here in yellow is an example of a wind turbine. But you see in this example what we would consider a two megawatt wind turbine. So it's capable of producing two megawatts at its maximum capacity. You see here there's this marker and above that the wind turbine is producing its rated capacity, but below that it's not producing its rated capacity. Behind that in orange is a wind speed distribution. So this is looking at a wind project. I'm not sure which one. This is wind speed for every half meter per second from 0 to 22 m/s over the life of the project. If we deploy the minimization technique for curtailments, minimization is trying to achieve about 50% reduction in mortality. There's been an agreement in the industry between owners and operators and the American Wind Energy Association that says below 5 m/s if you curtail the wind turbines you're minimizing your impact to bats and that is about equivalent to a 50% reduction in mortality. If we take it one step further we look at maybe going into avoidance of trying to minimize or reduce by as close to 100% as possible. We're looking at wind speeds close to the 6.97 m/s. I was actually just talking to one of our customers in South Africa. They're up to 8 m/s already. And then when we look at how much of the wind project is below that, that starts to be a big cost to the wind project.

So that brings me to the concept of what is the cost of curtailment? So as we said, minimization is approximately 50% effective. I think Matt was talking about this earlier, and Michael. So there's an opportunity to do better. This slide is a DNV study that was done about a year ago. And these are mainland projects but they're calculating 0.5% to 3.5% reduction in the annual energy production. Most of these projects on the mainland are only impacted for a migration season which might be from July to October or November. In Hawaiʻi, there a year-round impact to bats so there's probably a higher cost. This is something that I am passionate about is what is the replacement energy? We all have goals to achieve renewable energy standards. But if you're shutting a wind project down, what is that being replaced by? It's possible to be replaced by another renewable source, but most of these impacts are at night so it's probably not going to be solar. So does that mean we're protecting bats but allowing more reliance on fossil fuels?

How does the bat deterrent technology work? I have a feeling there's some people in this room that can probably do a better job than I can describe it this but let me give it a try. So this is not a concept that we really developed ourselves. This comes from nature. So there's a species of moths that is able to use a reverse echolocation where it's able to modify or change the sound so that it actually confuses the bat and the bat is not able to chase while the bats are hunting. What we've done with using ultrasound is we've created an ultrasound speaker that generates an ultrasound across the characteristic frequencies of these bats. It broadcasts the sound out and it interferes with the bats' ability to hunt, track, or echolocate. My favorite analogy doesn't work great in Hawaiʻi but when you're driving in fog or a snowstorm and turn your high beams on all of a sudden you can't see anything and you want to turn around and go away and go somewhere else. That's what the bat sees. It's not detrimental for the bat. It's not hurting the bat. But it wants to be out of that airspace. We understand that bats communicate and navigate at many different frequencies. So what we consider a low frequency bat like the North American Hoary Bat or a high frequency bat like the Northern Long-eared Bat. So we built our system to run off six different frequencies from 20 kilohertz up to 50 kilohertz with the idea being that any one of these bats, if they're communicating or trying to navigate the frequency that we're generating with the bat deterrent unit, it is blocking their ability to navigate and then they're going to turn around and exit the area.

We've done our best to ensure that we're minimizing the impact to the bat. So we had somebody ask me one time why don't we just create a big dome around the wind project. The physics of ultrasound don't allow us to do that. But we're also really minimizing impacts to the bat's natural habitat. So we're not excluding them from where they would otherwise fly or forage or hunt. We're doing our best just to exclude them from the rotor-swept area.

Here's one of our systems installed. So that's one speaker and another speaker behind it. So it does depend on the wind turbine style. Most wind turbines require five or six deterrent units and they're placed so that we're creating a sound field around the rotor swept area. In 2018, we participated in two studies. We did a study in Illinois using 30 turbines that are 15 control turbines, which were configured to operate normal operation. So that means no effect or no changes were made to the turbine. So it was allowed to startup and shutdown as was originally designed. And then there are 15 treatment turbines. And in this case, they did have a few extra deterrent units on them. This is actually a two-year study; the first year we had five, the second year we had eight. We're testing the effectiveness of installing them on the tower itself as well. So in this case the treatment turbines were the systems themselves plus a 5 m/s curtailment.

The second study we did was in Texas, which is a random block design. So that means we installed the deterrents units on all 16 turbines. And so these studies were done before I joined NRG. I believe it was done every other day or every two days. We would randomly switch the turbines that were curtailed versus the ones that had treatment. So in this case, if it was a control turbine, even though it had the system on it it would not be running and it would be operating feathered to cut in speed which means the blades are kept parallel until they hit their cut in wind speed but there's no change to the actual cut in speed itself. And then the treatment turbines had just the deterrent unit. No curtailment. So this is so the cut in wind speed would have stayed the same.

Both had a large search area. I think the ones in Illinois were searched maybe every other day or every third day. The ones in Texas, because it was a random block design, were searched every day. Illinois we had pretty good success. There were several bat species that were tracked. This is based on 500 carcasses or more that were recovered. Overall, this is with the deterrent plus curtailment. We saw a 68% percent reduction in the total bat fatalities, 57% in the Eastern Red Bat, and 71% percent in the hoary bats. I should have had this before this conference, but I don't have the actual breakdowns of how many bats were in each group for this test. But overall, we felt like it's a very good test. In Texas, we had a lot of bats counted in that test. We saw a 50% reduction and remember this is the control and the deterrents only. So this is not including any curtailment. So using just a deterrent, we saw an overall 50% reduction in bat mortality, with about 54% in the Mexican Free Tailed Bat and 78% in hoary bats. The other species, we didn't see enough total count to really have this statistically conclusive result. Obviously, if you look at this, there's 19 and with the Southern Yellow Bat there's more than we would like. So that does lead us to want to do some more testing and evaluation. But overall we did feel like the bat deterrent system did provide significant reduction in bat mortality.

Last year, we had our first full-scale installation. Kawailoa Wind installed these at all of their wind turbines last year. And while this is not a study and I don't want to say that our system is going to be 100% effective forever, in their annual report that they published in February, they've reported no Hawaiian Hoary Bat take since they've been installed.

So I'm going to talk just a little bit about what we're doing now, and then I'll be open for questions. We're working with the Texas State and NREL to do a flight cage test. So we got set up last fall. This spring bat season will be the first full-scale implementation of this. We have two of our units installed at each end of the flight cage and they have cameras spaced on the cage. We'll go ahead and capture bats during the day and bring them back to do a flight study at night. So it does depend on the bats in the area. They have access to Tricolored Bats and Mexican Free Tailed Bats and then another, the Cave Myotis. So that's what they're going to initially test with. So by testing on individual bats, we know exactly how it's responding and we're able to adjust or modify how our system is outputting power or frequency so we can turn off certain channels. We have six different frequencies so we can turn them on or off individually. We can actually do a lot of work on these bats and really determine the effectiveness of this. We're working with Vestas right now to map out installing on a V136. That's a turbine with a 136 meter rotor diameter. So it's a 60 to 65 meter blade. So we're pretty excited about that. Ultrasound just by design is hard to get to go a long way. So this will be an interesting opportunity to really prove that we're getting out as far as we can. The next steps are the extension of the effectiveness of our ultrasonic range. So we're doing a lot of studies on the propagation ultrasound and how we manage to make it better. And then lastly, we have a relationship now with Vestas working with their engineers around where to install our systems and how to effectively service them because installation services are very important and that again will broaden our ability to protect as many bats as we can. So with that being said, I'm happy to take questions. Like I said, I have six weeks into this job but I'm happy to answer.

MEHRHOFF: So have you looked at habituation of the bats? Do they get sensitized or desensitized?

JOHN UGLAND: My perception is that because of the way it interferes with their ability to fly and navigate we don't think they can really habituate to it. Back to my analogy of driving in a snowstorm with high beams on, you just can't really get used to it. That being said that is a relatively new system. We've been commercially deployed for about a year. We've been studying for about three years. So we haven't had a huge opportunity yet to see if there is habituation.

JACOBI: How much maintenance do these systems require? How often do you have to retrofit them and what is the life cycle?

JOHN UGLAND: Yeah, great question. So it's designed for a 10 year lifespan. It doesn't mean you have to replace it every 10 years, but from a manufacturer ability standpoint that's our target. So we've done life testing for all components. It is solid state so that there's no moving parts. It's designed to be outside so we acknowledge that it's going to spend its life outside wind turbines. So we have several that have been the field now for three and half to four years. We've had a few small issues. We do monitor.

JACOBI: How do you do that? How do know if they're on or not?

JOHN UGLAND: We do remotely monitor them. We are actually working with all the wind turbines so that they get alerts from a remote monitoring system when the system is not working. Right now we do the monitoring ourselves. It's really simple. We are just measuring the voltage and current to each speaker and we have it set up to send us automated alerts and one of our engineers gets it once or twice a week just to see how everything's doing. We can tell if there's something starting to go bad because the voltage is going to start changing on that speaker. On serviceability, it does depend on how it's installed on the wind turbine. They are external and so on some turbine types they mount them on the top and the bottom. They're designed to be accessible from the inside. So we've worked with the turbines' OAM to be able to put holes in their turbines so you can remove them and replace them. On a few turbine types, like the ones at Kawailoa, they have steel nacelles so in that case they had to be mounted externally with magnets. Those are little bit more labor intensive.

LASHA-LYNN SALBOSA: So I have a two-part question. You know, this is exciting news. I'm cautiously optimistic. You mentioned repeatedly that these have a 78% reduction in hoary bat fatalities from your previous studies. My question is for your mortality estimates, were those done just for searched plots and what were the plot sizes? Before and after was that comparable? What I'm getting at is really drilling down on how did you look at the efficacy of these NRG systems?

JOHN UGLAND: Good questions. Again I'm not a biologist and I'm pretty new here. We're just an equipment provider and we worked with consultants to do studies and my project owner. So both of these studies are in the process of being peer-reviewed and published. So yes they are large plots, maybe 80 to100 meter plots.

LASHA-LYNN SALBOSA: Okay, my last question is from an agency standpoint. There is a great value in having a third party set up a design to really drill down and evaluate the efficacy of these NRG Systems bat deterrents. From what I'm seeing, especially in looking at their deployment here in Hawai‘i, it's great to have it fully deployed for the first time but I'd like to see an actual design of efficacy. There's so many unique characteristics here in Hawai‘i. We had Michael's talk that looked at the power analysis. There's some discrepancies and questions in terms of the efficacy of deterrent systems. I'm hearing that there are great results outside of Hawai‘i but applying it here and actually testing it, I'd like to see more partnerships in that.

JOHN UGLAND: Right, so both of those studies were designed by the consultants. So they did the mapping of the turbines and decided which ones and where. I had lunch today and we talked about how we can do this. Okay, thank you everybody.

Ultraviolet light deterrents: Marcos Gorresen, U.S. Geological Survey- Hawai‘i Cooperative Studies Unit

MARCOS GORRESEN: I'll give a quick presentation on ultraviolet deterrents. This alternative system that Paul Cryan from the USGS Fort Collins Research Center and I have been working on for a couple years. The current understanding of cognitive minimization is that this might effectively keep bats at very close range. Methods involve assessing the effects of this to tally searches and video camera detections. But since we don't know the cause of bat approaches to turbines at a relative scale, the question is why not attempt to apply deterrents at larger scales, and can we keep bats from interacting from further away? We don't really know how bats perceive turbines at distance or even up close. Bat vision is actually sensitive to light conditions. Acuity might be low so they might actually see trees or turbines like a brightly lit beacon from a distance, speculatively. Most of the bats that are impacted in North America as well as here are tree roosting bats so they may have been adapted to visualizing and being attracted to large columnar structures or features emerging on the landscape that kind of stick out like turbines on a prairie. So again, they may have heightened sensitivity to structures relatively bright and a turbine might look a little bit like a tree trunk.

So one of the first studies that we did before testing out UV deterrents, is testing out if bats could see. The study in 2014 found that yes, some bats of three families see very low light levels in the UV spectra. We followed up on this study that showed that flickering UV at a wall of trees could keep bats removed since they called less; so they're startled by it. In 2019, we started testing prototype UV light systems on turbines in Colorado. As more people work with acoustic deterrents it takes a lot of work to work out the kinks. That's kind of where we are right now. We have a some prototypes that we mounted at the National Wind Technology Center in Boulder, Colorado. There are looking at how to get those things up there and how to keep them operating. They're looking at how to get them through the Colorado winter. Of course we have failures and we're working from those. Here's what they look like. They're imperceivable on the turbine. At the same time we're also monitoring on video systems bat behavior around those turbines. We're noting different types of bat behavior. This looks like the basis for us to evaluate whether or not there's any deterrence effects when we get these systems up and running. This year we're actually going to be running a test of this at one of the turbines. Again, this is just more about bat response while in flight as opposed to bat searches for fatalities. We'd like to acknowledge the work received from NREL on this and BCI for their role in this. Thank you.

JACOBI: Do you have an approximate timetable in terms of when you might be semi operational?

MARCOS GORRESEN: Needs to be a couple of years. So we're just testing right now on one turbine. So we have a treatment and control alternating schedule to see if there are any patterns that are emergent. Hopefully, the next step is we can test on multiple turbines and actually do ground fatality searches probably through assistance from a third party..

MATT STELMACH: You’ve looked at a lot of video data; have you ever recorded a bat strike on thermal monitoring?

MARCOS GORRESEN: In Colorado we have; not here in Hawai‘i. That’s largely due to the placement of the camera. So like in the last study you actually place the camera at the base of the tower so you image the leeward back side of the turbine. So we’re missing a lot of the rotor-swept area. I think given Michael’s presentation on this we will assess that and deploy cameras in different ways so we can actually image the windward side in the full rotor-swept zone. With camera systems it’s a trade-off between broad coverage and detail at high resolutions. So until we can work with megapixel cameras were going to be stuck with imaging a small part of the rotor-swept zone.

BOGARDUS: Thanks Marcos, one question for you. As you’re moving forward on testing the efficacy of this, is there any value in you setting it up in such a way that it would have a systematic methodology for testing the efficacy of all deterrent systems that could be in place? I’m thinking about if there’s a framework in place to test efficacy for like NRG and this and where you can use the data to make it comparable.

MARCOS GORRESEN: I’m not sure that there’s one best way to place the cameras. It depends on if we’re say, trying to image the windward side, so we’d have completely different camera placement. I talked with Michael a little bit about what he might be working with at Auwahi where he’s applying these 3D methods that are a little more intensive and require bigger cameras. They also leave these cameras out for a longer time out in the field. So we might work out a system that combines his techniques with our techniques.

Low Wind Speed Curtailment: Loyal Mehrhoff, ESRC

MEHRHOFF: So we talked about low wind speed curtailment and I’m going to try to go through things relatively quickly since we’ve already talked about it and obviously the reason that the ESRC is interested in this because of the kind of changing comfort level between ten years ago or more when wind first started coming in for this most recent group of wind farms, rather than the ones back in the 80’s. But the amount of take that’s been projected and has occurred has gotten greater and there’s more concern about that. And then you couple that with the complications that we have with the Hawaiian Hoary Bat and particularly when it comes to the question of how things get permitted, or how the decision makers have to decide whether projects go forward. Typically when we’re looking at biology and making impact analyses we want to know what the population size is, what the impacts on that population are going to be, the amount of take, the amount of habitat you lose, and then what minimization you can use. And then if those don’t really fix the problem, what mitigation you can use, and then make a decision on whether or not the projects going to be good or bad. Of course with our situation, we don’t know what the population size is. So that really complicates the assessment. We can still go forward and do minimization. We have measures to do that or methods to do that. But mitigation, as we've talked about several times over the course of the last two days, we're not 100% sure that we have a way to make bats. So that is a problem.

So with minimization, we just talked about two cool ones. The more recent ones, both acoustic and UV. But the old standard so far for the last ten plus years has been low wind speed curtailment. This has been discussed so I'm not going to go into great detail. We're just refreshing you that we're looking at from when the turbines are actually moving and posing a risk to bats. If it's at a low wind speed like 3 m/s; Say if that's the factory level where the blade will begin to power up. At 3 m/s, 19% of bat activity would be lower than that. If you go up to say 6 m/s, then 73% of the bat activity would be occurring below that—it would presumably not be a risk. So that's kind of the basics of what the theory is behind the low wind speed curtailment. If you look at it, it ranges from 3.5 m/s to 8 m/s. You can see what percentage of bat activity would be below that cut in threshold and then you could anticipate that there would be some sort of corresponding reduction in facilities. If you look at the actual data, and this comes from across the mainland, you see that there's a lot of scatter but that there is a general increase in fatality reduction as you increase the cut in speed for low wind speed curtailment. But there's a lot of variability, particularly at that 5.0 m/s, because that's what most people use and that's where most of the data is. If you take the average of those this is how they track between the cumulative activity and the reduction in fatalities. You wouldn't expect them to track exactly, but that's what they track and if you look at those dots plotted against the graph on the left, which is the bat activity curve and then the cumulative bat activity versus the mortality, you see they tracked somewhat well. But realize that those are averages and you still have this large amount of variability, particularly at 5.0 m/s.

So what are the things you can say about that? Well, there's a lot of opportunity in there to do, as Matt said, fine-tuning. Not game changer kind of stuff probably like you're talking with deterrents, but something that would further be able to reduce the amount of fatalities that you're getting by tweaking the low wind speed curtailment. So I talked about two or three things that we should be looking at potentially. One came from one of our presenters here looking at whether to use a 10-minute or 20-minute rolling average to decide whether or not to turn on or turn off those turbines. In this particular study, they found a 20-minute rolling average was better than the 10-minute rolling average with respect to reducing the amount of bat kills. One note from earlier in this particular set of workshops, is that probably for Hawaiʻi we need to remember that this may be a 20-minute rolling average order to start on the turbines, but only 10-minute to turn them off. We didn't have that in our bat guidance for example, and we may want to add that in.

The other question which might be worth discussing later is they found a difference between the wind speeds that were being used coming from the turbine mounted wind meters verses the meteorological tower wind meters. That resulted in about a 1 m/s difference and that translated into increased bat kills using the higher wind speeds. So we need to kind of look at what the mechanisms behind that might be but that is something that we should probably look at in more detail for Hawaiʻi, maybe other places as well. Again, that's for maybe future discussion. So this one I do want to talk a little bit more about is rotor size. When I went back and looked at the graph that you saw of low wind speed curtailment by different speeds and there was a lot of variability in there, it looked like rotor size was potentially a contributing factor to some of those. And there have been a couple of studies; this one in particular from Good et al. 2018, was the original study, then they followed up with a second year from 2019. This is rotor size on the x-axis and the y-axis is number of bats killed per turbine. And so these were four different sized turbines at 5 m/s curtailment, all in the same wind farm. If you look at the graph, you see that as the turbines got larger they kill more bats. Now there are two compounding aspects to this. The first one is those were four different manufacturers. So there may be some difference between manufacturers. But this is a pretty dramatic difference. You're talking anywhere from a four to tenfold increase in bat kills as you get into the larger turbines compared to the smaller turbines. Again, this was with low wind speed curtailment in place. So, you also don't know whether or not the size of those turbines might just kill more bats or they don't respond very well to low wind speed curtailment. Those are two options or it could be a mixture of both of those.

If you look at other data from different studies, not the same set of data, so an independent set of data and you look at rotor diameter and the amount of reduction by low wind speed curtailment, they're all at 5 m/s, you can see that even in this one. This is just the reduction, not the total number of kills, but how much you're reducing the bat kills per turbine. Again, you find that the larger turbines do not do as well when they're in low wind speed curtailment. These only went out to 100 meters. So we don't know what happens when you get out to say 130 meters or something like that. But there's another indication that rotor size may not be helpful with respect to low wind speed curtailment. So you may find that large turbines will kill more bats and potentially then have reduced curtailment benefits. And the other thing to keep in mind is the low wind speed curtailment data that we use including the 50% reduction at 5.0 m/s—which is pretty good with the data that we've got—those are done on smaller rotors. In general, when you get the newer generation of rotors, that may or may not necessarily be holding true. We don't know till we actually get data on those. So there's a concern about that.

To kind of conclude quickly. You know, low wind speed curtailment has been pretty well documented. Higher curtailment cut ins tend to kill fewer bats. You can question the cost benefit of low wind speed curtailment. I don't think it's very productive to try to go back and say well does it work or not? We've got pretty good numbers behind it. There's still a lot of variation. Some of the things we could be looking at are using 20-minute rolling averages rather than the 10-minute rolling averages. Making sure we validate or make sure we understand what's going on with that difference between meteorological tower data and turbine mounted wind meters and making sure that those are actually measuring real wind speed because these are estimates on the turbines; they're not taking the straight measure of the wind. They're taking that and recalculating what it is. Then trying to look at the large rotor issues and trying to use smaller rotors when possible. So that's what I wanted to talk about with respect to the low wind speed curtailment. Questions?

UNKNOWN VOICE: If you have a wind farm of a certain size, say 30 megawatts, right? You could have a few large turbines or whole lot of little turbines. So if you had a whole lot of little turbines each killing a few bats versus a few large ones killing a lot of bats, what's the per megawatt of bat kills?

MEHRHOFF: So the question is if you're looking at kills per megawatt versus kills per turbine, and that's a really good one. In the 2018 study, the first one you had the same tracking. So even when you got out here with the large megawatts you were still killing many more bats per megawatt than you were with those small turbines. 2019 data was not as clean as that. So there were one of those megawatts where there was kind of a reversal on that. So it was not as clear cut. So the answer to your question is you need to look at the megawatts that you need to get out of your project and then be looking at the size of the turbine. Because in some instances you may want to go with the larger turbine, in other instances you may not. If you were just going off the 2018 data it's a no-brainer. It was the same story. You wanted a whole bunch of small ones compared to a few big ones. But that did not hold true for the 2019 data.

BOGARDUS: Loyal, did you look any more at the search area plots relative to low wind speed curtailment?

MEHRHOFF: So I think it was last year there was a study that came out by Manuela that talked about that being a concern. So it's a red flag and certainly you would expect that that could be an issue. So to increase larger search areas until you've got a handle on that for that particular low wind speed curtailment would be a good idea.

BOGARDUS: I know Michael mentioned it yesterday but it's something that we probably need to look at.

MEHRHOFF: Yeah, I don't have the ballistics data to be doing that set of analyses.

TOM SNETSINGER: I would highlight one other potential confounding factor is habitat associated with different turbine types that are being used there.

MEHRHOFF: Yes, that's correct because it's a single wind farm, but they're in four kind of phases and they're in different geographic units so it's not a random design for where those turbines are. There clunked. So that's a confounding thing. The one thing I can say is in some of the earlier studies just before this one in the same wind farm they took three of those and they actually did do actual calculations of the low wind speed reduction for those three. Not for the fourth one, but they never did give us the data for that. So I don't know whether you can tease that out. They tied it more to manufacturer than the turbine size, but you're right. That's a third confounding aspect of this one. Thank you very much.

ITEM 10. Modeling. Evidence of Absence model: Manuela Huso, USGS Forest and Rangeland Ecosystem Science Center

MANUELA HUSO: So I'm going to start with a little analogy. Let's say I flip a coin ten times and I asked you to tell me how many times I would see a head. I'm imagining that you're all guessing the best guess for the number of heads that you will see with 10 flips is 5. I'm going to put it into a little algebra. If you say M is the number of flips, G is the probability of heads, X is the number of heads, what you did in your head was take M multiplied by G to get X. So, ten times one half is five. Well, we all know that if we flipped a coin enough times that five is a pretty good guess but it could have been four, three, six or seven. So it's not exact but it's a good guess.

So hopefully you've also seen very clearly that this is going to be a little analogy for what we do in Evidence of Absence. M is the mortality number that were actually killed. G is a probability we detect them, and X is the number that we find. So what we do in mortality estimation isn't really exactly like this because we don't know how many flips have been made. That's exactly what we need to guess. What we do know is how many times we saw a heads. Well in this case, what's our best guess at the number of flips given that we saw four heads? Well, we do that same algebra, rearrange it a little bit, and now we say our mortality is how many we counted divided by what the detection probability is. So in this case, four divided by a half is eight. Now, we flipped it ten times and we saw four heads so eight is not right. But we also know that there's variation on it. So we're going to make a 95% confidence interval that says okay, chances are really good that is was somewhere between three and 13. Since ten is in there we did a good job. We've got it in our compass. So this is all really basic but it's very fundamental to what we do. We take what we see. We divide by our detection probability and we get an estimate and then what's really important is we put some variance around it - some uncertainty here. But what happens with this little approach (it's called the Horvitz-Thompson approach) if I see zero heads? what's my next best guess? Well it doesn't matter what my detection probability is; my best guess is always zero. Well, that's not very satisfying. So what we did with Evidence of Absence is move that beyond this Horvitz-Thompson approach and into a Bayesian world.

So I'm going to switch from the flip of a coin to something that has less of probability of detection and that's a roll of the die. Then look at what's the probability of rolling zero sixes. The probability of a six for a fair die is one in six. This graphic that I have here is the probability of rolling no 6's on the y axis and then the number of possible rolls that I could have done on the x axis. So if I look at zero rolls, certainly if I rolled it zero times, I have 100% chance that I'm going to observe zero sixes. That's sort of a given. So if you rolled no sixes, a good guess at the number of rolls is zero. But if you look at this, if I rolled it one time, I've still got a pretty darn good chance of not rolling a six; so it's not all that much less likely than rolling no times. And if I go all the way up to rolling the die it nine times, I still have a 20% chance of having rolled no sixes. That's still a pretty decent chance in most people's worlds. So in fact it comes out there is not really much of a surprise that we could roll ten or 15 times and roll no sixes. If our detection probability is one in six and we see zero carcasses; it's not by any means impossible for there to have been ten or 15 bats in our search areas. What we can do though is to keep going down that scale and finally get to the point where the chance that we would miss all of them is less than 5%. So we can get a 95% credibility level that says okay, we saw zero but it's very unlikely that there were more than 17 out there that we missed. That's the basis for Evidence of Absence.

What I want you to get out of this is two things. The first one is that even though we know the probability of detection exactly like we do with a flip of a coin or a roll of a die, we will not know fatality exactly. It's just a random event. While knowing detection probability is very important, it's not everything. Knowing detection exactly won't allow you to know mortality exactly. But the higher the probability of detection the better our precision will be and much less variation we will have on our estimate of mortality. It will go from 17, maybe down to somewhere between we observed 0 and maybe there's no more than three, if we have 50% detection probability. So that's two things, knowing probability doesn't tell you everything, and higher probability gets you better precision. So when you're looking at Evidence of Absence to try and help us understand compliance, what we do is we take user provided detection data, that's our probability of detection and it's based on our estimates that come from searcher efficiency trials and carcass retention trials, what fraction of the turbines we search, how big of a search area, all that stuff. We take that and combine it with our observed count (often zero) and from that get an answer that says how many can we possibly rule out as having been missed? Do we have evidence that we are less than M* given what we observed.

In Evidence of Absence we have a multiple years module that would estimate that M* for you. Here's an example. You can take the relative effort - this has to do with what fraction of turbines we searched, maybe even has to do with curtailment, but it's a measure of relative effort. In this case, we have five years' worth of data to be measured essentially the same way in all cases. We observed three carcasses. Two in the first two years. One in each year. Zero, one, then zero. We had a detection rate of about 40% all the way through until the fifth year when we dropped a little bit. I don't know exactly what happened. Maybe we increased the search interval a little bit but detection probability dropped. We put that into Evidence of Absence and out comes a graph just like what I just showed you. On the y-axis is the probability that your true value of mortality is greater than or equal to what's on the x-axis given that you observed zero, in this example, or given that you observed however many that you observed when you're working with your own data. The red just distinguishes your break point. In this case, I asked for 80% credibility level and given this graph doesn't exactly match the input that I just put there, but the idea is the same. I have an 80% credibility level. It says with your detection rate of one in six and the fact that you found no carcasses, there is at least an 80% probability that there were no more than 8 out there that you might have missed. Notice that it is very possible that there were 0. But it is also possible that there were more. Just like with the dice roll, knowing how many times we rolled a 6 tells us only a little about how many times we might have rolled the die.

So, how do we use this? Well, one way we can use it is to set take over the life of the project. But I think one of the things we need to do is ask ourselves what do we mean by permitted take? One option might be that if I say the permitted take level is two per year over 30 years then what I'm saying is that the total take over 30 years shouldn't exceed 60. But you know in any given year it might be three, or it might be four and then another year it might be zero. So I'm going to ignore annual variation as long as over the length of the project I don't exceed the 60. Alternatively, there might be some situations in which it's really critical that you not take more than two in any given year perhaps because of biological issues with the species. And so that gives you a very different kind of interpretation of what take means. The less than two every year is much more difficult to ascertain and to achieve. Essentially if you want to make sure you don't take more than two in any year, you're going to have to set your take limits at much less than that because the real world doesn't work in completely steady ways. It's not always exactly the same number every year.

Let's look at an example. These dots are the number of actual fatalities in any given year with an average of 2 per year. There's 30 years on the x-axis. So we can look at these and we can say that it varies all the way from zero up to about five. But what you should notice is that the number of years in which the annual mortality exceeded two is about a third to half of time. So that's something that you need to keep in mind when you're setting a take limit, that there is going to be interannual variation. We can use that information in Evidence of Absence and ask how our data might play out in the future. What is it going to look like? We can ask it to estimate data which is the annual mortality rate for your site. I'm still in the multiple years module. When I asked for projections, this is a kind of data that I will get. It will give me a series of cumulative mortality estimates. It takes my data (remember I had one, one, zero, one, and zero as the counts), and gives me an estimate of what my median 50% quantile is for each of those years. But in this case we're accumulating. So first year it's three, then next year I found another one at six. I didn't find one, it's still six. Then I didn't find another one so it's eight and I didn't find one so it's eight. As we're accumulating total mortality, not just annual but total, the alternative is to also just look at it one year at a time. The median estimate, M star, is just zero. This is just median. But the 95% confidence goes somewhere between one and 20. After five years, we get an annual mortality rate lambda over somewhere close to ten. That's not an annual rate. That's the finder rate. So that's saying that given the data that you have that you've given us with the detection rate, we can estimate that over five years you should expect to take approximately ten animals. There's variance on that, it's somewhere between two and 25. But if you look at this number, which is the baseline estimated fatality rate 1.967, it is indeed this number (9.865) and its confidence interval divided by five. So basically that's your annual rate. There is a potential if you've been at a site for five years and you have data from other site you think applies. This five year annual rate could give you a good estimate of what you might believe take would be over the next say 25 years. If you have the same turbines that you're going to measure every year and you have a similar wind regime and bat population it's a very reasonable thing to say that that lambda you just measure can be expected to be relatively constant over the next 25 years.

Now we move from estimating, which is done with data from the past - we observed the data;it's estimated because it's what we've seen – and we move into another area of prediction. It's our best guess at what's going to happen in the future but of course, none of us are going to be able to predict it exactly. We're just making reasonable assumptions and guesses. We can project out in time (I believe what Hawai‘i is using is the 80th quantile and that's a safe place to be with respect to projections.) What the software does then is it graphs those first five years over in the left-hand corner. On the x-axis is years, on y-axis is cumulative fatalities. The first five years we have data and those blue, red, yellow represent the estimates that we have for what was taken in those years cumulatively. Then in gray is what we project out. If we can assume that what happened in the past is going to continue to happen in the future this is telling us that as we go out to 30 years, by the 30th year we will be on average at the center of our projection, but chances are we'll be somewhere above or below it. The mean and the median are both about at 60. So it looks like we're in a pretty good place for this particular situation. At the top of the box is the 75th quantile of actual mortality; the top of the darkest gray box is the 75th quantile of what we are likely to estimate as having been killed. I know – subtle difference, but if you spend some time thinking about it, it'll sink in. At about the 25th year the 80th quantile would indicate an exceedance of the take limit. You can also look at this and say "If my 80th quantile is going to be above my take in 25 years, maybe I need to modify now. Maybe I need to do some minimization. Maybe I need to change my take limit and increase it to something that I think is more likely to happen." Or you might say, "On average, it looks like I'll hit my take mark. Some sites might be above, others below, but in the long run, they're on target, so I don't need to initiate minimization procedures."

So that's all this does; is give you tools to work with. The general framework we're working with is the bat population that may or may not be able to tolerate 60 deaths spread out over 30 years. I guess by setting the take limit at 60 that's what we're thinking that they can tolerate. But perhaps the population cannot tolerate five or ten in one year and then zero for a whole bunch of years later. So, we need to kind of monitor take rate because for one thing it may be different than what we originally thought it was or it may change in time.

We want to do this by taking advantage of continuous monitoring so that we can follow and keep reevaluating where we are. We worked pretty hard with Region 3 to develop some monitoring guidelines and goals and ways to use Evidence of Absence and we came up with two types of objectives. We've got the long-term where we have evidence that total take is less than whatever we set. In this case 60 in the example we're working with. But we want a warning too, especially in the beginning if it looks like the underlying take rate is more than 2 per year. We just kind of guessed that it's two per year. So, here's an example of again annual fatalities and year on the x-axis and 60 is our target. This white line with dots represents a random sample of cumulative fatalities and you can see that on year 25 it actually exceeds the 30-year take limit. So how conservative do we want to be when we are estimating this? We use alpha to control our credibility level. So if we wanted to say our credibility level was like 90% then here's how much above the real track we probably would be. By the 10th year we would be saying, okay, it looks like we don't have 90% credible levels to indicate that we're below that 60. If we use 80% it would be less than that and it take us until about 15th year. Finally if we do an alpha of 0.5 you can see that we actually missed it. Here it crosses in year 25, but our 50th quantile says we're still under it. But apparently in this particular case just for example we must have found one in the 26^{th} year. We now are saying in the 26th year that it looks like we've exceeded. I'm not saying you should use 0.5, I'm just saying that there are consequences to your selection of credibility level and they need to be evaluated. I'll talk to you a little bit later about the document where you can get some insight into what the consequences are.

So short term then, we can look at these in three-year increments, or 4 or 5 year increments – your choice. So let's take these three years and let's calculate an average rate that might have generated those data and we see the interval is 1.6 to about seven. Two is inside so we don't have any evidence that we've exceeded it. Two is in that interval so we're okay. Then we do it again for three years but it's a moving average and we keep doing it and finally we get to this one and it's outside. The rate that we have over these three years was greater than our take rate that we've permitted. What does that mean? Maybe it's an indication that lambda (the average take per year) has changed and it's actually increasing for some reason. Maybe it's a trigger that says well, maybe now we need to do some curtailment or we need to do something else to try and compensate. Or maybe it's just a high sample and it will come back down next year, so let's wait and see. That's up to you. And you can do that for the life of the project.

In working with Region 3 we came up with this document (A Framework for Decision Points…) that I encourage you to look at it. It's full of a ton of graphics, but it asks all those questions about what happens if we set take and what happens if we're wrong? What if we were too low or too high? If we set take higher than actual, are we making industry mitigate more than they should? If set take lower than actual, are we losing more bats than the population can tolerate? Those kinds of things. What kinds of levels of assurance are appropriate for long term versus short term kinds of triggers? And then what are the effects on the species? If we set credibility at 85%, how often can we expect to trigger exceedance of the long term limit, both when we're right in guessing the take rate, but also when we're wrong? It's all very integrated and kind of complex but a lot of these "what if" questions are being addressed.

In summary, we can never estimate exactly. But in the long term sense, although no one can tell you exactly how many were taken in a year, the more years we can accumulate the more precisely we can estimate what that total take was. We get a lot of benefit from cumulative and continuous monitoring. In the short term we can warn when the take limit seems to have been exceeded in a very short period. We can't predict exactly when it's going to happen, but we can give you some good ideas of what you can expect if the assumptions that you made are fairly reasonable and consistent for the future.

MATT STELMACH: I'm wondering how the short-term triggering relates to early monitoring. Having a few years of monitoring seems like you have less data to inform the Bayesian model and so higher likelihood of triggering the short-term trigger early in the monitoring.

MANUELA HUSO: The short-term trigger that we tend to work with is a three year moving average. So we don't really talk about triggering the first couple of years. It's not until the third year and then it really goes for three-year increments. There's no reason it has to be three years. It could be five years. One year, you're right, is probably a little bit too narrow a range and the precision with which you can estimate a rate for one year is almost not worth it. Because it's a moving average, it's not more likely to be triggered in the first few years than the next few years as long as you keep that window constant.

Vortex population modeling exercise: Theresa Menard, ESRC Bat Task Force

THERESA MENARD: Hi everyone, this exploratory population modeling exercise of the Hawaiian Hoary Bat was developed by the Bat Task Force on which I serve. The chief modelers were myself and Dr. Loyal Mehrhoff. So population viability analysis or PVA is an analytical tool used to measure the processes that can lead to extinction. Data can be applied to a suite of scenarios to estimate a population for probability of persistence or extinction. For those of you who don't know me, I worked at The Nature Conservancy for the past 20 years and I did my Master's thesis about 20 years ago now on the seasonal activity patterns of the Hawaiian Hoary Bat. My own familiarity with Vortex comes from using it to estimate the amount of time it takes to clear pigs from TNC's fenced units. Also, we examined the probability of controlling mongoose on Kaua'i using Vortex. We used it to internally verify the Maui Parrotbill population modeling done by others and now to conduct this exercise on Hawaiian Hoary Bats. So the Bat Task Force wanted to identify: one, specific population dynamics parameters needed to conduct an acceptable PVA; two, to particularly identify impactful parameters that should be prioritized for research; and three, general trends or results that might inform conservation decisions or provide management sideboards for wind projects.

And how did we do it? We started by gathering the data from published literature and unpublished Master's theses, Doctoral dissertations, etc. and scanning them for input we need for our models on reproduction, such as: age at first offspring, one year; maximum number of broods per year, one; maximum number of progeny brood, two; sex ratio at birth, 50/50; maximum age of female reproduction, 5 years; maximum life span, 8 years; and percent of females breeding, 80 to 95%. Unfortunately, we did not find good data on mortality estimates. So we relied on an expert elicitation that was done by Frick et al. (2017) to guide their decisions on this paper entitled "Fatalities at Wind Turbines May Threaten Population Viability of a Migratory Bat" and the expert elicitation really relied on the best guesses of nine experts from mainland hoary bats. Diane Sether, of the U.S. Fish and Wildlife Service, got the results of this expert elicitation for our group. But when we plugged in the mortality guesses into a Vortex it led to a population decline and we did not want to work with a model in decline. Because the only published trend we know of for the Hawai'i subspecies is stable, as shown in the graph of Gorresen et al.'s data, we looked for a reasonable mortality estimate that would give us a stable population. We ultimately decided on using an adult mortality estimate derived from Lentini's work in 2015, which reported about 33% annual female adult mortality for species of microbats that produce more than one young. But this was not for *Lasiurus*. Lentini's paper was titled a "Global Synthesis of Survey Estimates for Microbats" and they have 625 survival estimates for over 44 species.

Okay, our model outputs initially looked like this with year on the x-axis and the population size on the y-axis and the different models' outcomes in different colors. These models all have the same data on reproduction and other life history parameters but differ with respect to mortality values. So what this graph shows is that the population can either increase, be stable, or decrease depending on mortality values you use. As I said, when we used the expert elicitation mortality guesses from Frick the populations declined and I'm referring to the red and orange lines which use adult mortality estimates of 48% and 35% respectively. But when we use Lentini's mortality estimate of 33% for adult microbat species with more than one young the model produced a stable population, the blue line, and using even lower adult mortality estimates of 28 to 30% led to increasing populations, the green lines.

So the task force decided to focus on developing models that produce stable to slightly increasing population trends and assumed population trends were not habitat limited. This is similar to what Friedenberg and Frick did in 2019. In other words, now that we found a reasonable stable population model we further explored it with manipulations. So under these narrowed conditions, we produced three models, A, B, and C, the details of which are included as an appendix in our report. Model A reflects our best guess model. Model B used Hawai'i data over mainland data and model C averaged the data of all hoary bats from Hawai'i and the mainland. Then we ran each model with different levels of take of an initial population of 1,000. So here you can see the effect on population size over time under different annual take regimes for our model A, our best guess. This model produced a stable to slightly increase population trend when there is no take, the black line at the top, with the exponential rate of increase R= 0.0082 and the annual rate of change Lambda R= 0.0816. So the annual take of up to 1% of the population, the orange line, seems to maintain a stable population and annual take greater than 1%, that pink and red line, lead to a decline in population. So when it comes to take it may be easier for you to think in terms of numbers of bats rather than percentages of the population. So for the orange line, which represents an annual take of 1% of the population that would mean ten bats could be taken per year given an initial population of a 1,000 and the resulting population would be stable. A take of five to six bats per year represents the scenarios with half a percent take of the population, the green line, could result in slightly increasing populations. But take of

2%, the red line, meaning about twenty bats taken annually at the start and ending with eight bats taken annually would lead to a population decline.

Now moving on to Model B, this is the results for models which prioritized the Hawaiʻi data over the mainland hoary bat data. Again, no take being the black line at the top and this model produced a stable to slightly increasing population trend. The annual take of this was half a percent. I think this is a slightly decreasing one. An annual take greater than 1% results in declining populations. So if you are wondering why model B did not produce stable or slightly increasing populations with half a percent to 1% take like we saw with the previous Model A it is because the percentage of adult females is now less.

Finally here are the results from Model C which uses the average of Hawaiʻi and mainland hoary bat data when both are available. This model produced a stable to slightly increasing population trend, the black line, and the annual take of up to 1% of the population seems to maintain a stable population. So that's the green and orange lines. But taking greater than 1.5% lead to declining populations. So to summarize this part, all models had no take scenarios that lead to slightly increasing populations, which is what we wanted, and then under all three models the annual take of bats has a negative impact on population growth; even in some cases half a percent take reduced some populations. When modeled annual take exceeded the annual growth rate, model numbers declined. We also looked at how population size and total annual take might factor into population trends. We did this with Model A, our best guess model. On this graph the x-axis is the annual bat take and the y-axis is the probability of extinction. So for example, if the initial population is 1000 bats the probability of that population going extinct starts to rise dramatically when more than 30 bats per year are taken. If it reaches 60 bats per year the chance of extinction is about 70%.

The main point is that these models indicate that projected levels of take may pose a relatively low risk to large Hawaiian Hoary Bat populations. For example, if the proposed annual take of bats for the Island of Hawaiʻi was 30 bats per year and the bat population is over 5,000 there may be relatively low risk to the population here. But conversely an island with less than a 1000 bats may not be able to sustain the loss of 30 bats per year. It would have a high probability of extinction. So this is our first ever Hawaiian Hoary Bat modeling. A much more sophisticated and intensive modeling effort is needed before we rely heavily on this effort and I ask for your advice, your extra data, and if you've got better mortality data, please let us know and we would like to refine our model further. Any questions?

PRICE: I think most of us in the room are empirical scientists and may not have a lot of experience with expert elicitation. And so I just want to make a quick note on that because I have received a minor amount of training in expert elicitation so I am by no means an expert. However, Jennifer Semanske who's on that Frick paper, her stuff holds up in court. So a lot of times when people want to go out with a lawsuit they see expert elicitation as being the weakest link but her stuff holds up in court. So I just want to make a note of that. So say it's a best guess, there's a method to the madness. So for empirical scientists that are used to like there's a method of getting data, there's methodology to this and I've seen it in action. If you have a reasonable amount of expertise in something, you know more than you think you know, and when you get enough experts contributing to something the average actually approaches the true data. This has been shown to hold up if it's done right. So I just wanted to make a note on that since that was used as a major input of your work and you described it as a best guess. And a lot of people in the room might discount the entire rest of the thing that you said, and so I just wanted to kind of make that statement. The input data that was used from the Frick model, if Jennifer Semanske is on that paper, it's good.

THERESA MENARD: Which is why we tried it initially but it led to declining population, which is what they found.

JACOBI: I appreciate you doing this. This is something which I think is really necessary. But as you say, I mean, it's a first step there and it doesn't have all the answers. What is the information that is most needed, that can be achieved, that you can get, and needs to go in here at this point? I mean, obviously there are certain things we're gonna have a real hard time getting but what are the things that are really most critical that we can get that will help move this long further?

THERESA MENARD: So we did a sensitivity analysis too which is shown here. The steeper the line, the more sensitive the model outcomes were to it. But what we identified is we need adult mortality, juvenile mortality, percent of females of breeding, and the number of brood. We also looked at the maximum age of reproduction. But we came up with a list of research: determining the current path population trend on Oʻahu and Maui; determining if past habitat restoration projects have increased populations; and then determining the size of bat populations on Oʻahu, Maui and Hawaiʻi, which is what everybody wants to know. But even if we could get it to an order of magnitude it would help a lot. Determining if bat populations are habitat limited and getting to carrying capacity and then determining adult bat mortality, juvenile bat mortality, and the maximum age of reproduction.

JACOBI: Those are sort of an order of do-ability too because number one and two are achievable. Number eight [determining maximum age of bat reproduction] is a challenge.

MEHRHOFF: Having done some of this, because the study that we looked at shows a stable to slightly increasing population, that sets a real sideboard on how all these models need to at least be able to perform. For Oʻahu, that's really important. So I think that's why it's there because it's the island that probably has the most pressure from take so that's the one that is probably most needed.

JACOBI: That links into the WEST study in a very good way.

MEHRHOFF: If they can give the trend; if we can't then no.

LASHA-LYNN SALBOSA: In addition to getting a handle on understanding that ballpark starting population on the island, what I didn't hear is looking at the other sources of mortality because it's not just the percentage of take that's permitted but also looking at what other factors of mortality that's causing population decline. That's really the unknown in terms of limiting factors and threats. So that's another big thing when you deal with PVAs that we don't have any idea on that aspect.

THERESA MENARD: Correct. I mean, I've looked at numerous specimen records and some of the reasons stated for the bats being collected in the first place, a lot of them were impacts with vehicles and flying into barbed wire fences. So that's one thing The Nature Conservancy did was remove that top row of barbed wire from around our fences at the Kona Hema preserve because we had snagged a bat or two.

WINTER: Can you go back to that graph? Can you explain it a little bit?

THERESA MENARD: So unlike the other graphs the y-axis here is probability of extinction, not population size. So you run the model with several iterations and then because of the variability and the different parameters there are a little bit different results each time you run it but it gives you the probability of extinction. So for example, eight out of ten populations are likely to go extinct given the same input parameters. So that happens more frequently when you had fewer bats. I mean, it makes sense [that] the larger the population, ~~here~~ the more bats can be taken from it without throwing the bats into extinction. ~~Because if it's small you can take fewer bats.~~

WINTER: So I'm just trying to reconcile that with our knowledge. I think there's been 183 takes so far. How does integrate with this?

THERESA MENARD: I don't know that because these are bat takes per year and you're giving me a total.

WINTER: Lauren, what is the bat take so far for the theoretical population?

LAUREN TAYLOR: With EoA it's about 190 for 14 years for all islands including unobserved and indirect take.

PRICE: So given that the genetic work is suggesting that the different islands might be different populations it'd probably be best to represent this as like five populations in a metapopulation and probability of extinction at each of the subpopulations.

THERESA MENARD: Right, and I could model that too and then you would have to know dispersal rates and then what's the mortality associated with this dispersal.

PRICE: From genetics that should be able to give you estimated immigration.

THERESA MENARD: What I thought was interesting from the last speakers talk was the variation and take over time. So we didn't model variation in take over time. We set it as one percent, right? So that would be another refinement that we could add to this model.

MATT STELMACH: My understanding is that Vortex is very sensitive to carrying capacity. How did you select carrying capacity?

THERESA MENARD: We did what Frick did in her estimates which was to set an upper limit of carrying capacity at about ten times the initial population to let the model run but to manage unbounded growth.

ITEM 11. Draft Hawaiian Hoary Bat Guidance Document 2020 update. Overview of changes from the 2015 edition: Loyal Mehrhoff, ESRC

MEHRHOFF: So we had this great 2015 guidance that came out and it was really wonderful and I love it. It was time for an update. So this is kind of a quick run-through and comparison of the 2015 and 2020 draft update. So just notice that I'm trying to identify key things that changed, important changes, but also want you to know things that might be controversial. So you guys give us input on what makes sense, what doesn't make sense, is there something better out there, do we have research that we missed or that we didn't get quite right. So that's the kind of information we want to get feedback on in the draft phase. So in the actual 2020 version we talk about key changes but when it went out it didn't actually have the PVA that Theresa just went through. So there's some revisions to what we think some of the impacts might be and recommendations on take and avoidance. For example, the deterrence has come online in the discussions of the low wind speed curtailment. Also, things like the equipment issues that may or may not be contributing to take. A new section on adaptive management because one of the things we found over the years since 2015 is we really haven't had as good an adaptive management implementation as we would like. So we want to talk about that and get some more meat into the adaptive management section summary of the research program that originated based upon the 2015 workshop. Because a lot of what we're doing now, there's an increased concern, and the comfort level has been exceeded in some instances on some of the amounts of take out there. So there was more emphasis on how close we might or might not be getting to issuance criteria under the State statutes. So we wanted to make sure that we had all of that in the document. You can look at and understand where that may or may not necessarily be legal.

So if we look at things, you know, we've looked at the processes that we thought people should look at. This is guidance and not rulemaking. We do want to look at ways to address the site specific monitoring for the pre-construction need to post-construction monitoring for bats and how we can do that to get the most amount of information. I love hearing from Matt on trying to figure out some way to do more of a grand statewide scale rather than side by side. Then we did think based on the way we've seen analyses go recently and some of the results from the PVA stuff that there were some conservative assumptions that we would recommend; those are listed up here. Trying to be consistent with the Gorresen report of stable to slightly increasing population growth, not assuming that there's a lot of compensatory reproduction and they're not habitat limited. Then we set some tentative population levels for some of the islands. Again, we want feedback on all of those; The reason we wanted to set those conservative limits is because, Theresa went through this, it doesn't make a lot of sense to be using this as a population model for the Hawaiian Hoary Bat and we have nothing to indicate that that's what the actual populations are doing. We have one. Hopefully we'll get two or three occupancy trends that we can use to better inform this but we would like to see that stuff be someone close to observed reality. That's the one I'm talking about. We're hard-pressed to put that into a 5% growth rate, right?

We did recommend that tiers not be used as part of the HCPs. A tierless future would be nice. Then consider these key factors when selecting sites. How turbine size might impact bats and how the operation of those might impact bats. Recommending low wind speed curtailment of 6.5 m/s. Deterrence systems, we're all super excited and hope that that's the silver bullet.

Potential for impacts on larger turbines. Looking at the 20-minute rolling averages versus 10-minutes and then trying to get a handle on this discrepancy on turbine mounted versus meteorological tower wind speeds.

With adaptive management, we definitely want to see this be more heavily used and be more rigorous. We're hoping there's going to be some research needs to come out of this particular workshop and we'll try to be looking at that as far as the research agenda goes. Theresa already went through the PVA specific needs. So I'm not going to go over those. But research is something that we need to get clearly engaged in for the future to try to move us to a point where we're all comfortable with impacts to bats. That's kind of the quick overview of the things that are different between those two. Those are ones that we would really like to see some feedback on through the comment process that Lauren has outlined. So that's all I want to do to summarize those big differences between 2015 and 2020. Thanks.

PRICE: So looking over the 2016 RFP and comparing that to what you say that we need, I actually see a bunch of those things on the 2016 RFP. You guys were asking for population modeling and demographic information that includes percentage of breeding females, number of broods per year, and age at first breeding, and connecting habitat quality to reproduction and survival and what's important to life history stages. Actually like 80% of what you guys were asking for in the RFP is the questions I've been asking for the last two days. I'm just wondering as we recognize those are expensive studies, they take more time. They're much harder to get at, reproduction and survival. But without those things we can't do our job. You guys tried to get that information in 2016. It's four years later. There's huge progress that's been made in understanding a lot about the ecology and the life history. I don't know how that information plugs into our decision making here though for the one way bats are being managed in the state which is for HCPs, right? That's the management that's being done? And so how do we get at this information we need to make sure that our only native terrestrial mammal is still around in 100 years? So you guys tried four years ago. I'm asking a really big question.

MERHHOFF: I think that the layout of the 2016 research agenda was very good at identifying the things that need to be done. Some of those are being addressed and some of them are very hard questions to get. I think that what I would personally like to see is to focus on a smaller suite of things that directly relate to the issuance criteria associated with HCPs. Since HCPs have funded some of that research it seems like that would be the most important thing to be focusing on that really makes or breaks things. And so that's why I think that next iteration should focus on a much smaller suite of topics and not stray from those things we really want for that. So that would be my suggestion. But the research agenda was great and a lot of great stuff got done and you've heard it over the last couple of days. So I don't feel it's bad. Just that now we're a little different than then in that there's a certain discomfort level in the levels of take now that there wasn't earlier. So it's more important I think to focus on those items that delve specifically into the decision making. That's my personal opinion.

JACOBI: Just to follow up on that, when we the ESRC put together that RFP we were trying to do two things. One is we were trying to organize the issues and then tie them into what the data needs are to address those issues. The second thing is we were overly optimistic as we put up the RFP that all these issues would be addressed potentially. And of course only certain ones were done and the very hard ones were not addressed in this. I fully agree with what Loyal is saying. I think this time around what we need to do is go back and look at that overall outline in terms of what the issues are and the needs are and do whatever refinement we need on that. Then focus on the real key things that we need to have and whether it's through a general RFP or a directed RFP, find a way that we can really try to address those really key things as well as we can.

BOGARDUS: I'm just going to go off of Jim. Jim actually is the only member of the ESRC that was on ESRC at the time the RFP went out. I was staff at the time. I think that we were overly optimistic and we have a lot of big questions because think about it, you know four or five years ago we knew a lot less than we do now. I also think we underestimated the cost of doing some of those things. I remember at the time working really hard with folks trying to get some of the gaps and we only were getting things for certain areas of the RFP and so we were trying to actually talk to people about doing ones on other side of those research questions. People didn't think that they would be able to get a sample size or do it in a quick enough time frame and so no one actually put it in. There are good solid reasons for them not doing so and we had those conversations at that time about trying to get those research proposals. I guess I would put it back on the research community: do you think that we've got tools, techniques, and methodologies now that maybe we didn't have five years ago that would help us better answer those questions that we still have gaps on? That's a bigger conversation. We don't have time to dive into it. But I want you guys to think about it. I think that where we had gaps five years ago we still have gaps. We need to figure out whether or not we have better information to help us get at those gaps and where we don't.

LAUREN TAYLOR: All right. Thank you Loyal. That concludes our presentations.

ITEM 12. Wrap-up discussion.

SMITH: I been talking to the Committee and we really feel like the best use of our time now would be to make the best use of the people here. We have a lot of experts in the field. We're going to open it up to have a free conversation here. Some of the things we would like to cover would be things like avoidance, minimization, monitoring, mitigation, research, and next steps. We will be recording everything. We'll keep all the minutes and we'll circle back and start to look at how we can compile this and start the next steps. Where we're going from here. There's the issue of the bat and the guidance document. What we're trying to do is come up with the guidance and work with all the different players. It's going to end up protecting bats and hopefully recovering them going forward. Then there's, you know, just a lot of different interests in the room and some difficult issues like renewable energy, wind, and how you manage all these things, so a lot of different things going on. We want to try to make this process work for everyone. I'm just going to kind of open up on the floor.

ILANA NIMZ: Hi, I'm Ilana Nimz. I'm a biologist and arborist. I was looking through this. Obviously, it's a 70 page packet I got yesterday. I noticed it's for renewable wind energy proponents and the old document had other focuses too, and I'm specifically interested in trees and tree trimming. Is there another document that addresses that for 2020 or are you keeping the 2015 things for that?

LAUREN TAYLOR: We can provide you DOFAW recommendations. I think you have my email and we can connect but I'll let them answer as far as the new direction of the paper.

JACOBI: Yeah, it's not to minimize the importance of that because it is important but we wanted to really have this document focus on the wind aspects of things. So whether there's another guidance document. I mean, we're not doing that for all the different issues that we're dealing with on the ESRC. This seemed to be one that really needed that full attention on and so that'll be done in other ways, but it is an important issue.

MARIE VANZANDT: Hi, my name is Marie, I'm with AEP Renewables, the owner and operator of Auwahi Wind. I wanted to thank everybody today for coming and the ESRC for presenting this venue for presenting the latest bat research. AEP submitted a comment letter laying out some of the concerns that we have about the current state of the draft guidance document for 2020. I'm here to advocate that industry be more involved and have a feedback process. I think ultimately the guidance is going to be applied to future wind development. And so it's going to be important to understand the practicability of a lot of the recommendations so that feedback loop is going to be important.

LAUREN TAYLOR: And I'll add that all the letters that we received so far on the guidance document have been forwarded to the ESRC.

TOM SNETSINGER: And just also to follow up on what Marie said we've submitted a letter also with comments on the guidance, and I wanted to touch on a couple parts of the research question. I'm interested to hear from Michelle on the U.S. Fish and Wildlife Service's perspective on the research question, and the second is to sort of consider where the funding is coming from. I think we all know with it was the amendments and our subsequent tiers [of mitigation] that funded a lot of the earlier research. There is a not lot of money on the table that I see right now for that.

BOGARDUS: So when I answer I'm speaking for the U.S. Fish and Wildlife Service. Okay, there is no question that there are research needs for bats and that they are extensive and that they are important and that we need that information in order to make better decisions. So I don't want to dispute that. I don't want to claim otherwise, but at the end of the day in order for research to be used as mitigation under U.S. Fish and Wildlife Service policy it has to have a direct benefit on the ground to bats. It's a really high bar to reach. We got there a couple of years ago, but it took a lot of effort on our part and we barely made it happen and even then I don't know if we would be able to make it happen with those same research projects today. So I am not going to say that research can't be done. But I will say that in order to make it happen it has to be very tailored and it has to get specifically at on the ground benefits to bats. So what that means is that if someone wants to propose doing a research project for mitigation credit under the U.S. Fish and Wildlife Service policy, we need to be working extremely closely together. We need to start talking about what is that question that we're trying to answer. How is that going to be conducted, do we have at least reasonable expectations that the project is going to be able to answer the question that we're posing, and what does that mean in terms of implications for on the ground management of bats? If we can get there, then we can get there. If we can't get there then it's not going to be looked at as offsetting mitigation under the U.S. Fish and Wildlife Service for issuance criteria for an HCP. Again, that is not to say that that research is not incredibly valuable and needed in the

Hawaiian Hoary Bat world. It's just I can't say it any cleaner than that. And I know that there's been a lot of conversation between the applicants and USFWS, DOFAW, and the ESRC about what that looks like. But at the end of the day, it's not within my purview to change U.S. Fish and Wildlife Service policy on it.

JACOBI: Just a follow up on that a little bit. Part of what we're trying to do in the ESRC is through the guidance document and putting together a framework like we had for the RFP, based upon the information here, is to really identify those key issues that need to be followed up on both from a research perspective as well as from the management enhancement. We were very fortunate to have the opportunity to use research as a mitigation step several years ago. Whether that's available or not anymore, it doesn't really diminish the research that's going to be there. I also want to emphasize that there is other funding that is currently used for research. Some of these key things on deterrents, on some of the other things that are going on. Some of the funding through USGS through Department of Energy and so forth. There are programs that are continuing to address some of these big issues. Especially with things such as deterrents and minimization, but we still need to find other ways to get funding for these other key issues. And so that's why it's really important to identify what are those most important issues that need to be focused on and that we can actually get information on that will help us change our approach to management and protection of bats. So that's really what we're trying to do. So, I think it's contingent on all of us to be able to look collectively at how we can achieve that.

BOGARDUS: Okay, just to follow up on that really quickly. Yeah, so we obviously need other funding streams to help support bat research; that's clear. I would also say that even though bat research is unlikely to be used as mitigation credit there are incentives for doing bat research for applicants anyway, and we want to try and help make that happen. So if anyone has ideas on how we can do that, that's great. For example, doing research on deterrent efficacy in the long run likely has a large scale benefit for folks. Because it ultimately will help with cost efficacy in the long run. We hope. So I think that there are other options other than just research as mitigation to help get at the funding needs that are necessary to get the questions that we need answered.

PRICE: So, I think the one other thing just to note is that, I think most of the people in the room know that there's the ESA where you basically have to prove that you're not doing any harm to the persistence of the species. Then there's 195D in Hawaiʻi which is unique in that you have to show net benefit. And so when this committee is reviewing the applications you're having to show us that you're not only making up for the things that you're killing but that you provide a net benefit to the species. If you can't show that we can't vote yes. That's our job on this committee. And so the problem is that we don't know those answers, which is what we were listening for the last couple of days. And so you're stuck stabbing in the dark if you don't have answers. So it's not my hard job it's USFWS to sort that part out. But well, you've got to prove that you can grow bats or else you're going to be stuck minimizing to zero right, or to really low numbers that don't hinder persistence of the species.

SMITH: That's not really what the law says. The law says net environmental benefits.

MEHRHOFF: And contribute to recovery.

PRICE: So can we cause a species extinction?

SMITH: You just said net environmental benefit to the species. That's not what the law says. This is a Linda Chow thing.

PRICE: I'm just trying to make sure I understand.

SMITH: It's not that clear talking to Linda and trying to figure out where we need to get when we're issuing ITLs. We just need to get an issuance criteria. We really have no authority to go above and beyond issuance criteria. So we need to figure out what minimum issuance criteria is to get to that point by law.

MEHRHOFF: And that's what the checklist has, all those things. You can look at that. I want to change topics and ask a question for you guys. So one of the things that we have tried and struggled with is, you know offsets, growing bats, this kind of stuff but one of the key things is being able to show that bats are habitat limited or how to do that efficiently or effectively or at all. So do you guys know or have documentation of where you can say that Hawaiian Hoary Bats are habitat limited?

MATT STELMACH: It seems like you have the population at a starting point to say if we're changing population size, it's kind of circular.

MEHRHOFF: It can be very circular, it doesn't necessarily have to be but it certainly is a key thing to have with that.

DAREN LEBLANC: Can I expand on that a little bit and instead of just limiting it to habitat say do we know what the limiting factors for the bat population is in the islands?

MEHRHOFF: Of course.

SMITH: That goes to the point. If it hasn't spread over all the available habitat and there's some limiting factors so what are the factors that are keeping it from doing that?

THERESA MENARD: To get to your question. The one thing I think about is an anecdote from Quentin Tomich in *Mammals in Hawaiʻi* when he wrote about how bats seemed to fill the air from an observation of an early explorer in the 1880s. And this was a behavior seen over Pearl Harbor and we don't see that today on Oʻahu. I'm wondering, you know, we still see swarming on the Big Island and maybe Maui, I don't know. I haven't seen it there but it's a behavior we don't see on this island anymore. Is that something because the central plateau has been farmed, the effects of pesticides, or is it because the Navy has done something to the harbors at Pearl? I guess I feel that maybe if we had the wetlands back at Pearl and more insects or we had grasslands where we know bats can get moths, maybe that's one way they're limited on Oʻahu. That's the only thing that comes to mind to answer your question.

KRISTIN JONASSON: Just talking about things about swarming in historical records. One thing I noted when I talked to the large number of landowners was hey, can I put a bat detector in your yard? You don't know me. It's people who are not even aware that bats are killed at turbines. They say, oh man, like 15 to 20 years ago we had so many bats. We don't see them at night. I don't see them anymore. You're not gonna find them out in my yard. And so we did still hear them there, but what I was getting from these people who are not aware of the environmental situation is a cumulative impact of people that are saying we've seen a change. So although that's just my conversations with the large number of people I think there has been like a large change in the landscape in the islands over years and maybe the WEST study is saying that, we don't see bats where we see people. My guess is that it might be something more to do with like insects and how quickly and effectively they can get insects. So in my work I look at energetics, basically how much energy a bat needs to get around because flying is so expensive. It's not just your total number of moths, it's how many miles can you get an hour? Can you make a living doing that? I know the insect apocalypse is something to talk about the last 20 years and like even concerned areas in Germany where we're having massive declines in insects. So maybe it might not be like ground habitat, but just like can you eat enough to get living? But thank you for listening.

MATT STELMACH: I want to take a step back from the limiting factors and think about the regulatory context when we were going through the HCP amendments recently. I heard frequently in the HCP Amendment process "I can't approve this if it doesn't agree with the guidance" and I want to think about how this future guidance will be used and what place that has in conjunction with 195D. If this is rulemaking then we should be explicitly go through the rulemaking process. If this is not rulemaking, I'd like to see something the document that says that this is not rulemaking and how it will be used as opposed to how it will not be used.

BOGARDUS: So I can't fully answer that question. But I'll take a stab at starting it when we originally put together the 2015 version of the guidance document. It was never intended as rulemaking. It was intended as guidance to help and improve streamlining consistency between projects and to help avoid delays in putting together the HCP. It was always open for if people wanted to propose other things. That was open and the Committee would have to discuss that. That's what we saw happen. Right? We saw that happen in every single project all the way through. There were differences from the guidance document and that's okay; that is what it is. But at the end of the day, it's guidance. It was never intended to be thou shall do it this way or it won't get approved. It was intended if you do it this way you will have a faster and more streamlined review process because we're pretty darn sure that this is the direction that they should go. Now here's the problem. We got a huge amount of new information over those five years and as new information was coming in the door that guidance document quickly became out of date and I think that we are likely going to struggle with that again this time. That's the nature of bats right now. And that's a good thing because we're getting new and better information. But what that means for us is that we need to be careful about this as guidance. It's real-time guidance. It's the best that we know right now, the best available information from the industry, from our research partners, from our people on the ground, and we're grateful for that and it's likely going to change in the next couple years.

SMITH: And it's not rules.

JACOBI: Okay. Well, what I was going to say is as Michelle said we learned an awful lot from the last time and the guidance reflects what we in the ESRC believe is sort of the current condition based on the information we have. We are open to new information coming in. We are open to new interpretations of that. But this is what our expectations are in terms of if somebody submits a project, these are sort of the guidelines of what we're expecting to see in the Committee. But if there's some new evidence, new information that you want to present or new reasons why we should look at things differently, we're open to that. But this really stands as sort of our current understanding of where we believe things are and how they apply to the process of an HCP.

BOGARDUS: I think that you can guess that if it's not consistent with the guidance document, fair warning, there's going to be a higher level of deliberation on it at the ESRC. It's not a bad thing.

MATT STELMACH: To put that in context, there are three paragraphs about the ecology of the Hawaiian Hoary Bat and three pages about low wind speed curtailment. So, this looks like a regulatory document to me and not a guidance document.

PRICE: I'm going to circle back to just one thing earlier. So 195D-21 under habitat conservation plans: the plan will increase the likelihood of recovery of the endangered or threatened species that are the focus of the plan.

MEHRHOFF: And net environmental benefits.

BOGARDUS: So it's increase the likelihood of recovery for the endangered species that are part of the plan and to have a net environmental benefit. It's mentioned in two places. And that's true it's actually in like three or four different places.

UNKNOWN SPEAKER: So could it be an either/or or both?

BOGARDUS: Both. Alright. I got a question for you guys. So a lot of when we talk to people on the mainland typically from U.S. Fish and Wildlife Service Region 3 and people that are dealing with Indiana bats and other things, they are all like siting, siting, siting. We haven't been dealing with siting partially because by the time the project gets to us, it's already sited and they've already got their power purchase agreement or close to it anyway, and we're already like partway down the road of what that site is looking like, right? But the other reason why is because we are just at this point where we assume bat presence everywhere? You guys tell me: is there anywhere that you see a lower risk for bats on the islands?

SMITH: I think if you look at the WEST maps it clearly shows there's areas of higher and lower incidence. For instance, the Gill folks may be coming in for a wind project and out in ʻEwa where they were looking at it because I was looking at that ridge and it seemed to show pretty low detections out there.

BOGARDUS: So another part of this question. Sorry and adding to it is looking at the likelihood that wind farms are attractive and what that means in terms of risk changing over time. All right, you guys, take a stab?

KRISTIN JONASSON: One thing, knowing that these bats seem to forage near forest edges and along gulches and things is when you cut pathways through the trees on forested ridge tops to put up your turbines that looks like an awful lot like where I try to put my mist nets when I'm trying to catch bats. Like along roads, over rivers, clear linear features with trees on the side. So if that's where I like to catch my bats, that's kind of creating habitats where bats like to forage.

THERESA MENANRD: I was thinking about the times when I was monitoring in the field and I would go to some of these super windy places and I never saw bats there. I'm thinking of Kohala on the very windward side. It was just super windy. Maybe I thought the insects are maybe getting too blown around and maybe the bats had a hard time maneuvering to capture them. So those places come to mind.

SMITH: Can I ask a question for the wind industry folks. What kind of process do you go through when you're looking at siting areas. I'm sure some of it's opportunistic land prices and what not. But you got to be looking at wind regimes. I'm just wondering what sort of process you go through and is the likelihood of bat takes taken into consideration?

MARIE VANZANDT: Yeah, so I guess the first step in the process is that there's a need for renewable energy. And so here in Hawai‘i you guys have a goal of 100% renewable energy. So that would be the first step, that there's a need. We would look near substations, but then also for an interconnection point. We also you know, it's all about the resource. So we're going to go to areas with a consistent wind resource. We're going to measure that wind resource over a couple of years using meteorological towers and then we're going to look at what the appropriate height of that turbine would be based on that wind resource. And once we find an appropriate site, then we would look at pre-construction studies looking at what endangered species, what archaeological sites are there. What land availability is there, and from there we would again continue to microsite and narrow down the location.

JACOBI: I just have a quick follow-up. Is there a common wind resource map that everybody uses or it does everybody do their own thing? And if there is a common one, can we get a copy of it?

MARIE VANZANDT: Yeah, I think there are pretty publicly available wind resource maps. They are online.

JACOBI: And is that's what everybody is using or you have your own special ways that you sort of voodoo things?

MARIE VANZANDT: So we would use that as a starting point. And then from there we would look at the site-specific conditions using meteorological towers.

PRICE: How do you determine the height of the turbine that you're going to put up?

MARIE VANZANDT: Based on the wind regime at that site.

PRICE: So are you putting up stuff to measure the different heights because I'm getting that if you're doing that, at the same time, you know that if you put it up at a site that you got a lot of bats at that height you're going to be paying more money down the road. Then maybe you could put up some acoustic monitoring at your different heights to check for that.

MARIE VANZANDT: And so acoustic monitors are put up typically throughout that process. What we have found on mainland sites is there is no correlation between, even at different heights, pre-construction and post-construction acoustic monitoring. Whether it be on the ground or even at meteorological towers.

MEHRHOFF: It's not clear why that is.

PRICE: Okay because that 2017 or 2019 study was published… peer-reviewed published. They did find correlations between bat mortalities and pre-construction bat activity at particular heights.

DAVE YOUNG: Yeah, it was post-construction data and post-construction monitoring. Pre-construction data is not predictive of post-construction mortality. There's a new paper that's going to be coming out this year. There's been some stuff presented at some of the meetings related to this but about four different papers done over time that looked at this relationship. We did it more recently with about ten times the amount of data because we have been sitting on a wealth of data and sort of put that to bed. But you hit on a topic that I think is important here. This is the attraction theory. So post-construction acoustic data does align with post-construction mortality data, but that's after you build the things.

DAVE JOHNSTON: I want to just respond to a question a few minutes ago but related to habitat and wind siting. So about eight years ago, Mitch Craig invited me to come over to specifically look at the Kawailoa siting well before it was built, although these things are like a train running amok and there's a lot of energy and a lot of resources behind them. I told Mitch after spending a week out there that I thought that that was probably the best habitat on the island. Then he asked me why? Well, you've got a perfect machine here. That frankly worries me because you have these deep gulches that have a whole lot of native species. They look like they have plenty of insects. You have plateaus that you're putting up 100 meter towers and you have a crosswind which would make a low wind inside those gullies and I explained that. I think he explained this to his powers that be but it was much too late and we know the rest of that story. So it's kind of frustrating from my perspective for him to try to tell people what's going on and not seeing much difference.

LASHA-LYNN SALBOSA: I do have another topic I wanted to bring up. But before I change the subject, I'd like to speak to siting. One of the things that that's become very clear to me and working on, managing over the last several years is that it's not just wind and it's this: the siting is not just the activity levels from acoustic monitors because it's not predictive of the mortality once the turbines are up. But having the expert bat biologists involved pre-construction to look at the sites. There's a lot of habitat factors involved. I think that would be very useful in the future for any wind farm siting. I think that's very important. But what I wanted to do you know looking at the time we have here and listening to the talks, I'm always thinking of next steps and I'm wondering if the Committee and the attendees after listening to the talks havae key collaboration needs that can happen after this workshop that would serve everyone's collective objectives? I can think of a couple but I was wondering if folks wanted to put it down on the record? One in particular that jumps out to me is working with BCI and NRG systems to really look at a third party analysis of the efficacy of detterents in Hawai‘i. That’s something we really need. The other one is looking at the WEST study for O‘ahu and drilling down to look at the calls per minute and looking at if you can get a handle on the number of bats that you might have in some local area of some island area like O‘ahu. As you folks mentioned there’s a ton of information that can be gathered by the data and if there’s a meeting of heads here where we can talk about clear, concrete next steps to solve some of these really critical questions since we have everyone in the room now. We can talk about siting, we can talk about the past and things like that and how to bring the bats back, but I think looking at connecting partnerships and really pushing forward is what we really need in the near future.

SMITH: We’re going to send some surveys to everybody attending and hopefully get some good feedback on what we think our next steps are and how we’re going to work forward. Given what we’ve heard here at this workshop, we would like to circle back and say what are the next steps. Should we have another workshop? Should we have a series of discussions or presentations at the ESRC meetings to help inform? But trying to get at you know, where we get further down the road toward working all the different issues and how to try to find some resolution. One thing I have that Frank brought up earlier talking about this attraction issue. I saw that paper there was a presentation with time and I actually saw the videos of the towers and apparently the way that the paint is… it has the same radar signature as the surface of water. The bats are coming in and doing dipping behavior on the towers. And they’re going through the turbines again and again doing this behavior and yet this may be a question for some of the industry folks. They’re all shiny white and that’s never changed.

FRANK BONACCORSO: Could I add on something for a question for the wind industry folks and everyone can answer both? Is there any hope in the medium-term that a design to gather wind energy other than big large rotary blades is going to be commercially feasible?

MATT STELMACH: I just want to speak to the texture [as a minimization measure]. There was a pilot study about texturizing turbines. There was only a handful of turbines, but the results they found was no significant difference. So it’s not to say that that’s the only way to do it. There may be other experimental designs that favor to specific conditions. But that’s the first study that I’ve seen and it had no significant results in texturizing turbines.

FRANK BONACCORSO: Any answers on my question?

MARIE VANZANDT: I think we’re always looking at new technologies, but for my company in particular, we’re focused on wind and solar because those are the most commercially viable options out there for producing the megawatts that are being requested by the electric companies.

FRANK BONACCORSO: But is there a different structural design? I guess that could gather wind.

MATT STELMACH: Most of the other designs, their production capacity is so much lower that it’s not feasible.

JOHN UGLAND: It's the physics of wind. So your available energy is the third power to your rotor-swept area. So the bigger your rotor-swept area the more power you make. So it's hard to do that if you're rotor-swept area is tiny right? So unfortunately that's just physics.

FRANK BONACCORSO: That's not the answer I'd hoped for but that answers my question.

LAUREN TAYLOR: We have about 30 minutes. So if the ESRC has pressing questions. Then one other request I have as staff is if we want to deliberate on a comment process, timeline, and what you want that to look like as I will receive them… so that I know what you want.

WINTER: Nobody answered Dave's question. But why are the turbines always white?

LILY HENNING: Part of it is the community around them. Imagine them on the landscape and imagine them a different color. It is partially a visually issue.

WINTER: Well to me white stands out pretty starkly.

MEHRHOFF: I have a question for Michael. On your study on 10- verus 20-minute rolling averages and then more importantly the wind meters on the turbines versus on the meteorological towers, can you talk about what you think might be going on there?

MICHAEL SCHIRMACHER: Yeah. So basically that study was in West Virginia. There's a meteorological tower on the project and we compared basically what the reading was at the turbine that was closest to that and we got something like a meter per second higher. We looked at that after because we saw higher fatalities at the turbines that were curtailed based on the anemometer on the turbine versus those that were based on the meteorological tower. There's a number of things that could be factored. It could be the weight of the turbine was affecting the meteorological tower. There was a prevailing wind direction there, but there's some correction because the anemometer is downwind of the turbine so that can affect the reading. There's a freestream correction that's applied so that could be another factor.

PRICE: I have a question for the wind folks. So 2017 Romer paper is supposed to be a pre- and post- set up. So I'll be really interested to see the data set that you guys have that's showing that and was your study in Hawaiʻi. Your data looking at pre- and post- and no correlation at different heights.

DAVE YOUNG: The study we did looked over historical data. We looked at pre- and post-construction and sites where we had acoustic data from all over North America and North Canada.

PRICE: I think Hawaiʻi could be unique in that we have resident populations of bats as opposed to migratory. But I'd be interested to see your data set.

DAVE YOUNG: What's the name of the study again?

PRICE: It's the 2017 Romer et al. in Biological Conservation. Anyway, you're telling me that pre- and post-, I can't predict where to put my towers to minimize bat mortality? You're telling me that you know when you overlap your wind curtailment with what you've got to get to to make money and to make it worth your while to do renewable energy, which we all support the idea that we've got to get to renewable energy. So you're telling me we can't do things that are economically viable to reduce impacts to bats? So those are your minimization sides and we're being told that's really hard. And then we're looking at the data and going we just can't grow bats, we don't know how to that. That puts all of us in a really hard position. Essentially, somebody earlier said, we want renewable energy, right? You don't want global warming, right? So I'm sorry, these bats are a nuisance. Can you just speak to that? I'm hearing a lot of can't do that. Where do we go?

MARIE VANZANDT: I would say as an industry we want to do the right thing. We want to reduce bat fatalities at wind farms. At Auwahi, we curtail voluntarily at 6.9 m/s. I don't think we have said we can't do things. Also, I think with bat deterrence technology, there's a lot of questions of whether it'll work or not. But we're willing to try it and in the next month, we're installing the technology at the site. So I would say yeah, we can't shut off the turbines at night. Otherwise, we're a solar farm.

BOGARDUS: I just want to caution us here. Wind energy poses a lot substantial threats to Hawaiian Hoary Bats and other species in the Hawaiian Islands. We wouldn't be here if it wasn't and we wouldn't have been wrestling with these decisions and this process for the last, what is it now? Seven years if that was not true. This has been one of the hardest issues that DOFAW, USFWS, ESRC has faced. That being said we would not be in this room today if it had not been for the partnership of the industry in the room and from the relationship between the industry and the researchers here in this room. And I feel it is really valuable that we're here today with the information that we've got. And is it everything that we need? No. Is it everything that we wanted to be? No, but it is a hell of a lot more than we had before. And I value the partnerships that help make this possible and I think that industry has made a lot of strides to where it's at. I just want to recognize the effort of everyone in this room, whether you're industry or researchers or agencies that help make this possible because it has not been easy and it has not been quick and it hasn't necessarily been required from everyone for all of this to happen.

DAVE JOHNSTON: Slightly different subject, but I want to recommend that people use acoustic monitoring to a very specific use and so when you do a study ask a very specific question and then go about it in a very systematic way so that you can do a power analysis and see if you're going to collect the kind of data that you want. Because I'm beginning to see a little bit of well, we've got this acoustic study and then we can do XYZ; you know pretty soon you're making in some cases some really big assumptions. So I think in the beginning, decide what you want to do, and then do a really good job of it. Then mine the data because you're going to answer a question of whether or not they have one pups or two pups. I'm being a little facetious here, but I'm getting back to Kawailoa and they did a pre-construction acoustic monitoring survey of that site and it was decided that there were very few bats there.

SMITH: I can follow up on Michelle's comments. One of the things I kind of always say is wind energy is the best thing that ever happened to bats. About 30 years ago, nobody was even paying attention to bats. We really have the opportunity to look at the wind industry as a partner in this. It is a very difficult regulatory issue for the agencies, but we also have the opportunity to actually come out ahead. We can come out ahead on renewable energy and we can come out ahead on bats because we're able to leverage a lot of resources from the companies as they operate. You know, the Holy Grail is avoidance and minimization, right? Let's kill as few as possible then figure out how to get smarter on mitigation. I really think we could come out ahead with bats doing better. There's been a whole lot more attention on bats. I mean we had DOFAW O'ahu Branch here at this meeting with a whole bunch of people that are working on bats. Thirty years ago, we didn't have anybody working on bats. We had probably nine people from the Branch here just focusing on this kind of thing. So, maybe I'm just a hopeless optimist but I'm thinking the goal for me is that we make wind energy work and we also want to come out with more bats in the process. It's a win-win if we do this right. Right, and we have a lot of smart people working on it. I just gotta believe that we can do both.

MEHRHOFF: I think you're a hopeless optimist.

SMITH: If I wasn't I would have quit a long time ago.

MICHAEL SCHIRMACHER: Coming from a different perspective on the mainland where we found a different problem, where we have had some of these solutions since 2008 and it's basically a competitive disadvantage for someone to implement it there just proactively, and someone to not and so coming to a place where it seems like everyone is working towards the same thing.
The level of curtailment and we're talking year-round, not like a three-month period of time, at 6.9 m/s. I also think that like collectively working together, another limitation we have in the mainland is being able to share data and information. So over these 12 years just think of how that information has been collected and how we can come up with ways to do that analysis to really start to see what's going on. I think there's a lot of opportunity there to continue to learn from partnerships.

BOGARDUS: Okay, our three big issues from 2016 still hold true: population, population trends, and limiting factors. Tell me whether or not we have a chance of getting at those issues better today than we did five years ago. And if so, what would that look like?

MARCOS GORRESEN: I think the tools have improved a lot in the last decade or so. So I think we're a lot closer to getting at some of these questions and we'll sample farther and longer. We're still moving in vast amounts of video recordings and we're getting to a point that processes that much more rapidly to generate some answers. So I think that the tools are there to answer this and things are also getting cheaper. Audio supplies are a hundred bucks compared to the thousand dollar devices. So that allows us to cover more ground for longer periods of time. There's also new modeling techniques for converting some of this data. I gave a presentation on how to rate models and it's not been explored very much. There was that one paper where I gave an example that makes data of that. So that's something we can do here in Hawai'i as well as start taking all of this detection data we have. We can do some basic mapping and do some extrapolations of that.

MICHAEL SCHIRMACHER: I was going to say, we're facing a similar problem on the mainland. Thinking about Hawai'i and being this closed population on an island, it seems like if you can't do it here then you can't do it anywhere. There's also the opportunities that if you are able to prove some type of method here on the islands then it might be able to be re-applied on the mainland. So there might be opportunity to use resources there to help you guys answer your question.

BOGARDUS: Are you going help make that happen for us?

DAVE JOHNSTON: Yeah, I'd like to support Dave's idea here that this actually is and has been for us a wonderful opportunity to move the science. Our math is much better today. The tools are as Marcos said smaller, cheaper, and better. And I absolutely think we have tools now and in the very near future to do much more.

JOEL THOMPSON: Based on the data that we have gathered at this point, planning forward-looking processes I think we could do a lot better than that. We have these other understandings of more consistent and broad distribution in terms of capture probabilities or detection probabilities. All these things that five years ago we were trying to do power analyses to look at what would it take to do this on an island and we were handpicking, you know a few nights of data from a wind project here and there and applying that across the various islands to look at those sample sizes. So I think the tools will be here to look at what it would take to have a large-scale monitoring program that might be very efficient and effective over long term trends.

BOGARDUS: Which is kind of what you've been looking at for Oʻahu and leeward Haleakalā.

SMITH: Just kind of build on that, we're kind of looking island by island. Sort of the populations, we do monitoring and we start to figure out how we can fine-tune those programs. We've been talking to some of the companies. We might be able to find, you know, scalable options where we have projects that are collaborative between even different operators. So we'll have one big monitoring program and people can buy into shares of that. The sort of economics of scale. We might be able to do better work for cheaper. And so I really see a trend of improving things getting better. And so I think that we can continue along those lines and that's sort of the goal. I think especially if we stay collaborative amongst the groups and really try to work together. There's challenges with the wind energy side, but there's also opportunities and so we need to leverage both and try to leverage those opportunities so that we can move forward. Ultimately, make some of the investments that are required to be able to permit the wind industry's stuff. We can even make that more cost effective and have better outcomes for the bats.

MATT STELMACH: So collaboration has been one of the topics that comes up over and over. I'm wondering what the mechanism for that is. Are we talking about meeting on an annual basis or is there something that we can do more frequently? Is this DOFAW or USFWS sponsored? Is this the ESRC framework? What does that look like? What's the frequency? And what scale is that operated in?

SMITH: Well I'm kind of new to this committee. And this is my first bat workshop but I guess this is only the second one. I've given a number of workshops and I used to run them through a 501c3 which is kind of a nice way to do it. Again, private entity, you can get away from some government issues. I would really like to see this effort move forward. You know, take it out of being an ESRC meeting is just my suggestion and turn it into more of a workshop or symposium. More of a scientific forum. We're all getting together and sharing. Everybody's talking about the different issues. And I would like to do another one of these workshops. Maybe just as a workshop and not as an ESRC meeting, you know, within another year. So a year from now we do another workshop. We make it a symposium workshop, two days, stretch out a little bit more. So we have a little more time to interact. This is awesome. There were so many good people here, but it was a little compressed and I think there's a little bit of frustration. And not having enough back and forth and interchange so that folks here are really able to get the most out of the folks that are here. I'd rather do more smaller ones, maybe fewer speakers then try to cram everybody into one thing. So this is a great platform right now. It's been five years since we did one and so this got a bunch of stuff off our chest, but now I think we can do some small more focused ones and we could have some emphasis on a particular area. We'll look into how that goes and I'll be talking to the ESRC and staff about what we think. That's kind of my plan and I'd like to keep it going. So maybe we have another one in the meantime, so we'll be following up with the survey. Outlining what are the next steps, what do we need. Then can we start to touch on some of those at the ESRC meetings. Maybe a forum where we have an agenda item with people we will ask to speak to us and answer questions that we're wrestling with in terms of the actual permitting side and working with the industry. And we've been so focused on permitting that we're really struggling with that. We could focus on being more proactive and really looking at the science and the management of bats. Once we start to transition to that we're really going to start to get ahead. That's kind of the direction I'd like to go.

PRICE: Is there the possibility of USGS leading that because they're kind of a permanent institution and has had continuous bat research going on? So not to put you guys on the spot but is that something that you guys, as the research arm of the Department of Interior, could help coordinate. There's also the possibility of quarterly online like webinar style meetings. Because we're all in all different places. It costs a lot of money to get people here and it costs a lot of carbon. So maybe you could do webinars quarterly that would help if we're going to stay up to date on the methods because it sounds like they're changing so fast.

GORDON TRIBBLE: We would take our lead from the ESRC. So if the Committee wants us to engage in that way we would. I wouldn't want to do that in a way interposing ourselves in the process that's really yours to control.

PRICE: My suggestion comes from caring about the species as a whole and just saying I think it should be a part. Our job is very specific to 195D and ESA. It would be nice to have something removed from that.

GORDON TRIBBLE: Okay. Well, let's talk more. I'm open to the idea. I just don't want to have the appearance or the reality of too many chefs in the kitchen and crosswires. Right? So as long as that's coordinated and it doesn't have to be an MOU or anything, just everybody understands that this is going to be a series of science discussions. And then that's where we're going to end it. Then any sort of regulatory issues stay with this group here.

FRANK BONACCORSO: I can assist with something on a voluntary basis. I'd like to comment on Ted Weller's platform, which I think is very refined. It has privacy if you want to set privacy. Why don't we get more data entered in there and make that a priority since I bet if we look at everybody that has taken acoustic data in the state that we're approaching a thousand point locations. Let's get that in. Then get Jim's approaches with other physical biotic layers for Hawai‘i in there and see what we can see. I think we may see some fabulous patterns coming out of that. Do other people agree?

DAVE JOHNSTON: Absolutely, and for the record we probably have well over 315 locations for our current study site in Maui alone. So I'm guessing we have over 500 points of detection.

KRISTINA MONTOYA-AIONA: Are those going to be available to everyone?

DAVE JOHNSTON: It's going to take time to make it available and we have to ask our clients, both government and private, if they're willing to release those.

MEHRHOFF: So I'm going to be a wet rag on that one until you can show me the statistics formula you're going to use to give me an answer on that. So I want to see what test you're going to do that's going to show me that. Otherwise it's just going to be exploratory data analysis. But if you say, this is how you're going to take the data and you're going to test for x then I'm all in. If you can show me what you're going to run and say that if I get this then it's going to tell me, you know, what the population trend is or whatever the key thing we want then I'm all in. But I just worry that you'll have just a bunch of cool data, but not answering a specific question that we need from the ESRC recommendation perspective.

CHRIS TODD: What does that mean, you're all in?

MEHRHOFF: I think it's a great idea that we should do that. What happens is that you know, we try to advocate for people to put that in and make it happen to where you can then do the analysis. But if you can't tell me how you're going to do the analysis and what you're going to spit out at the end, I don't disagree with going ahead and trying to do that, but I don't think it's going to be a game changer for us.

GORDON TRIBBLE: I for once publicly agree with Loyal. Putting large databases together is easier said than done and they need upkeep. As part of an office that maintains the Hawai‘i forest bird database, we put aside probably half a FTE and everyone that does forest bird transects in the state sends us their data and then we seem to have inherited the kūleana to QAQC the data and output the database, give it back to anyone and everyone upon request, and it's quite a drain. We do it because it's important and it's part of our mission, but I'm not saying I want to do this for the bat data unless there's a mission.

SMITH: If there's any burning questions, we got about five minutes.

BOGARDUS: I want to make sure we answer Lauren's questions. This is towards the bat subcommittee: what are the next steps for the bat white paper? Lauren was asking for a timeline for comments and how that review process is going to go. Can the bat subcommittee speak to that? And I'll just say from the U.S. Fish and Wildlife Service side, we haven't actually submitted comments on it yet. But so what does this look like?

SMITH: I don't want to rush this process and I would like to take our time. There's no defined process right now. We could come up with one. But right now we don't have a timeline and I want to make sure there's plenty of input and when you know, we try to come out with something that it's something that has broad consensus. We say that it isn't a regulatory document but it has been used in a way that appears as a regulatory document. I just want to make sure it's good. I think just the conversation is good. This whole conversation is good as we move forward so I can talk to the committee. I don't think we have anything right now in terms of a timeline.

LAUREN TAYLOR: It'd have to be deliberated on record. It'd have to be a public meeting if the ESRC is all going to deliberate on that.

SMITH: We'll put it on the agenda for the next meeting. I want to say that we really appreciate everybody coming and really appreciate the experience in the room and the expertise and what not. I really want to see sort of this community of folks that are all certainly around bats, all the people that have an interest in bat conservation, recovery, and the intersection with regulation and renewable energy and whatnot. I'd like to expand this conversation and the framework under which we work with each other. I'm not sure the ESRC should really be the center of the universe on that because we're just one small piece of the regulatory puzzle. We have different agencies. This is just an advisory committee to the BLNR. Maybe because we have a lot of people that know and care about things there's a certain logic to us driving things. But from a regulatory standpoint maybe that doesn't make much sense and I'd really like to see if we can figure out how to expand how we interact to really move the whole subject of the Hawaiian Hoary Bat forward. So I'd like to have this conversation on the Endangered Species Recovery Committee. I'm hoping that since we've got some of the really difficult regulatory stuff at least for the time being, that we can start being more proactive. Hopefully we can help to drive that process, but we should look at other ways to collaborate like a more open workshop type format.

ITEM 13: Adjournment

SMITH: But with that I'm going to call this meeting to adjourn.