Debunking Critical Assumptions to Improve Forest Elephant Censuses and Monitoring

Interim Report 2

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Project Start Date: awarded 01/06/2018, finances received 03/2018

Project Completion Date: We have encountered several additional, unexpected delays. These includes strikes at the partnering Institute (IRET), and the PCR machine (necessary for genetic analysis) breaking. We have found alternative solutions but it has greatly slowed progress. At this point we are unsure how long it will take to obtain all the genetics data.

2. Specific Conservation Needs Addressed

Knowledge of elephant numbers is essential for understanding trends in populations, creating viable conservation strategies, and monitoring the effectiveness of these management actions. Our project addresses three major assumptions in the most common elephant census methods to improve elephant abundance estimates.

3. Goals and Objectives

The overall goal of this project is to refine forest elephant population estimates and promote better informed conservation planning and management. Our specific objectives are to:

1. Create a non-biased, easily applied protocol for determining independent dung observations in the field and create an alternative distance-based abundance estimation model that provides a correction for misinterpreted defection events.
2. Derive a distance-based abundance estimation model that adaptively determines dung decay depending on easily classified environmental conditions.
3. Derive a distance-based abundance estimation model that accounts for the probability two dung piles across space and time came from the same elephant (i.e., a spatio-temporal probability of re-sampling individuals).

We have not changed our goals nor objectives since the original proposal.

4. Specific Actions Taken

For each of the following objectives we have taken the following steps:

1. We refined the SNP panel to 17 SNPs, adding 5 to the original 12. After determining which SNPs to add, an electrical surge shorted out the Realtime PCR machine in the IRET lab. We have secured an agreement with another lab in country, Center of Medical Research Lambaréné (CERMEL), to analyze the remainder of our samples. We are still in the process of analyzing the remaining samples.
2. We have obtained all satellite data necessary for analysis of dung degradation. We have created a cox-hazard survival model for the dung decay and we are in the process of creating two user friendly plug-in models for dung decay. These two models will allow users to either download existing satellite imagery as covariates or collect in-the-field data while conducting the transect surveys.
3. Similar to Objective 1 we are adding additional SNPs to all samples necessary.

5. Changes in Proposed Activities

Thus far none of our activities have differed from our original proposal. However, because the time it took to decide which SNPs to add and the loss of IRET's PCR machine, the timeline for genetic analysis has been delayed again.

6. Conservation Outcomes and Accomplishments

Since the las interim report we have made substantial progress on Objective 2. We have determined that dung degrades far faster in Gabon than in other areas and that environmental factors such has substrate, precipitation, and habitat type influence the degradation time whereas factors such as site have less to no influence on degradation. The markedly faster degradation suggests that previous studies in Gabon may have underestimated the abundance of elephants in this region. This is potentially great news for elephant numbers and conservation! As a follow up to this study we will reanalyze data from various studies in the region to obtain an updated abundance estimate.

We have established the basis for using 17 SNP genetic markers for identification of individual elephants. This is not only a critical step in our project, but can be used in a wide variety of other elephant conservation projects. For example, this technique is now being used for genetic mark recapture studies to determine the abundance of forest elephant populations in Gabon. As our project reaches completion we will have more findings, accomplishments and conservation outcomes to report.

7. Elephants and Communities Impacted

Our project is facilitating the growth of the Agence National des Parcs Nationaux (Gabon's National Park Agency; ANPN) elephant genetics lab. We are helping develop the capacity of the lab and showing the need for a permanent *in situ* lab in Gabon. Supporting the functioning of this lab will continue to aid elephant management and protection across Gabon through their continued work identifying hotspots of elephant poaching through genetic testing of ivory seizures.

We have expanded our collaboration with the Wildlife Conservation Society who (also in collaboration with ANPN) is conducting a forest elephant census across all of Gabon. In addition to using the SNP panel in the genetic mark recapture portion of their census, they are incorporating our models into their population analyses. Our research will facilitate forest elephant conservation and management planning in Gabon.

8. Problems Discovered

During the interim the PCR machine we use needed to be sent to Europe to be fixed after a power surge. This caused an additional delay. To maintain productivity while repairing the PCR machine, we created an agreement with the Center of Medical Research Lambaréné (CERMEL) to use their PCR machine. The technician has been working on our samples since November but progress is much slower.

9. Project Success

So far we have been successful in completing the initial stages necessary for this project. We genotyped 12 SNPs for all of our samples. We have created a cox hazard survival model for Objective 2 and are using it to create a general model that can be incorporated by any organization using distance analysis for elephant dung. This is on schedule to be used in WCS's Great Elephant Census in Gabon. Our longer term goal is to have our results integrated with all Distance analyses for forest elephant population assessments. We will do this by publishing our results in academic journals and working directly with organizations conducting elephant censuses to improve their estimates.

10. Next Steps

Our next steps for each of our objectives are as follows:

1. Once all the samples have been analyzed, we will assess the number of dung piles believed to be independent that were from the same individual, as well as the number of dung plies believed to be from the same individual but actually belong to unique individuals. We will then either create an easy to follow protocol for determining individual dung piles in the field, minimizing over- or underrepresentation of individual elephants, or recommend that all dung is counted without observer bias and develop a hierarchical step in the Distance model that corrects for the probability of individual identity. After completing Objective 2 we will begin the framework for these models so that once the finalized genetics data is obtained we will quickly and efficiently be able to run these models.
2. Our next step is to integrate the dung degradation as a hierarchical step in the Distance model to enable users to employ an adaptive degradation rate with easily collected covariates minimizing the chance of underrepresenting dung in habitats where it quickly degrades or overrepresenting dung in habitats where it does not quickly degrade.
3. We will associate the individual identification from Objective 1 to the dung sample's GPS referenced location to determine the spatio-temporal distribution of the individual elephants. This information will be used to develop a hierarchical step, incorporated into the Distance model, to model the probability of resampling the same individual over space and time.

Once we have created the intended guidelines and models we will share our results directly with organizations implementing transects, as well as through reports and scientific articles. Our goal is to implement our methods and models into current practice as quickly and fluidly as possible so that conservation decisions can be made based off the most accurate information possible. We expect our methods to be immediately incorporated into the Wildlife Conservation Society's Great Forest Elephant Census in Gabon and we will reach out to other organizations conducting similar field studies.

11. Human interest story.

In order to create the genetics panel for individual identification we needed dung samples from reference pairs- known mother and offspring pairs, siblings, and unrelated individuals. With the dense forested environment it is impedingly difficult to observe the elephants. It was getting towards the end of our field work and we still did not have the mother offspring pairs necessary. We were hopeful that our luck would change as we were following one of our collared elephants, Marijo, who we were pretty sure had two young with her. We followed her for three days around the village of Mouyabi near the south of Ivindo National Park. We were so close to her! We could hear her group foraging in the dense underbrush but could not get close enough to safely observe the group. Sure enough we were finding juvenile and infant size dung piles, but we were also finding dung piles from two different sized adults meaning we could not be sure which dung belonged to who. Disappointedly, we had to continue on to our other focal follows and began the two day trek to Langoué Bai Camp inside Ivindo National Park. Being at the end of the rainy season, rain poured on us most of the hike and halfway into the next day, preventing us from staring our next focal follow. On a whim we decided to visit Langoué Bai- a swampy forest clearing, known to attract elephants and other animals who eat the mineral-rich mud. The bai was still misty from the rain but as it haze began to burn off we noticed an odd shine coming from one of the elephants, surprisingly enough after a closer look with the binoculars we confirmed it was a GPS collar on none other than Marijo. She is easily identifiable for her small stature and lack of tusks. Better yet she was there with an infant and a juvenile! Finally, after months of trying to track her to a place where we could confirm her and her offspring's dung we happened to be visiting the bai at the same time.

12. Summary of Progress

Our project intends to improve estimates of forest elephant abundance to inform conservation and management decision making. This project builds on previous forest elephant work by establishing objective criteria for field observers to identify independent defecation events, rates of dung decay in diverse habitats, and by modeling the spatio-temporal probability that two dung piles come from the same elephant. We are genotyping elephant gut cells collected from their dung piles (similar to forensic identification at crime scenes) to unbiasedly determine if observers can correctly identify unique dung piles and to create the proposed spatio-temporal models. We have completed most of the groundwork necessary for our project. We have designed a robust panel of genetic markers (single nucleotide polymorphisms; SNPs) which are used to identify individual elephants from the dung samples. We have completed our first dung degradation models showing that forest elephant dung degrades at a faster than estimated rate suggesting that previous population abundances may have been underestimated. We already have organizations interested in using our methods to improve their estimates of elephant populations!

13. Associated Organizations

Duke University: Primary and co-investigators
Rare Species Conservatory Foundation: Co-investigator
Florida International University: Co-investigator
Fauna and Flora International: Co-investigator
Agence National des Parcs Nationaux: Collaborator providing genetic expertise
Institut de Recherche en Ecologie Tropical: Provides laboratory space

14. Financial Report

The second installment of funds has not yet been used.

17. Intent to Publish

We intend to publish our findings in an academic journal and as part of Amelia Meier's PhD thesis at Duke University. The article will likely not be written until 2019 and the appropriate journal has not yet been chosen.

18. Media Coverage

Our project has not received any media coverage.

19. Media Links

We do not have any specific media accounts associated with this project. Our personal sites are:

Amelia Meier:
https://www.poulsenlabduke.com/who-we-are.html
https://nicholas.duke.edu/people/students/meier
https://www.researchgate.net/profile/Amelia_Meier3
https://www.facebook.com/amelia.meier.33

Matt Shirley:
https://www.facebook.com/mecistops
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