• MSSP Consulting: Limited Duration Project Description and Intended Scope

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Intake Date: [10]/[18]/[2022]
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Project description and Goals:

Based on the information provided during the intake meeting, our understanding of the Client's project is as follows.

Ultimate Goals:

- The client is looking for improvement in visualization of the data.
- The goal for the project is to test the idea that birds should be able to retain information about chemically defended prey species and their mimics over long periods of time.
- The experiment is mainly focused on training the bird to recognize the toxic butterfly and observe how long it can memorize.
- Find out how time influences how birds learn aposematic signals and generalize them to palatable mimics.

Experiment Setup:

- The experiment was conducted during summer 2022
- The experiment was conducted at Quabbin Reservoir in MA.
- Four experiments in distinct geographic regions of the park(Quabbin)
- 7500 fake models, 3000 for learning and 4500 for testing
- 25 of each Butterfly model within sites, 20 sites separated with 250 meters.
- The experiment used three different groups of butterflies, Battus (the toxic one), Limenitis (the mimic one of the Battus) and the control group, Junonia.

Experiment Description & Procedures:

- The client designed this experiment where they created fake butterfly models of three different groups of butterflies.
- Battus and Limenitis has overlapped habitants
- They placed these fake butterfly models on big foliage to resemble butterflies at rest Quabbin Reservoir in Massachusetts.
- In the first experiment, set out the "model" and the "control" for four days, record evidence of bird attacks on a daily basis and take them down. Four weeks later(learning gap), return to the region and set out the "mimic" and the "control", then record evidence of bird attacks on a daily basis for 4 days.
- Since the facsimiles are made from clay, attack marks are easily distinguished.
- All the data are collected between 9am till noon since most attacks happen in the morning from 6-9am. Almost no attacks happen after noon.
- Repeat the experiment at other locations, but with different time gaps. 2-week gap, 1-week gap, simultaneously.
- For the simultaneous one, all three types of butterfly facsimiles will be presented at the same time.

- Compare the data collected and find the pattern to prove the hypothesis.

Definitions, Vocabularies, and Basic Understandings:

- Battus philenor: Toxic Butterfly, blue patterns, serve as unpalatable “Models” group
- Limenitis arthemis: Non-toxic Butterfly, have similar patterns as Battus philenor to avoid being eaten by predators, serve as palatable “Mimics” group
- Junonia Coenia: Non-toxic Butterfly, brown color serve as palatable “control” group
- Facsimile: an exact copy, especially of written or printed material.
- Palatable: Pleasant to taste
- Batesian Mimicry: Batesian mimicry occurs when predators (birds) learn to avoid chemically defended “model species”, resulting in protection against predation for mimics that look like the model
- Aposematic: (colors, markings, etc.) serving to warn or repel predators.
- Bitrex: A chemical that is bitter and mimics the unpalatability of Battus, but instead it is non-toxic and will not harm the birds.
- Mimic evolved the pattern to avoid predators
- Transect: a straight line or narrow section through an object or natural feature or across the earth's surface, along which observations are made or measurements taken.

Expectation of the experiment:

- During the 4 days period of learning, we expect a low attack on Battus and high attack on Junonia.
- For the next experiment, we replace the Battus with Limenitis, the mimic group of the Battus, we expect a low attack of Limenitis and high attack on Junonia if the mimic is working.

Data Description:

- Binomial data: 0-not attacked, 1- attacked (because multiple attacks rarely happen)
- 30000 observations in total

Suggested Model & Improvements:

- Binomial Model
- Generalized linear mixed model (GLM)
- Change variables in the axis

Other:

- There will be no more experiments conducted in the future. Case is closed

Questions for the Client:

- How many days of evidence recorded after the learning gap. Is it 4 days as well?

Initial milestone and Deliverables:

To address the Client's needs, we will use reasonable efforts to provide the following initial work product for Client's review by [11]/[1]/[2022].

The project should be done before the semester ends

- We can play with different variables and come up with a new graph
- All the graphs our client made were about Attack Rates ~ Days

Purpose of the consulting: The purpose of this consulting arrangement is 1) to train both Boston University (BU) MSSP and PhD students on the process of statistical consultation and 2) to provide a service to improve the quantitative aspects of research/projects on BU's campus. Student consultants will be monitored by MSSP faculty in order to help the consultants provide

their best possible service. Nevertheless, we ask that you understand that students are not (yet!) professional consultants, and we thank you for your patience and cooperation in this regard.

Scope of the project: The project described below has been approved for what we call "limited duration" consultation. As the name suggests, such projects are intended to be fairly focused, with a total duration of no more than 10 student hours' worth of work. Consultation will involve MSSP student consultants and PhD leaders, supervised by MSSP program faculty. An initial intake meeting should have been held and additional meetings, as needed, will be arranged at the mutual convenience of the Client and the student consultants.

Attribution: When the scope of the work is of 'limited duration' but nevertheless is used in any sort of academic product (e.g., presentation, project, abstract, or publication), we would ask that you please include an appropriate acknowledgment. For example, Clients may include "We acknowledge the help of [NAME] of the MSSP statistical consulting service under the guidance of Professor [NAME]" as a footnote accompanying grant support and related uses[1].

Modification of Intended Scope of work: At any time during this process, if both the Client and the MSSP Team mutually agree that the above proposal does not adequately address the Client's needs, we leave open the possibility of holding additional discussions to alter the above proposal. Consultations anticipated to require substantially more than 10 hours of work may be recommended for collaborative consulting. Evaluation of such recommendations typically will include a discussion of co-authorship on resulting end-products.

Disclaimer: Client acknowledges the work will be performed by current students in BU's MSSP and PhD Program with some faculty supervision. As such, we make no representations or warranties, express or implied, of any nature, including without limitation, warranties of merchantability or fitness for a particular purpose. Client acknowledges and agrees that all work performed is provided on an "as-is" basis only. We will use reasonable efforts to preserve the privacy and security of data provided to BU or work product generated by BU and its students and faculty that includes material identified by Client as confidential, but we shall have no liability for any loss or release of data or data use.

[*Optional (add if Client is affiliated with BU but is a separate legal entity – e.g., BMC, Ryan Center)* Release: Client releases BU and its trustees, employees and any students participating in this project from any and all claims, liability, and damages of any kind arising from Client's use of any work product or other use of the results of the project.]

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[1] We explicitly do not insist upon co-authorship for projects of `limited duration' type -- although, of course, if the conventions of your field permit, co-authorship for at least a subset of the consulting team is always greatly appreciated. This MSSP policy is intended to allow clients maximum flexibility in seeking out and benefiting from our statistical consulting work while, at the same time, promoting best practice regarding academic intellectual property. Our perspective is informed by the American Statistical Association's guide *When You Consult a Statistician … What to Expect*, which states that any such product "should acknowledge the participation of the statistician, consistent with the value of that participation."