The Influence of Natural Sounds on California Ground Squirrel (*Otospermophilus beecheyi*) Vigilance and Predator Detection

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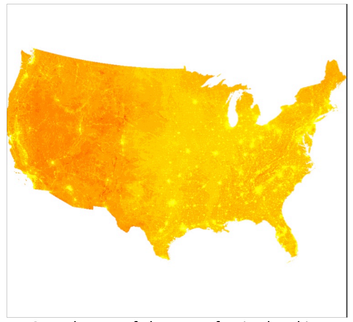
Background

The California ground squirrel is a social animal that lives in burrows. Colonies range in size from a few individuals to dozens. Living in colonies provides protection from predators such as hawks, coyotes, and rattlesnakes. For protection, colonies usually have a sentinel that is vigilant for predators. Additionally, each squirrel must weigh the risk of foraging versus being vigilant so they can better detect incoming predators.

Many factors affect how a ground squirrel behaves, but in this study we are looking at how a changing soundscape affects their behavior. This is relevant because the sound-scape of the US has changed drastically due to human activity. This change is causing the behavior of prey species to change[1]. In particular CA ground squirrels become more vigilant and forage less in response to increased anthropogenic (human-induced) noise[2].

However, it is not known how natural sounds affect the behavior of squirrels. The intent of this study is to explore this relationship.



Soundscape of changes of noise level in the United States. Brighter colors indicate a greater increase in ambient noise.

Basic Design

- This experiment will use 3 treatments to test the effects of natural sound on behavior:
  - Cicada Calls (low frequency)
  - Rushing Water (river noises, high frequency)
  - Control (a "no energy" track played on a speaker to control for EM energy)
- These natural sounds are broadcast ~ 50 meters away from a colony at the level of 85 dBFLT at 1m
  - Squirrels thus experience a biologically relevant stimuli of 50-80 dBFLT[3]
- Investigators were 30-50m away from the colony in a hunting blind to hide their presence
- 9 colonies were chosen for testing
- Each colony underwent 3-6 tests
  - 1 test for each of the three sound conditions- cicada, river, and control
  - If possible each of these three conditions was completed once with adults and once with juveniles

Hypothesis

An increase in natural noise will increase the vigilance of the California ground squirrel.

Predictions:

- Individual and group of squirrels will spend less time foraging and more time vigilant when exposed to natural sound treatments.
- Squirrels will be quicker to flee from a perceived predator as a result of increased vigilance when exposed to natural sound treatments.

Behavior Trials

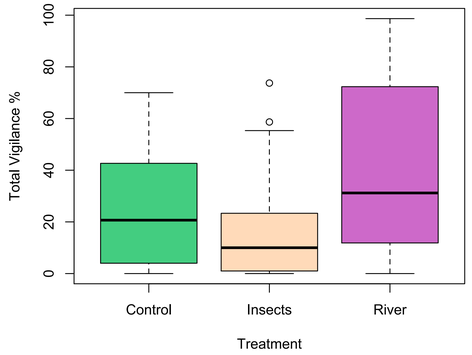
- These trials involved 5 minutes of constant observation.
- Behaviors were separated into 11 categories: vigilant on two legs, vigilant on four legs, foraging and vigilant, foraging, moving, social, grooming, resting, dust bathing, digging and tail flagging.
- Time spent performing each activity was converted to a percentage spent performing each activity.

Focal Individual

During this trial, a single individual was observed for the duration of the test. Using a spotting scope, this individual was randomly selected from the visible population.

Results:

- There was not a significant difference between the time individuals spent vigilant for the control and insect (cicada) treatment.
- However, during the river trials individuals spent significantly more time vigilant for predators.
- Other important factors:
  - Average group size
  - Group composition

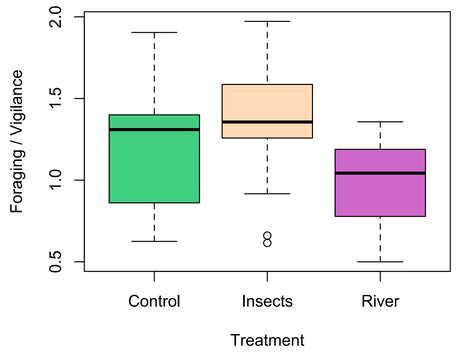


Group

This trial was done simultaneously with the individual trial. A scan of all visible squirrels was performed every 30 seconds and each individual's behavior was recorded.

Results:

- There is very little difference between the three treatments.
- This suggests that other variables are more important in determining group behavior than the noise treatments.
- These variables include:
  - Average group size
  - Group composition



References

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2. Rabin, Lawrence A., Richard G. Coss, and Donald H. Owings. "The effects of wind turbines on antipredator behavior in California ground squirrels (Spermophilus beecheyi)." *Biological Conservation* 131.3 (2006): 410-420.
3. Francis CD, Barber JR (2013) A framework for understanding noise impacts on wildlife: an urgent conservation priority. *Frontiers in Ecology and the Environment* 11, 305-313.

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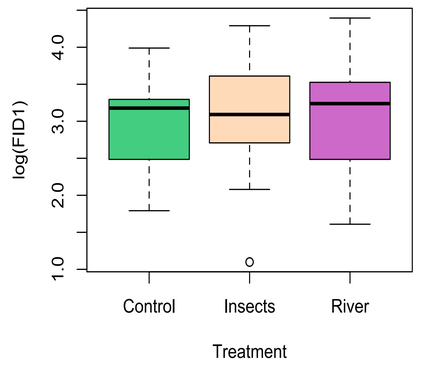
Coyote Detection Trials

- This trial tested squirrels' ability to detect an incoming predator with or without the addition of sound to the environment.
- A robotic coyote was made by combining a RedCat Racing Rock Crawler and a coyote decoy.
- The robotic-coyote started 50m away from the focal squirrel.
- It was driven at a steady pace toward the squirrel to simulate the hunting style of a coyote.
- The Flight Initiation Distance (FID) was recorded.

Results

- This plot shows that the FID was not significantly different depending on the treatment.
- This is not what our predictions and hypothesis expected.
- Factors that are more important in determining FID are:
  - distance of squirrel to its burrow
  - number of other squirrels present
  - Composition of surrounding colony



Discussion

- These initial results are cryptic and further analysis is necessary.
- Squirrels do not respond to high frequency noises (cicada).
- Squirrels respond more consistently to low frequency noises (river).
- Many variables besides the sound level contribute to squirrel behavior, notably the average group size, group composition, and age of the individual.