Photosynthetic Capacity within the Phantom Gas Field Project

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Introduction

- Anthropogenic noise has proven detrimental to bats, birds, and other species whose success is affected by unnatural sound.
- It is unknown how/if noise affects ecosystem functioning, including ecosystem services such as carbon storage.
- To test how noise affects ecosystems, we are broadcasting recorded natural gas-well-compressor noise in sagebrush steppe outside of Boise.
- Our component of this large-scale, collaborative project is to quantify insect herbivory and plant physiology.

Hypothesis

We hypothesize that shrubs in "noise-on" sites will have increased insect herbivory (leaf damage) leading to declines in photosynthetic capacity.

Methods - NDVI

- Remote sensing data from NASA satellites in the near-infrared (NIR) and visible-red spectra is used to create the Normalized Difference Vegetation Index (NDVI).

$$\frac{NIR-red}{NIR+red} = NDVI$$

- Output of values form -1 to 1; values of 0.2 and above are considered to represent vegetation that is photosynthetically active.
- Quantifies plot-scale (250 m^2) photosynthetic capacity.

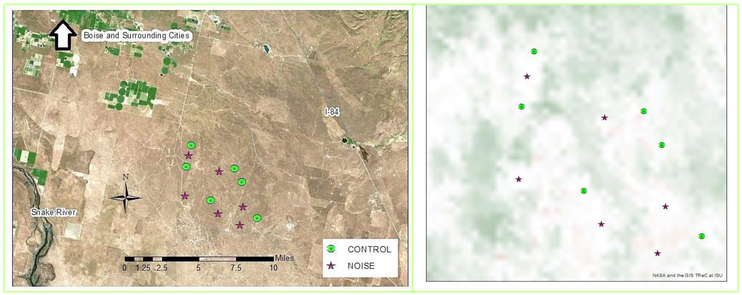

Figure 1. A map was created using ArcGIS by ESRI and our own GPS coordinates (left panel), then NDVI data from the GIS Training and Research Center at ISU were downloaded for each day available within the timeframes of interest (sample day, right panel).

Methods – Chlorophyll Fluorescence

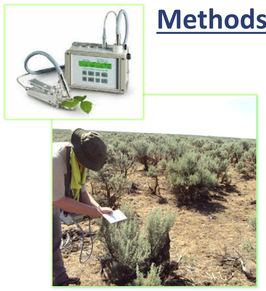

Figure 2. Using the fluorometer in the field. Measured three shrubs/site biweekly.

- Photosystem efficiency: for a given amount of light delivered to a leaf this is the percentage of light being used for beneficial photochemical reactions.
- Measured using a Walz portable Mini-Pam Photosynthesis Yield Analyzer.
- Quantifies leaf-level photosynthetic capacity

Results - NDVI

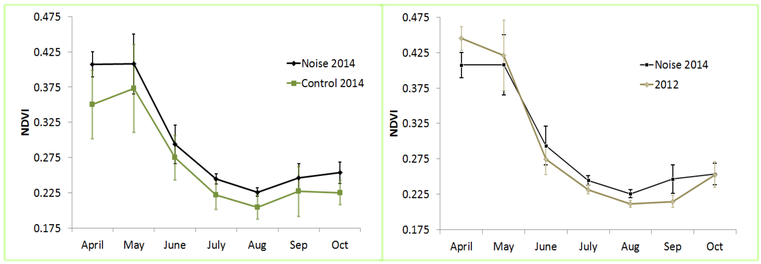

Figure 3. Monthly mean NDVI values for the study during summer 2014. Error bars are ± 1 SD. In 2014, NDVI was slightly greater at the noise-on sites compared to the control sites (P>0.05), and greater than at the same sites in 2012 (P>0.05).

Results - Fluorescence

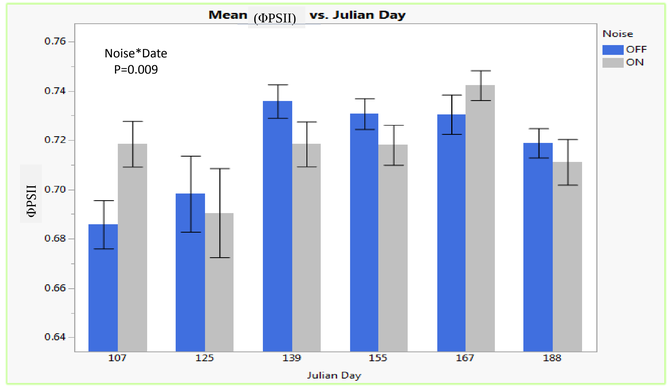

Figure 4. The percentage of light being effectively used for photochemical reactions (ΦPSII) is less at the noise-on sites. The noise effects on ΦPSII are not significant overall (P=0.43), but there is a significant Noise X Date interaction.

Conclusion and Further Study

- Our measurements show small and variable differences so far. We expect that may change as the summer progresses and the soils continue to dry out.
- To date, photosynthetic capacity in shrubs varies little between noise-on and control sites.
- Our team will continue taking measurements though October 2015. Other measurements include:
  - Soil moisture levels.
  - Respiration and gas exchange.
  - Growth of reproductive and vegetative stems.
  - Seed production/viability.
  - Stable carbon isotopes (water use efficiency metrics).

Other Phantom Gas Field Research

Several other graduate and undergraduate students are actively doing research on the effects of noise on this sagebrush steppe ecosystem as part of this project. We will continue to broadcast noise well into fall 2015. Other research includes studying the chemical compounds in the leaf litter produced on these sites, as well as insect dynamics, bird counts and patterns.

Figure 5. Numerous studies are being conducted on these sites to assess the ecosystem-wide responses to anthropogenic noise.

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