

Physiological Responses of Sagebrush to Human Noise-Induced Changes in Arthropod Herbivory

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Background

Birds and bats provide essential ecosystem services such as predation on plant-damaging herbivorous insects.

Increases in human noise-disturbance alter avian predator activity, creating the potential for "top-down" alterations in ecosystem services across multiple trophic levels (birds/bats→insects→plants→soil).

The impacts of altered soundscapes from human noise has not been thoroughly investigated across multiple trophic levels, nor have the mechanisms underlying these ecosystem-scale changes.

Our study is one of the first to examine the effects of noise pollution across multiple trophic levels, using an experimental approach.

We broadcasted recordings of natural-gas-well compressor-station noise, and investigated how this noise resulted in changes in shrub herbivory, growth, and physiology, presumably because of noise-induced reductions in bird and bat predation on herbivorous insects.

Research Questions

- Will shrubs growing at study sites exposed to chronic human noise experience an increase in arthropod-herbivory, compared to shrubs growing in control ("quiet") areas?
- Are there differences between photosynthetic CO<sub>2</sub> assimilation, chlorophyll fluorescence (photosystem II efficiency), and water stress among control (noise-off) and treatment (noise-on) shrubs?

Methods

**Study Site:** National Birds of Prey Conservation Area, SW of Boise, ID.

12 sites: 6 treatment sites broadcasting recordings 24hrs/day; and 6 control sites with no broadcast noise.

Each site was located >0.5 Km away from any road to exclude potential vehicle disturbances and/or noise biases

A total of 72 shrubs (*A. tridentata*) were measured monthly for:

**Herbivory**-- stem growth, number of leaves, and herbivory damage (bite marks and total leaf damage).

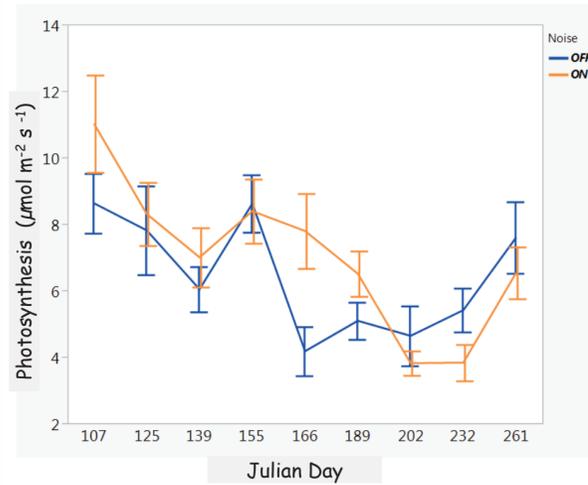
**Gas Exchange**—photosynthesis, respiration, transpiration, and stomatal conductance were measured using a LiCOR LI-6400 portable photosynthesis machine

**Water Status**—pre-dawn water potentials were measured using a portable pressure chamber (PMS Instruments, Model PMS-1000).

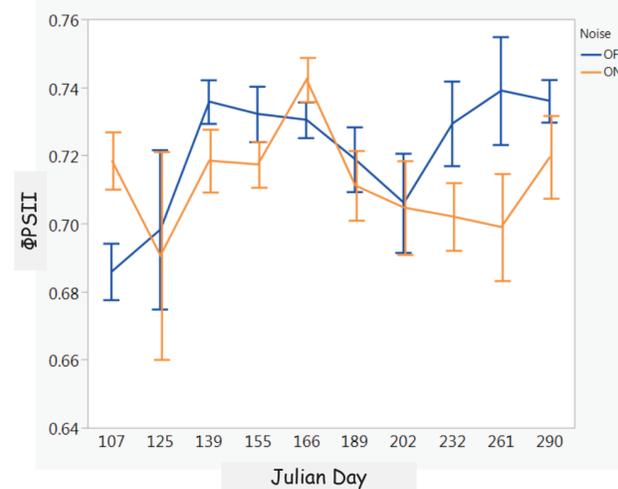
**Leaf Chlorophyll Fluorescence**—photochemical efficiency was measured using a Walz Mini-Pam Photosynthesis Yield Analyzer.



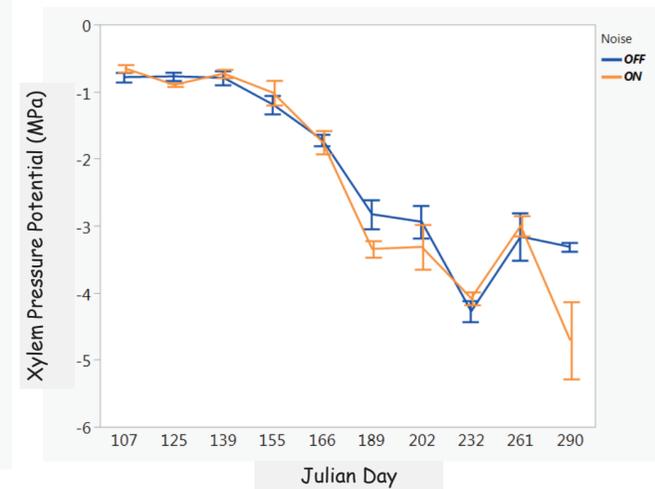
Results



**Fig. 1.** Variation in photosynthesis from April through September 2015. Points are means ± SE. Noise did not have a strong effect on photosynthesis throughout the summer, however, there appears to be greater photosynthesis in noise-on shrubs during the summer months than in control shrubs. Preliminary data suggests that herbivory on treatment shrubs was 2x greater than at control shrubs.



**Fig. 2.** Variation in photochemical efficiency ("ΦPSII") from April through October 2015. Points are means ± SE. Noise had a marginal effect on photosystem efficiency throughout the summer. Preliminary data suggests that herbivory on treatment shrubs was 2x greater than at control shrubs.



**Fig. 3.** Variation in pre-dawn water potentials from April through October 2015. Points are means ± SE. Noise did not have a strong effect on pressure potentials of shrubs throughout the year, however, there were occasionally significant differences later in the summer.

Discussion

- During the late-summer months, when water was more limiting, **experimental noise had some effect on shrubs**, with less significant effects at other times during the growing season.
  - *Photosynthesis* was greater in shrubs at noise-on sites during mid-summer, but lower in shrubs at noise-on sites towards the end of the growing season.
  - *Photochemical efficiency* was frequently less in shrubs at noise-on sites, especially at the end of the growing season.
  - *Water potentials* in shrubs at noise-on sites were occasionally more negative, especially later in summer
- Taken collectively, our preliminary evidence suggests that **human noise may affect shrub herbivory and physiology**, with potential cascading influences at ecosystem scales. Further analysis underway to determine the statistical and biological significance of our findings.



Acknowledgments

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Ongoing Research

- Processing of vegetative and floral samples for <sup>13</sup>C and <sup>15</sup>N isotope ratios, to determine if there were any changes in isotopic discrimination because of herbivory and/or noise directly.
- Analyses of the amount of herbivory damage between our control and treatment sites
- Analysis of shrub reproductive success, through floral stem production and seed number and quality.
- Regression analysis and AIC model building to incorporate findings from other members of our research team (including bird and bat populations, insect abundances, leaf litter fall analysis, and shrub defense-compound analyses)

