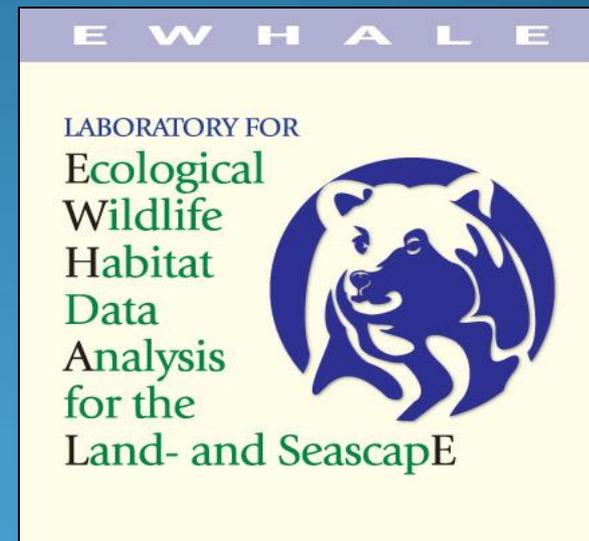


Predicting the Distribution of Human-made Noise in the Soundscape: An Indicator of Habitat Quality

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Topics of Presentation

- Anthropogenic noise effects on Wilderness
 - Summary of preliminary findings
- Anthropogenic noise effects on wildlife
 - Summary of preliminary findings

Proliferation of Mechanization

- 200 years of machine development
 - Steam engine -> Locomotives
 - Internal combustion engine -> Most vehicles today
- Machines have enabled human population growth
- Increased degradation of ecological systems



The Wilderness Act of 1964

- Preserve the last remaining wilderness areas
- *“affected primarily by the forces of nature, with the imprint of man’s work substantially unnoticeable”*
- Beneficial to wildlife as refuge from human impacts



Significance of Sound

- Communication among individuals
- Detection of predators and other risks
- Locating resources
- An indicator of biodiversity and disturbance



What is a Soundscape and Soundscape Ecology?

- A soundscape is the combination of:
 - Biological sounds = **Biophony**
 - Geophysical sounds = **Geophony**
 - Anthropogenic sounds = **Anthrophony**
- Soundscape Ecology is the study of:
 - Temporal and Spatial Variation of Sound in the Landscape

Biophony



Geophony



Anthrophony



Winter Soundscapes in Alaska

- Wilderness areas are expected to be dominated by silence, geophony, and biophony
- ANILCA 1980 allows snowmachines in Wilderness areas
- Motorized activity in these areas may increase risk to wildlife



Importance for Studying Soundscapes

- Studying the soundscape can provide evidence of what wilderness areas are being affected by snowmachines and other sources of human activity



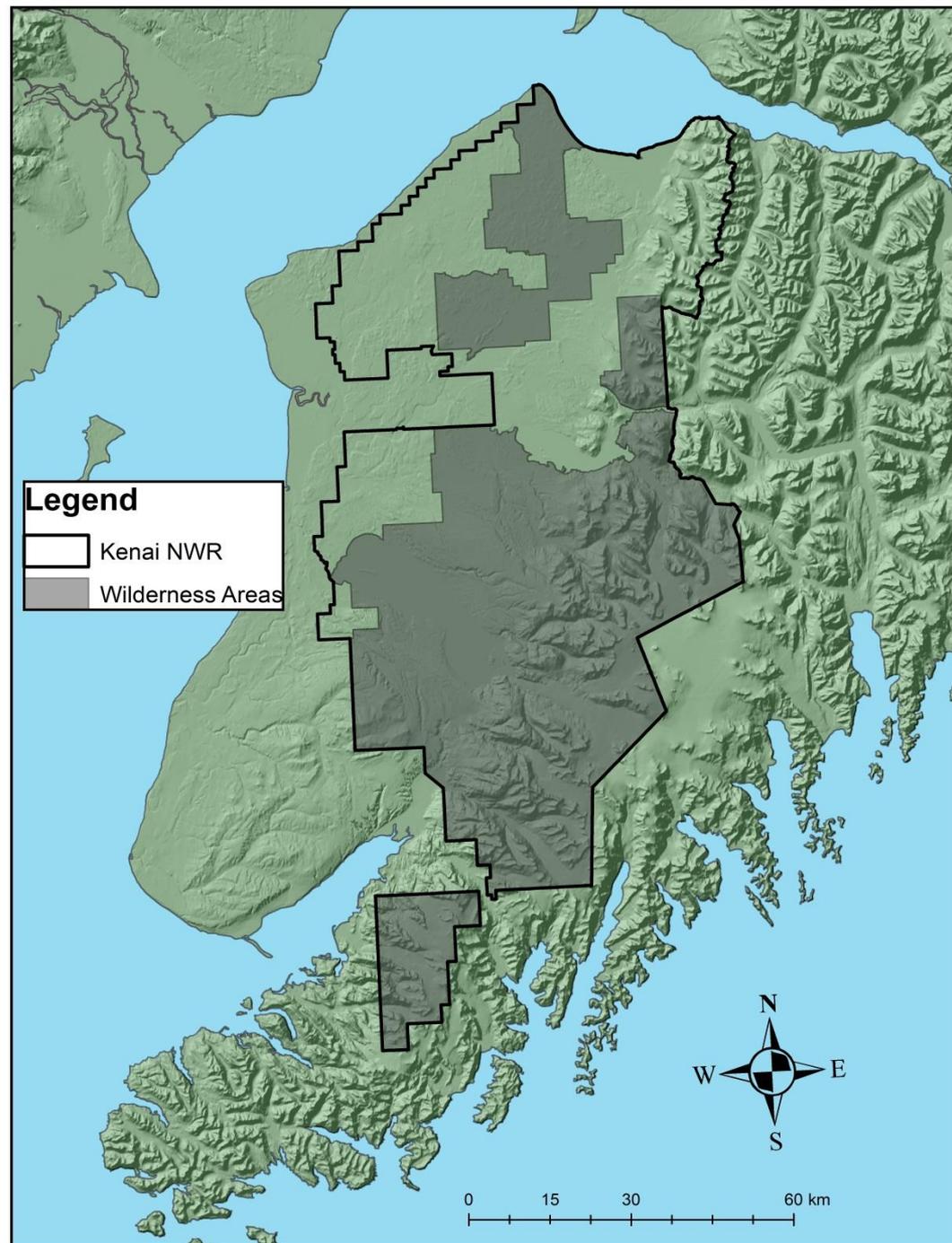
Objectives

- Sample sound within wilderness and non-wilderness areas
- Create a spatially explicit model of anthrophony
- Determine what sound sources were most prevalent



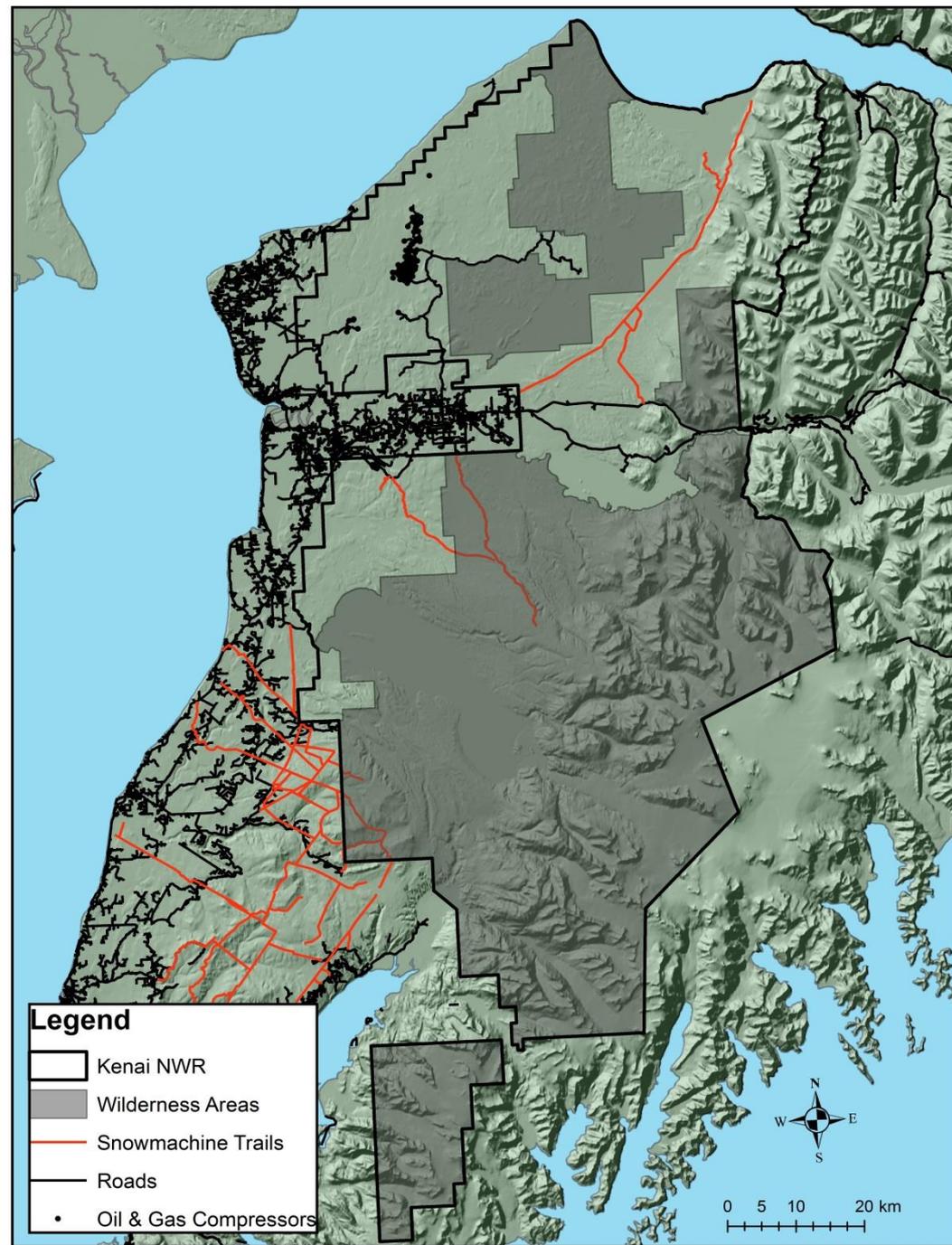
Kenai National Wildlife Refuge

- 2 million acres
- 1.3 million acres of designated wilderness
- Mandated to preserve wilderness while allowing snowmachine access



Kenai NWR Sources of Anthropophony

- > 1 million visitors/yr
- Along a major Hwy
- Major flyway
- Oil & gas development
- Snowmachining



Sampling the Soundscape

- 12 non-wilderness areas
- 8 wilderness areas
- December 2010 – April 2011
- Larson Davis 831 and Wildlife Acoustics SM2 sound recorders
- Recorded for 20 sec every 15 min
- 8 kHz sample rate



Storing Sound Data

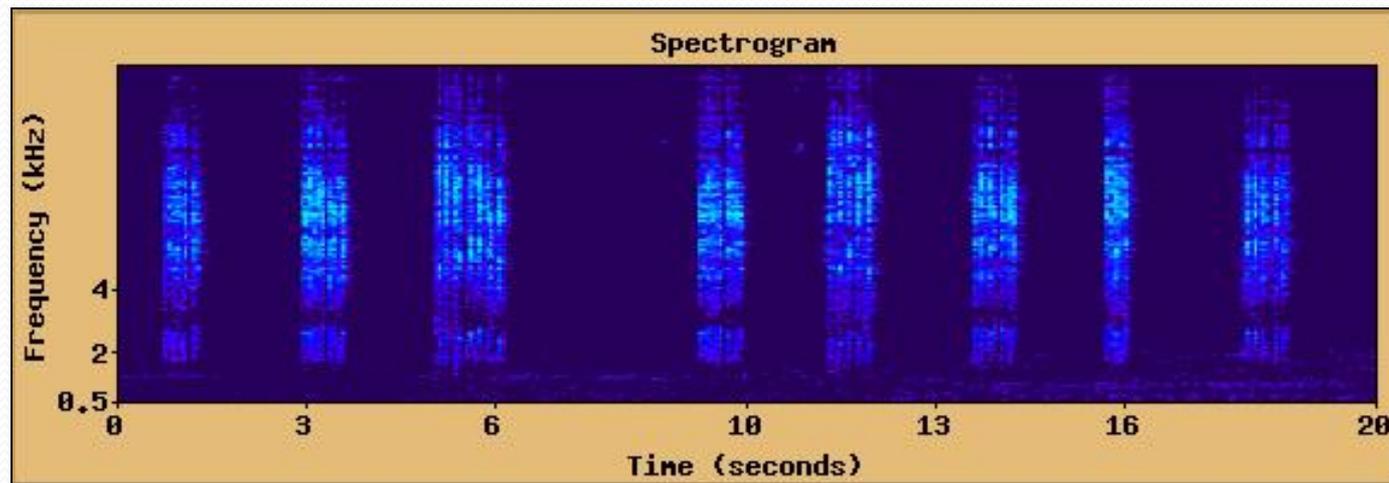
- Sound files were entered into the **Remote Environmental Assessment Laboratory** sound library
- An automated system for analyzing large sound datasets
 - 64,000 sound files
 - 34 GB of data

www.real.msu.edu



REAL Sound Data Analysis

- Sound files (.wav) converted to spectrograms
- Partitioned into 1 kHz frequency band widths (bins)
- Welch (1968) algorithm for calculating Power Spectral Density (PSD)
- Quantifies the amount of sound energy in each bin

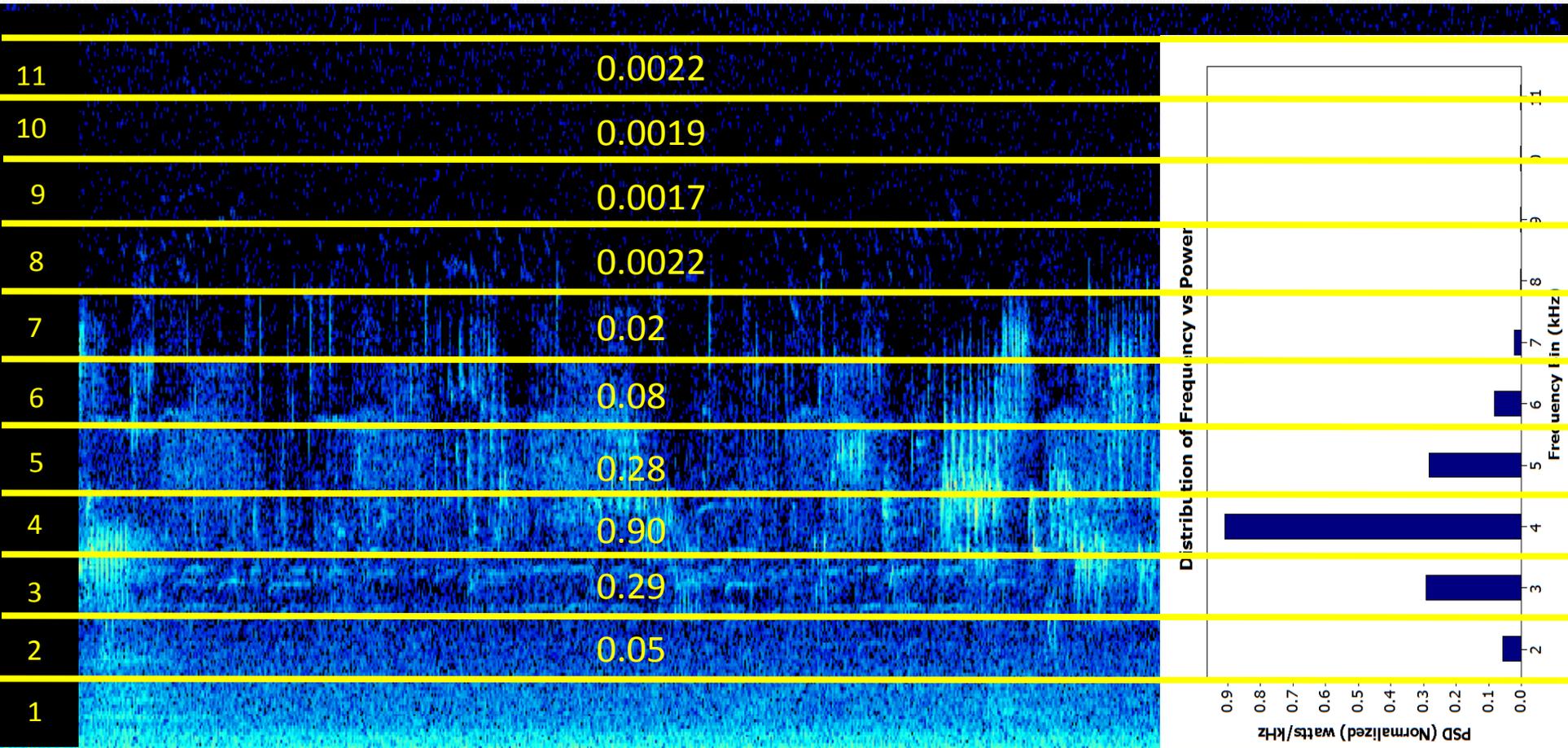


Sound Power Partitioning

Sound Frequency
Bins (1 kHz) intervals

Power Spectral Density (PSD)
normalized values (watts/kHz)

Power Spectral
Density pattern

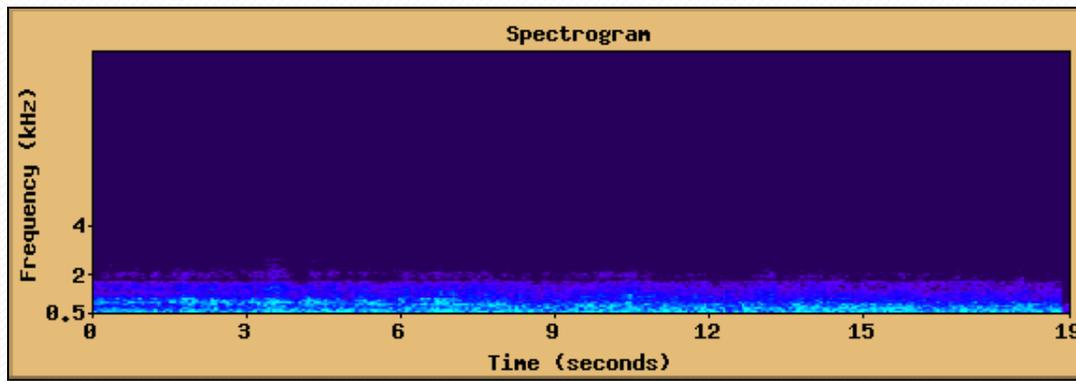


PSD=Welch (1968)

Time (Seconds)

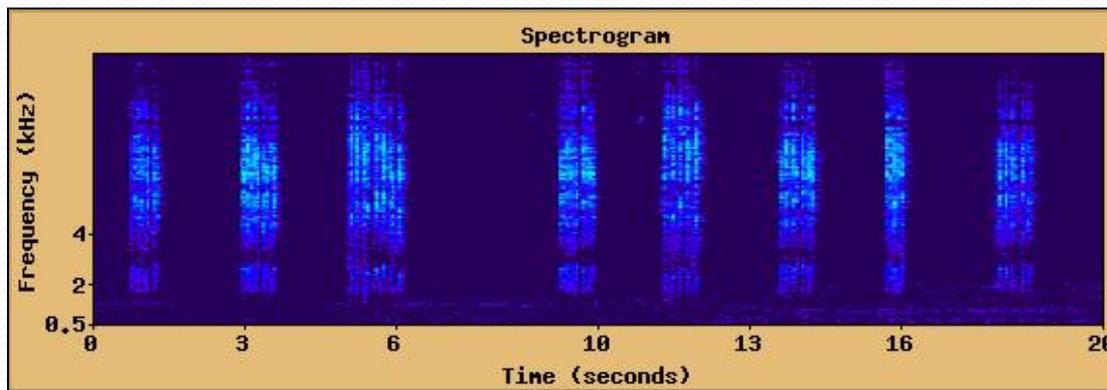
Defining Anthrophony

- Anthrophony typically occurs at 1 – 2 kHz



Airplane

- Biophony typically occurs at ≥ 2 kHz



Gray Jay

Spatial Modeling of Anthrophony

- Averaged PSD values of anthrophony for each station
- Each spatially explicit location had an average PSD value
- Overlaid PSD spatial layer with human-made sound sources in ArcGIS
- Computed data layers in TreeNet Machine Learning Software
- Generated an output of predictions to entire study area

Distribution of Anthrophony

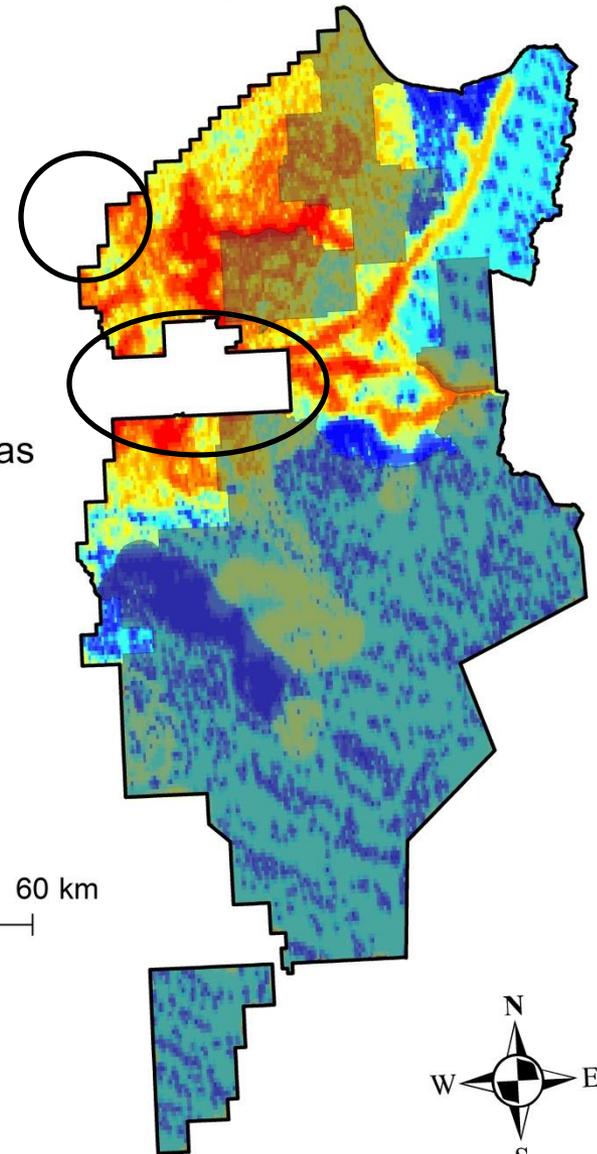
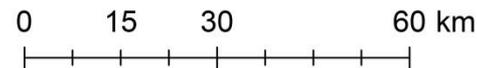
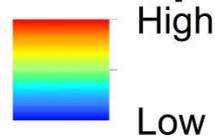
- Hot Spots
 - Soldotna & Kenai

Predicted Distribution of Anthrophony
December 2010 - April 2011

Legend

-  Kenai NWR
-  Wilderness Areas

Anthrophony



Distribution of Anthrophony

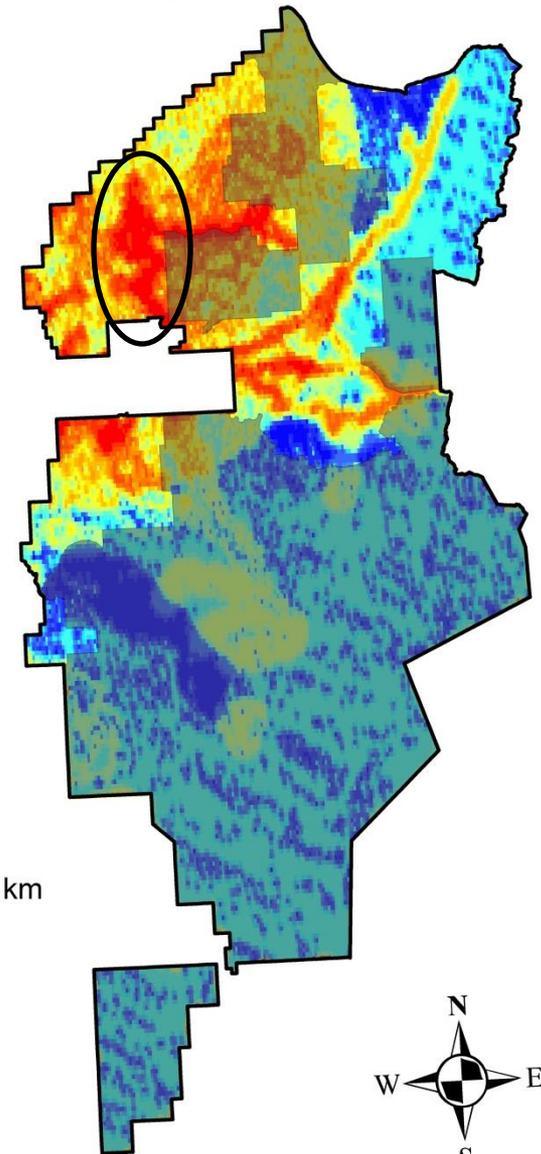
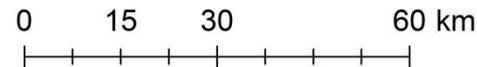
- Hot Spots
 - Soldotna & Kenai
 - Oil & Gas Compressors

Predicted Distribution of Anthrophony
December 2010 - April 2011

Legend

-  Kenai NWR
-  Wilderness Areas

Anthrophony



Distribution of Anthrophony

• Hot Spots

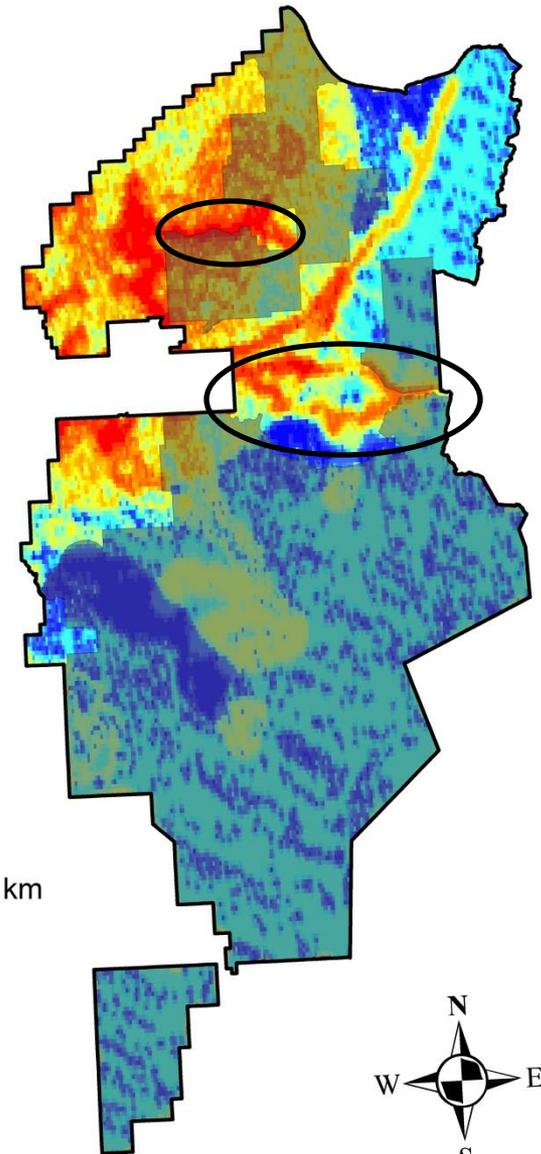
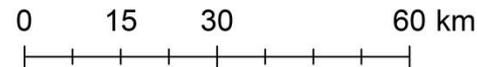
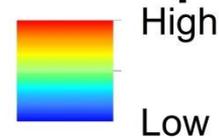
- Soldotna & Kenai
- Oil & Gas Compressors
- Roads
 - Swanson River Rd
 - Sterling Hwy
 - Skilak Lake Rd

Predicted Distribution of Anthrophony
December 2010 - April 2011

Legend

-  Kenai NWR
-  Wilderness Areas

Anthrophnoy



Distribution of Anthrophony

• Hot Spots

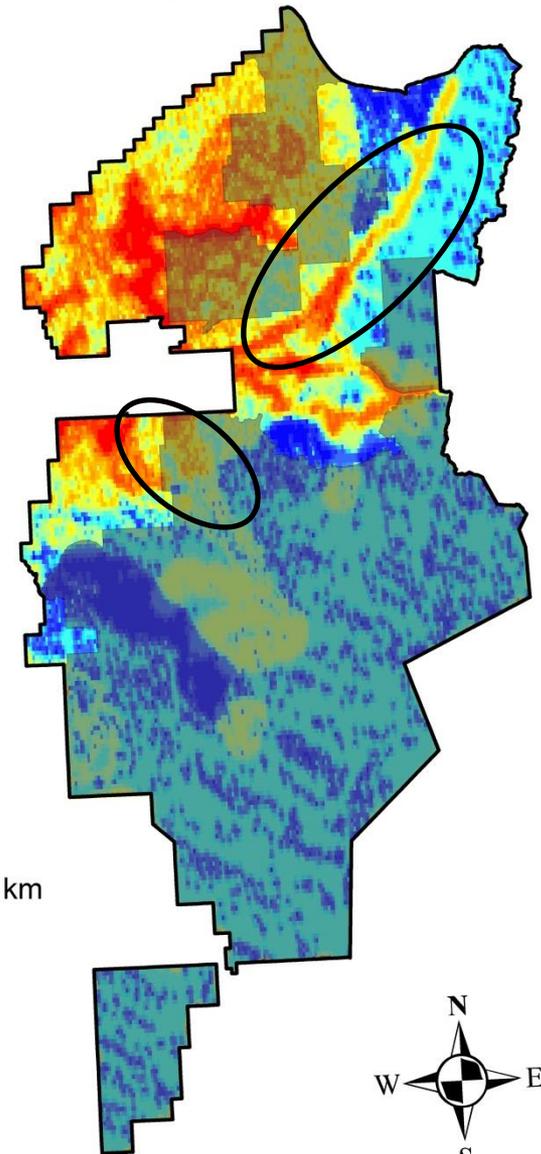
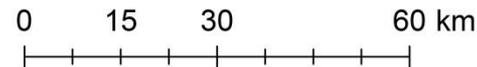
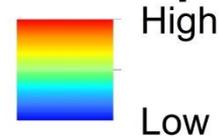
- Soldotna & Kenai
- Oil & Gas Compressors
- Roads
- Snowmachine trails

Predicted Distribution of Anthrophony
December 2010 - April 2011

Legend

-  Kenai NWR
-  Wilderness Areas

Anthrophony



Distribution of Anthrophony

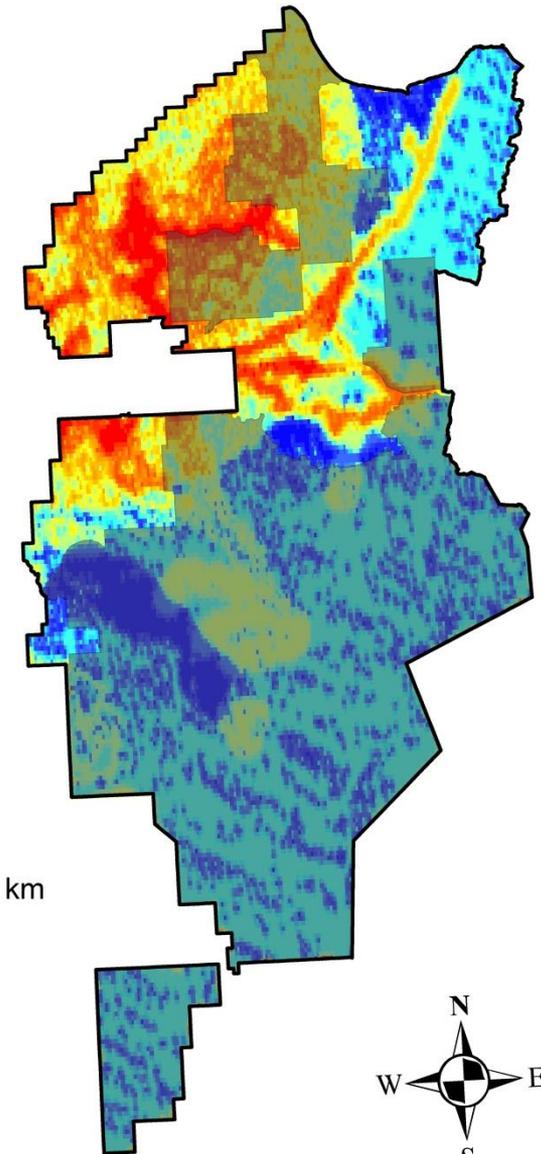
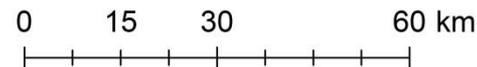
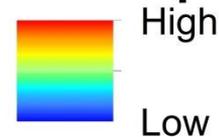
- Hot Spots
 - Soldotna & Kenai
 - Oil & Gas Compressors
 - Roads
 - Snowmachine trails
- Northern Wilderness most affected
- Southern Wilderness least affected

Predicted Distribution of Anthrophony
December 2010 - April 2011

Legend

- Kenai NWR
- Wilderness Areas

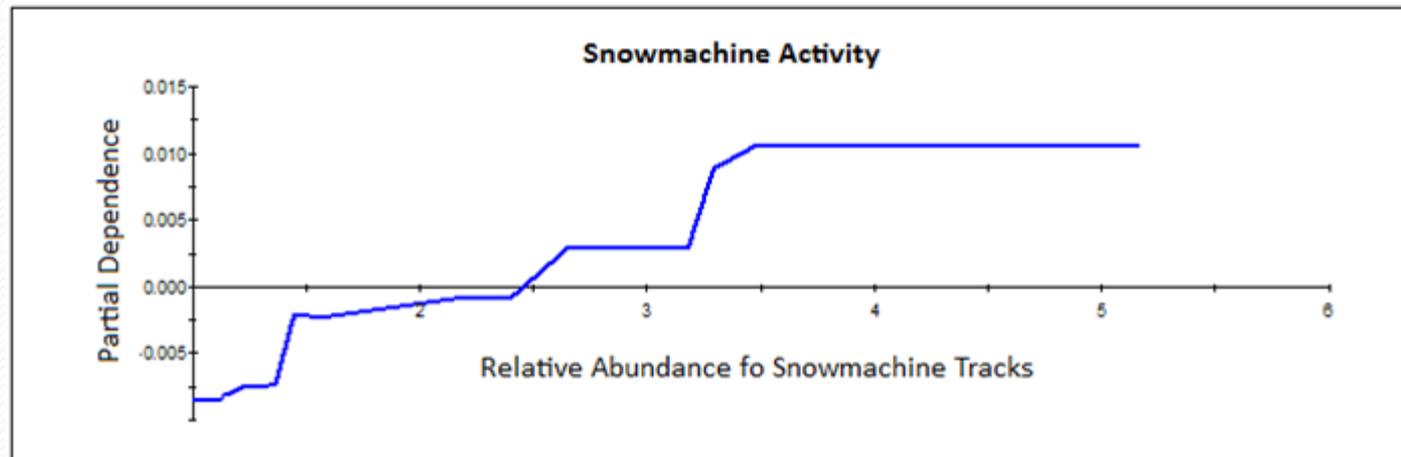
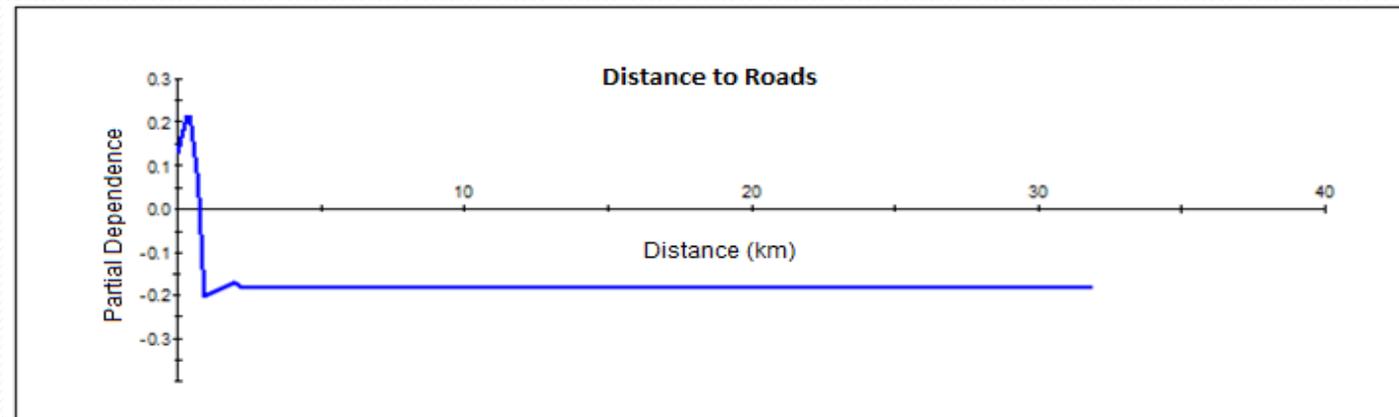
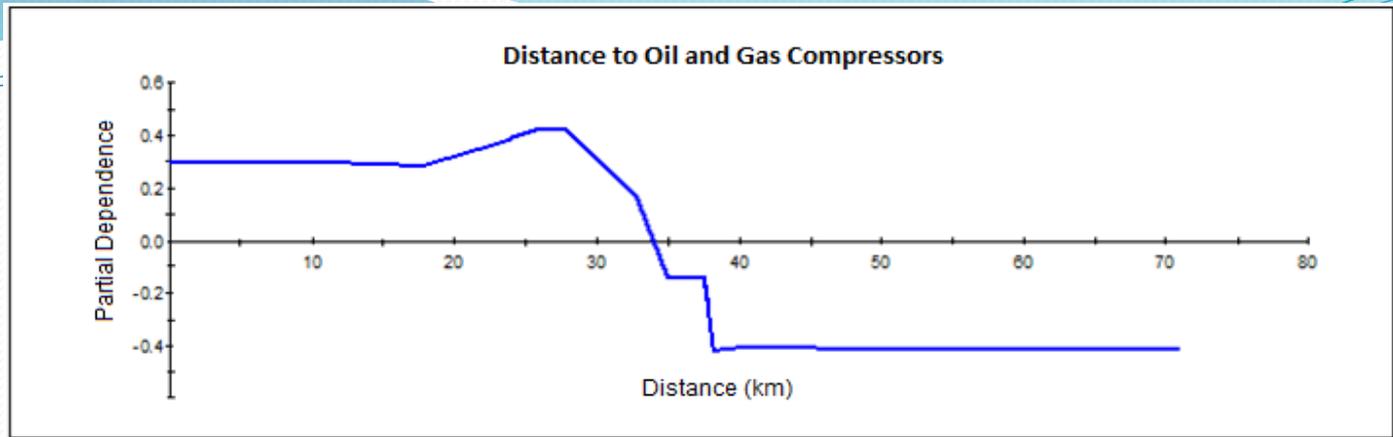
Anthrophnoy



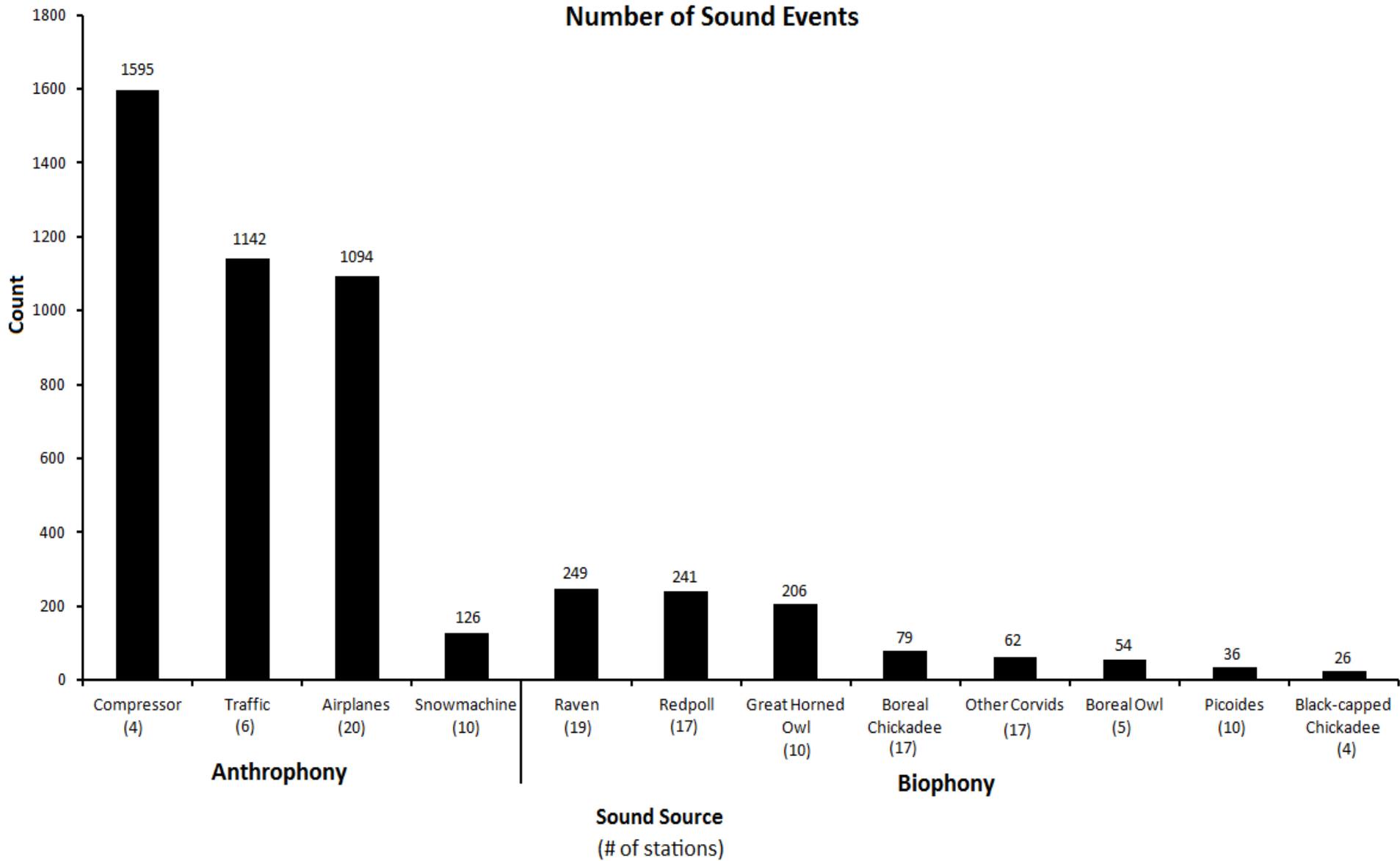
Variable Importance

Variable	Score
Distance to Oil and Gas Compressors	100.00
Areas of Snowmachine Activity	77.60
Distance to Roads	31.19

Predictor Dependence



Number of Sound Events

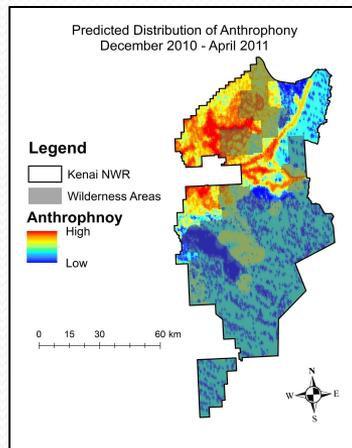


Summary

- Wilderness areas on the Kenai are not entirely protected from the *“imprint of man’s work”*
- Environmental impacts of oil and gas extend beyond the confines of compressors
- Airplanes are especially intrusive in most areas of Kenai NWR
- Compressor, snowmachine, and traffic noise indicate a decrease in habitat quality which may pose a risk to wildlife

Does Anthrophony Effect Moose?

- Human activity is known to physiologically and psychologically stress moose
- Anthrophony may be a component of this stress
- Hypothesis:
 - Moose stress hormone levels will increase in areas with higher levels of anthrophony

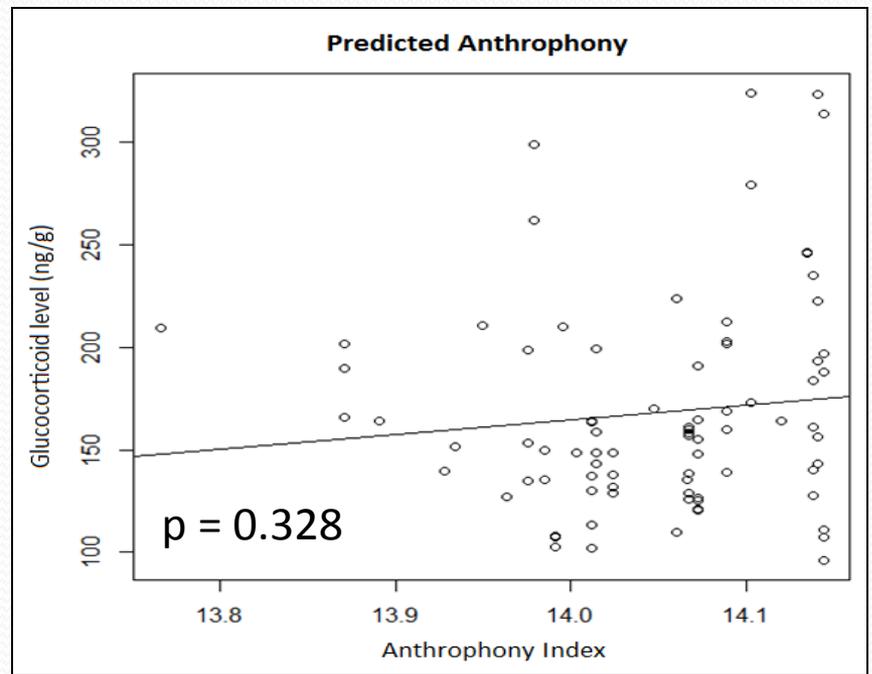
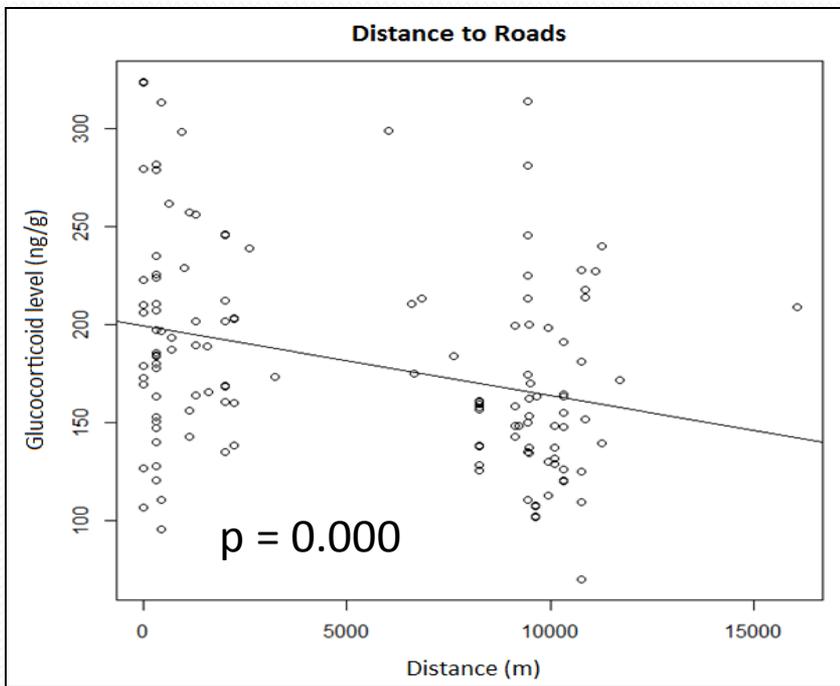
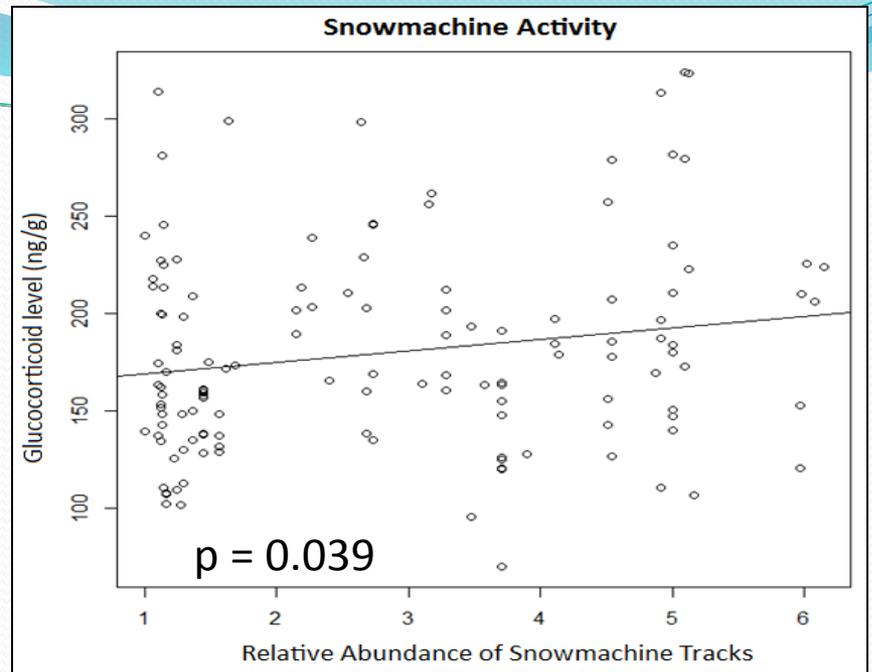
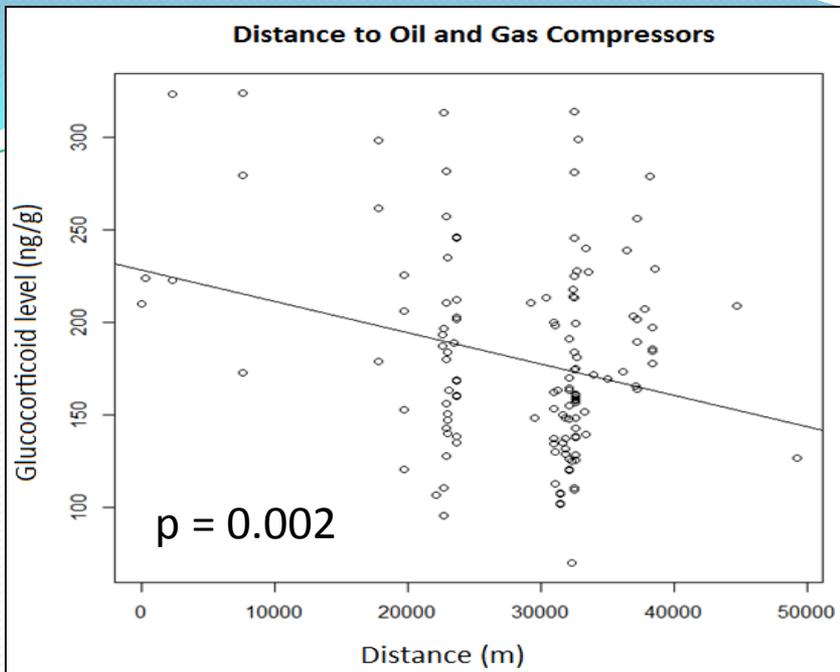


= Stress?

Stress Sampling and Analysis

- Data collection:
 - Collected fecal samples while traveling to and from sound stations
 - Recorded latitude and longitude of each location
- Analyzed feces for glucocorticoid steroids (GC)
- Overlaid GC levels onto layers of predicted anthropophony and other human-made sound sources





Summary

- Human-made noise is a significant factor that effects the northern wilderness areas of Kenai NWR
 - Decreases wilderness character and quality
- Moose stress levels are higher within areas of human activity
 - Moose select human activity areas for forage and protection from predators
 - Moose typically tolerant of human activity but with physiological costs
- High human activity was detected by sound sampling
- Moose stress levels were not directly correlated with high amounts of anthrophony
- The presence of human activity likely affects moose stress levels more than sound (more data to come)

Acknowledgements

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Questions?

