



# Baseline Sound Monitoring at Grant-Kohrs Ranch NHS

Robert C. Maher

*Electrical and Computer Engineering*

*Montana State University - Bozeman*



# Outline

- Introduction
- Long-term acoustical acquisition
  - Sound level meter
  - Audio recorder
  - Anemometer
- Assessment and analysis
  - Biophony, Geophony, Anthrophony
  - 1/3<sup>rd</sup> octave band analysis
  - MP3 recording 8,760 hours long: automated analysis
- Conclusions

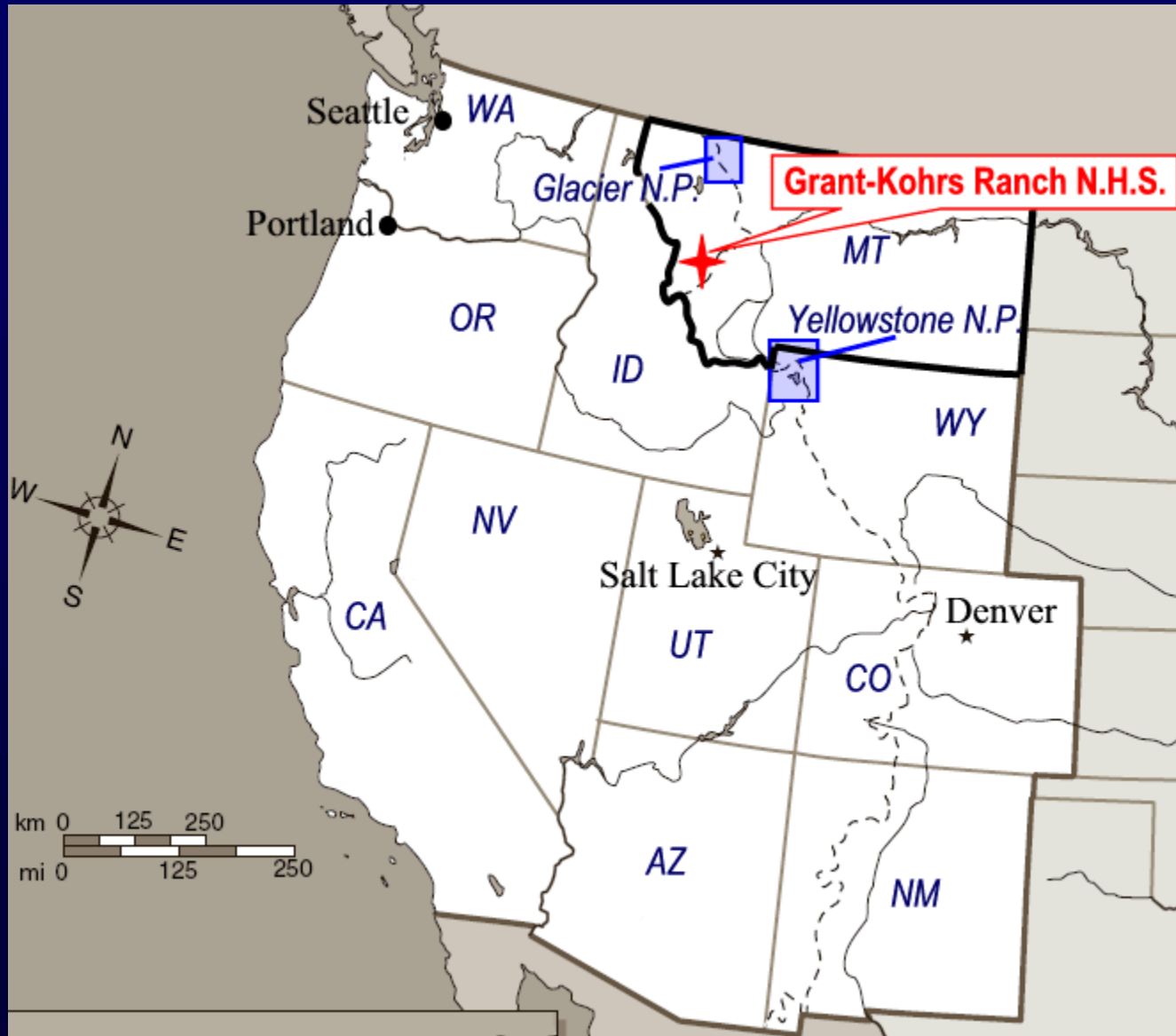
# Introduction

- Grant-Kohrs Ranch (GRKO) history
- NPS sound monitor history
- GRKO challenges and needs
- Acoustical Plan

# Grant-Kohrs Ranch

## National Historic Site (1977)

- Deer Lodge, Montana
- A working cattle ranch commemorating the heritage of American cowboys, stock growers, and cattle operations during the 19th and 20th centuries.
- Congress: maintain the site as a working ranch.
- Cultural soundscape is essential: all the sights, sounds, and sensations associated with ranching.





# Soundscape

Three Sonic Components (*Krause*):

- ***Biophony*** -- animal and biological sounds
- ***Geophony*** -- geological, hydrological, and meteorological sounds
- ***Anthrophony*** -- sounds caused by humans and human activity

# Grant-Kohrs Challenges

*Substantial increase in transportation noise may impact the integrity of the ranch's cultural soundscape.*

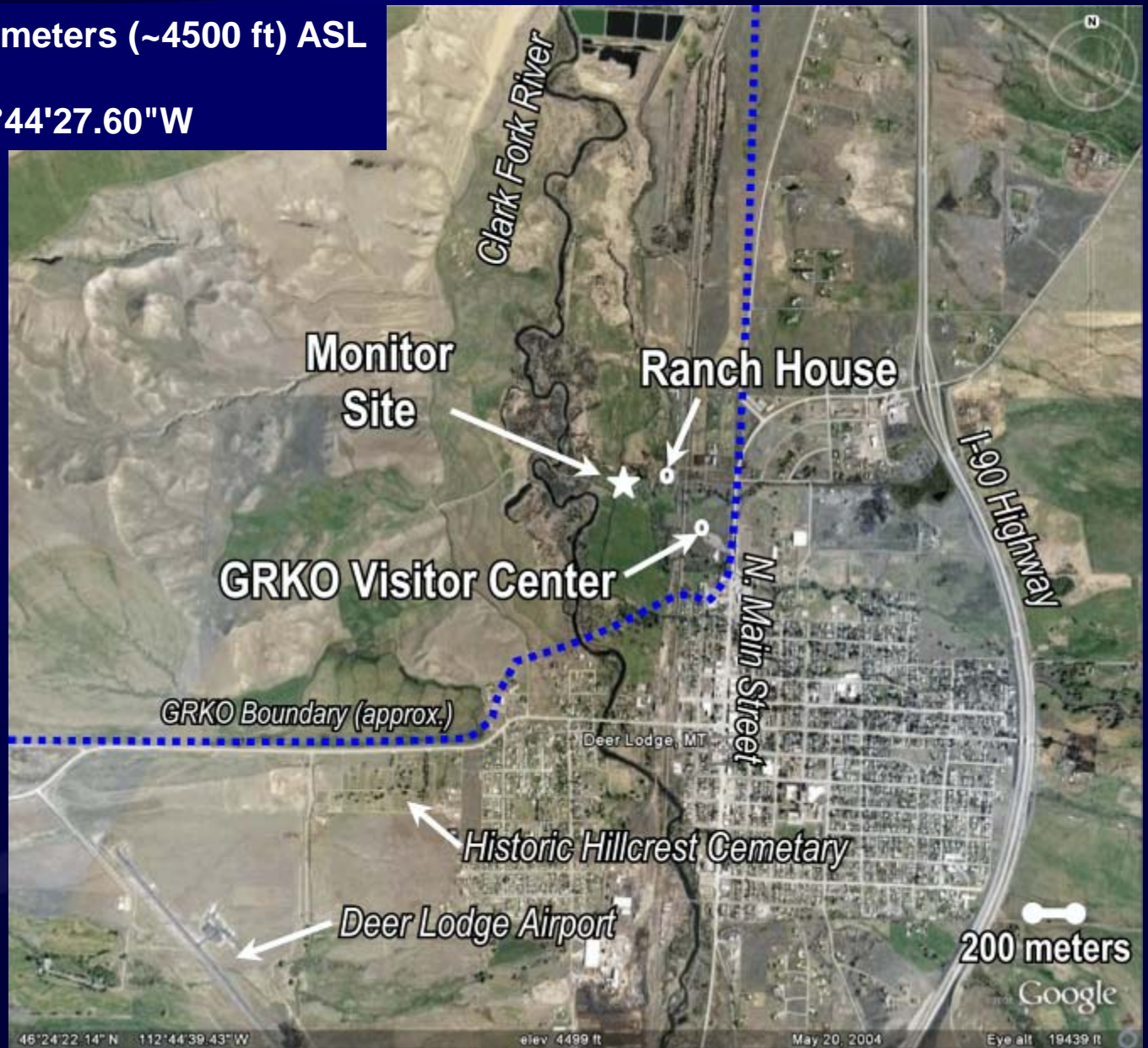
- Highway traffic noise: I-90 passes within 1 km of the GRKO Visitor Center
- Deer Lodge airport general aviation expansion (2.5 km southwest of the GRKO Visitor Center)
- Neighboring ranch was purchased, subdivided into luxury home sites. Some homeowners may now fly into the area in private jets and helicopters.
- Potential establishment of a rifle range in the vicinity of the ranch.



Site elevation: 1370 meters (~4500 ft) ASL

Coordinates:

46°24'27.24"N 112°44'27.60"W



# National Park Service Act (1916)

- *“...to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.”*

# Soundscape Regulatory Context

- 1872 Yellowstone National Park Act
  - 1916 National Park Service (NPS) Organic Act
  - 1949 Executive Order 10092 (Boundary Waters no-fly zone)
  - 1964 Wilderness Act
  - 1969 National Environmental Policy Act
  - 1972 Noise Control Act
  - 1987 National Parks Overflights Act (NPOA)
  - 1988 Special Federal Aviation Regulation (SFAR) 50-2 (GRCA)
  - 2000 National Parks Air Tour Management Act
  - 2000 NPS Director's Order #47 (soundscape preservation)
  - 2002 Winter Use Plan (Yellowstone)
  - 2006 NPS Management Policies (soundscapes)
- 
- Miller, Nicholas, P., "US National Parks and management of park soundscapes: a review," Applied Acoustics, vol. 69(2), pp. 77-92, February 2008
  - R.C. Maher, J. Gregoire, and Z. Chen, "Acoustical monitoring research for national parks and wilderness areas," Preprint 6609, Proc. 119th Audio Engineering Society Convention, New York, NY, October 2005.

# NPS Management Policies 2006

National Park Service *Management Policies 2006* include natural and cultural sound resources within park units.

- Section 4.9: Soundscape Management  
*Excerpt: “The Service will restore to the natural condition wherever possible those park soundscapes that have become degraded by unnatural sounds (noise), and will protect natural soundscapes from unacceptable impacts.”* [http://www.nps.gov/policy/mp/policies.html#\\_Toc157232745](http://www.nps.gov/policy/mp/policies.html#_Toc157232745)
- Section 5.3.1.7: Cultural Soundscape Management  
*Excerpt: “The Service will preserve soundscape resources and values of the parks to the greatest extent possible **to protect opportunities for appropriate transmission of cultural and historic sounds that are fundamental components of the purposes and values for which the parks were established.**”*

<http://www.nps.gov/policy/mp/policies.html#CulturalSoundscapeManagement5317>

# Engineering Considerations

- Long-term soundscape monitoring and statistical assessment (24/7/365)
- Low power audio recording equipment suitable for harsh environments
- Cost appropriate for widespread use
- Calibration and stability for both ecological research and regulatory monitoring
- Automatic detection and recognition of sound sources

# Acoustical Plan

- GRKO does not currently have any soundscape data
- A “baseline” is needed to document the seasonal and diurnal soundscape to enable management under 2006 NPS policies
- Automated measurement of sound levels and sound recordings continuously for 365 days

# NPS Technical Requirements

- Wind speed and system temperature measurements logged automatically every 10 seconds.
- 1 second Leq ANSI Type 1  $\frac{1}{3}$ -octave sound levels (~427 MB per month)
- Digital audio (MP3) recordings: continuous 64kbps from sound level meter microphone (~25 GB per month)

# Long-Term Collection



March 17, 2009

May 5, 2009





# Project Status

- So far, two months of data collected (mid-March to early May)
- Primary sounds:
  - Biophony: birds and occasional livestock
  - Anthrophony: distant highway traffic and nearby freight trains
  - Geophony: wind, Wind, WIND!
    - 10-40 km/hr not uncommon (Beaufort 5 or 6)
    - Turbulence and audio signal cut-outs

# Research Tasks

- Typical aural sampling protocol
  - Select one 24 hour period per “interval”
  - Audition 10 sec of audio taken every 2 minutes, manually documenting any recognizable sonic events
  - 10 seconds of audio every 2 minutes comprises 720 sample segments, or two hours of extracted audio.
  - Experts needed to identify biological sounds.

*And what about the remaining 22 hours that day...and all the other 24 hour periods??*

# Research Tasks (cont.)

- Automated analysis procedures
  - Correlation of SPL, MP3, and wind data
  - Fast search of MP3 spectral data
  - Assisted identification of bird songs, etc.
- Integrity and sustainability of collection procedure
- Permanent archiving for subsequent use

# Sound Examples

- 🔊 March 18, 2009 9:34PM MDT (45'')
  - 🔊 April 15, 2009 6:13AM MDT (before dawn)(1')
  - 🔊 May 1, 2009 11:22AM MDT (5')
  - 🔊 May 4, 2009 6:23AM MDT (after dawn) (2.5')
- [http://ece.montana.edu/rmaher/audio\\_monitor/grko.htm](http://ece.montana.edu/rmaher/audio_monitor/grko.htm)

# Conclusions

- Basic data collection framework is useful
- Automated data analysis is essential
- Prefer higher quality uncompressed audio data
- Wind issue
- Site setup and maintenance issues

# Acknowledgements

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