Noise Mapping: Modeling Chronic Natural Gas Compressor Noise in Pennsylvania's State Forests

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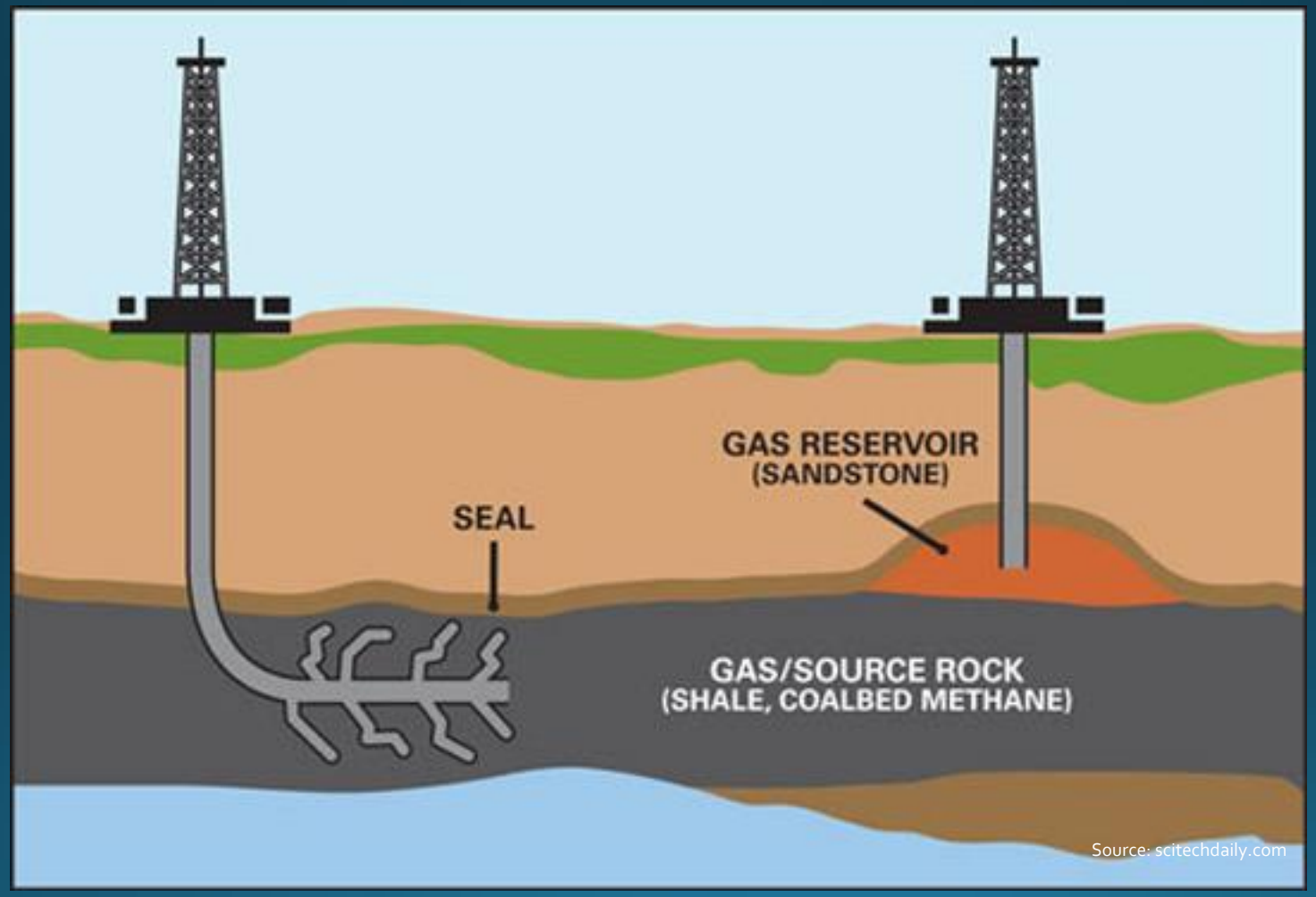
Source: Elk State Forest Wikipedia

Overview

- Background
  - Natural gas development in PA
  - Compressor station noise
  - Recreation Opportunity Spectrum
- Research Questions
- Methods
- Findings
- Conclusions

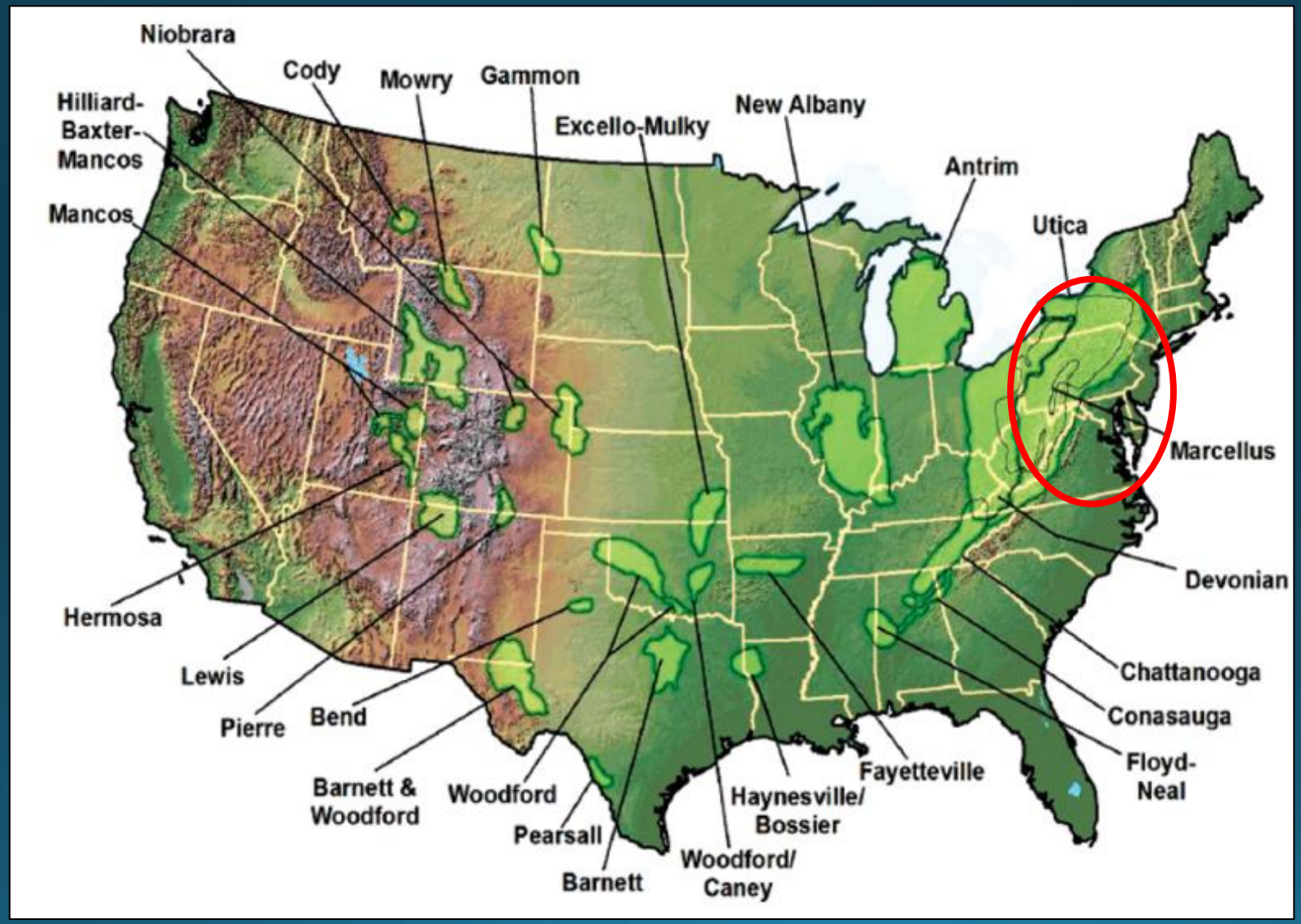
Natural Gas Extraction

Unconventional



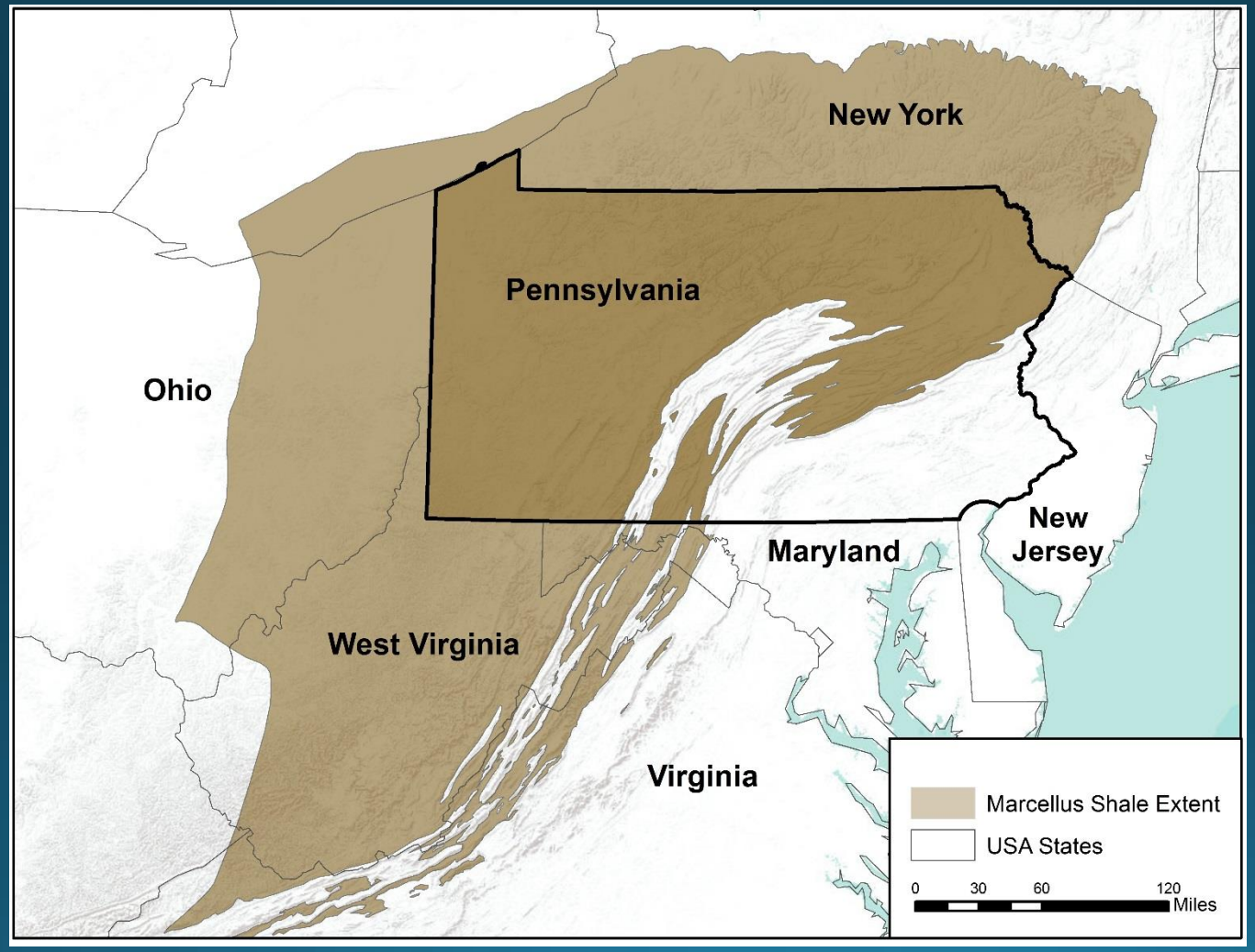
Traditional

Shale Basins



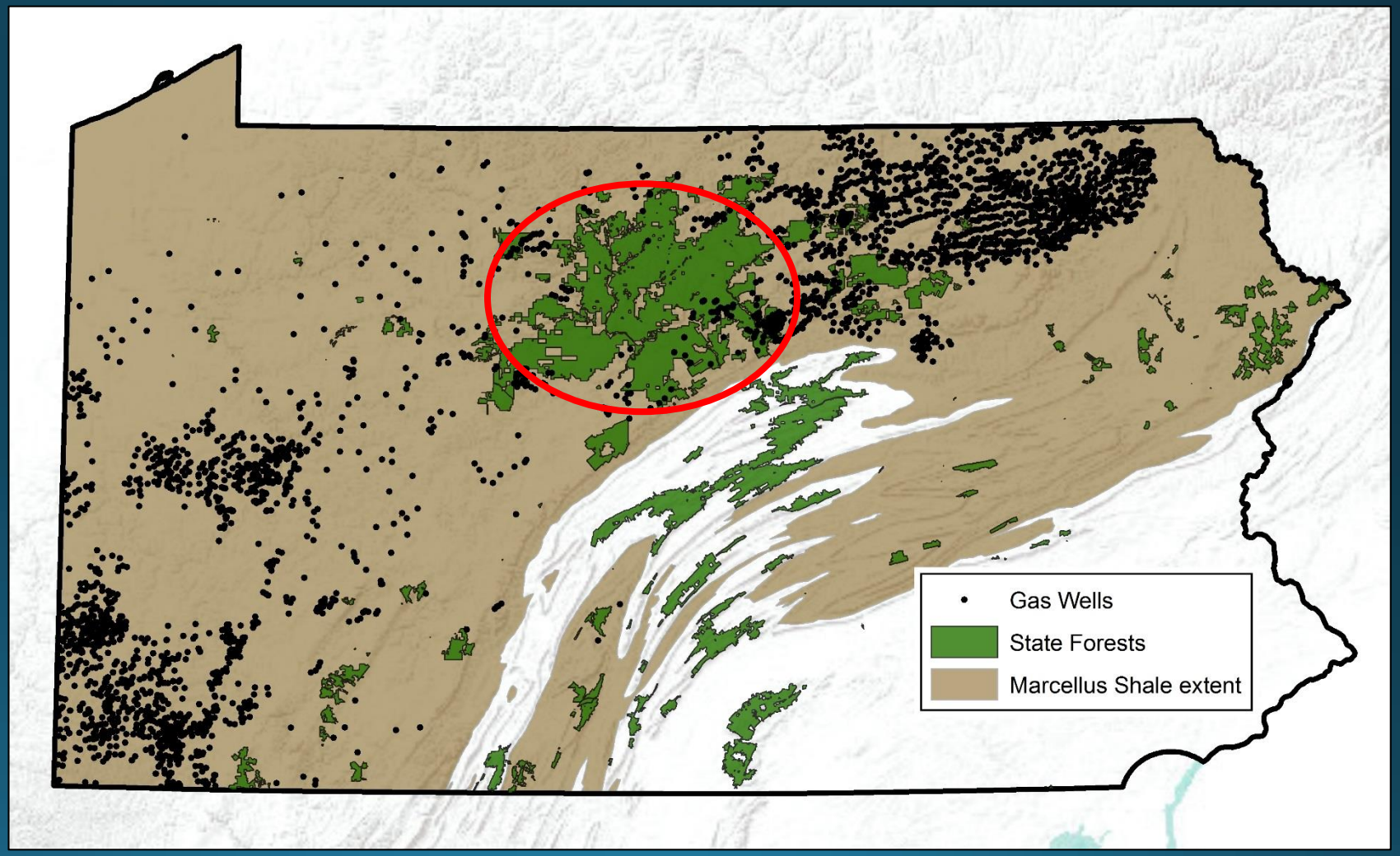
Source: Kargbo et al. 2010.

Marcellus Shale



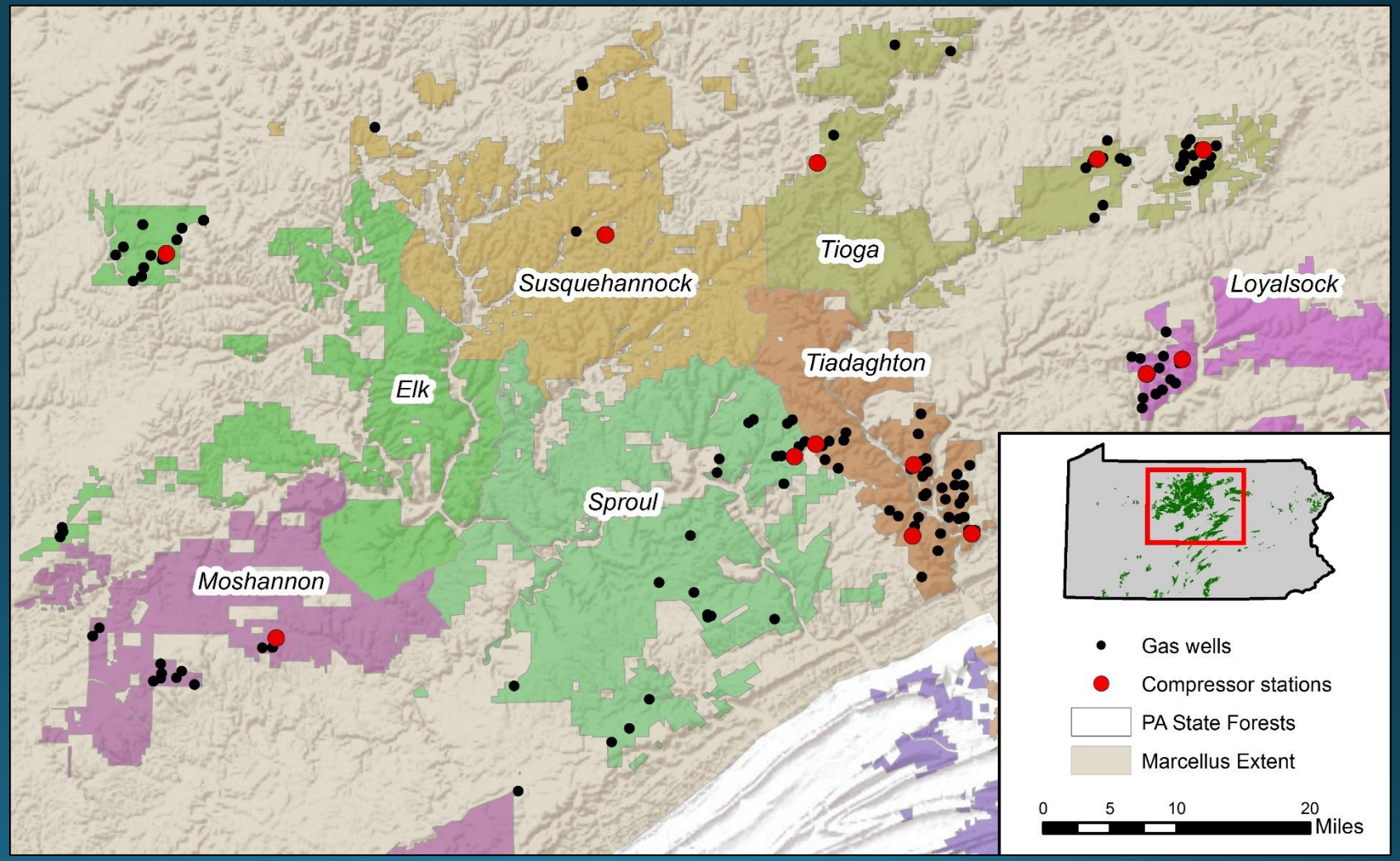
PA Gas Extraction

- 10,000 active unconventional gas wells
- Fewer wells on PA state forest lands
- More development anticipated

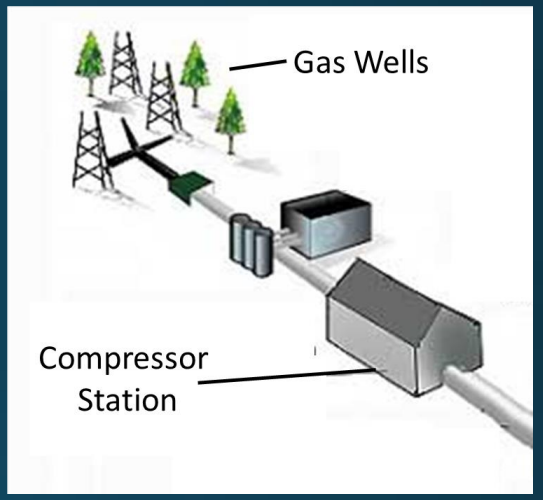


PA State Forests

- Largest contiguous forest in Eastern US
- 600+ active wells
- 14 active compressor stations (CS)
- Several CS pending
- 100-200 CS anticipated
- CS noise concerns

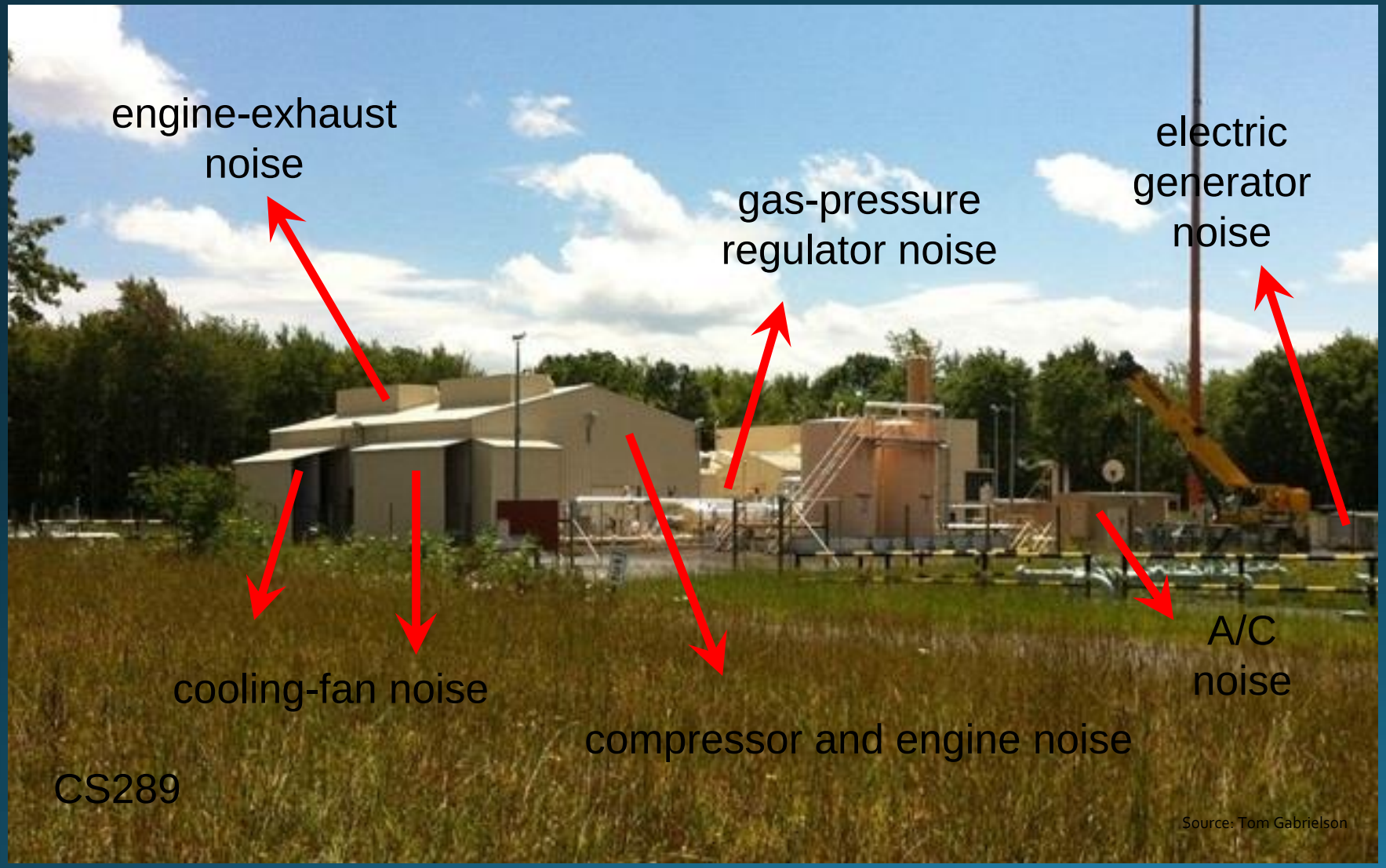


Compressor Stations



- Collect gas from surrounding wells
- Pressurize for distribution

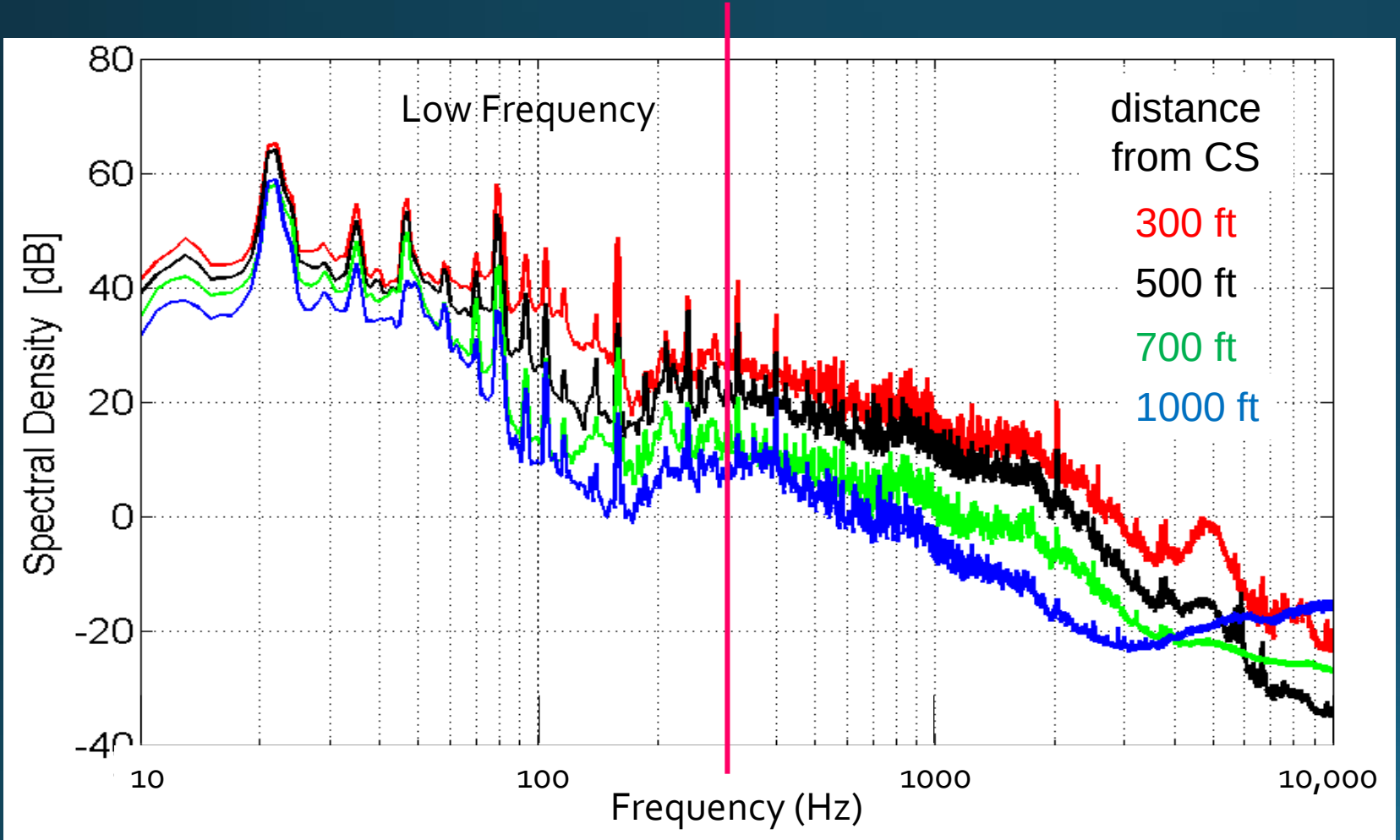
Compressor Stations



- Loud
- 80-105 decibels (A-weighted)
  - Motorcycle = 95
  - Chainsaw = 100
  - Helicopter = 105
- Chronic noise

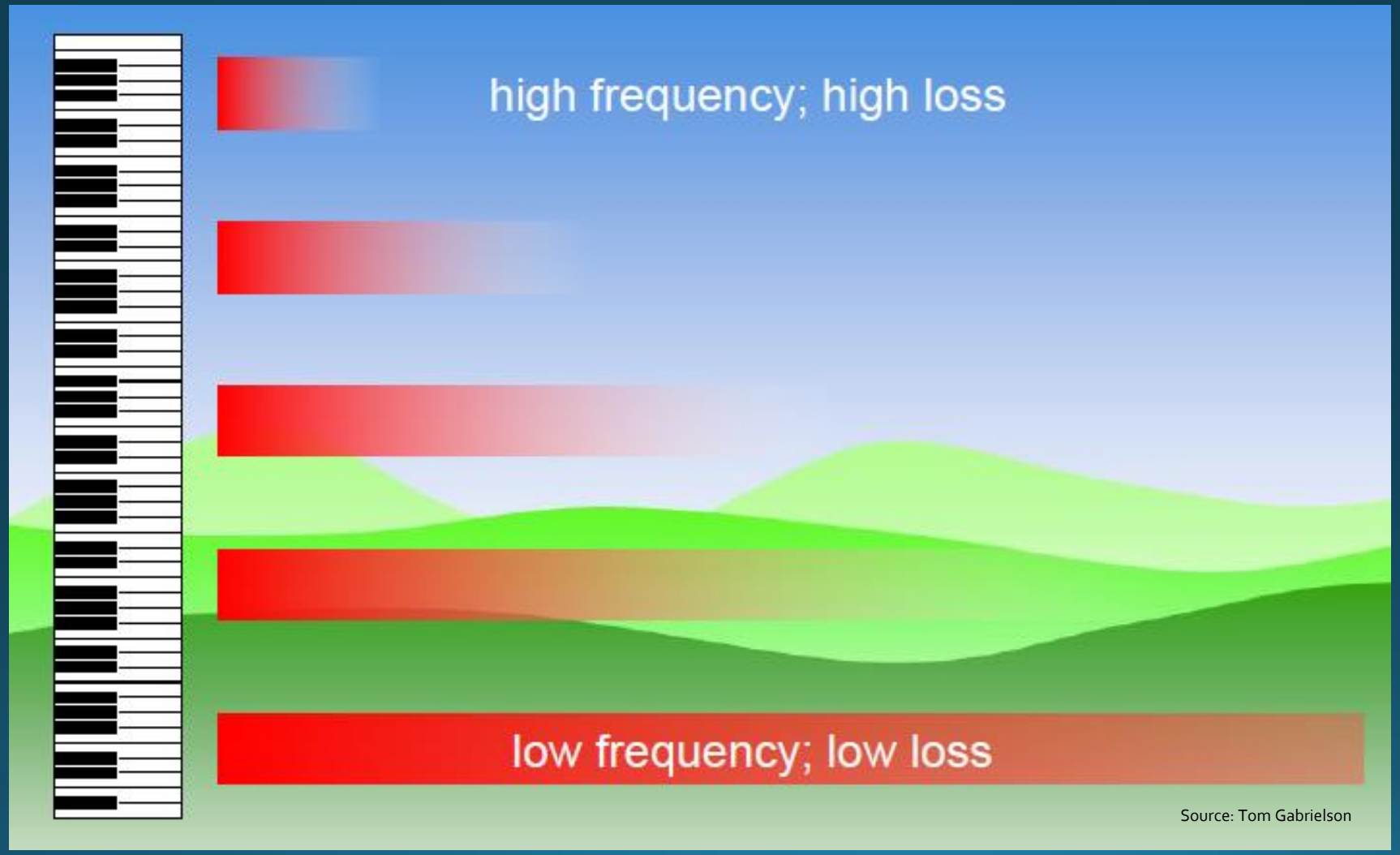
- Decibel = power
- Frequency = pitch
- Low frequency

Compressor Stations

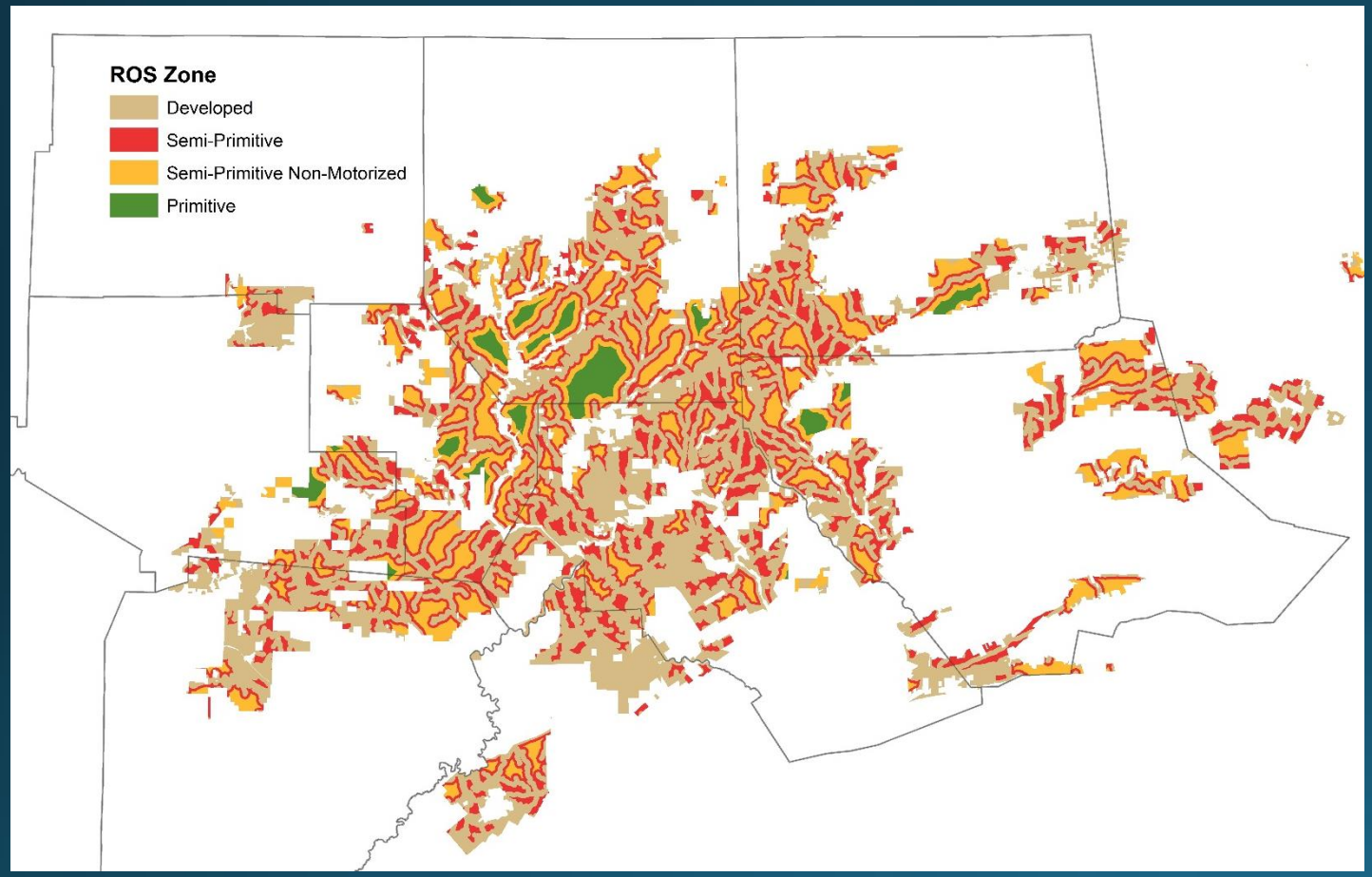


- 300Hz ≤ Low freq
- Most “power” (high dB level) is low freq noise

Travel Distance



Recreation Opportunity Spectrum (ROS)

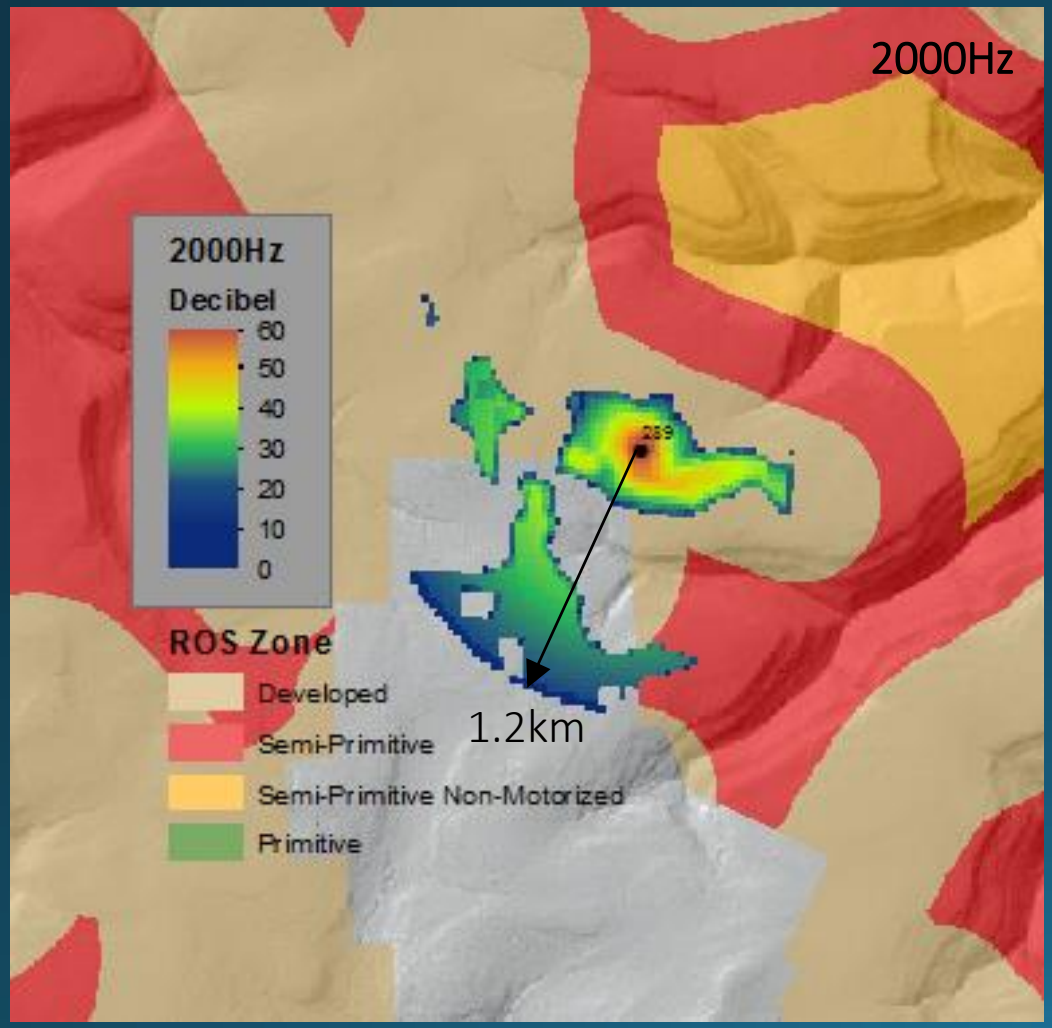


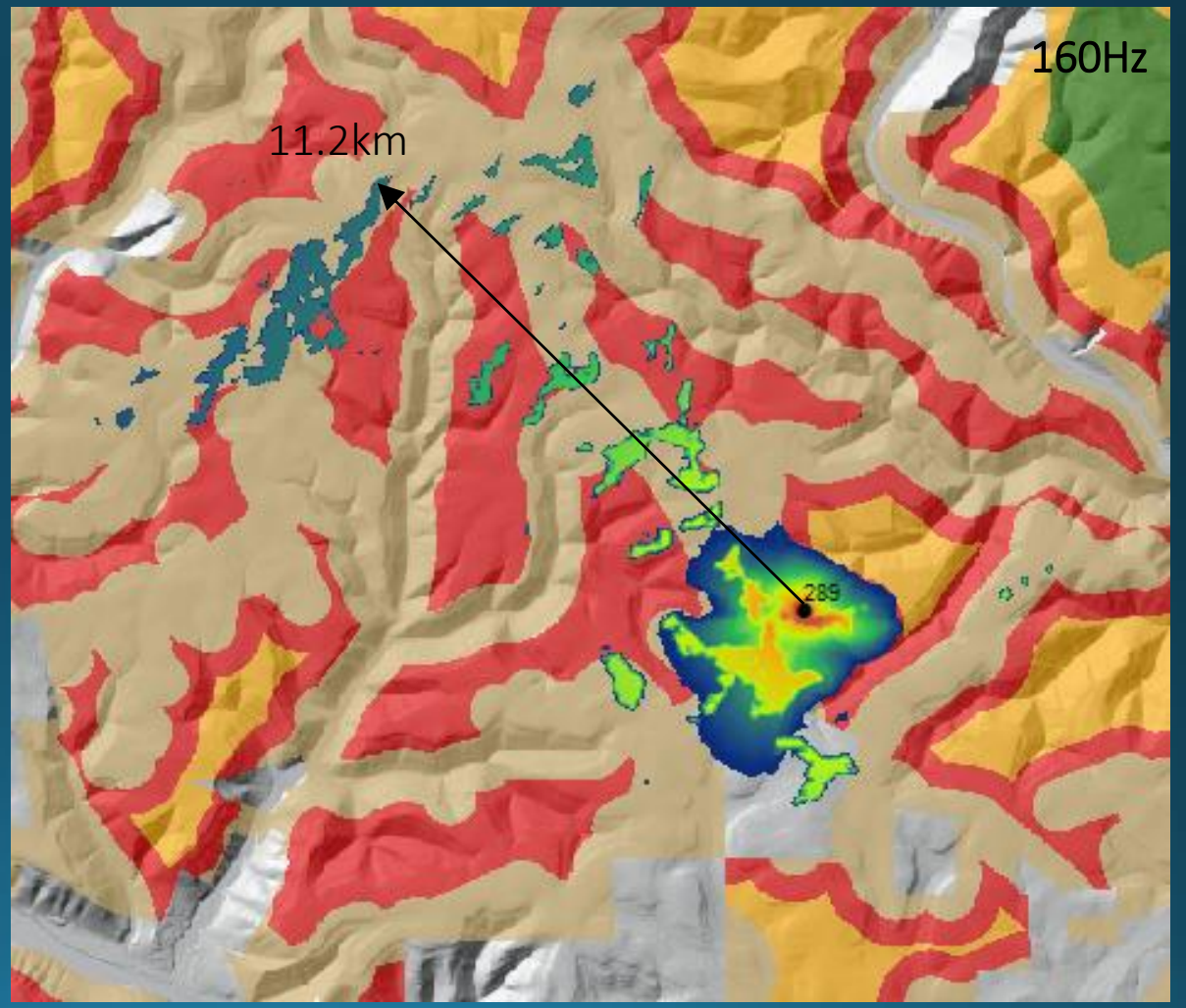
Primitive	Semi-Primitive Non-Motorized	Semi-Primitive Motorized	Developed

← Most remote & natural — Least remote & natural →

- Planning tool
- Categorized based on distance and size
  - Primitive = 1000ac and 1mi from road
- Managing land to ensure wilderness experience
- Noise impacts not fully considered

Recreation Opportunity Spectrum (ROS)





Research Questions

What we know:

- Anticipate ↑ development on state forest lands
- ↑ compressor stations
- CS emit low frequency sound
- Low frequencies travel far
- ROS is a current planning tool

Research Questions

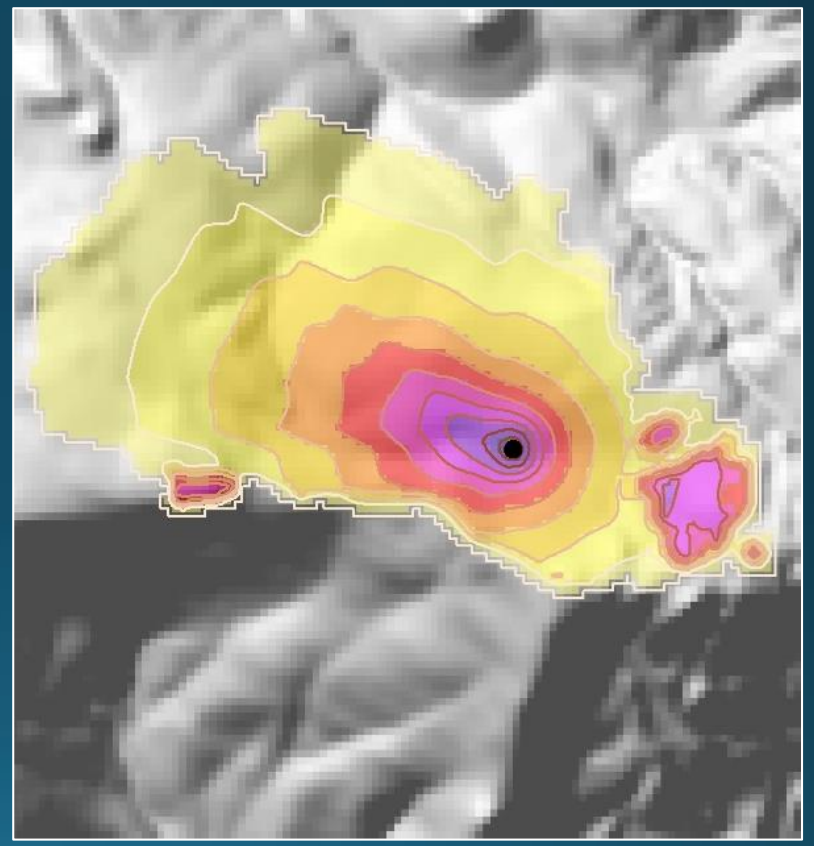
What we want to know:

- What is the spatial extent of the gas compressor noise?
- Would noise propagation models modify ROS maps?
- What topographic features may ↓ CS noise propagation?

Methods: SPreAD-GIS

- 1980's: System for the Prediction of Acoustic Detectability (SPreAD)
- Developed by USFS and EPA
- 2010: GIS model
- Model noise propagation from a point
- Low frequency range

1. *Topography*
2. *Land cover*
3. *Wind speed and direction*
4. *Air temperature*
5. *Humidity*
6. *Season*



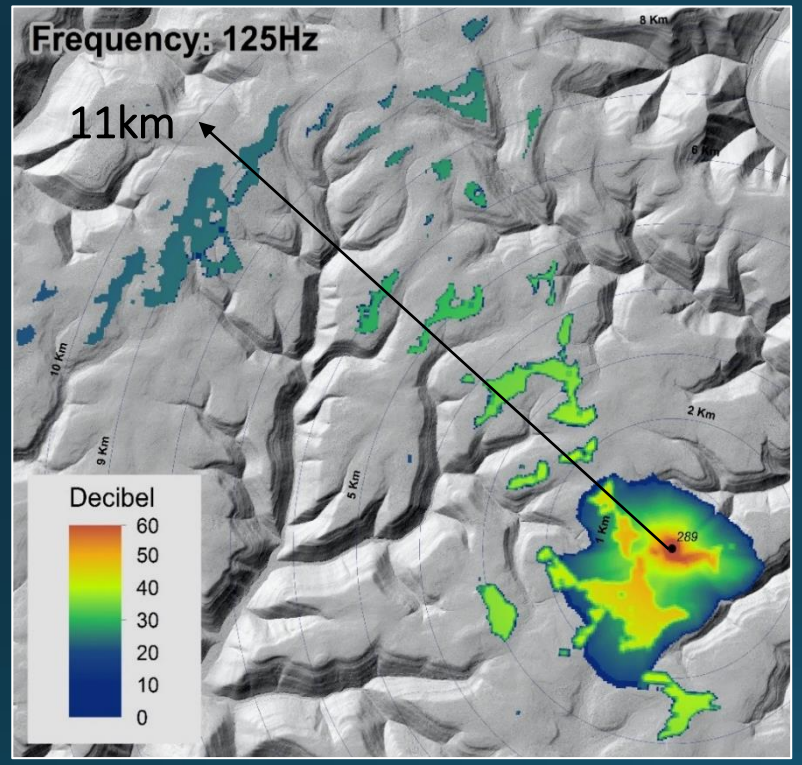
Methods

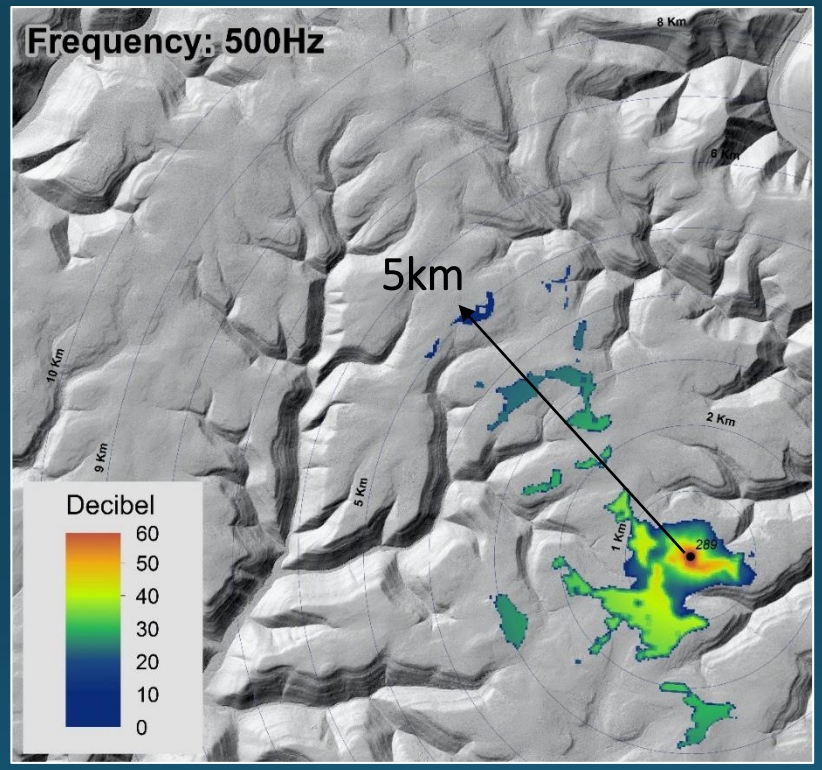
Frequency (Hz)
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000

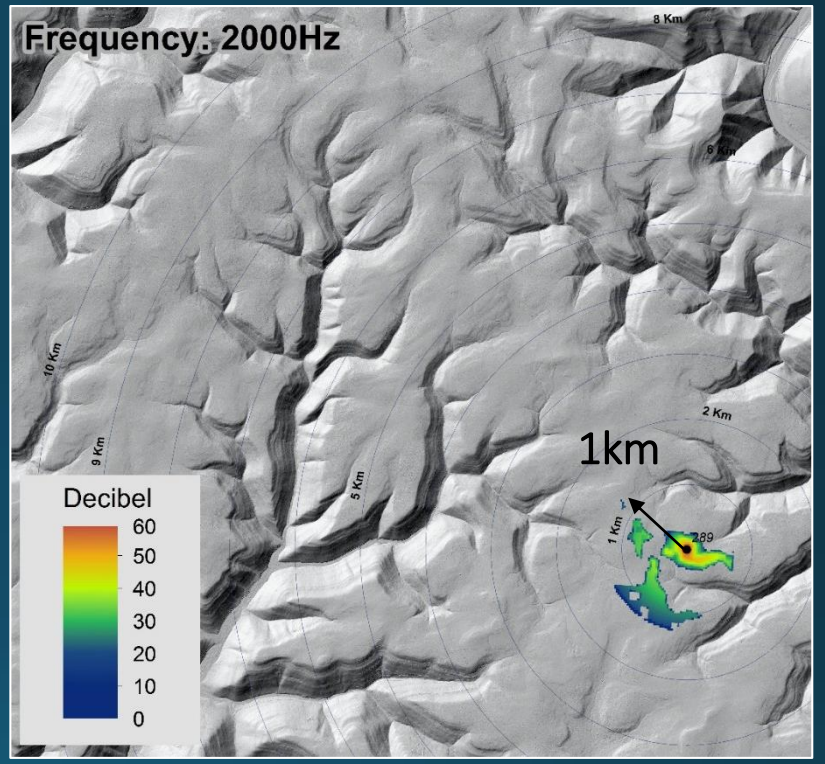
- 13 frequencies
- Empirical data for CS 289
- Run all frequencies
- Compare noise propagation:
  - Area
  - Distance
- Frequency with max area & distance
- Run model for other sites at this frequency
- Overlay with ROS

Results

Frequency Comparison

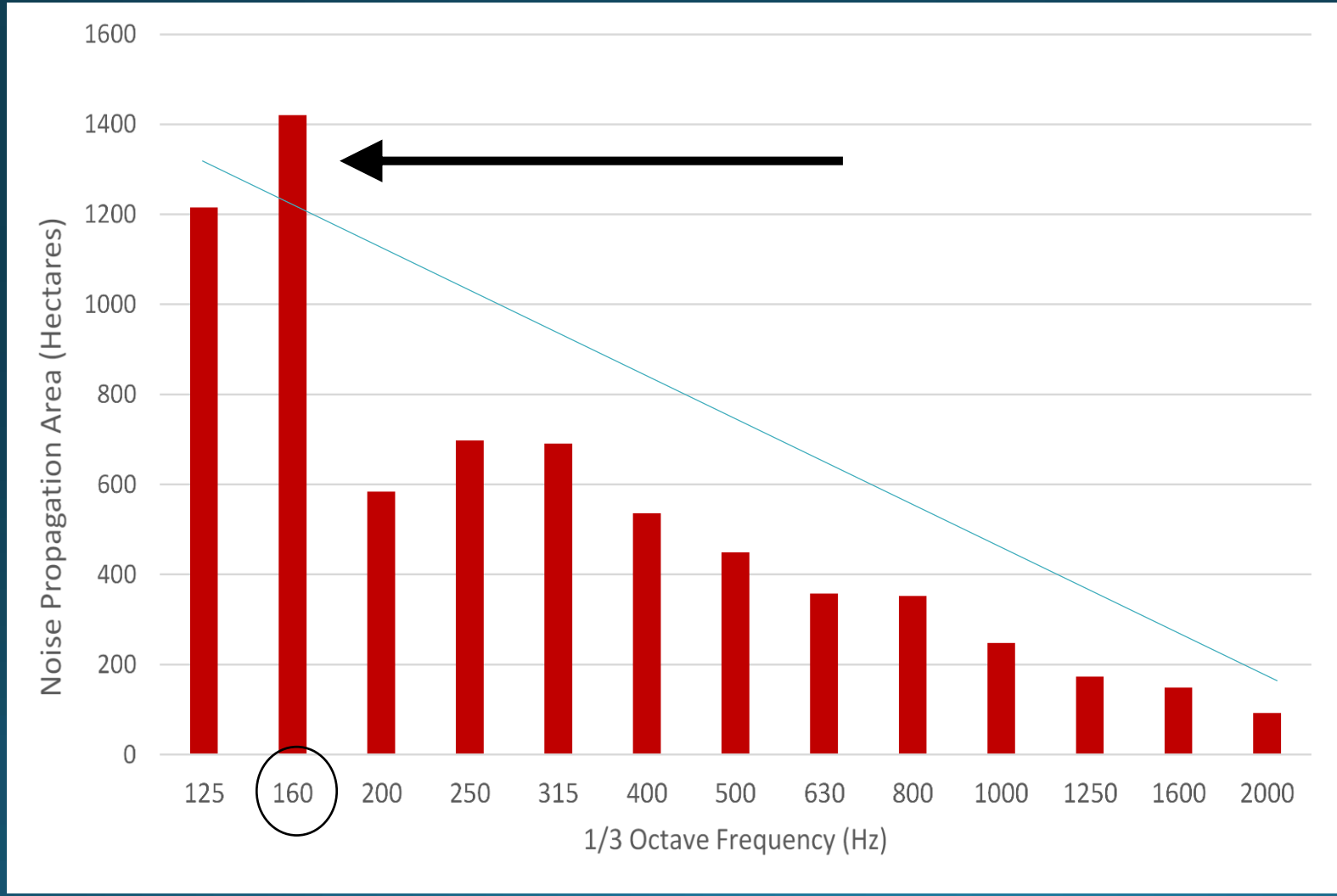


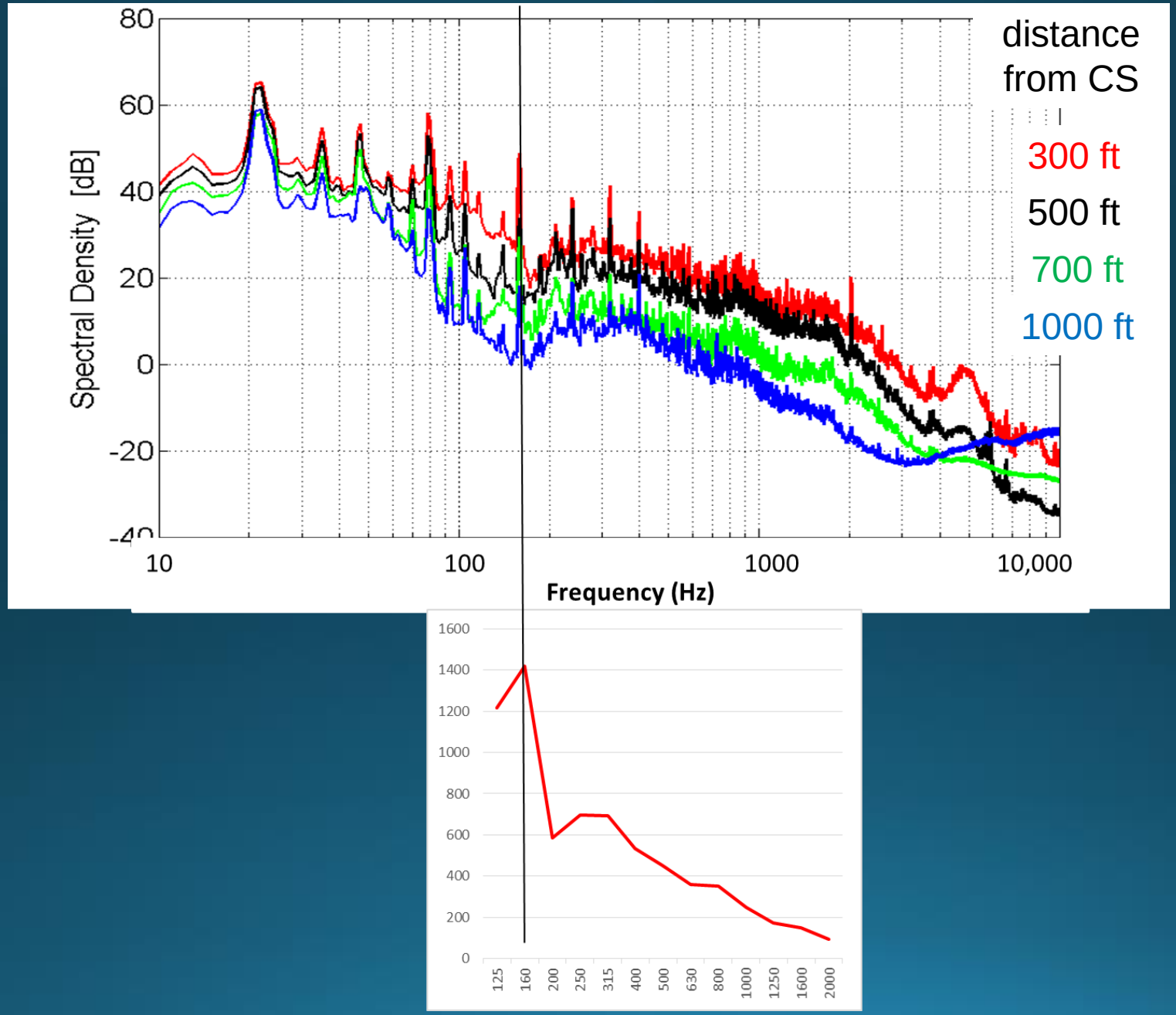


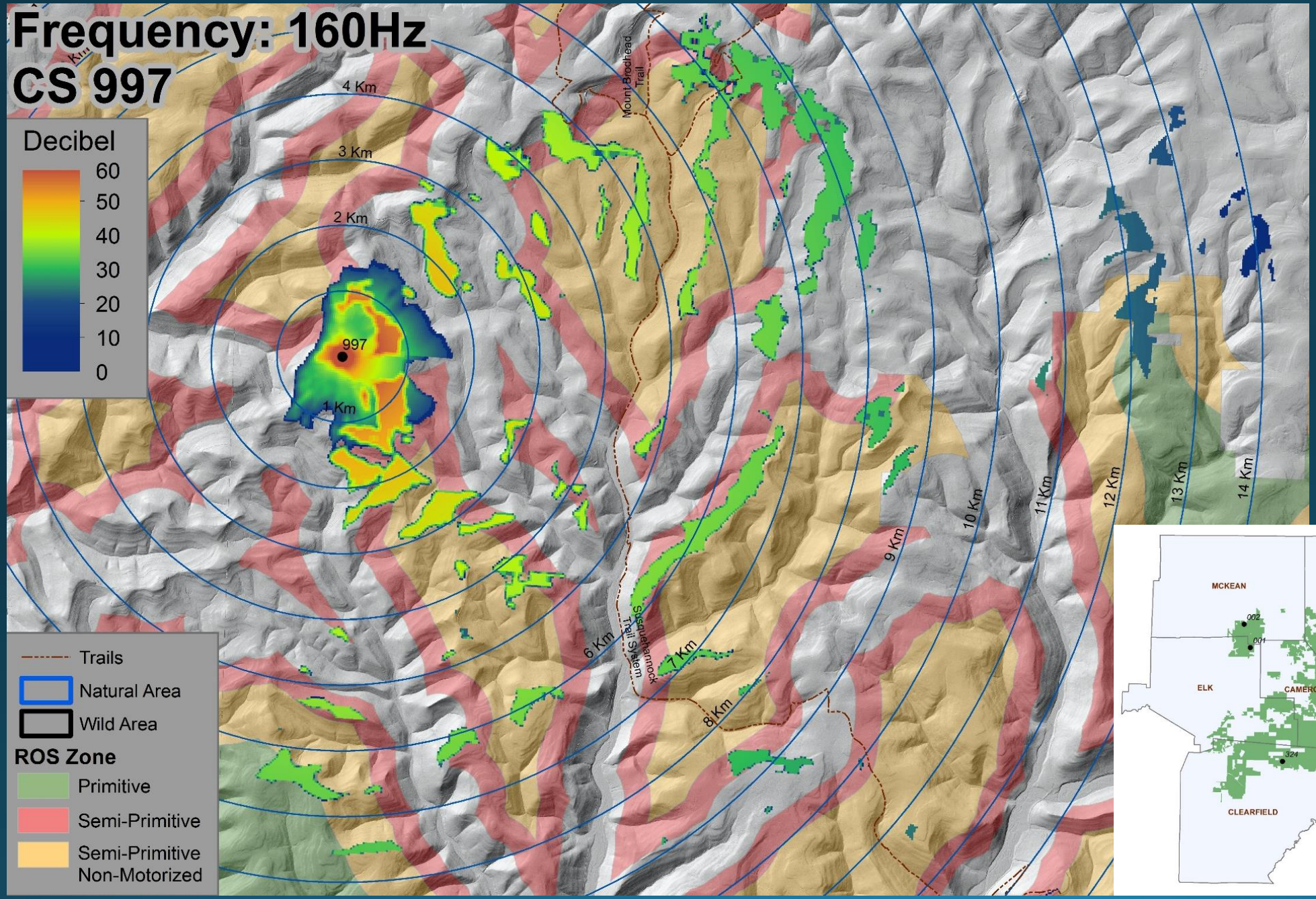


Frequency (Hz)	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000

Frequency Comparison



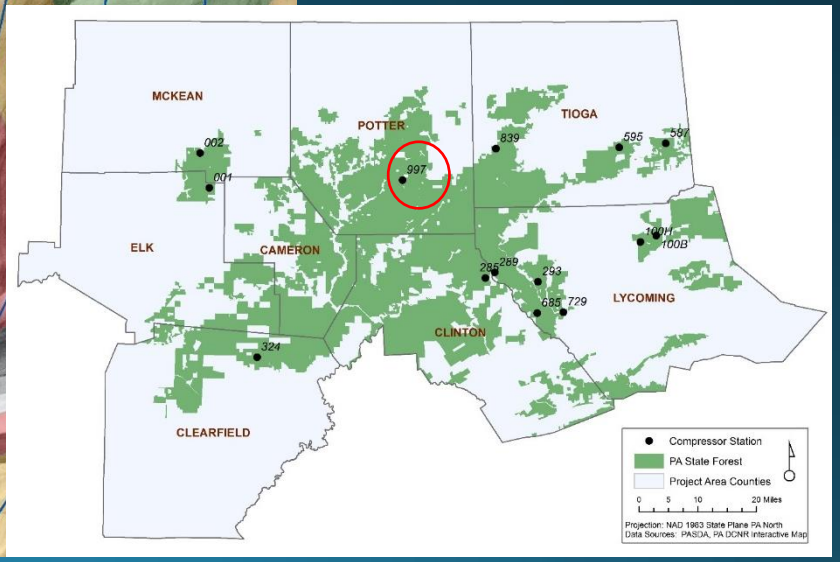

distance from CS
300 ft
500 ft
700 ft
1000 ft
Spectral Density [dB]
80
60
40
20
0
-20
-40
10
100
1000
10,000
Frequency (Hz)
1600
1400
1200
1000
800
600
400
200
0
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000



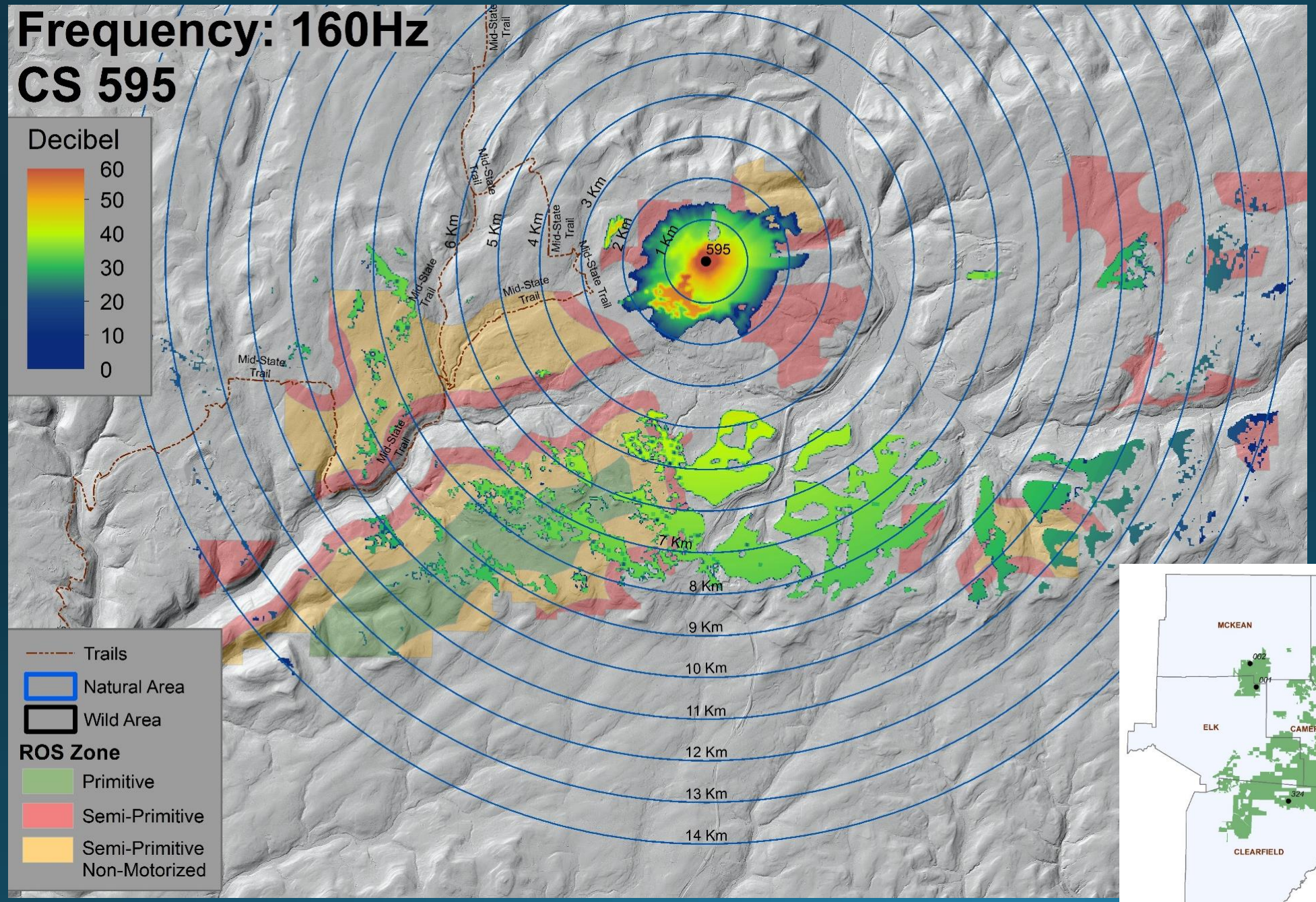
Area:
1,600 Ha

Primitive Area Overlap:
50 Ha

Distance:
14 km



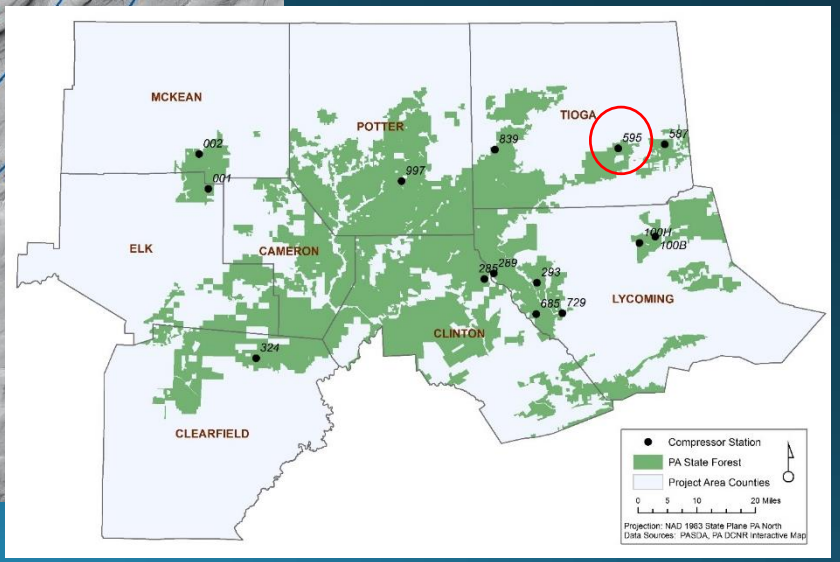
Frequency: 160Hz
CS 595



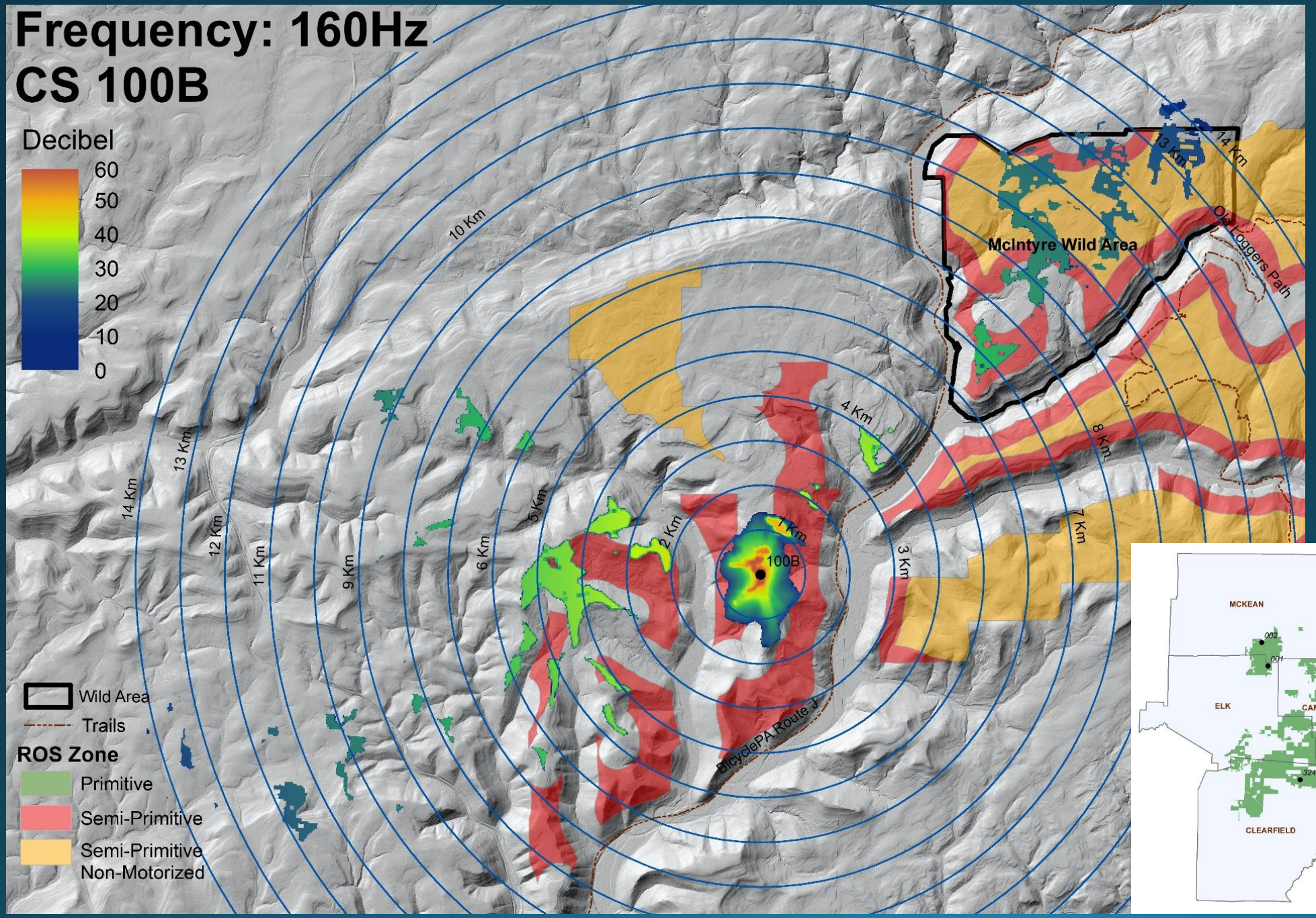
Area:
3,500 Ha

Primitive Area Overlap:
200 Ha

Distance:
14 km



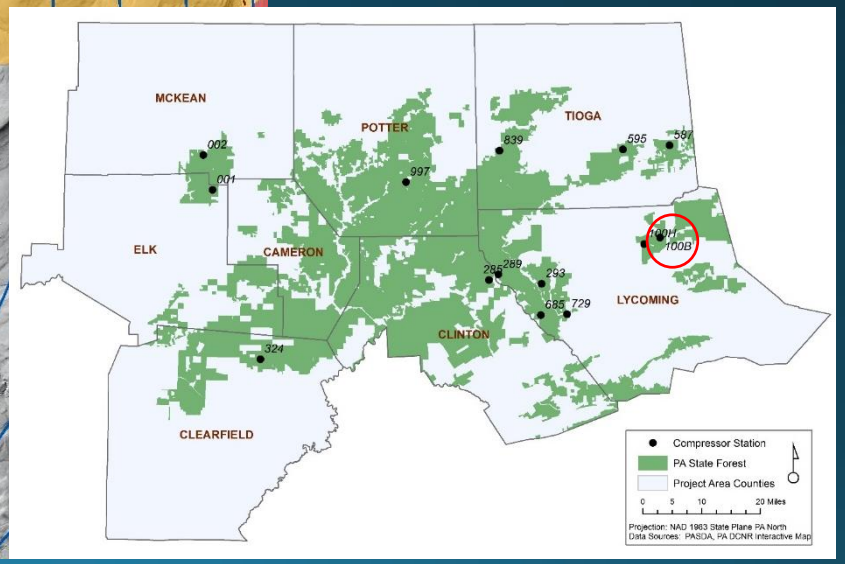
Frequency: 160Hz
CS 100B



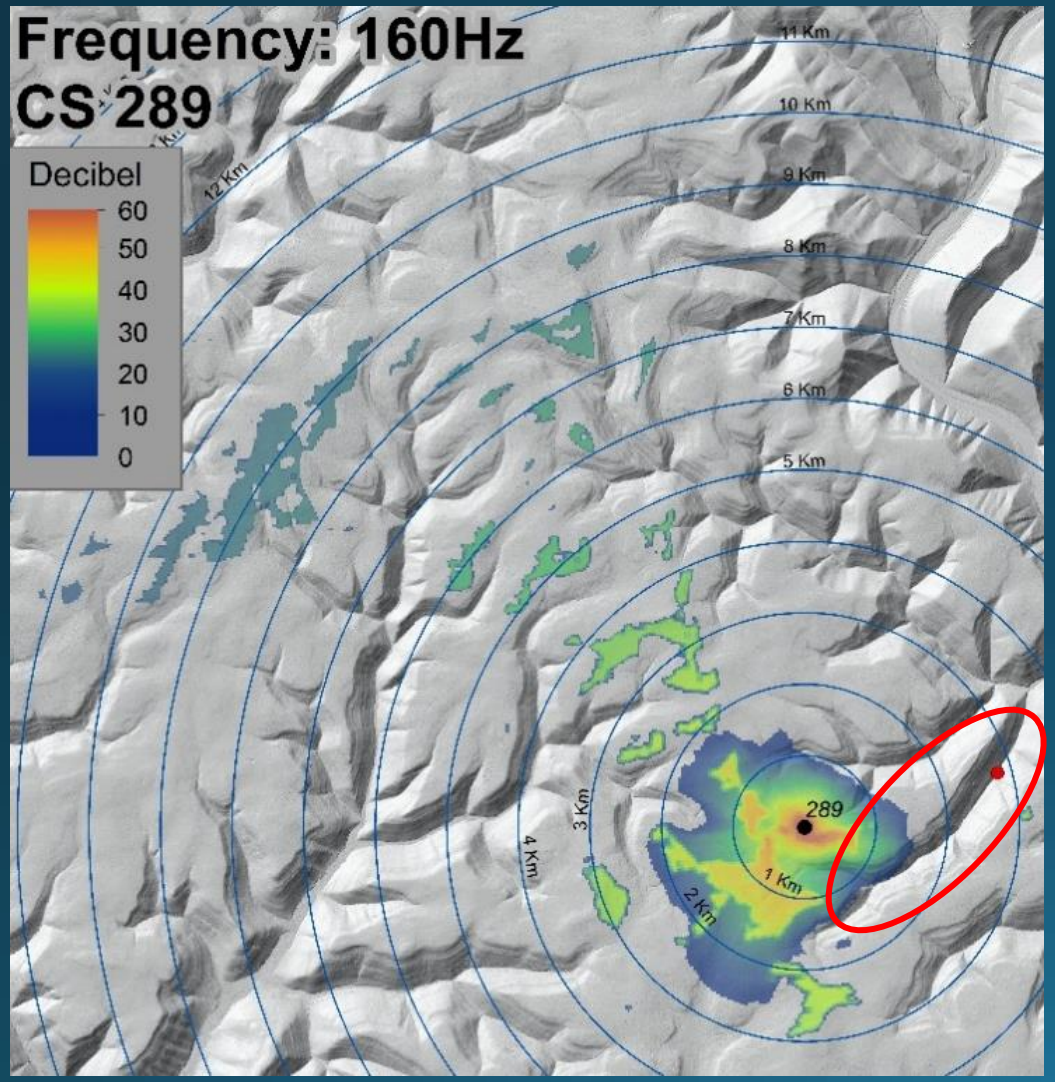
Area:
1,400 Ha

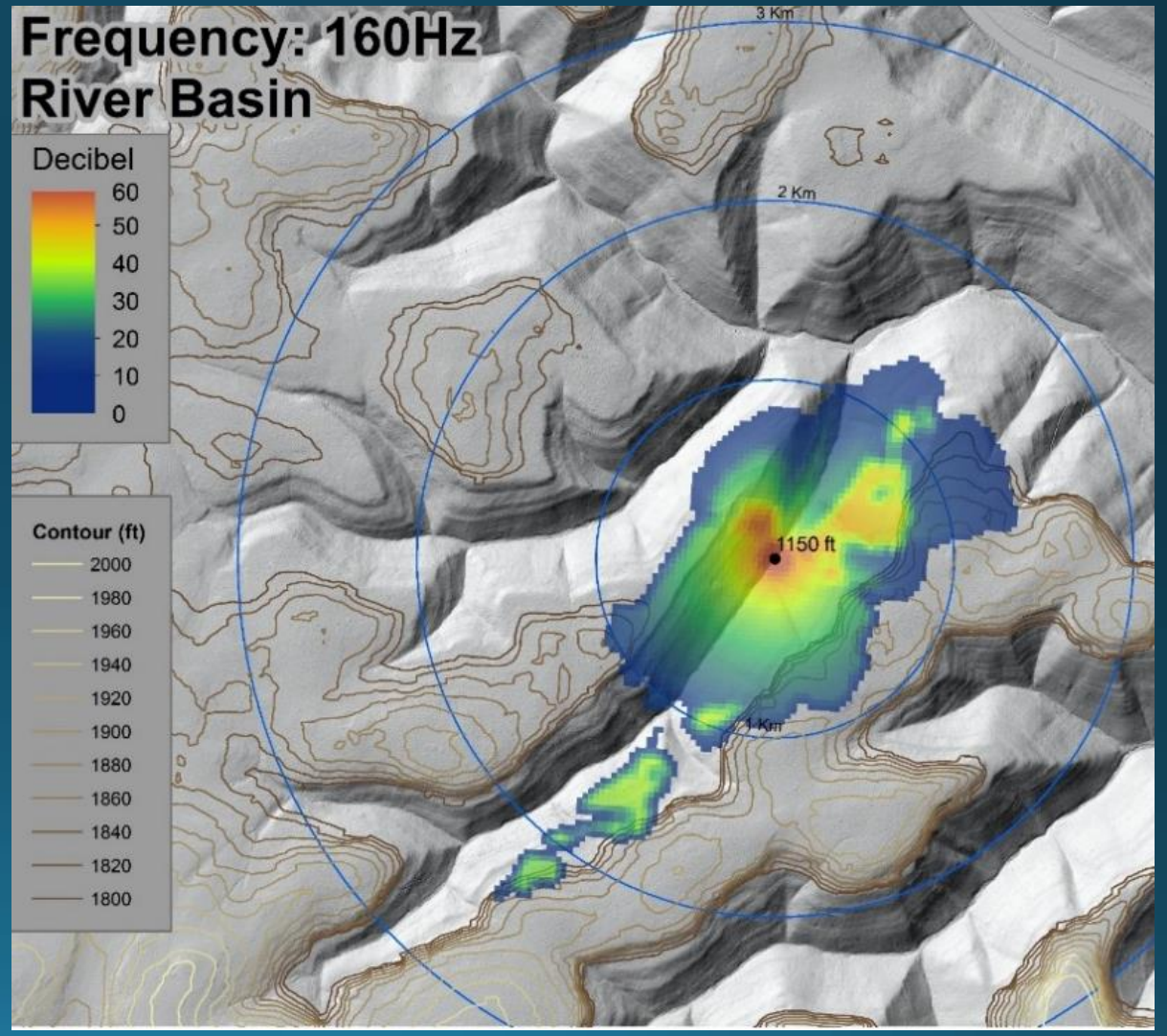
Wild Area Overlap:
450 Ha

Distance:
14 km



Topography


Frequency: 160Hz
CS 289
Decibel
60
50
40
30
20
10
0
11 Km
10 Km
9 Km
8 Km
7 Km
6 Km
5 Km
12 Km
3 Km
4 Km
2 Km
1 Km
289


Frequency: 160Hz
River Basin
Decibel
60
50
40
30
20
10
0
Contour (ft)
2000
1980
1960
1940
1920
1900
1880
1860
1840
1820
1800
3 Km
2 Km
1 Km
1150 ft

Topography

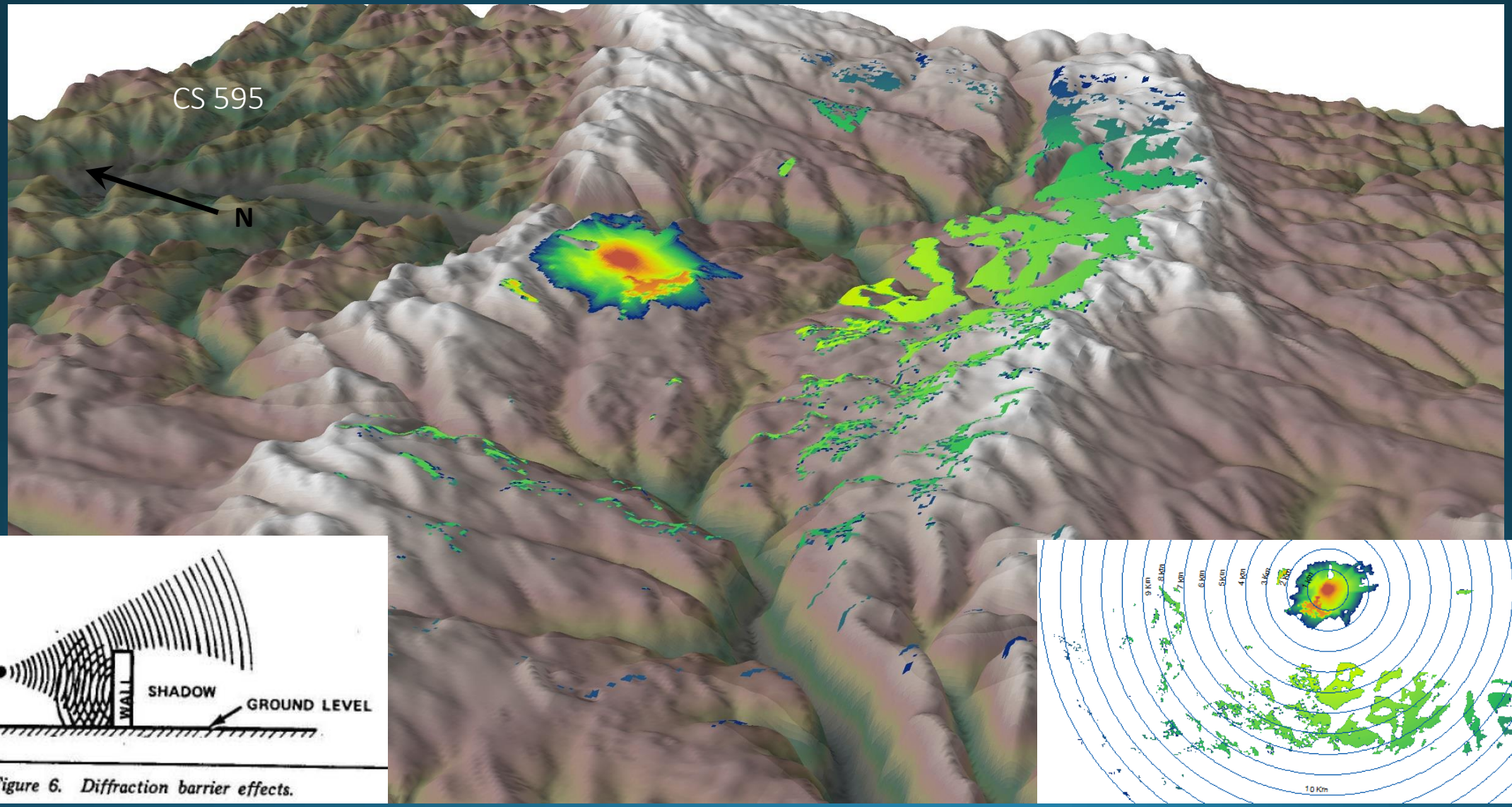
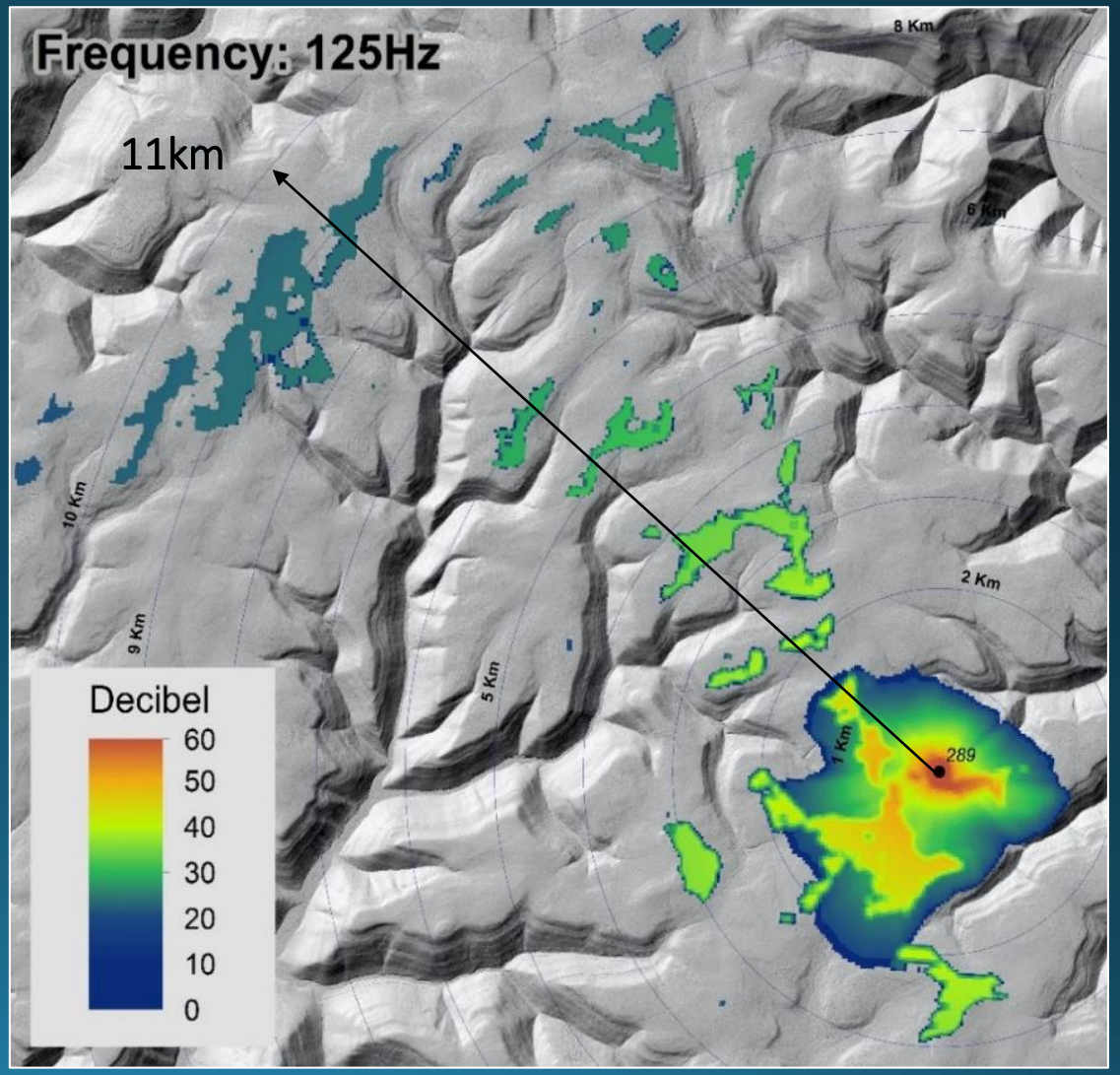


Figure 6. Diffraction barrier effects.

Conclusions

- CS produce low frequency noise
- Low frequency noise travels 11-14km*
- Areas as large as 1,400 ha (3,500 ac)*
- ROS may require modification
- Topography could influence noise spread
- Basins may be best for new CS placement to contain sound

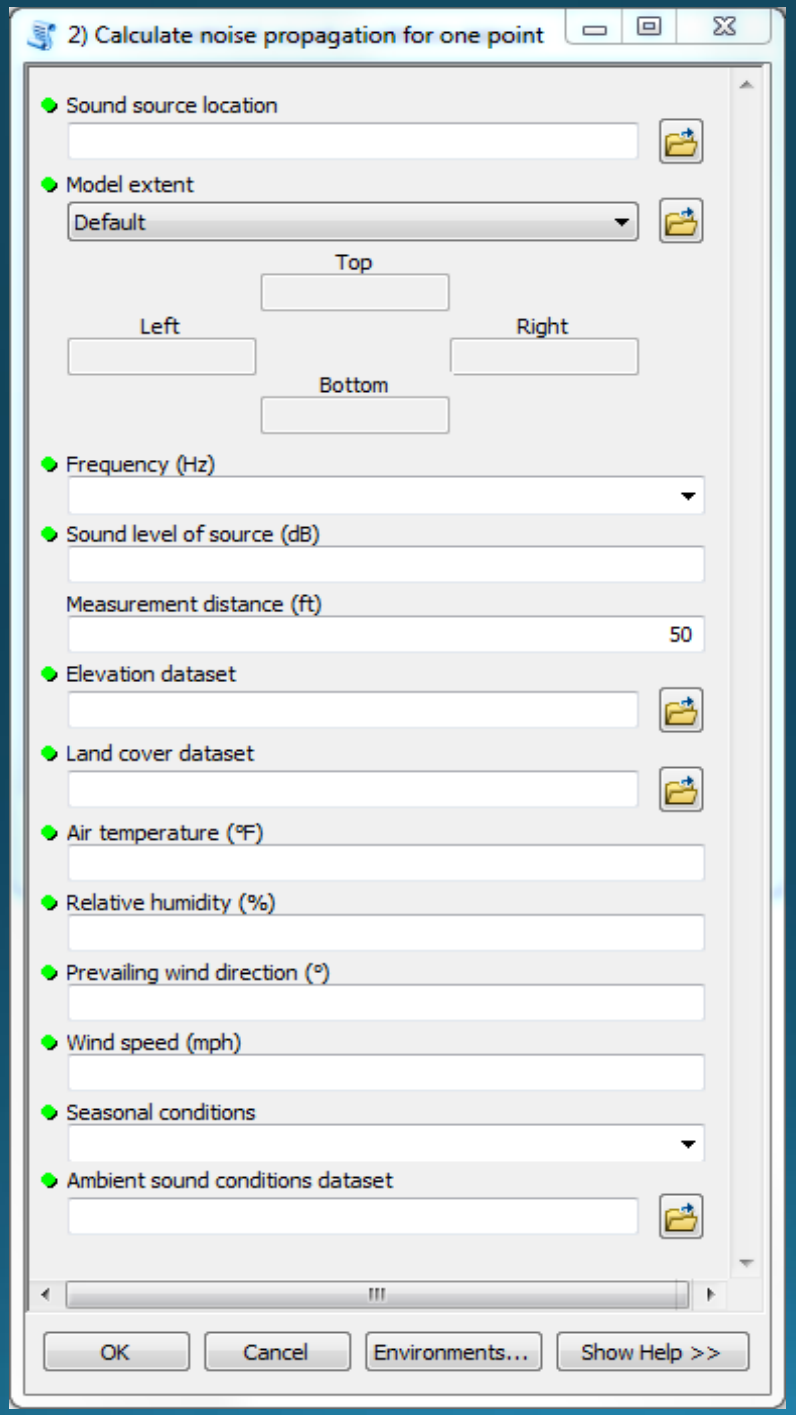
**Note: propagation doesn't necessarily mean impact or audible sound*



Acknowledgements

- Penn State University
- Dr. Julian Avery
  - Penn State Advisor
- Dr. Tom Gabrielson
  - Penn State Acoustics Lab
- SUU GIS Lab

Questions?


2) Calculate noise propagation for one point
Sound source location
Model extent
Default
Top
Left
Right
Bottom
Frequency (Hz)
Sound level of source (dB)
Measurement distance (ft)
50
Elevation dataset
Land cover dataset
Air temperature (°F)
Relative humidity (%)
Prevailing wind direction (°)
Wind speed (mph)
Seasonal conditions
Ambient sound conditions dataset
OK
Cancel
Environments...
Show Help >>