Influence of Anthropogenic Sound on Burrowing Owl Crepuscular Space-Use

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Question

Does sound from anthropogenic sources affect burrowing owl space-use during peak foraging times?

A. Barros

Burrowing Owl

- Crepuscular
- Prey: small mammals
- Nest in burrows in open grasslands
- Development: Ranching, farming & petroleum extraction

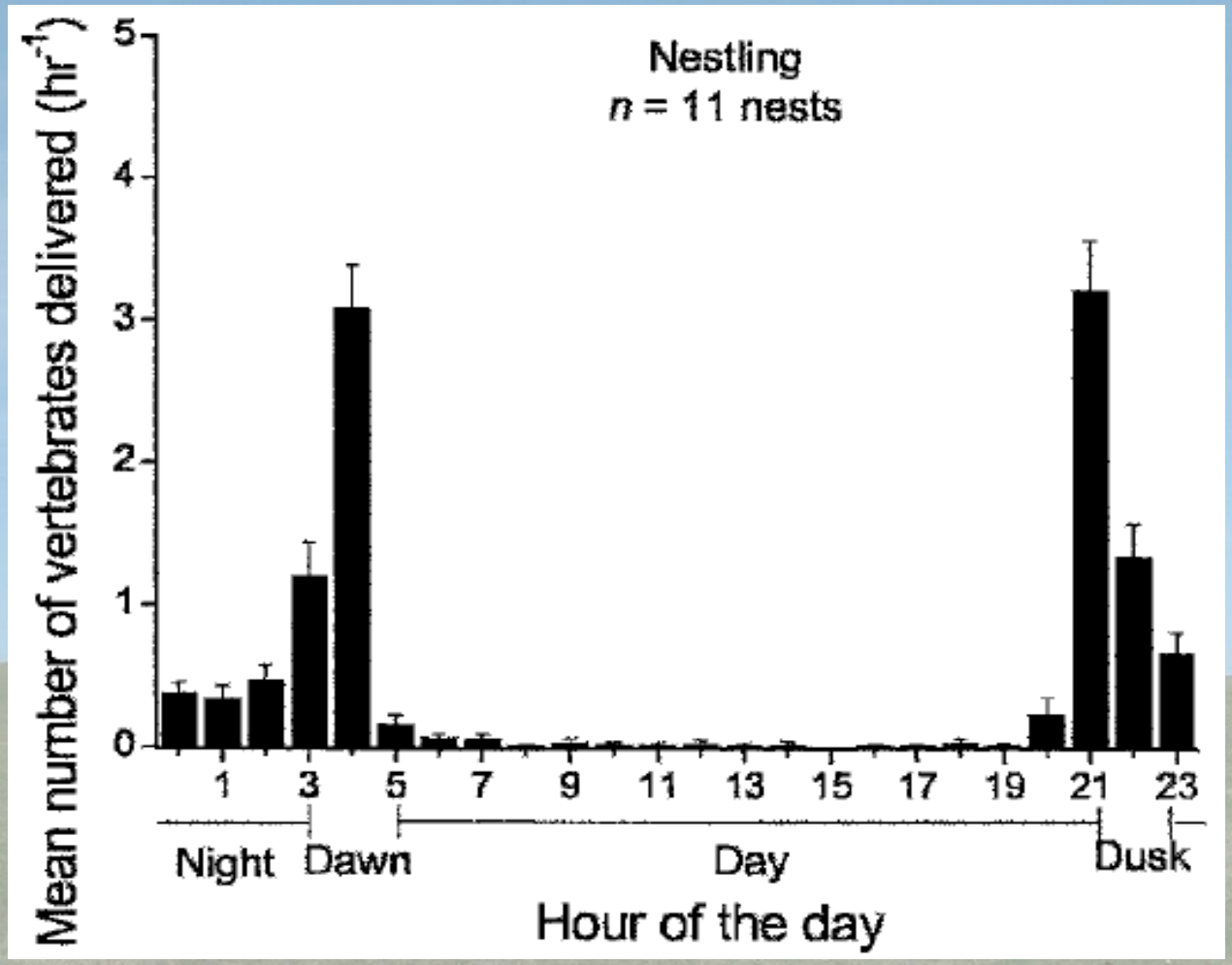
Photo: C. Jardine

Prediction

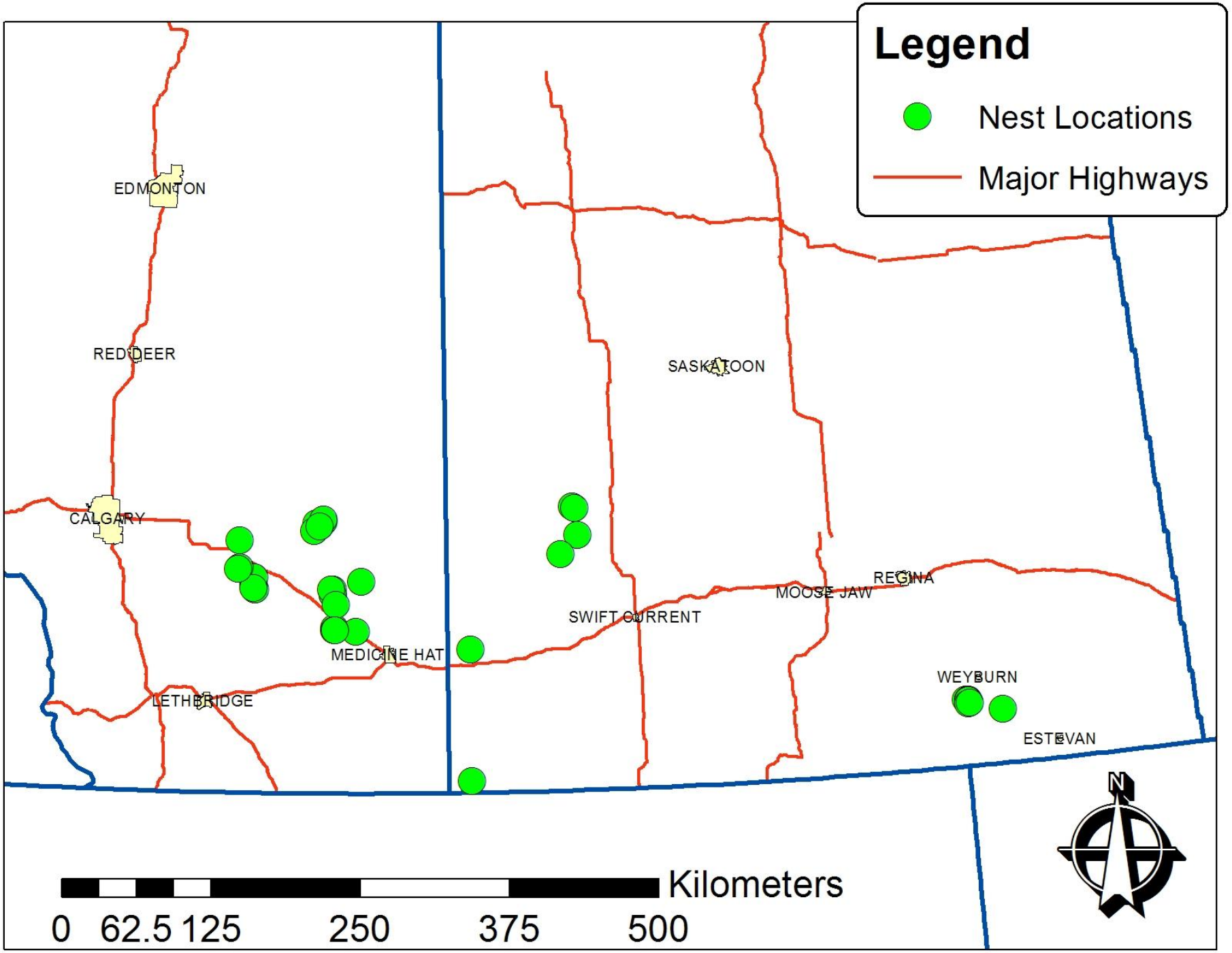
While hunting, owls would avoid areas with high levels of sound during peak foraging times

- Rely on auditory cues for hunting (Dice 1945)
- Avoid noisy areas because:
  - Previous unsuccessful hunting attempts
  - “Aware” of sound masking

Peak Foraging Times



Poulin & Todd 2006


Legend
Nest Locations
Major Highways
EDMONTON
RED DEER
CALGARY
SASKATOON
SWIFT CURRENT
MOOSE JAW
REGINA
MEDICINE HAT
LETHBRIDGE
WEYBURN
ESTEVAN
N
Kilometers
0 62.5 125 250 375 500

Tracking Owl Movements

Tracked adult male owls with 7g GPS datalogger

- 1 location/15 min.

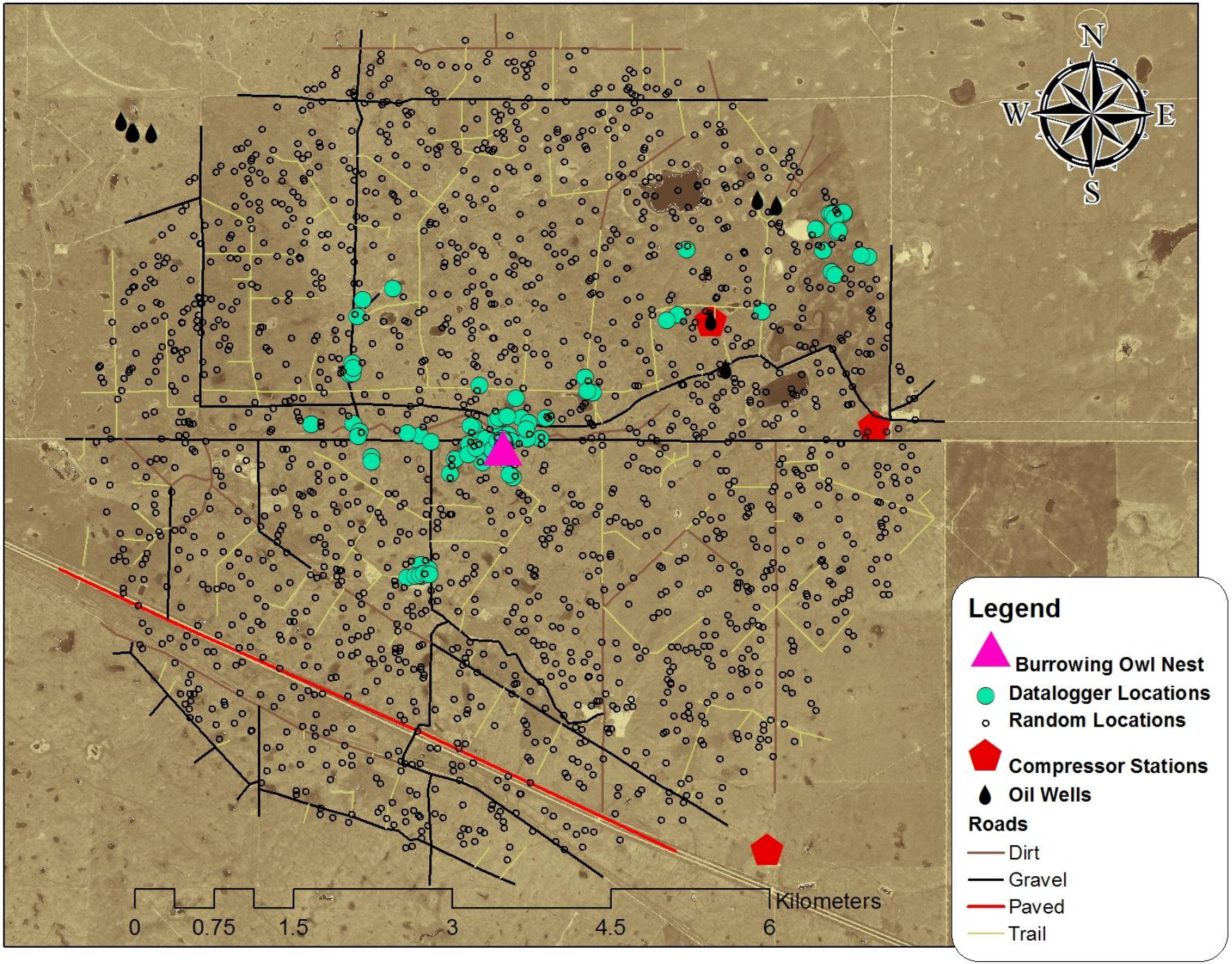
J. Fonger

K. Russell

Datalogger Data

- Tracked 65 owls
  - 3,286 datalogger locations ($\bar{x}$ = 51, SE = 5.65)
  - 306 nights ($\bar{x}$ = 4.71 nights, SE = 0.41)

- Available defined as:
  - Max. distance travelled from nest
    ($\bar{x}$ = 2.33km, SE = 4.85)
- Generated five random locations per datalogger location within available area


N
W
E
S
Legend
Burrowing Owl Nest
Datalogger Locations
Random Locations
Compressor Stations
Oil Wells
Roads
Dirt
Gravel
Paved
Trail
0
0.75
1.5
3
4.5
6
Kilometers

Sound Pressure at Datalogger and Random Locations

1. Calculate sound power levels of oil wells, compressor stations and roads

ISO 3746

Determination of sound power levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane

- Pump jacks, screw jacks, generators, small compressor stations

ISO 8297

Determination of sound power levels of multisource industrial plants for evaluation of sound pressure levels in the environment

- Compressor stations, gas plants, oil batteries

Road Noise Prediction

1 - Calculating sound emissions from road traffic

(Abaques 2008)

- Roads with >30 vehicles per hour
  - Vehicles per hour
  - Percent heavy vehicles
  - Average speed

Photo: T. Schowalter

Sound Pressure at Datalogger and Random Locations

1. Calculate sound power levels of oil wells and compressor stations
2. Added sound pressure level from
   - 10 nearest oil wells
   - All facilities < max. distance travelled + 5km
   - Roads < max. distance travelled + 5km

$$L_\Sigma = 10 \cdot \log_{10}\left(10^{\frac{L_1}{10}} + 10^{\frac{L_2}{10}} + \cdots + 10^{\frac{L_n}{10}}\right)\ \mathrm{dB}$$

3. Account for sound attenuation

ISO 9613_2

Attenuation of sound during propagation outdoors – General method of calculation

Sources of Attenuation:

- Geometric divergence
- Atmospheric absorption
- Ground affects
- Barriers

$$L_{fT}(\mathrm{DW}) = L_W + D_C - A$$

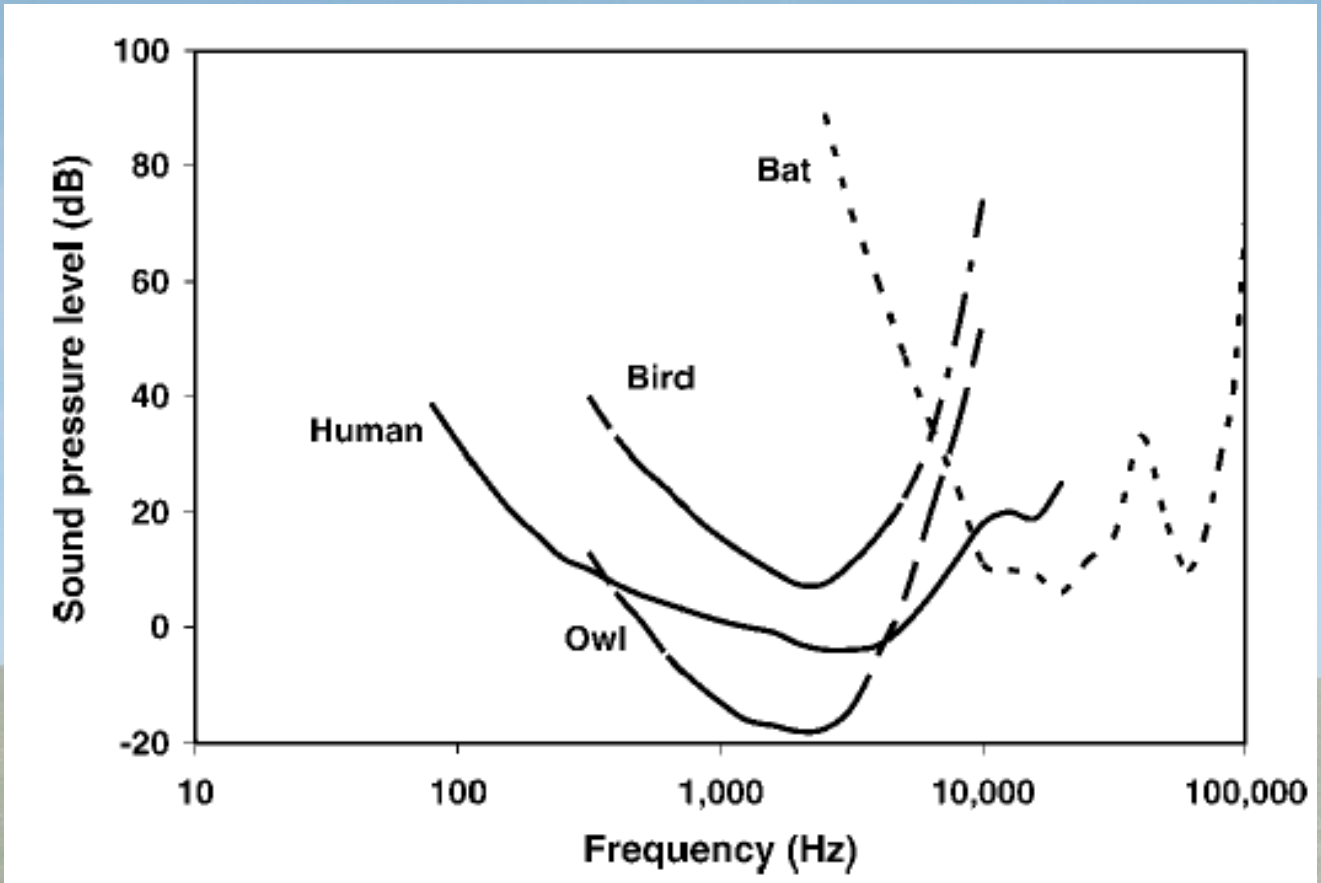
$$A = A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}$$

Wind Speed: $\bar{x}$ = 11.25 km/h, SE = 0.21

Sound Pressure at Datalogger and Random Locations

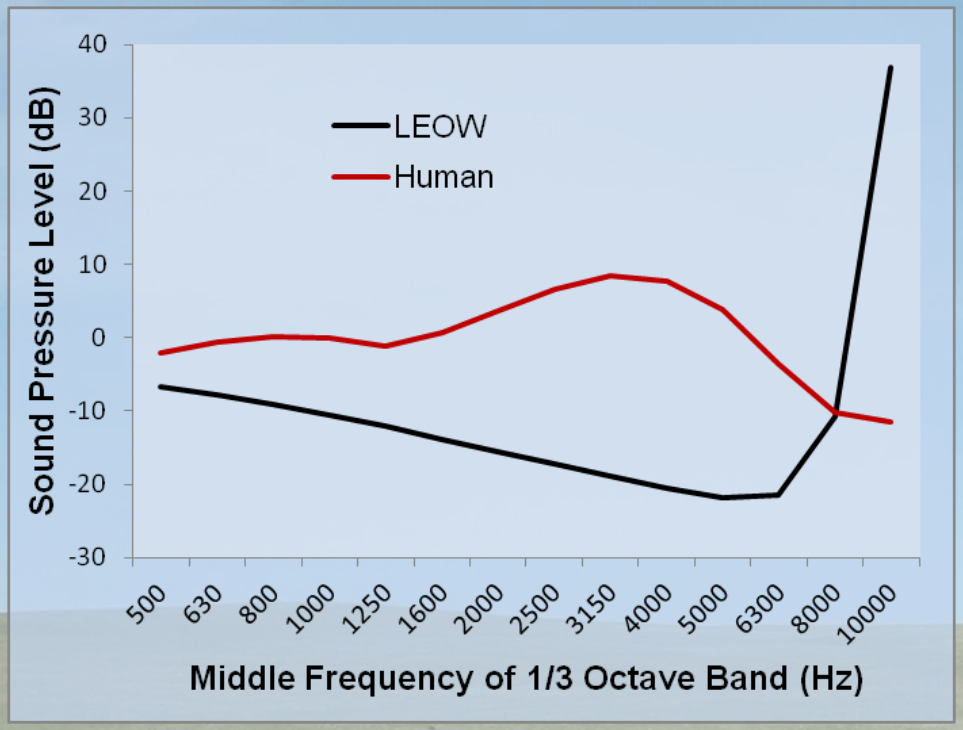
1. Calculate sound power levels of oil wells and compressor stations
2. Added SPL from
   - 10 nearest oil wells
   - All facilities < max. distance travelled + 5km
   - Roads < max. distance travelled + 5km
3. Account for sound attenuation
4. Adjust SPL to reflect owl hearing
   - Birds can detect sound 1.5dB above background sound (Dooling *et al.* 2000)
   - Weight sound to reflect sound perception of target species

Hearing Thresholds



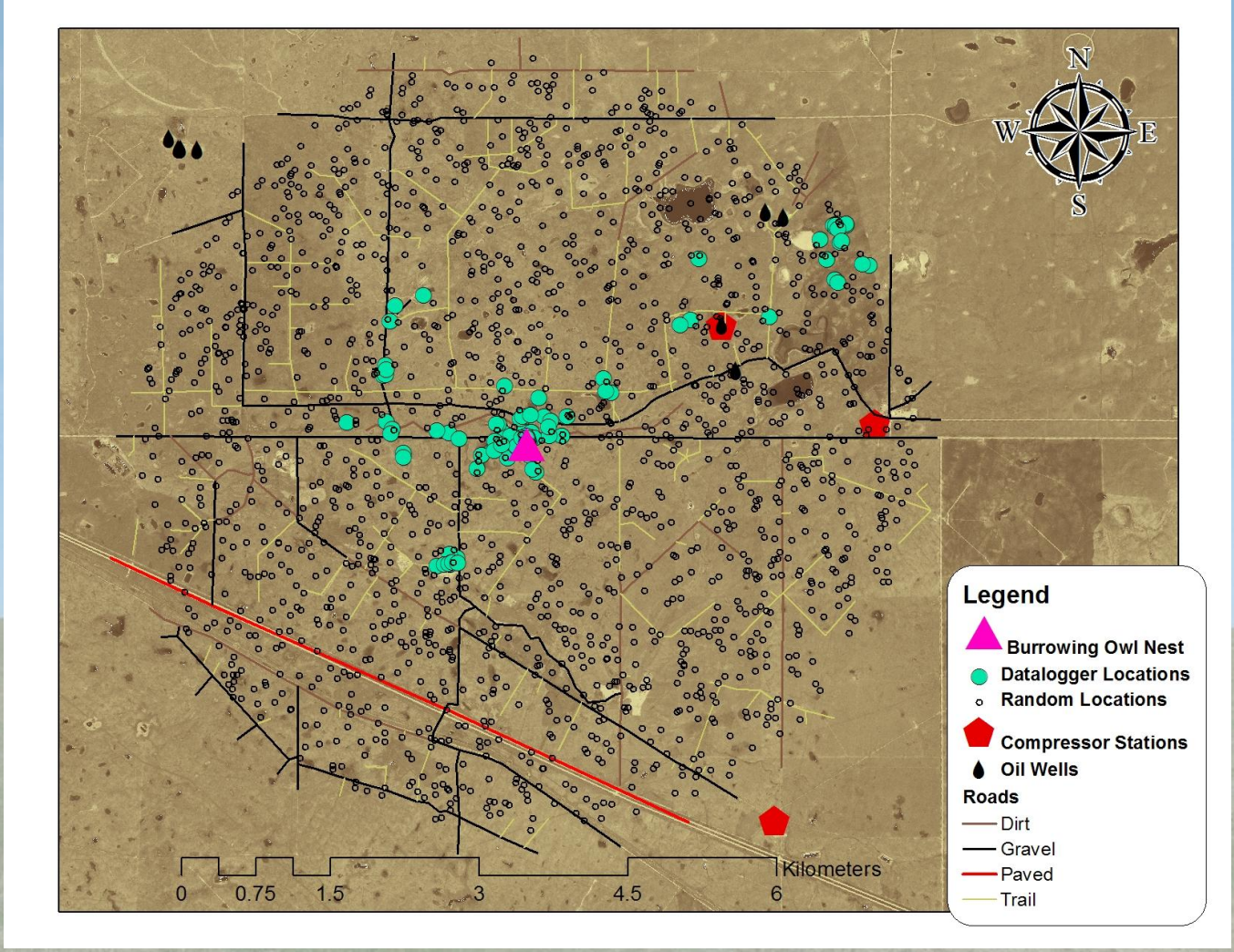
Pater et al. 2009

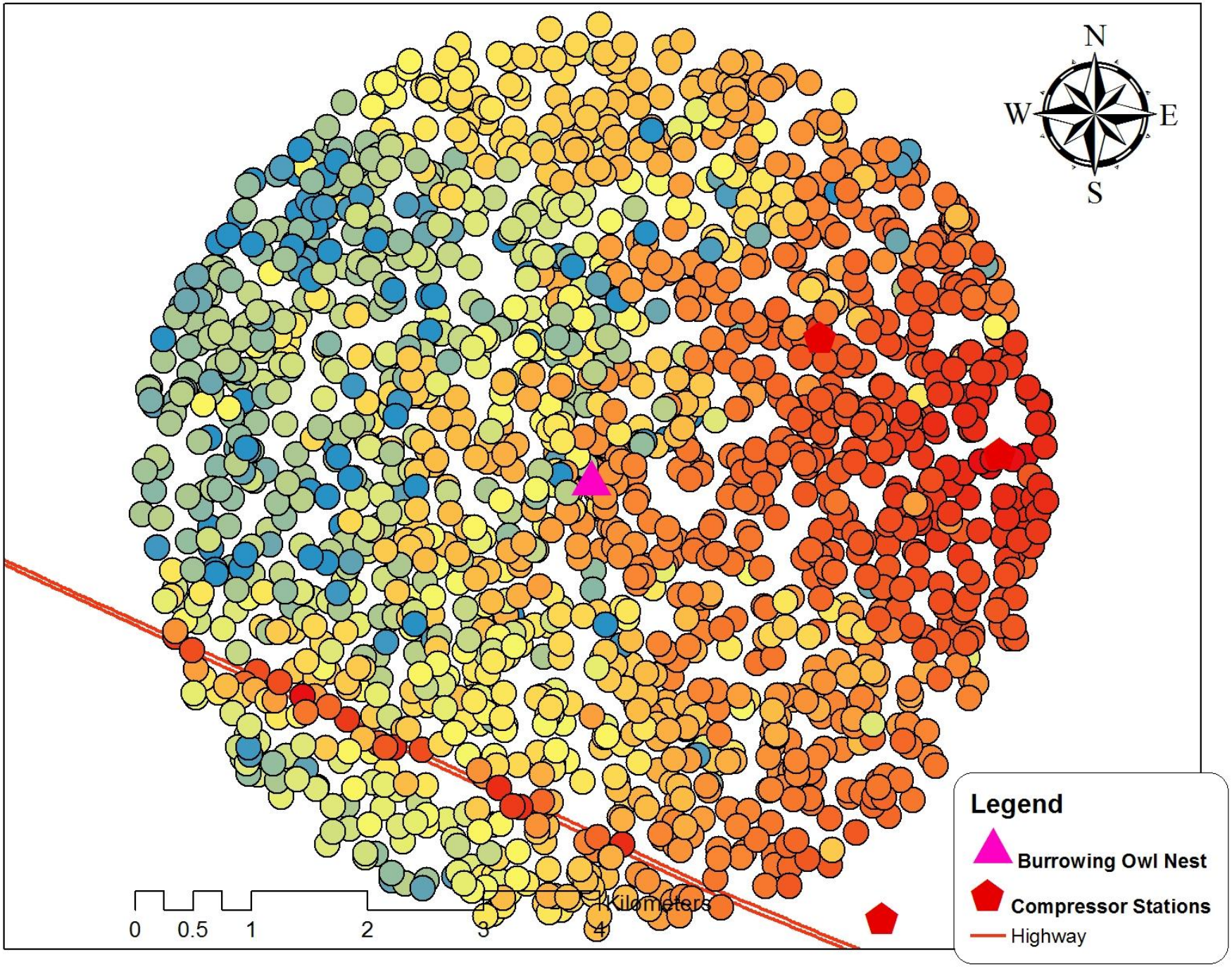
Owl Behavioral Audiogram



Van Dijk 1972

Sound Pressure Levels at each Datalogger and Random Location




N
W
E
S
0
0.5
1
2
3
4
Kilometers
Legend
Burrowing Owl Nest
Compressor Stations
Highway

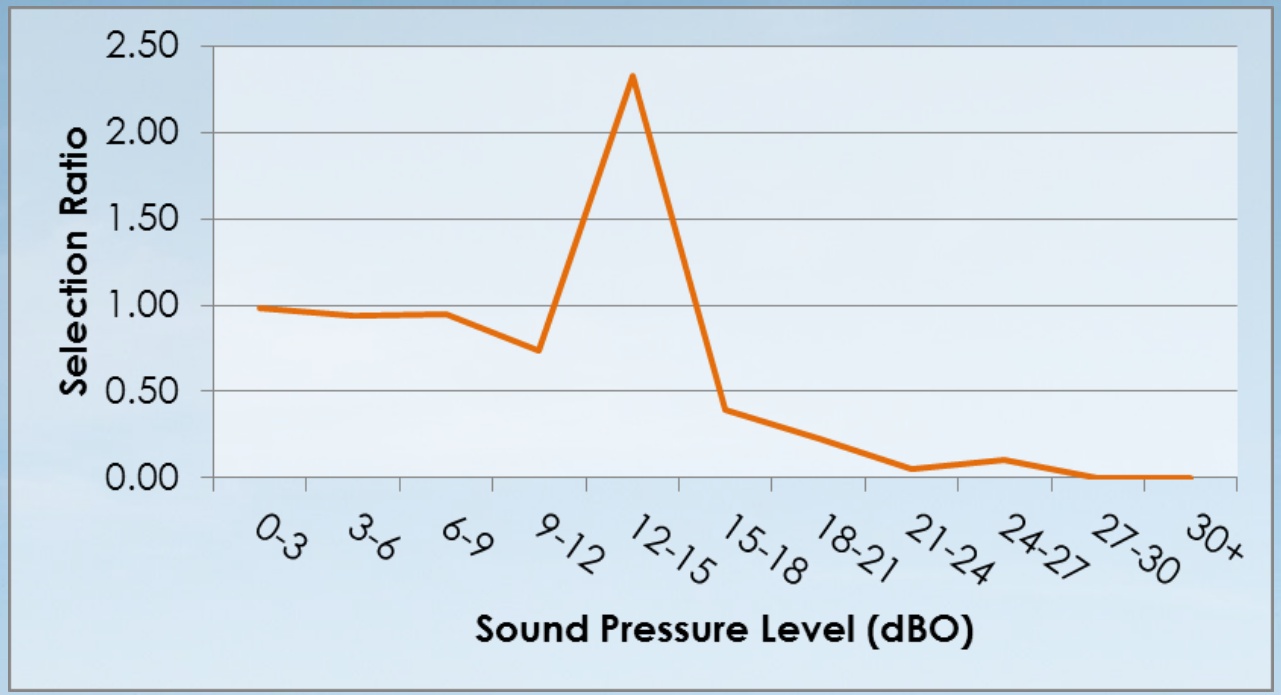
Resource Selection Analysis

- Mixed effect logistic regression
  - Random locations down weighted
  - Owl ID random effect
- Variables
  - Sound pressure level
  - Distance to nest
  - Land cover
    - Native grass, tame grass, riparian area, water body, paved road, gravel road, dirt road, tall woody vegetation, human structures, annual cropland.

Model Selection

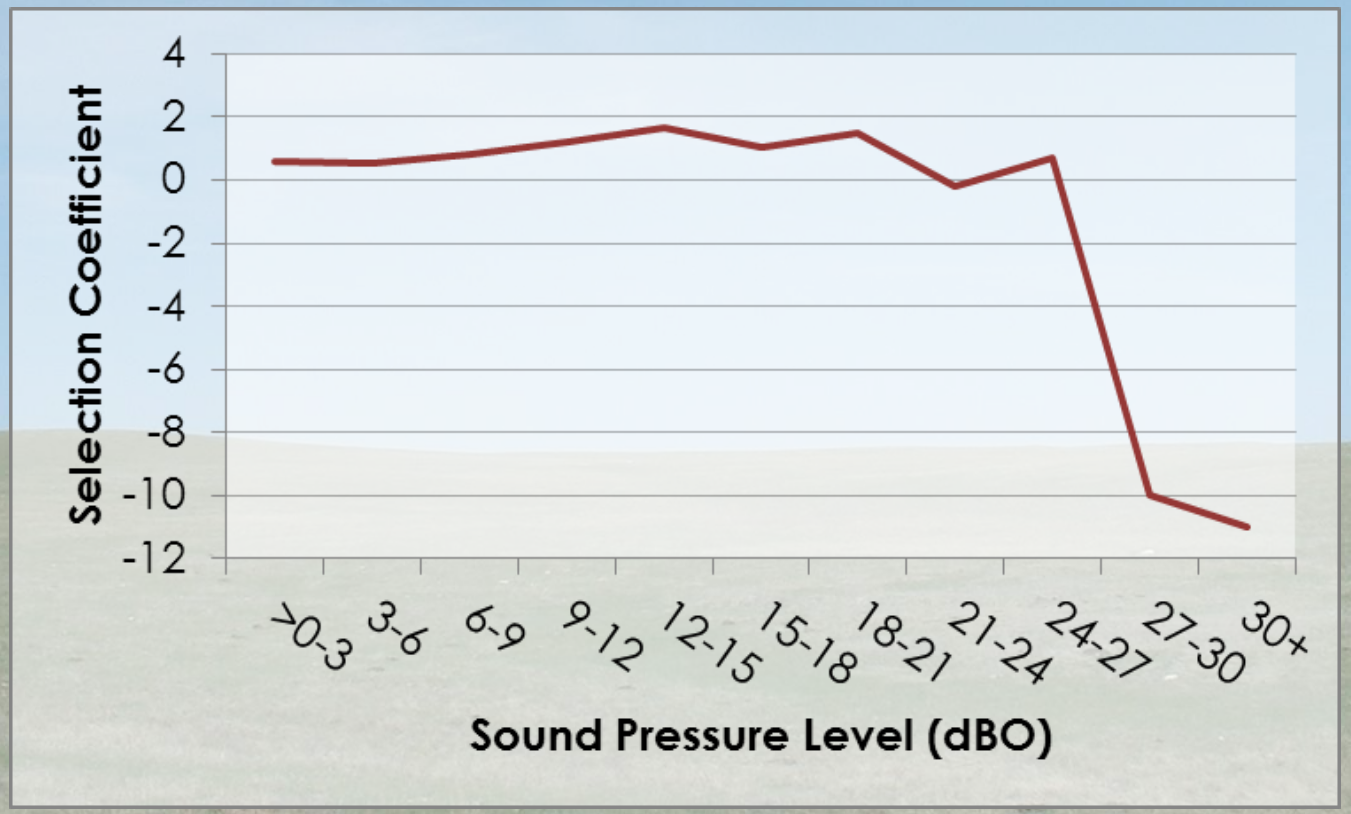
Model Description	AIC	ΔAIC
NestDistance + Landcover + SoundPressure	4144	0
NestDistance + SoundPressure	4170	26
NestDistance + Landcover	4178	34
NestDistance	4200	56
Null	8211	4067

Selection Ratio



Selection Coefficient

- Sound pressure levels put in top model as categorical variable (reference = 0 dBO)



Summary

- Top models contained sound pressure levels
- Owls are avoiding areas with higher sound pressure levels

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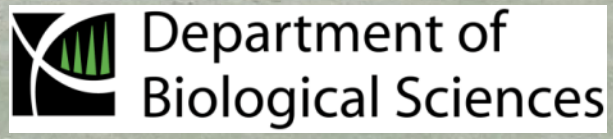
Funding Partners



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