Predicting habitat use by bats to protect bats and inform wind energy development

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Introduction

Although wind turbines are a clean, renewable source of energy, sometimes they incidentally kill bats and birds in large numbers. In 2012 for example, an estimated 600,000 bats died due to encounters with turbines at wind energy facilities in the U.S. alone (Hayes 2013). Migratory species such as the Mexican free-tailed bat (*Tadarida brasiliensis*) and hoary bat (*Lasiurus cinereus*) have the highest mortality at wind energy facilities (Arnett et al. 2008, Ellison 2013, Kunz et al. 2007). Arizona has both high species richness of bats and a high proportion of migratory species (bats that migrate long distances or regionally) that creates a high risk of mortality from interactions at wind energy facilities (Hinman and Snow 2003). Over 200 MegaWatts of power are currently being generated by wind energy in northern Arizona and up to more than twice as much is being proposed or under development (Corbinmeyer et al. 2013).

Objectives

Our objectives are to determine the species composition, examine bat use, study topographic features on the landscape that might influence bat movement (e.g., long distance migration), and identify elevational movements (e.g., regional migration) by bats.

Methods

- Set up SM3Bats (Wildlife Acoustics) at points (n=18) that are characteristically similar to where wind energy has been developed or proposed in northern Arizona already
- Microphones 8 m above ground
- Summer and early fall monitoring (6 July to 11 September, 2015)
- SonoBat version 3.2.1 US West (Arcata, CA) to identify calls to species or species group (Table 1)
- Linear regressions in R to look at bat activity relationships with:
  - Elevation
  - Topographic features
    - Distance to cliffs
    - Distance to water
    - Landform type
  - Landcover type

Figure 1. The bat detector set up at one of the sampling points. The microphone is attached to the top of a 8 m pole.

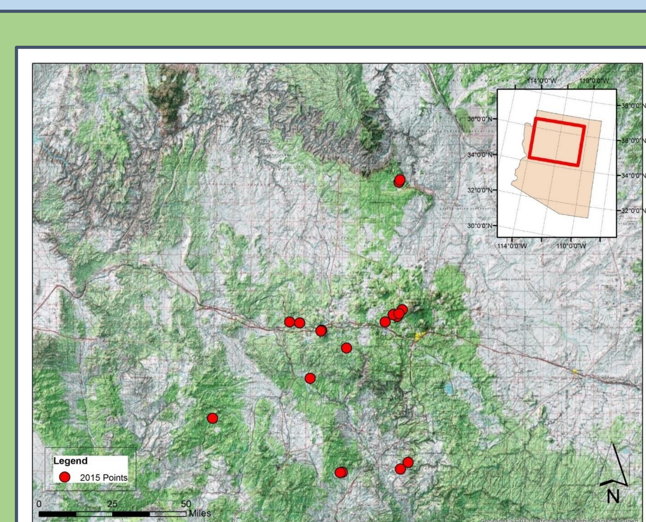

Figure 2. Locations of bat detectors used in this analysis.

Table 1. Expected bat species in northern Arizona and the species groups in which they might be found after running calls through Sonobat 3.2.1.

		Acoustic Group			
Species	**Common**	**High Frequency**	**Low Frequency**	**Q25**	**< 15 kHz**
Eumops perotis	Greater western mastiff bat		X		X
Nyctinomops macrotus	Big free-tailed bat		X		X
Tadarida brasiliensis	Mexican free-tailed bat		X	X	
Antrozous pallidus	Pallid bat		X		
Corynorhinus townsendii	Townsend's big-eared bat		X		
Euderma maculatum	Spotted bat		X		X
Idionycteris phyllotis	Allen's lappet-browed bat		X		X
Lasionycteris noctivagans	Silver-haired bat		X	X	
Lasiurus blossevillii	Western red bat	X			
Lasiurus cinereus	Hoary bat		X	X	
Parastrellus hesperus	Canyon bat	X			
Eptesicus fuscus	Big brown bat		X	X	
Myotis auriculus	Southwestern myotis	X			
Myotis californicus	California myotis	X			
Myotis ciliolabrum	Western small-footed myotis	X			
Myotis evotis	Long-eared myotis	X			
Myotis occultus	Arizona myotis	X			
Myotis thysanodes	Fringed myotis		X		
Myotis velifer	Cave myotis	X			
Myotis volans	Long-legged myotis	X			
Myotis yumanensis	Yuma myotis	X			

Preliminary Results

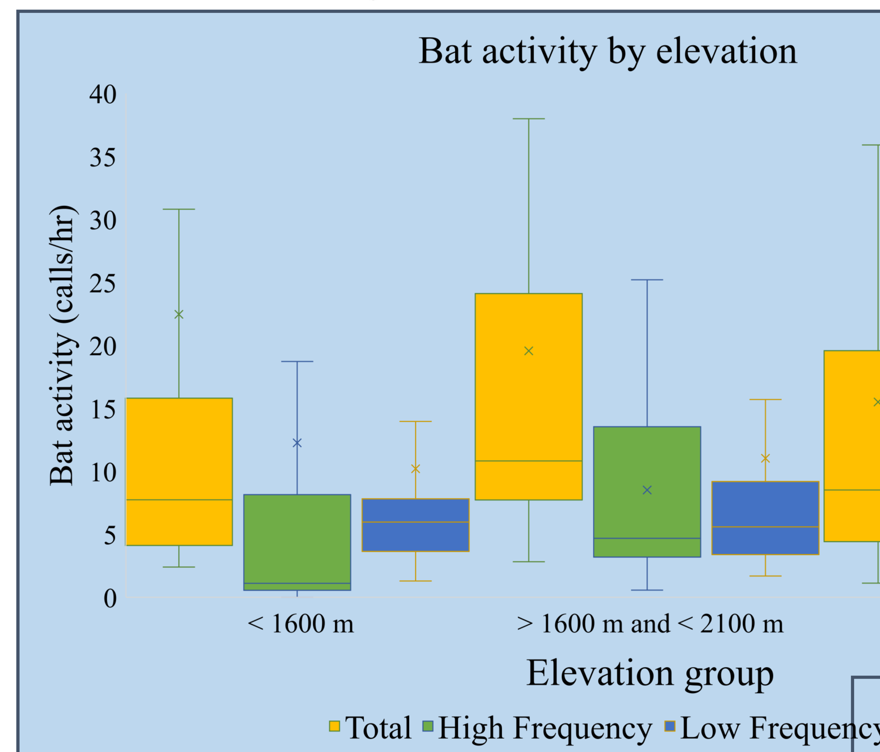

Figure 3. Bat activity by elevation for all bat calls combined (Total), high frequency bat calls, and low frequency bat calls.

We collected 38,851 bat calls. We did not detect any relationships with elevation and bat activity of all bat calls combined (Total), high frequency call group, low frequency call group, and the < 15 kHz (Figures 3 and 4). However, in these preliminary results, bat activity of the Q25 group was highest at lower elevations (Figure 4).

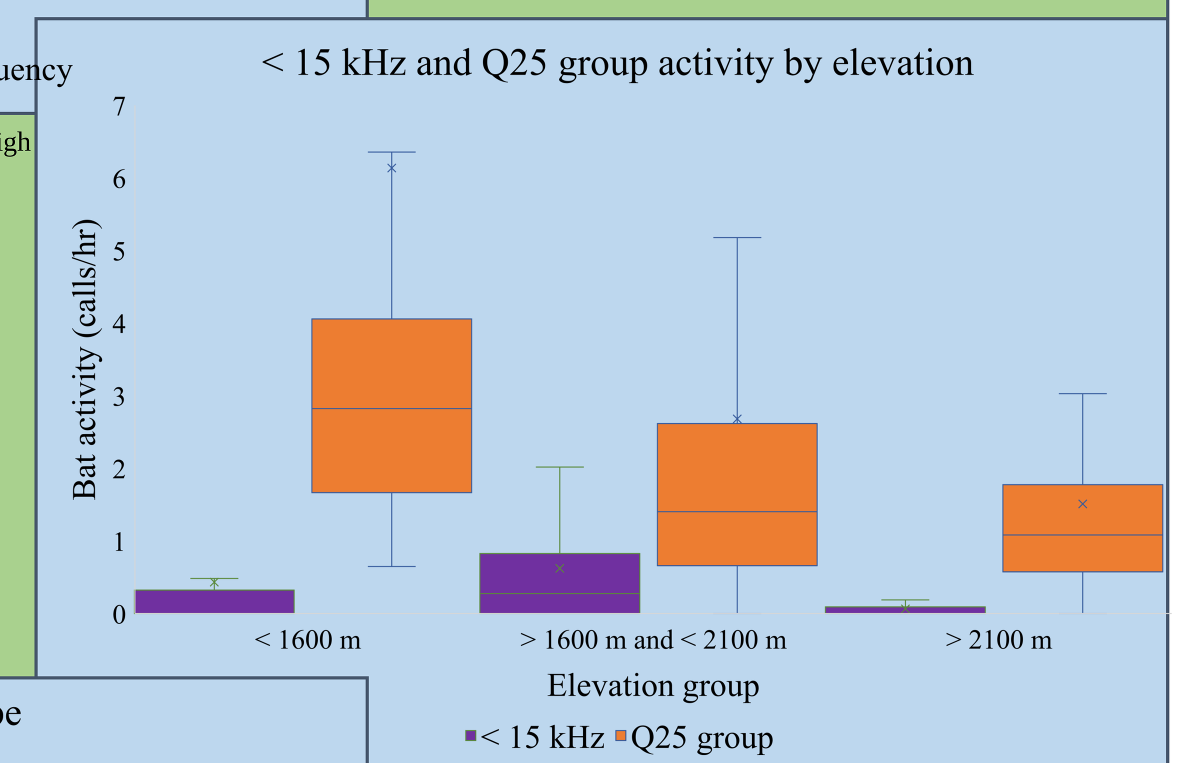

Figure 4. Bat activity by elevation for species groups < 15 kHz and Q25.

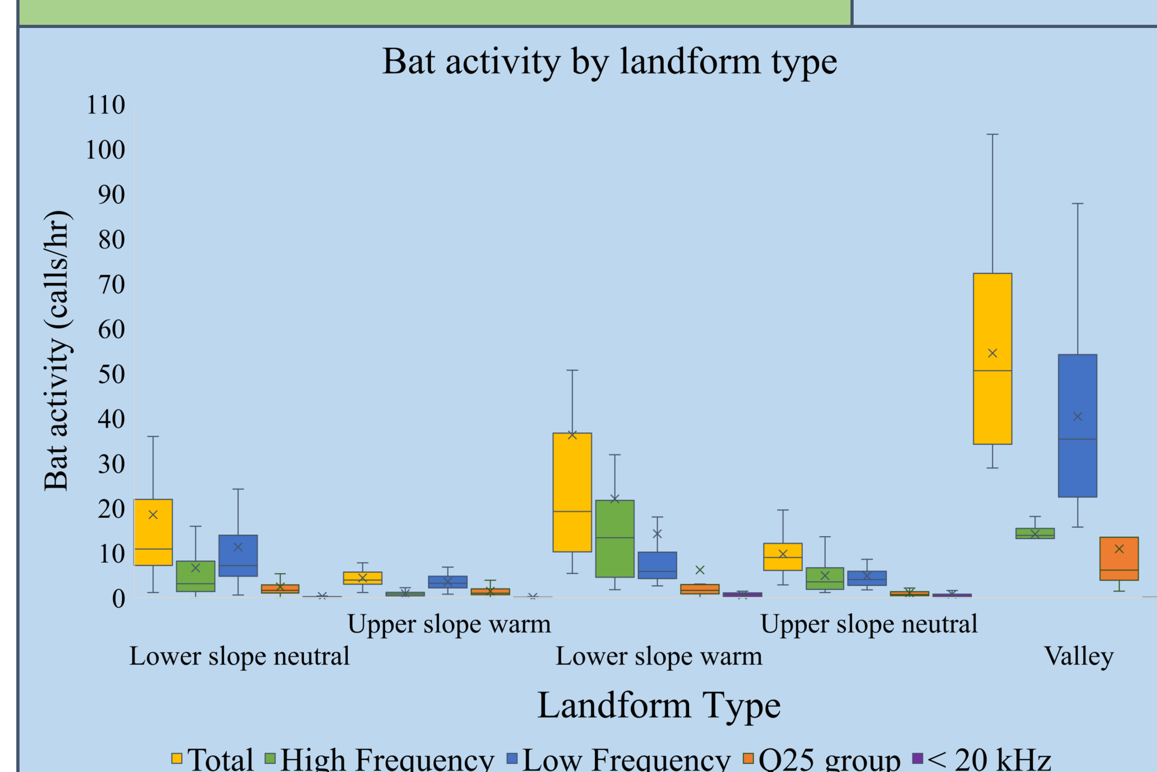

Figure 5. Bat activity by landform types for all bat calls combined (Total), high frequency bat calls, low frequency bat calls, < 15 kHz bat calls, and the Q25 group.

Valleys and warm lower slopes had significantly more bat activity than the other 3 landform types for all species groups except the < 15 kHz group. This group had more activity on neutral upper slopes (Figure 5).

Out of the three landcover types in which the detectors were deployed, all species groups had higher activity in evergreen forests than in grasslands or shrub/scrub lands (Figure 6).

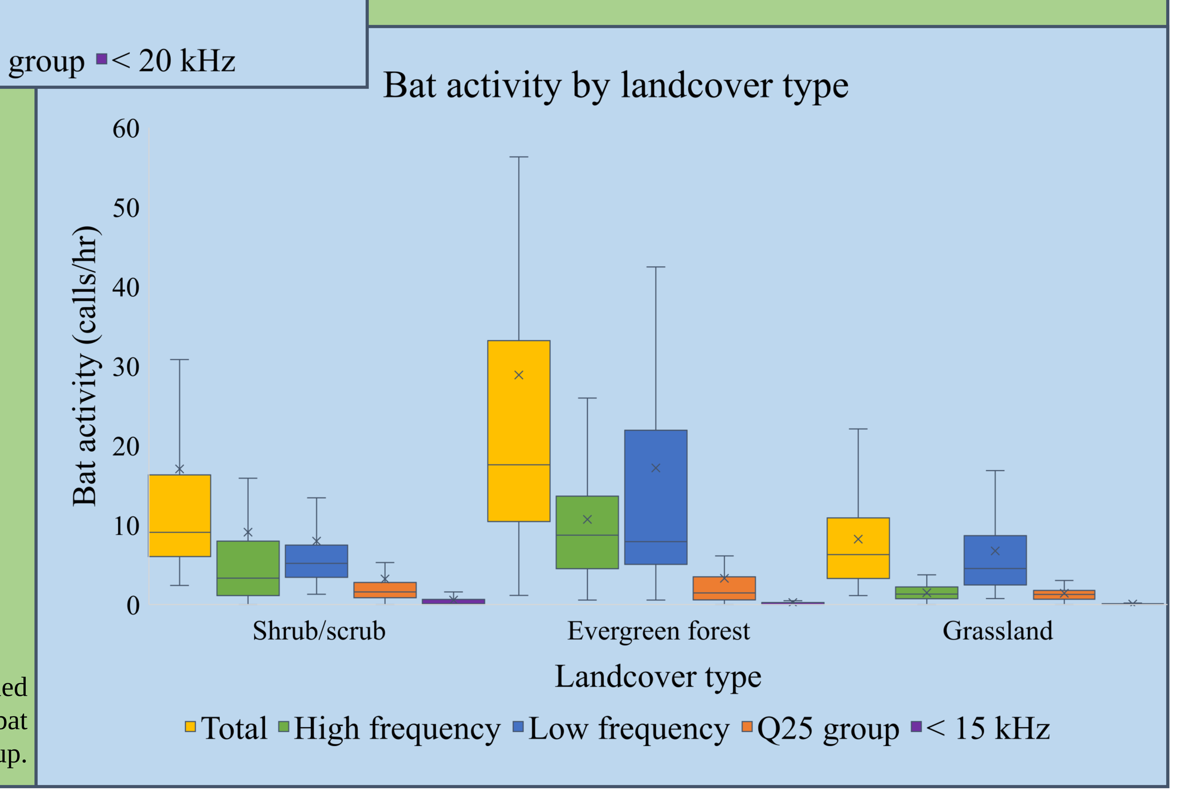

Figure 6. Bat activity by landcover types for all bat calls combined (Total), high frequency bat calls, low frequency bat calls, < 15 kHz bat calls, and the Q25 group.

Discussion and Future Work

Higher activity of some species, especially the species that are more likely to be killed by wind turbines, at lower elevations could be problematic for wind energy industries in northern Arizona. Although there are developments across a broad range of elevation in northern Arizona, on average, wind development so far has been below 2000 m in elevation in northern Arizona. However, most wind energy development in northern Arizona so far has been on flat upper slopes, flat lower slopes, shrub/scrub land, and grassland. Higher bat activity in valleys, warm low slopes, and evergreen forests might indicate these areas are good sites for bats and will not overlap with sites that are best for wind energy development. With more field seasons and more detector locations (Figure 7), we intend to look more in to these possible relationships. Our ultimate goal is to create a map of northern Arizona that will predict the risk to bats by wind development. We hope that this will help inform future wind development siting in northern Arizona.

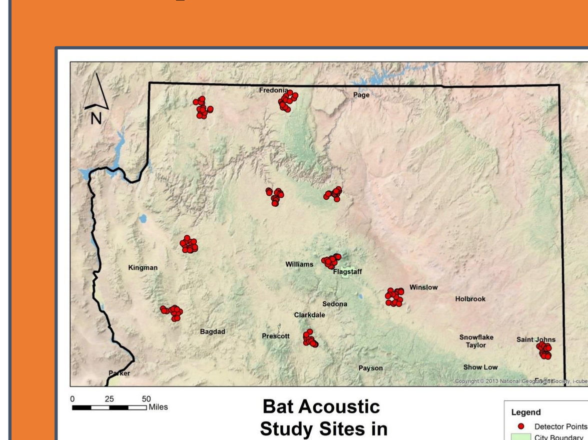

Figure 7. Study points in northern Arizona for 2016 and 2017.

Acknowledgements

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