The management implications of individual variability in sensitivity to noise within wildlife populations

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In addition to a variability in noise sensitivity between different species, there is also an often-overlooked but important individual variability within species and particular populations

A significant minority of many populations reacts to noise at a lower intensity than the mean noise response threshold

Ocean species: More study of noise-specific behavioral response thresholds

Very sensitive species: 120dB Harbor porpoise, Bowhead whales
Moderately sensitive: 135dB Beaked whales
Quite tolerant species: 160dB Humpback and Sperm whales

(Note: underwater sound of 120dB is equivalent to airborne sound of 58dB; 160db in water equals 98dB in air)

Also, within nearly all species and populations studied, there is much individual variability in noise thresholds for behavioral responses including avoidance and foraging disruptions:

Bowhead whales[1]:
13% avoid sounds of 110-120dB
50% avoid sounds of 130-140dB (and another half tolerate this sound)

Seals response to seismic survey sounds[2]:
Animal density drop by 43% when survey is operating
(56% tolerate the sound, 43% are more sensitive)

355 bowhead whales
Responses to seismic survey sounds at 130-180dB[3]:
About half showed no observable response, while the other half showed moderately high behavioral responses (6 on a 9-point scale)

Terrestrial species: Indications of similar variability

Tropical birds show avoidance to conversation noise[4]:
Reductions in bird densities in the presence of conversational noise of 50dB (library speaking volume) and 60dB (excited child)
(measured from 3.5m, so quieter than this in the farther field where birds were detected)
35% decline in combined auditory and visual detections
(65% tolerated the noise, 35% more sensitive)

Nesting birds near noisy or quiet oil and gas installations[5]:
Among songbirds, which were the most likely to show declines, indications of significant individual variability in sensitivity:
30% reduction in nesting density around noisy installations
(70% tolerated the noise, 30% more sensitive)

Nesting patterns near wind farms in the UK show the same patterns of species and individual variability[6]:
9 of 12 species showed some avoidance to 500-800m
In the 6 species with the most response, population reductions topped out at 38-53% (47-62% tolerated the noise)

Unlike animals, we can talk with humans to seek answers about why some individuals respond to noise levels that don't bother others

Among humans, we find a clear spectrum of individual psychological and behavioral sensitivity to noise[7]
(unrelated to auditory sensitivity/acuity)

Noise sensitive	Moderately noise sensitive	Noise tolerant
Above audible sounds apt to be attention-grabbing May find new sounds more threatening	Reactions increase with noise Responses are sound- and situation-dependent	Rarely perturbed even by loud sounds Pays relatively little attention to new sounds
20%	***30%***	***50%***

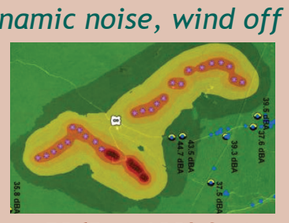
Behavioral responses to moderate noise suggest that this may be an interspecies trend

Many studies find about half the population to be robustly tolerant of noise / In most species, a significant minority responds at much lower sound levels

Is a more-sensitive subset of populations experiencing a concentration of chronic behavioral or stress effects?

How loud is it in and around wind farms?

Peak sound: 98-105dB at blades
(aerodynamic noise, wind off blades)[8]



58dB at 600* feet
50dB at 800-1100 feet
45dB at 1500-2900 feet
40dB at 1800-3600* feet
34dB at 4000-7200* feet

**Idealized spherical spreading. Landscape features reduce actual levels; turbulence at the turbine can increase source levels; atmospheric conditions can aid propagation.*

In practice, turbines can be inaudible in ambient noise at a quarter mile, *and* they are often clearly audible above natural ambient levels at beyond a half mile, or even a mile in some conditions

Behavioral disruption in response to moderate noise sources

Masking of calls and/or predator vigilance
"There is great potential for noise at turbine sites to interfere with the detection and assessment of alarm calls. In turbine environments, **animals have shifted their antipredator tactics** to utilize the visual modality more as seen by increased levels of ALERTNESS and PROXIMITY TO SHELTER. In doing so, squirrels appeared to attempt to compensate for acoustic masking as a result of turbine noise."[10]

Displacement/Avoidance
"Songbirds appear to be sensitive to remarkably low noise levels, similar to those in a library reading room. The noise level at which population densities of all woodland birds began to decline averaged 42 decibels (dB), compared with an average of 48 dB for grassland species. **The most sensitive woodland species (cuckoo) showed a decline in density at 35 dB**, and the most sensitive grassland bird (black-tailed godwit, Limosa limosa) responded at 43 dB."[11]

Sound is within 5dB of peak levels "only" 12% of the time[9]

hrs/yr

dB at receiver

12% of the time at loudest levels is:

44 days of round-the-clock peak sound

176 days of peak sound for 6 hrs (more than half the days of the year)

Or, shorter periods on more days

Whatever the duration of peaks, they are likely to cluster seasonally to cause periods with chronic peak exposures

Special considerations near wind farms:

Biologically significant vulnerabilities related to moderate noise exposure

Any sensitive predator/prey relationships that could be affected by decreased Listening Area?
Stress effects of increased vigilance
Energy budget effects of decreased hunting effectiveness

Any populations that cannot afford chronic negative impacts or displacement of a more-sensitive minority of individuals?
Populations that are not abundant elsewhere in the region
Species that are under consideration for increased protection

Are there suitable alternate habitats nearby that can accommodate small- or moderate-scale displacement from the immediate vicinity of the windfarm?
Is this an "island" habitat?
(forested ridges in otherwise cleared land, or wetlands/riparian areas)

Be aware of the presence (or lack) of suitable travel corridors free of noise barriers that may inhibit movement of sensitive species or individuals

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3 GW Miller, VD Moulton, RA Davis, M Holst, P Millman, A MacGillivray, et al. (2005). Monitoring seismic effects on marine mammals - southeastern Beaufort Sea, 2001-2. In SL Armsworthy, PJ Cranford, and K Lee (Eds.) Offshore oil and gas environmental effects monitoring: Approaches and technologies (pp. 511-542). Columbus, OH: Battelle Press.
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9 Kalinsky 2010, ibid. Extrapolation of percent into days per year, etc, by Jim Cummings, affirmed by Ken Kalinsky
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11 Richard T. T. Foreman and Lauren E. Alexander. Roads and their major ecological effects. Annu.Rev.Ecol.Syst. 1998. 29:207-31 (citing Reijnen et al, 4 papers, 1995 and 1996)