Effects of Noise and Other Human Disturbance on Wildlife



John Morton, PhD



Sound rarely occurs in a vacuum

It's usually associated with something visual ...and sometimes something physical



Is it the boat or the noise from the boat? Or is it both?



Walrus haulout at Cape Seniavin in Bristol Bay

https://news.uaf.edu/spooked-easy/

Is it the jet skis or the noise from the jet skis? Is the whale happy or upset?



Blackstone Bay, Prince William Sound

Are noises the same above and under water?



Mooney et al. 2019

Are sound measurements equally meaningful for humans and other animals?

Black line = response of quiet rural community residents exposed to new or unfamiliar noise

Shannon et al. 2016

Do animals hear the same sounds we hear?

Human hearing overlaps with other vertebrates, but many species hear lower (infrasound) and higher (ultrasound) frequencies than we do

		10	Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
Tuna	50 Hz-1.1 kHz (4.5 8va)						
Chicken	125 Hz-2 kHz (4.0 8va)						
Goldfish	20 Hz-3 kHz (7.2 8va)						
Builtrog	100 Hz-3 kHz (4.9 8va)						
Cathsh Trae from	50 HZ-4 KHZ (0.3 8Va)						
Tree Trog		0.3 8Va)						
Canary Cockatiol			_					
Darakoot		5.0 ova)	_					
Flenhant	17 Hz-10 5 kHz (0 3 8va)						
Owl	200 Hz-12 kHz (5 9 8va)						
Human	31 Hz-19 kHz	9.3 8va)						
Chinchilla	52 Hz-33 kHz (9.3 8va)						
Horse	55 Hz-33.5 kHz (9.3 8va)						
Cow	23 Hz-35 kHz (1	0.6 8va)						
Raccoon	100 Hz-40 kHz `(8.6 8va)						
Sheep	125 Hz-42.5 kHz (8.4 8va)						
Dog	64 Hz-44 kHz (9.4 8va)						
Ferret	16 Hz-44 kHz (1	1.4 8va)						
Hedgehog	250 Hz-45 kHz ((7.5 8va)						
Guinea pig	47 Hz-49 kHz (1	0.0 8va)						
Rabbit	96 Hz-49 KHz (9.0 8va)						
Sea lion		8.0 8Va)						
Gerbii			_					
Albino rat		7.0 OVd)						
Hooded rat		7 1 8va						
Cat	55 Hz-77 kHz (058va)						
Mouse	900 Hz-79 kHz (1	648va)						
Little brown bat	10.3 kHz-115 kHz	3.5 8va)						
Beluga whale	1 kHz-123 kHz (6.9 8va)						
Bottlenose dolph	in 150 Hz-150 kHz(1	0.0 8va)						
Porpoise	75 Hz-150 kHz(1	1.0 8va)						
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https://commons.wikimedia.org/

Does hearing differ among taxonomic groups?

What about invertebrates?

What noises can animals hear?

< 10 Hz to 159 KHz Sensitivity to -20dB Mammals C Birds **100** Hz to **8–10** KHz Sensitivity at 0–10dB Fish 🔰 200 Hz to 800 Hz Sensitivity at 50–70dB Reptiles 50 Hz to 2 KHz Sensitivity at 40-50dB Amphibians 100 Hz to 2 KHz Sensitivity at 10–60dB

Bioacoustic masking of insect communication

- Sounds for aggression, mating, predator avoidance, detection of parasite host species
- Many invertebrates communicate < 10 kHz and hear within the frequency spectrum of anthropogenic noise
- In addition to sound wave pressure, some invertebrates communicate via particle velocity (flies*) and vibrations through plants & ground

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Meta-analysis: experimental studies of 109 species shows all taxonomic groups are impacted by anthropogenic sounds

Standardized mean difference (95% CI) from random effects models

Kunc and Schmidt 2019

When is sound disturbing?

Animals assess risk

"A jet aircraft taking off may not ruffle the composure of the most timid rabbits grazing near the runway"

— Worden 1973

Literature review of effects of anthropogenic noise on wildlife (1990-2013)

	Noise source							
Biological response	Environmental	Transportation	Industrial	Military	Other			
vocal behaviour	20.3%	9.9%	1.4%	1.9%	2.8%			
movement	1.9%	4.2%	5.7%	6.1%	4.2%			
physiology	_	4.2%	5.2%	2.4%	7.5%			
population metrics	1.4%	4.2%	4.7%	0.5%	_			
vigilance	-	0.9%	0.5%	0.9%	0.5%			
mating behaviour	-	1.4%	0.9%	_	0.5%			
foraging behaviour	-	2.4%	_	0.5%	-			
direct fitness metrics	0.5%	0.5%	0.9%	-	_			
community-levelmetrics	0.5%	-	0.5%	-	_			

2/3 of studies focused on marine mammals and songbirds

Shannon et al. 2016

In a perfect world, the effects of anthropogenic sounds on wildlife are modeled as dose-response curves

Tyack and Thomas 2019

Species tolerance Group size Food abundance

> Initial behavior Experience Habituation Reproductive status

Duration Magnitude Frequency

Source Behavior Travel vector

Distance Wind direction Environment Heart rate/MR Flight – fight response Reproductive fitness

<u>Average ~ 90 dBA.</u> But@ 60 mph > 115 dBA, during radical maneuvers < 95 dBA, and 15 dBA louder when leave the water

Underwater noise 100 Hz - 10 kHz generated by jet stream, with frequency-modulated tonals corresponding to impeller blade rates and harmonics

Source Behavior Travel vector

Duration Magnitude Frequency

Acute Noise

Chronic Noise

Chronic traffic noise (80 dB) interferes with Greater Mouse-eared Bat's prey capture rate by 22%

Barber et al. 2009

Chronic noise

- Chronic noise from natural gas compressors cause hypocorticism in adult females and nestlings
- But increased corticosteroids in nestlings exposed to acute stress

Distance Wind direction Environment

Vegetation cover affects how traffic noise decreases with distance

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Heart rate/MR Flight – fight response Reproductive fitness

"While we have no fear of them, son, the feeling is not mutual. Watch as I demonstrate just how a slight tap on the shoulder instantly initiates a fight-or-flight response, resulting in an amusing phenomenon known as an 'adrenaline rush.'"

Fight-flight response to acute noise events

- Sympathetic nervous systems stimulates adrenal glands to release adrenaline (epinephrine) and other catecholamines
- Glucocorticoids both stimulate and suppress sugar release
- Increased heart rate, blood pressure, breathing rate
- Dry mouth, tunnel vision
- After threat is gone, takes 20-60 minutes to return to pre-arousal levels
- Flying is energetically expensive! 5-6 times more calories/unit time than swimming or running away

American Black Duck response to acute human disturbances in daytime (automobiles, people, aircraft, boats)

Feed

Rest

Alert

Swim

Other

Fly

Morton 2002 Morton et al. 1989 American Black Duck response to acute human disturbances in daytime (automobiles, people, aircraft, boats)

Disturbed flock = 14.21 kcal/hr Undisturbed flock = 6.80 kcal/hr

> Morton 2002 Morton et al. 1989

Caribou moved 70% faster and crossed twice as many habitats in response to simulated oil exploration noise (90-100 dBA)

Fig. 1. Mean movement rates per experimental test period (+SE) for exposed (1993–94) and control caribou (1993).

Fig. 2. Mean number of habitat patch changes per experimental test period (+SE).

Bradshaw et al. 1997

Species tolerance Group size Food abundance

Sanderlings wintering on Assateague Island National Seashore

Human disturbance reduced Sanderling densities by 60%

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6.31 kJ/hr (undisturbed) vs 9.64 kJ/hr (disturbed)

But Sanderlings tolerated disturbance when food was available (mole crabs)

SANDERLINGS PER 200-m PLOT

Derived means adjusted for variability due to Julian date, air temperature, and wind speed.

Morton 1996

Pre-migratory fat gain in Lesser Snow Geese staging on the Arctic Coastal Plain

- < 300,000 geese
- feed < 16 hours a day (hyperphagia)
- eat < third of body weight daily
- increase body fat < 400%
 in 2-3 weeks (22 g / day)

Brackney 1987

DAY

FAT GAIN

Simulated tradeoff between habituation and compensatory feeding effects on fat gain

75-80 overflights/day reduce fat gain by 50% assuming nonflight habituation and 50% compensatory feeding

75-80 overflights/day reduce fat gain by 38% assuming no habituation and 100% compensatory feeding

Brackney 1987

Species tolerance Group size Food abundance

Initial behavior Experience Habituation Reproductive status

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Mariana Fruit Bat colony "tolerant" to B1 bomber departure (110 dBA)

66 of 144 flushed but quickly resettled

Morton 1996

Mariana Swiftlets are intolerant of human disturbance in their cave

Morton and Amidon 1996

Species tolerance Group size

> Initial behavior Experience Habituation Reproductive status

Duration Magnitude Frequency

Source Behavior Travel vector

Distance Wind direction Environment Heart rate/MR Flight – fight response <u>Reproductive fitness</u>

Habituation to noise (100-125 dBA)

- Operate no earlier than 3-4 weeks prior to veraison and stop right after harvest
- Operate during daylight hours, 30 min before sunrise and 30 min after sunset
- Move weekly so birds do not get used to their location

Mean heart rate elevated by simulated aircraft noise (83 – 112 dBA)...but diminished with repeated exposure (habituation)

Weisenberger et al. 1996

Species tolerance Group size Food abundance

> Initial behavior Experience Habituation Reproductive status

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Ways you can reduce disturbance of wildlife

- Appreciate natural sounds and sights
- Keep your distance, alter your route
- Use a long lens (binoculars, scopes, telephoto camera lens)
- Stay downwind
- Color choice
- Move slowly
- Be respectful

