SECTION I - Animals Have Unique and Extensive Hearing Abilities

Hearing is an important sense for animals. Most species have extensive hearing abilities. They are capable of hearing a broader range of sound than they can vocalize and hearing continues to function during sleep and even hibernation (1). Scientists are still discovering the different ways that animals hear and use sound. Their unique methods of hearing and increased sensitivity opens up another world that humans can only imagine.

Increased Range and Sensitivity

As mentioned above, many animal species have an extensive range of hearing. Many animals, like dogs, can hear beyond the human range of 20,000 Hz (2, 3). Frequencies above the upper human range are known as *ultrasound*. Dogs can hear up to 45,000 Hz and cats can hear to 64,000 Hz (3, http://www.lsu.edu/deafness/HearingRange.html). The hearing of domestic cats is 10-25 dB more sensitive than human ears and they can change location and shape of ear with 27 muscles (2). The winners for the best hearing for terrestrial mammals are bats. They can hear up to 120,000 Hz, enabling them to pursue minute insects in the dark without colliding into objects (3).

*Infrasonic sound* (low frequency, below human hearing range) has longer wave lengths that can travel further, making it an effective way for animals to communicate or detect danger over long distances. Elephants use their large ears and feet to hear infrasonic sound. Their toes are surrounded by a “balloon of fat and tissue” that act like receivers as it does in marine mammals. Their feet are “seismic transmitters and receivers” of low frequency sound, able to communicate over vast distances and sense storms or earthquakes. Giraffes, okapi, and horses also use infrasonic sound to communicate (2). Other uses of infrasonic sound include flocks of birds and schools of fish which use low frequency sound for group cohesion; homing pigeons can detect infrasonic energy, enabling them to know when a storm is approaching as well as sensing storm intensity; tigers use infrasonic sound to stun prey, while alligators use infrasonic sound to find a mate and claim territory (2).

Good Vibrations

Wood and leaves are better conductors of sound than air and enable tree dwelling insects to communicate with each other and gather information transmitted through the air to the leaves and wood. Katydid do “rapid push-ups” to create vibrations to communicate with their species on tree limbs without announcing their location to predators. They sense or “hear” the vibration through their legs. Spiders “listen” through all 8 legs by sensing vibrations to detect prey in their web as well as sense danger (2).

Hearing is Seeing

Animals who are virtually blind, like the microchiroptera bats (many species of bats are not blind) and moles, have impressive adaptations that allow them to rely solely on hearing. Bats can hunt an insect every 6 seconds in the dark and some bats can find fish under water by using the “acoustical signature of ripples” left by the fish (2). Gleaning bats can identify insects by the sound of their footsteps (3). To survive, the bats’ prey (moths), have adapted to hear the ultrasonic sounds of bats. The tiger moth will emit an “ultrasonic scream” to stun or confuse the bat (2). Burrowing animals also rely on sound as a critical sense. In the ground, sound travels faster and louder than in the air. Moles use “seismic echolocation” by “drumming” their head on their tunnels to find their way around obstacles. Moles use their paws to hear the echolocation, predators, and other moles (2).

Sound is Survival

The ability to hear is critical for both an animal’s individual survival and the survival of the species. It enables them to detect prey, avoid predators, find mates, and identify suitable habitats (1). Detecting the sound of prey is crucial for a majority of predators. Barn owls, fox, marsh hawks, grey mouse lemurs, and robins use the minute sound of their prey moving, such as rustling of the leaves, to detect and catch prey (1).
SECTION I - Cont.

Avoiding Predators
Detecting sound is just as important for prey species to avoid predators. Tungara frogs and white-browed scrubwrens detect approaching predators by the sound of their movement (1). Seals can tell the difference between Orca pods that prefer to eat salmon or seals and behave differently with that information (2). Some animals give predator-specific alarm calls. For example, the vervet monkey makes a different call for an airborne predator versus one on the ground and the troop will exhibit different evasive behaviors (2). Prairie dogs are more specific and call out the size, how close, how fast or slow, and color of the predator (2). Ants send out alarm calls by clicking mandibles or hitting their heads against the ground (3).

Finding Mates
Bird songs play an important role in finding mates and holding territory to the point that a species has a different dialect depending on its environment and area that is passed down from their parents (2). Male fruit flies can pick out a female fruit fly out of ~2000 different species by the identifying the sound of her wingbeats (2).

Identifying Suitable Habitats
Some animals use the alarm call of a different species, like the alarm call of a squirrel or bird (1). Some species, such as migrating songbirds and newts, are known to listen to other species’ calls to gather important information that is used for habitat selection (4,5). Frogs rely on calls of their species to find breeding habitats. One African frog species leaves an area when it hears fire (1).

SECTION II - How Noise Affects Wildlife
Only in the last 150 years has the invention of the motors made humans louder than natural sounds like thunder or migrating hoofed animals (2). Animals evolved for thousands of years without the sound of cars, industry, and airplanes. Urban growth, rapid expansion of transportation, oil and gas extraction, and motorized recreation are largely responsible for “chronic noise exposure” on land including our protected natural areas (1,3). Noise increases as our population and use of technology increases. The US population has increased by 1/3rd from 1970-2007 and another 23 million since 2007 to 2016. US road traffic has tripled to 5 trillion. US aircraft traffic tripled from 1981-2007 (1). Even our public lands like National Parks have been infiltrated by “extensive sources of noise on public land” such as oil and gas extraction and motorized recreation (1). Noise from roads travel over 1 mile into a forest (1,3).

Can You Hear Me Now?
Noise hinders the ability to perceive these important biological sounds and is referred to as masking (sound or frequencies that block or hide other sound or frequencies; 1,3). Different species respond differently to noise (5). It affects some species more than others and there are individual responses just as there are in people. Noise can mask vital sound cues within a species as well as sounds of predators and prey. If noise is within an animal’s hearing capacity, it can cause permanent hearing loss or temporary damage (5). For example, at 50-60 dB people and animals begin to have hearing loss, raised stress hormone levels, and hypertension (1). Fifty feet (15 m) from highways, traffic noise commonly ranges from 70 to 80 dB (federal highway administration: https://www.fhwa.dot.gov/publications/publicroads/03jul/06.cfm). 83% of US is within 1km of road (1). Research has shown a decline of 234 species of birds and mammals in proximity to infrastructure such as roads (6). It is estimated that an increase of just 3dB from transportation noise reduces the listening area by half. In Yosemite National Park, high air traffic caused a noise increase of up to 5 decibels (3). This caused up to a 70% reduction of the range in which predators can hear their prey (i.e., a 100 foot range is reduced to 30 feet; 3).
SECTION II - Cont.

Predation
Noise can influence survival and reproductive success and the ability to hear alarm calls to keep group cohesion (1,5). There can be greater predation if a number of species abandon an area such as nesting colonies that rely on numbers for safety. Over time, this could influence genetic diversity (5). Some species or populations may not have an alternative habitat and are limited to a noisy habitat.

Can’t Find a Date
The effect of noise on individual fitness can have severe impacts on populations. One example is a bird species known as great tits. Female great tits would typically choose lower frequency males as mates. In noisy areas noise would mask the lower frequency calls. Not able to hear the preferred males, females chose the higher frequency males. The higher frequency males tended to have smaller clutches and fewer fledglings which impacted the number of offspring and caused lower reproduction rates (5). Masking also affects spatial orientation. Female frogs were less successful and took longer to locate calling males. Decreased reproductive success was also found for Eastern bluebirds (bird species) (5). These effects on individual fitness can have severe impacts on populations.

Finding food
Mammals and birds have been shown to increase vigilance due to noise which in turn reduces food intake. Prey species are hiding or watching for predators instead of eating because their range to hear predators is reduced by noise (7). Great mouse-eared bats that hunt by keying into the sound of their prey walking tend to avoid areas with noise (1). Species of bats avoided hunting in areas with road noise and success in catching prey was reduced (5). Tree swallow nestlings were found to beg less when exposed to noise (5). Searching for prey increased and hunting success decreased in the fish species, sticklebacks (5).

Don’t Leave
The “Phantom Road” study simulated the noise of traffic in a pristine habitat and found the noise decreased the bird population by over one-quarter and some species including sensitive species avoided the area completely (7). Birds tend to abandon an area if noise masks key cues for survival or if noise is perceived as a danger. Some bird species increase in noisy area because their predators avoided it, creating a prey haven. Sage grouse have abandoned areas with unpredictable road noise (1). Carnivores and ungulates also avoid areas with road noise (1).

Changing that Tune
Birds change the frequency or amplitude of their call to avoid masking. Low frequency bird vocalizers tend to be more negatively impacted by continuous low frequency noise than high frequency vocalizers. This is due to masking, which can influence 1km of area from the noise source (1). Frogs, birds, and mammals change their vocalizations or timing to avoid masking of their calls (7). European robins sing at night to avoid noise (5). Military jets have been shown to cause behavior changes in harlequin ducks (1).

Research has just begun to comprehend the effect of noise on animals and how animals use sound. There is still more to be discovered. Our ecosystems, wildlife, and open spaces are stressed by climate change, habitat fragmentation and loss, water and air pollution, as well as noise pollution. “Noise management” may offer a “rapid tool to improve the resilience of protected lands” and our wildlife (1). National parks have been tackling noise issues in our parks by reducing traffic noise with shuttle buses, working with the military and civilian airports to redirect flights, and limiting motorized recreation (3).

What can you and your students going to do about these issues?
Literature Cited


