Use of Ears and Auditory Senses of Animals Living In the Woods of the Vermont Mountains

Fox listening from Den of Old Hard Maple

Compiled by Roger Irwin, Fred Person and Dhyan Nirmegh
Public Service Board, Sound Workshop, July 29, 2014
Montpelier, Vermont
This study examined marten ecology relative to wind farm development using radio-marked marten, camera trapping, and snow track surveys to meet study objectives.

• Mortality (predation) was biased towards females and young.
• Disturbance from wind farm construction resulted in less use and periodic displacement of marten, although marten maintained presence in the study area.
• Winter access by competitor canids was enhanced by maintained roads and snowmobile trails at high elevation.
Impacts of Wind Development on the Abundance and Distribution of high-elevation birds in Northern New Hampshire, with a focus on Bicknell’s Thrush

A report submitted to New Hampshire Department of Fish and Game by Clinton R. Parrish Department of Biological Sciences Plymouth State University, June 2013

We determined that avian responses to wind development could be attributed to one or more of the following three factors:

(1) Direct loss of forested area for turbine pads and access roads

(2) Fragmentation

(3) Influence of turbine presence (noise, collision potential).
Bears

- Mitigation lands for First Wind’s Sheffield Wind project logged
- No change in forest management plan
Bats

- Stantec’s counting area minimizes findings by limited search area
- 70 – 80 m search area extrapolated out to 200 feet for 112 m long turbine blades
Estimates of bird collision mortality at wind facilities in the contiguous United States

Scott R. Loss, Tom Will, Peter P. Marra, Migratory Bird Center, Smithsonian Conservation Biology Institute, National Zoological Park, Washington, DC., U.S. Fish and Wildlife Service, Division of Migratory Birds, Midwest Regional Office, Bloomington, MN

• We estimate that between 140,000 and 328,000 (mean = 234,000) birds are killed annually by collisions with monopole turbines in the contiguous U.S.
• We found support for an increase in mortality with increasing turbine hub height and support for differing mortality rates among regions, with per turbine mortality lowest in the Great Plains.
• Evaluation of risks to birds is warranted prior to continuing a widespread shift to taller wind turbines.
Preliminary studies on the reaction of growing geese to the proximity of wind turbines


• The impact of infrasound noise, emitted by wind turbines, on the health of geese and other farm animals has not previously been evaluated. Therefore, the aim of this study was to determine the effect of noise, generated by wind turbines, on the stress parameters (cortisol) and the weight gain of geese kept in surrounding areas.

• Geese from gaggle I gained less weight and had a higher concentration of cortisol in blood, compared to individuals from gaggle II. Lower activity and some disturbing changes in behavior of animals from group I were noted.

• Results of the study suggest a negative effect of the immediate vicinity of a wind turbine on the stress parameters of geese and their productivity.
Acquired flexural deformation of the distal interphalangeal joint in foals

*Teresa Margarida Costa Pereira e Curto*, TECHNICAL UNIVERSITY OF LISBON, Faculty of Veterinary Medicine, Dissertation in Veterinary Medicine, 2012

- Since 2008, the high prevalence of acquired flexural limb deformities front was observed in the Lusitano stud farm. The present study aimed at studying the acquired flexural deformities of the distal interphalangeal joint (DFAAID) foals on a stud farm which, in previous years, showed variations in their environmental conditions due to the installation of wind towers on adjacent land.

- Histologically the most significant alterations were the dissociation of myofibrils of the smooth muscle. This was predominantly seen in the small intestine but also in the walls of small capillary vessels, including those of the tendon vasculature.

- In the case series presented here, there was no obvious cause for the development of this problem, therefore we hypothesized that unusual environmental conditions might have played an important role in the development of this condition, especially those introduced in recent years.
Study of Equines Exposed to Low Frequency Noise

Nuno Castelo Branco, Mariana Alves-Pereira, et al, 14th International Meeting on Low Frequency Noise and Vibration and its Control, Aalborg, Denmark 9 – 11 June 2010

- This report is a follow-up to the 2007 case of family R, exposed to Low Frequency Noise (LFN) generated by Wind Turbines (WT), and who had begun to develop signs of LFN-induced pathology consistent with vibroacoustic disease.

- Mr. R must remain to care for thoroughbred Lusitanian horses and bull that he breeds for bullfighting.

- The pattern of onset of equine flexural deformities before and after the installation of WT in the farm’s vicinity, led to check ligament biopsies of 4 foals raised on Mr. R’s farm, and of 1 foal purchased by Mr. R from another breeder. It was shown that all 3 foals raised on Mr. R’s farm disclosed the classical signs of LFN-induced responses: thickening of blood vessel walls due to proliferation of collagen in the absence of inflammatory processes. The purchased yearling foal did not exhibit these morphological features.

- The results presented herein strongly suggest that the presence of LFN-generating WT in the vicinity of this horse breeding farm can play a significant role in the triggering and onset of equine flexural limb deformities.
Mink Farm in Denmark

• It happened two weeks ago. Minks began to bite their puppies and each other.
• ...since they [the wind turbines] began to spin last fall, the number of stillbirths and deformed puppies increased fivefold, says Kaj Olesen Bank.
• The proportion of females that refused to mate has quadrupled as compared to last year, when there were no wind turbines behind his mink farm. — June 2014
Goats in Taiwan

Wind farm 'kills Taiwanese goats'

• A large number of goats in Taiwan may have died of exhaustion because of noise from a wind farm.
• A farmer on an outlying island told the BBC he had lost more than 400 animals after eight giant wind turbines were installed close to his grazing land.
• The Council of Agriculture says it suspects that noise may have caused the goats' demise through lack of sleep.
• Abnormal noises could affect growth and feeding of the goats, officials say. – May 2009
Noise-induced gastric lesions: a light and electron microscopy study of the rat gastric wall exposed to low frequency noise

Jorge FonsecaI; José Martins-dos-SantosI; Pedro OliveiraI; Nuno LaranjeiraI; Artur AguasII; Nuno Castelo-BrancoIII

• CONCLUSIONS: Deeper layers of gastric wall undergo alterations, including fibrosis of the submucosa caused by collagen IV deposition, an early marker of neoangiogenesis.

• Vascular alterations included thickening and thrombotic phenomena, but also images of newly formed vessels.

• This study suggests that, at least in the stomach, LFN-induced fibrosis could be linked with neoangiogenesis.
Effects of infrasound on hippocampus-dependent learning and memory in rats and some underlying mechanisms


• To investigate the effect of infrasound on the hippocampus-dependent spatial learning and memory as well as its underlying mechanisms, we measured the changes of cognitive abilities, brain-derived neurotrophic factor receptor signal transduction pathway and neurogenesis in the hippocampus of rats.

• The results showed that rats exposed to infrasound exhibited longer escape latency and shortened time staying in water maze.

• These results provided novel evidences that the infrasound of a certain exposure parameter can impair hippocampus-dependent learning and memory, in which the downregulation of the neuronal plasticity-related BDNF-TrkB signal pathway and less neurogenesis in hippocampus might be involved.
Infrasound increases intracellular calcium concentration and induces apoptosis in hippocampi of adult rats


• In the present study, we determined the effect of infrasonic exposure on apoptosis and intracellular free Ca²⁺ ([Ca²⁺]i) levels in the hippocampus of adult rats. Adult rats were randomly divided into the control and infrasound exposure groups.

• Elevated [Ca²⁺]i levels were observed on days 14 and 21 after rats received daily treatment with 90 or 130 dB sound pressure level (SPL) infrasonic exposure (p<0.01 vs. control).

• Apoptosis in hippocampal neurons was found to increase on day 7 following 90 dB SPL infrasound exposure, and significantly increased on day 14.

• These results demonstrate that a period of infrasonic exposure induced apoptosis and upregulated [Ca²⁺]i levels in hippocampal neurons, suggesting that infrasound may cause damage to the central nervous system (CNS) through the Ca²⁺-mediated apoptotic pathway in hippocampal neurons.
Involvement of microglial cells in infrasonic noise-induced stress via upregulated expression of corticotrophin releasing hormone type 1 receptor


• Infrasound is a kind of environmental noise and threatens the public health as a nonspecific biological stressor.
• In this work, we exposed Sprague-Dawley rats and in vitro cultured microglial cells to infrasound.
• We found that infrasound exposure resulted in a significant activation of microglia cells and upregulated their expression of CRH-R1 in the PVN in vivo.
• Our in vitro data further revealed that in the absence of neurons, infrasound can directly induce microglial activation and upregulate their CRH-R1 expression.
• These findings suggest that in addition to the PVN neurons, microglial cells are the effector cells for infrasound as well, and involve in the infrasound-induced stress through upregulated expression of CRH-R1.
Infrasound-induced changes on sexual behavior in male rats and some underlying mechanisms

Zhiqiang Zhuang, Zhaohui Pei, Jingzao Chen

- To investigate some bioeffects of infrasound on copulation as well as underlying mechanisms, we inspected the changes of sexual behavior, serum testosterone concentration and mRNA expression levels of steroidogenic factor 1 (SF-1), steroidogenic acute regulatory protein (StAR) and cytochrome P450 cholesterol side chain cleavage enzyme (P450scc) in testes of rats exposed to infrasound of 8 Hz at 90 or 130 dB for 1, 7, 14 and 21 days (2 h/day), respectively.

- Our conclusion is that adverse bioeffects of infrasound on reproduction depend on some exposure parameters, the mechanism of which could involve in the decreased expression of some key enzymes or regulator for testosterone biosynthesis.
Infrasound-Induced Hemodynamics, Ultrastructure, and Molecular Changes in the Rat Myocardium

Zhaohui Pei, Hanfei Sang, Ruiman Li, Pingxi Xiao, Jiangui He, Zhiqiang Zhuang, Miaozhang Zhu, Jingzao Chen, Hong Ma

• Recent interest in adverse effects of infrasound on organisms arises from health concerns.
• We assessed the association between infrasound exposure of 5 Hz at 130 dB and changes of cardiac ultrastructure and function in rats.
• Our experiments suggested that infrasound exposure of 5 Hz at 130 dB directly damage rat myocardial ultrastructure and tend to aggravate cardiac function.
• The effects of infrasound on the cardiovascular system should be further studied.
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Introduction

I am Dhyan Nirmegh of Starksboro, Vermont co author of the Booklet, “Impacts of Industrial Wind Development on Wildlife and Ridgeline Habitat”. The photos that I am submitting today are taken by Roger Irwin of Maidstone and Shirley Nelson of Lowell, Vermont

Some of last month’s sound experts painted a rosy picture of people living with Wind Power sound in Europe. One expert said there was little opposition and alluded to the fact that problems with sound in Europe had been addressed by changing the blades degrees and gear boxes.

It’s quite the opposite.

There are many problems.

In a Norway study, Sveinulf Vagene, says that the World Health Organization report entitled “Burden of Disease form Environmental Noise” concluded that Wind turbines noise is not just an annoyance it can cause major health problems. He states people are sick but Norway still has little understanding of how the noise is affecting people.

Germany and Denmark have halted some facilities in order to do further studies.

Germany, France and Canada have major protests taking place. European people have been fighting ailments from which they said are caused by Noise from Wind Turbines.

Under the European Umbrella Organization EPAW (European Platform Against Wind Development) there are 621 subgroups in 24 countries. These groups are desperate people whose lives have been downgraded by Wind Power Noise.

People have been dying of heart attacks, and had a myriad of other ailments.
Vibro Acustic disease is where low frequency noise causes change in the vascular system. This research is only being studied at the University of Portugal according to the Norwegian study.

What about Wildlife?

Do we just focus on bears?

There are hundreds of species of Birds, Bats, animals and amphibians that are affected. And yet, I have yet to see any detailed studies of animal hearing and the effects of sound, low frequency sound and Infrasound.

If doctors say there is even a slight chance of people getting heart disease, what is it doing to our wildlife?

Some people that have camps hear these wind turbines say that the amount of wildlife has diminished, but if animals are actually staying in these areas how are they adapting or how are they coping? I have only heard of one study of wildlife after the turbines are up and that has been done in New Hampshire with the Bicknell’s Thrush.

Last session sound experts talked only about sensitive monitoring devices above ground. There are no sound devices that are put into the ground or into seeps, streams or vernal pools.

What happens when the sound and vibrations travel through rock edges, water and ground? I did my own experiment at Lowell. I submerged my head in fresh snow pack and could hear the towers still.

What happens when the snow cover is solid? Animals use the ground for cover, borrowing into, for homes, hibernation, resting and raising young.

Birds and animals have very keen hearing.

- They depend on it to escape predators
- Depend on it to breed and continue the species
- Depend on it to communicate
- They depend on quite areas to nurture and relax.

Many of the large animals have long cupped hears.
• Full of fine hair, which helps pull in sound vibrations
• Ears are directional on most large animals. They can move to the sides and forward on the head without the head moving
• Example of Owls having large facial disks that funnel sound to their ultrasensitive ears.
• It’s not always sound they pick up. It is also frequency and minute vibration these animals are picking up on.

There are very few scientific studies being done on how animals are affected by Wind Turbines noise. Why?

We have capable Universities and Colleges and capable grad students, capable Wildlife programs and we at present already have four Industrial Wind Facilities in the State of Vermont.
Why is it that we can’t take the time to do Wildlife studies?

We share this land with Wildlife and are the big pivotal manual in these eco systems. We feel like we need to be in control but we are shirking our responsibility of being stewards of our environment.

The last time the Public Service Board held a hearing on sound, April 13th, 2014, we heard from half the people that said the noise of the turbines didn’t bother them. They may be right they don’t hear it or was not affected by it and maintain that animals aren’t bothered. Some people event hunt on Lowell Mountain.

The people that are not affected say they see the wildlife, “the animals are in their yards”. Well, if they are not hearing the sound, then why not

The concerns of the people that hear the turbine sound, live it and are real!

Dhyan Nirmegh
Immediate Wildlife Destruction  
Photo by Shirley Nelson

Road Construction  
Photo by Steve Wright
Low Frequency Sound and Infrasound

Low frequency noise and Infrasound (such as emitted by wind turbines) are sound waves that are felt by the body rather than heard, probably by the utricle. Depending upon the amplitude or intensity, it produces feelings of extreme discomfort, a feeling that the body is vibrating. Depending upon the frequency and intensity, infrasound can keep you awake, or induce sleep. Therefore, it can cause sleep deprivation.

Infrasound induces stress and causes the body to secrete the hormone Cortisol. This effect is a medically recognized danger of long-term infrasound exposure.

Cortisol, plays a vital role in preparing our body for stressful “fight or flight” episodes. It increases blood pressure and blood sugar levels, and has an immunosuppressive action that provides needed alertness and energy during stressful experiences. However, during long term stress, or if Cortisol production is prolonged, its effects on the human body can become severe. A weakened or suppressed immune system will allow existing health problems to accelerate, and make it easier for new ones to be created.
Exposure to infrasound during early sleep hours can be particularly harmful. This is when the body normally produces the lowest levels of Cortisol. This might explain my 3am awakening and subsequent wakefulness. Artificially stimulating Cortisol production during sleep means that the Cortisol is not used and remains in the body, potentially damaging essential body functions.

A sound wave in air is a sequence of pressure changes. A sound wave in a liquid or solid is more like a vibration. This helps explain how Low Frequency Noise and Infrasound travel great distances and easily pass through solid walls, and can set up vibrations or resonances in rooms and body cavities.

Andrew Vivers (4/14/2014)
Arniefol, Glamis, Scotland

https://www.windturbinesyndrome.com/2014/turbine-headache-scotland/

Infrasound (20Hz or less) can affect the bodies of animals and humans.

### Hearing Ranges

<table>
<thead>
<tr>
<th>Species</th>
<th>Range (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humans</td>
<td>20-23,000</td>
</tr>
<tr>
<td>Coyotes</td>
<td>50-46,000</td>
</tr>
<tr>
<td>Cats</td>
<td>45-65,000</td>
</tr>
<tr>
<td>Frogs</td>
<td>100-3,000</td>
</tr>
<tr>
<td>Birds</td>
<td>200-12,000</td>
</tr>
<tr>
<td>Rodents</td>
<td>1,000-100,000</td>
</tr>
<tr>
<td>Rabbits</td>
<td>360-45,000</td>
</tr>
<tr>
<td>Turtles</td>
<td>20-1000</td>
</tr>
<tr>
<td>White-tailed Deer</td>
<td>250-12,800</td>
</tr>
<tr>
<td>Owl</td>
<td>120-12,000</td>
</tr>
</tbody>
</table>
Moose Have Excellent Hearing

They have been known to communicate to other moose using a low ‘hiccup call (which is imperceptible to humans) over a distance of 2 miles. Their ability to hear is enhanced by the reflective surface of their very large ears (about 67 sq. in.) coupled with the distance between their ears which gives them enhanced stereophony. On top of that, their ears move independently of each other which allow them to enlarge both the angle and the space of perception.

The Ecology of Management of the North American Moose.
Antlers and Moose’s Sharp Hear

Moose’s antlers are some of the most extravagant headgear in the animal kingdom.

- Act as elaborate hearing aids that help males to find calling females.
- Antlers’ sound-gathering qualities boost hearing by 19%
- Their ears are 20 times larger than humans
- It has been found that bulls with wide antlers have had better results in finding mates.

White-tailed deer hearing is its most important sense.

- Hearing range (250 Hz to 12,800Hz)

- Very large ears, along with independently angle and rotation deer are able to pinpoint where the sound is coming from

- Unfamiliar, out of the ordinary sounds of their environment warrants attention.
Young bears ears develop to full size sooner than any other part of their body. It is the black bears first line of defense. In a thick forest, hearing is the most crucial sense the bear can have. The bear often locates sound before using its sense of smell. Like dogs, bears hearing capability exceeds human range and sensitivity.
Emerging from A Winters Nap

Bobcats hear higher frequency sounds than humans. Their hearing is extremely acute.

- They have 30 different muscles in their ears they can recognize a sound, tone and locate the source of the sound instantly.

- They can independently rotate their ears in a 180 degrees.

- The shape of the ear directs and funnels sound to the center of the cats middle ear.
Mountain Predators

These Predators have the Ability to Change Hunting Territories

- The Coyote hearing range is 45 KHz which is 3 times that of humans
- The fox has the hearing range up to 150 yards at 60 KHz.
- There is evidence that the Weasel and Mink’s have high hearing ranges similar to the Coyote and Fox.
Ground Animals

Beavers Hear Excellently both on Land and Under Water

- The medium of water conducts sound better than the medium of air.
- Beavers spend most of their time in water.
- Ears are small flaps of skin perched high on the sides of their heads.
- Under water a flap of skin covers their inner ear and protects it from water.
- Their high hearing sensitivity is due to the large inner ear organs.
- The Beavers lodge is constructed such that half is below water and half above water.
- The beaver’s environment, create wet lands, a hone for other species of animals, amphibians, and plants, while helping to curtail climate change.
Beaver Pond Community

Otter

Painted Turtle, Frog and Rabbit

Photos by Roger Irwin
Rabbits hear much like humans but are able to hear higher pitch sounds than humans. Their ears move forward and backwards. With large erect ears that move independently, rabbits are able to pick up sounds a mile away. Hearing being its most vital sense, a rabbit can be hiding behind objects with their long ears sticking up and are able to hear predators and understand the acoustic landscape surrounding them.
Ground Animals

Vermont Woodchuck  Photo by Roger Irwin

Red Squirrel  Photo by Roger Irwin
Birds

- Birds have a smaller hearing range than humans
- They have strong recognition skill that can sort out the difference of the songs of other birds.
- Their ears located just behind the eyes covered with light feathers called auriculars
- Their calls can be masked with wind turbine noise.
Large facial disc around eyes covered with fine feathers help funnel sounds to ears slightly offset on the side of their head. This takes the owl less than 100\textsuperscript{th} of a second to determine the path of their prey.
IN THE QUIET VERMONT WOODS

Photo by Roger Irwin