Loss of natural soundscapes within the Americas

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Abstract

Species-specific creature voices within an undisturbed ecosystem evolve to perform within the acoustic parameters of that habitat and especially within the symbiotic structure imposed by the spectral content of other species voices occupying the same biome. The result is a rich integrated texture of sound spread over both the human audible and inaudible spectra with changing patterns given season, weather, and time of day. With over 30 years experience recording in the field, the author documents the loss of natural soundscapes within the Americas with observations demonstrated by field recordings and graphics.

Background

The loss of natural soundscapes begins with the loss of habitat, itself. However, this paper will focus on the affect of human-induced noise like, for instance, the stress behavior of specific creatures and signs of stress on habitat, in general, to convey aspects of the damage. Using standard field recording techniques, this affect can be shown through the recent discovery of the *niche hypothesis*, or *biophony*,[1] the premise that in an undisturbed natural soundscape of a given habitat, all vocal creatures are heard in a symbiotic relationship to one another much like instruments in an orchestra. Biophony also defines the boundaries of the biome by relevant creature sound and can also provide an indicator of its general vitality or degradation.

When this field research began in 1968, ten to fifteen hours was required to capture one hour of unimpeded natural soundscape while recording in the contiguous 48 United States. At that time approximately 45% of its undisturbed old growth forests were still intact. By 1999, however, the ratio of field recording time to the collection of acceptable material had shifted to nearly 2,000:1 in North America correlating to approximately 2% of its undisturbed old growth forests now left intact. That ratio of unimpeded recorded information in Central and South America has shifted from 10:1 to approximately 200:1 during that same period.

Historically, the notion of the niche hypothesis was first touched upon in the West as an incidental by Peter Marler and Kenneth Marten in the late 70s while doing a bird study at a particular site.[2] However, the researchers were unable to adequately quantify this observation with then-available technology or within the scope of their document. A similar phenomenon was also noted as part of a study of urban sound in Vancouver, BC around the same time by R. Murray Schaffer, author of the term, *soundscape*, and the concept of *acoustic ecology*.[3] In this study, Schaffer suggested that there might be a correlation between creature vocalizations, in particular, and the sounds of their habitat.

Natural soundscape, even in captive environments, plays a determining role in the behavior of otherwise wild creatures. A 1993 report related that tigers, lynx, and foxes panicked when a military jet buzzed Sweden's Froso Zoo, about 300 miles north of Stockholm during a routine training flight. Some of the animals tore apart and ate 23 of their babies, including five rare Siberian tiger cubs. Trying to protect their offspring, the animals resorted to infanticide.[4]

The notion that there can be a profound effect on biophony by the introduction of human-induced noise has long been understood by non-industrial cultures who depend on the integrity of undisturbed natural sound for determining a sense of place as well as for spiritual and aesthetic reasons. In fact, the very physical and mental health of earth-centered groups spread from the Equator to the Arctic depends, in large part, on the special relationship between the natural soundscape of their habitat and themselves.[5,6]

Traditionally, creature voices have been observed by abstracting single species and recording them, then introducing playback studies to observe affect. Also, human noise is measured as a factor of total environmental sound in an attempt to understand the relationship. However, little is known about precisely how wild creatures receive and process this information in their natural habitats although recent studies are indicating that the effect can be profound.[7] Since scant attention is paid to the stress induced by human noise to humans, themselves, and particularly as a result of noise interference in natural soundscape at any level, the loss of natural sound and its affect on living organisms may be more profound than what has been initially indicated. However, there may be other indicators of significance.

Description

The notion of the Niche Hypothesis was introduced formally in the West in 1988.[8] It posited that, in undisturbed biomes, what had formerly been considered by most in the West as a chaotic din of noise, was, in fact, an observable and distinctive orchestration of sounds made up of all the vocal creatures of the habitat—insects, avifauna, mammals, amphibians, etc. Subsequent observations led to the further notion that the discrimination and complexity of these acoustic patterns could be utilized to determine the health of a biome, its size, its relative location to others, and also its relative age. Two examples are described in Figures 1 and 2.

Fig. 1 illustrates the soundscape spectrogram sample of a secondary growth biome recording made on Pic Paradis, a mountain located on the French side of island of St. Maarten in the Antilles. The time illustrated covers 10 seconds on the "x" axis. The frequency range is 9.675kHz.noted on the "y" axis. Sub-tropical in nature, this relatively new-growth partially rural biome, sampled in May, 1986, is expressed with insects primarily occupying two niches: one between approximately 1.7kHz and 2.0kHz and the other between approximately 3.1 and 3.7 kHz. At dawn on this particular day, two birds filled these niches: One is a type of mourning dove (*Zenaida macoura*). It can be heard and seen at just below

500Hz. beginning at about 4.0 seconds with four iterations. The second bird is a lesser Antilles swift (*Chaetura martinica*). It can be heard and seen at frequencies between .85 and 7.9kHz and at 1.5, 2.5, 7.5, and 8.2 seconds, respectively.

Fig. 2 illustrates a more complex tropical biophony recorded in Borneo in March of 1991. Also 10 seconds in length, it demonstrates with clarity, niche discrimination established over a considerable evolutionary period, where a large number of creatures occupies various frequency ranges and times. Displayed in three niches, one band of insects can be seen and heard vocalizing between 6.0 and 7.6kHz, between 8.0 and 8.7kHz, and a bit less present between 13.1 and 14.0kHz. Filling niches otherwise unoccupied, are primarily three species of birds. The Asian paradise flycatcher (*Terpsiphone paradisi*) seen and heard twice (at between .5 and 1.7 seconds and between 7.7 and 8.7 seconds), in three niches simultaneously (approximately 2.7, 5.7, and 10.9kHz); the brown barbet (*Calorhamphus fuliginosus*) seen and heard four times (at approximately 1.25, 3.8, 6.8 and 9.25 seconds), in one niche at between approximately 4.3 and 5.2kHz.; and the ferruginous babbler (*Trichastoma bicolor*) sounding in a succession of notes at 1.8 and 5.4 seconds at approximately 1.1kHz. Of particular note is the flycatcher whose vocalizations are iterated in three niches at the same time, a development both time and biophonically sensitive.

A niche perspective of creature voices in undisturbed habitats has allowed us to observe the first direct correlation between human-induced disturbances during a spring field recording trip to the eastern Sierras. For instance, predation was observed on *Scaphiopus hammondi*, the threatened Western spadefoot toad, as a result of a low-flying military jet over the Mono Lake basin the evening of 29 April 1993.

Figures 3 - 6 illustrate a series of vocal events related to the incident. Figure 3 demonstrates the synchronicity of vocalization that occurs among many frogs at the same time so that no predator can detect the origin of sound emanating from any one organism. Figure 4 shows the effect of the flyover as it is occurring. Note the drop off of the numbers of creatures vocalizing as well as breaks in synchronicity. The Figure 5 sample, from recordings made 20 minutes after the flyover, demonstrates a continued inability on the part of the frogs to resume synchronicity. It was during this period that two coyotes and (what we believe to be) a great horned owl were observed in the available light drawn to the edge of the pond apparently to feed on the few remaining vocal amphibians. It was then that all vocalizations ceased for some time. It took fully forty-five minutes from the end of the aircraft fly-by before coherent vocalizations resumed (Figure 6). No more predators were observed in the vicinity after resumption of the synchronous frog chorus.

Figures 7 - 9 depict an earlier incident. The images represent a flyover that occurred in February, 1990 at a research site in the Amazon basin north of Manaus called Kilometer 41. Recording the dawn chorus one morning, a low-flying multi-engine military jet shattered the jungle soundscape. Figure 7 paints a picture of the niche prior to the onset of the jet. Note the finely delineated and discriminated features of the biophony. Figure 8 shows the effect of the soundscape with the jet passing overhead. And Figure 9 shows the change present with the jet still moving away from the site in the distance. Note the change in creature vocal discrimination, here, also.

Discussion and Conclusion

Measuring the effects of human-induced noise as a factor in natural soundscape loss has been mostly a subjective endeavor. This is because both human and non-human species respond differently to the types,relative amplitudes, and spectra of specific or combinations of introduced mechanical or human noises in relationship to the biophony. Also, the equipment used for such measurement tends to have limitations that creature ears do not and vice versa. In addition, site selection of a study may play a role in the manner in which human-induced noise affects living organisms.

One way to measure these affects would be to have a number of simultaneous systems set up at different locations throughout a given biome and measure the effect of introduced noise on natural soundscape. As for noise impact on humans, a study done in France invited subjects to adapt to sleeping in the laboratory. After an initial few nights of quiet, they were then subjected—while asleep—to fifteen nights worth of recorded traffic noise. The sleeping subjects were wired to instruments used to mesaure stress. "Heart rate, finger-pulse amplitude, and pulse-wave velocity were measured throughout the night, and each sleeper filled out a questionaire upon waking." Two to seven nights later, the subjects reported that they were no longer disturbed. However, the stress effects—heart rate, etc. "measured the fifteenth night were identical to those logged the first."[9]

We are beginning to understand late in the game that unimpeded natural soundscapes are a resource critical to our enjoyment and awareness of the natural wild; and that without them, a fundamental piece of the fabric of life will be sadly compromised, perhaps forever. The fact that noise affects the behavior of wild creatures has a direct effect on human experience. That is why it is important to attempt to hear and treat soundscapes differently—as important to our well-being and health as the preservation of pure fresh water, clean air, and non-polluted soil.

Technology

All of the recordings on which these spectrograms are predicated, were made using an M-S microphone system consisting of two Sennheisers; an MKH 40 (hyper-cardioid pattern) and an MKH 30 (figure-8 pattern). The pre-amp was an Aerco 48V phantom power supply set at -48dB input level. The recorder was a Sony TCD D10 Pro II digital audio recorder. None of these recordings were calibrated to any particular standard as the form of field research we were doing at the time did not demand regulation of that type.

Notes

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9. *Science News*, 121, June 5, 1982. 380.

Author and Presenter

For the past quarter century, Dr. Krause has traveled the world capturing sounds of creatures and environments large and small. He has worked at the research sites of Jane Goodall (Gombe, Tanzania), Birute Galdikis (Camp Leakey, Borneo), and Dian Fossey (Karisoke, Rwanda), recording and evaluating the effects of ambient sound on the vocalizations of the great apes. He was also Scientific Director of the operation that rescued Humphrey the humpback whale from the Sacramento Delta (1985) using processed feeding sounds of the same species to lure him to the ocean. Aside from his work in bio-acoustics, Dr. Krause also has a background in music having replaced Pete Seeger in The Weavers (1963), introduced and contributed synthesizer performances to over 135 major feature films including Apocalypse Now, and over 250 recordings with major musical acts. Through his company, Wild Sanctuary, he has recorded 50+ environmental record albums and creates interactive environmental sound sculptures for museums, zoos, aquaria and other public spaces. His latest book, *Into A Wild Sanctuary* (Heyday Press, 1998) explains the road to the discovery of biophony.

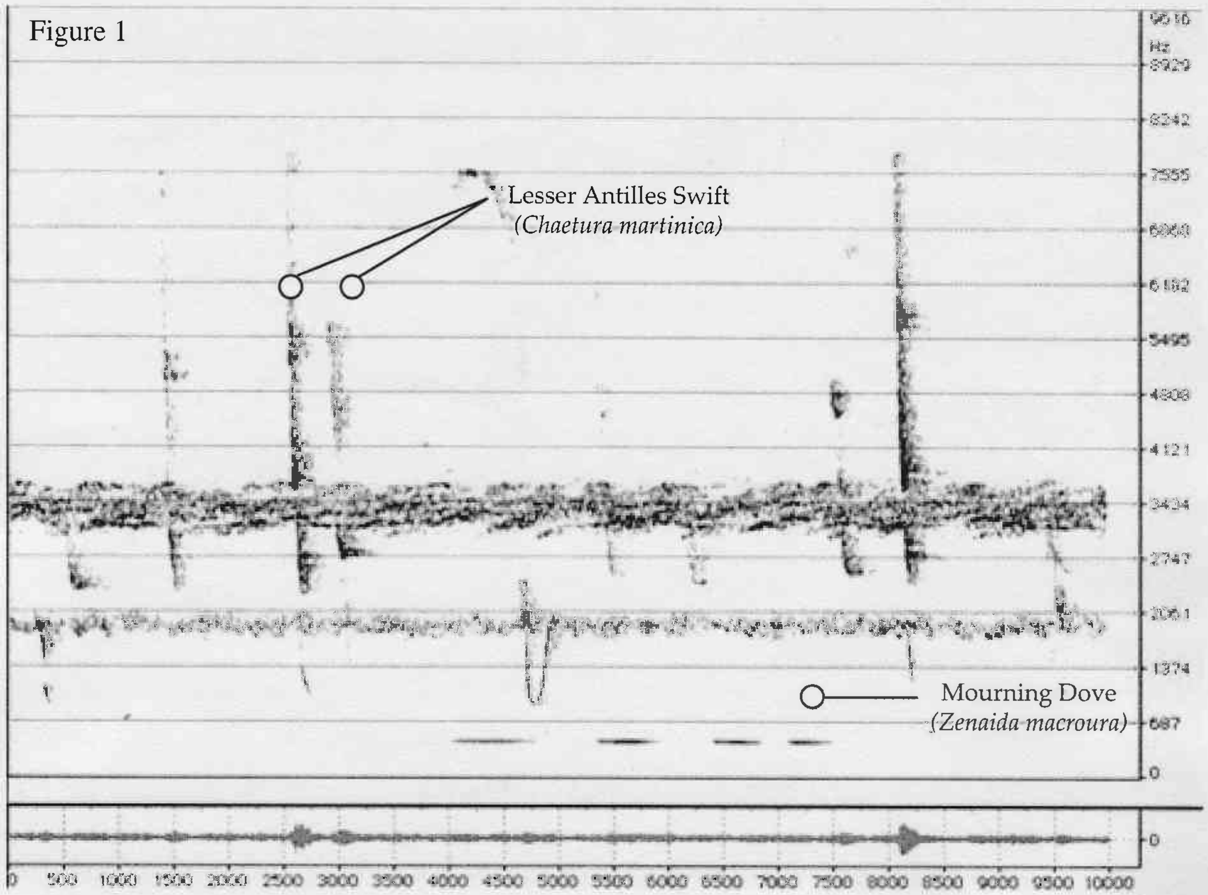


Figure 1
Lesser Antilles Swift
(Chaetura martinica)
Mourning Dove
(Zenaida macroura)

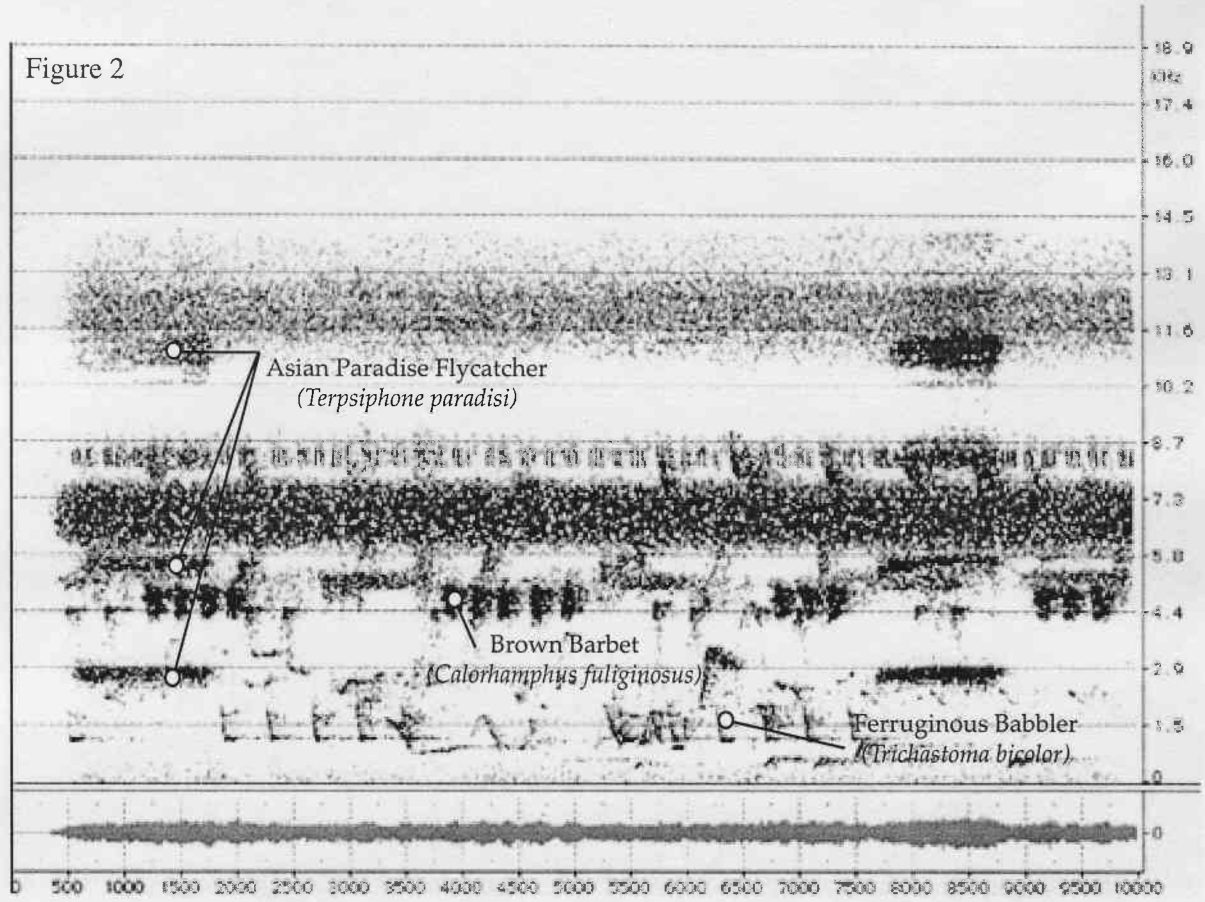


Figure 2
Asian Paradise Flycatcher
(Terpsiphone paradisi)
Brown Barbet
(Calorhamphus fuliginosus)
Ferruginous Babbler
(Trichastoma bicolor)

Figure 3

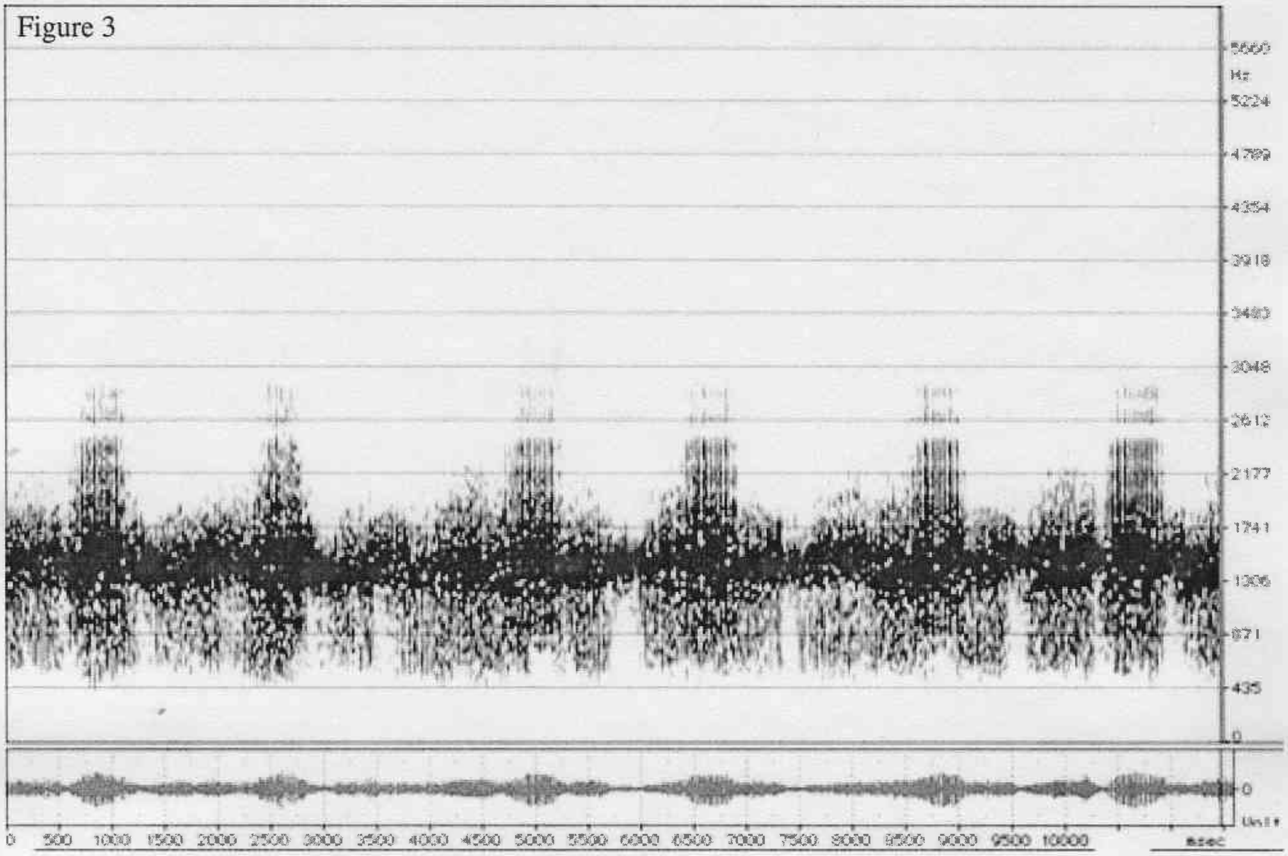


Figure 4

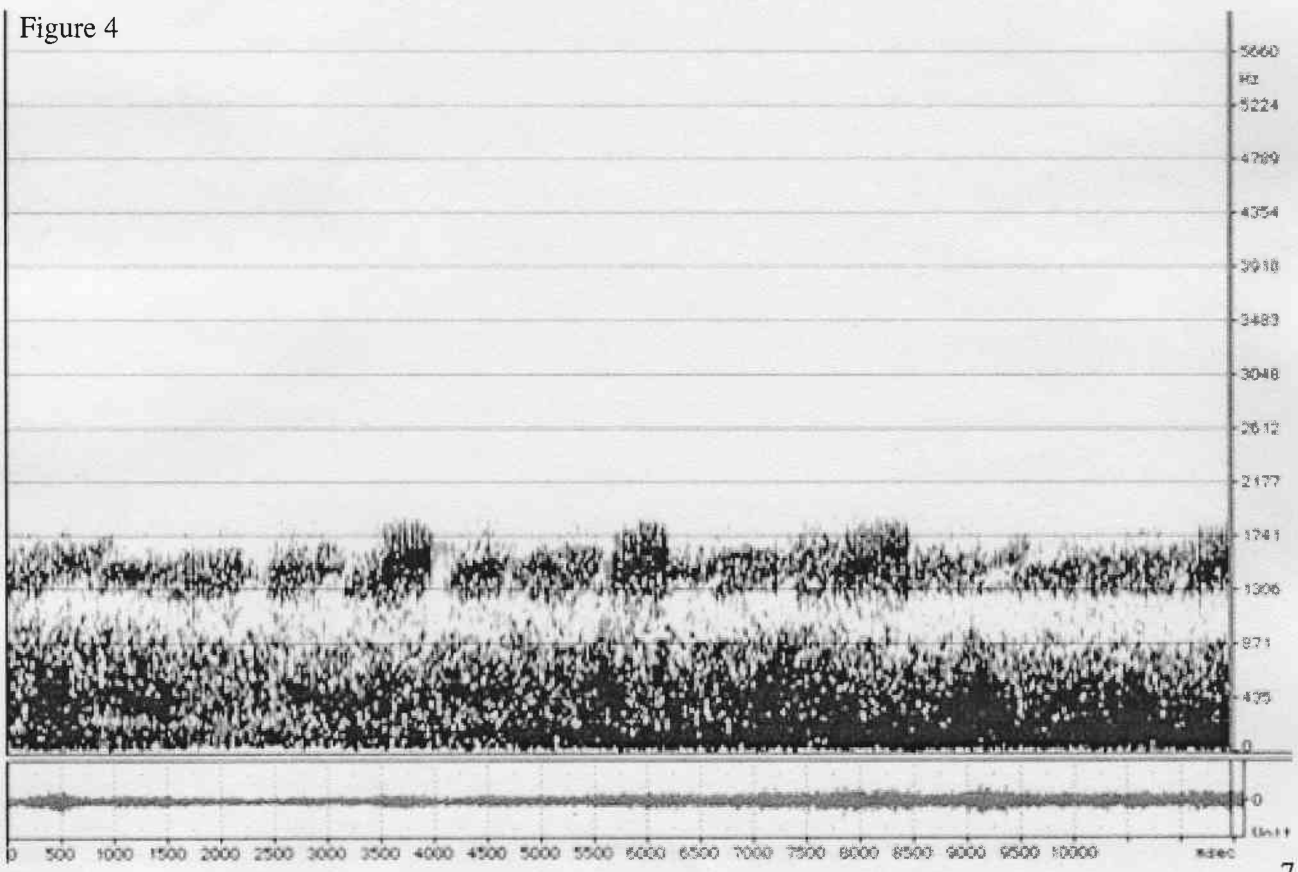


Figure 5

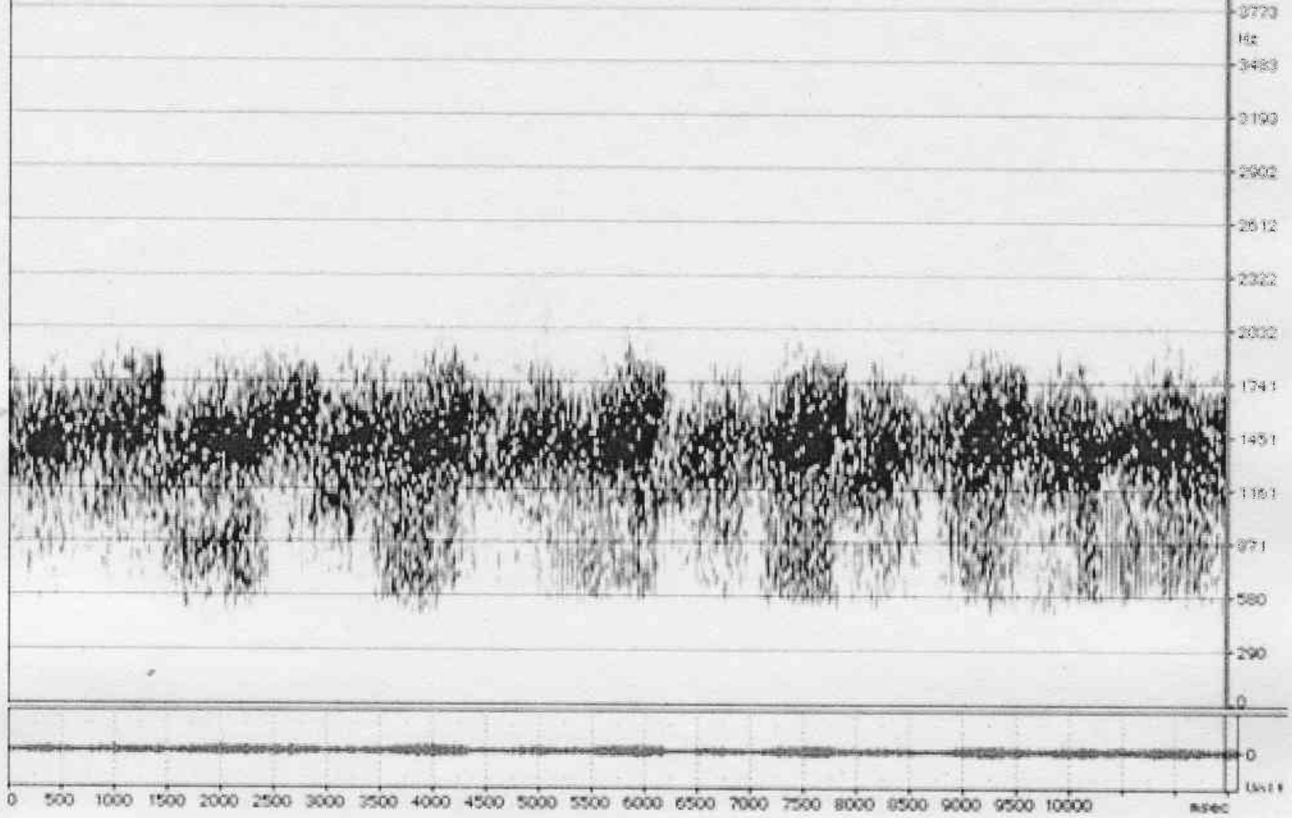
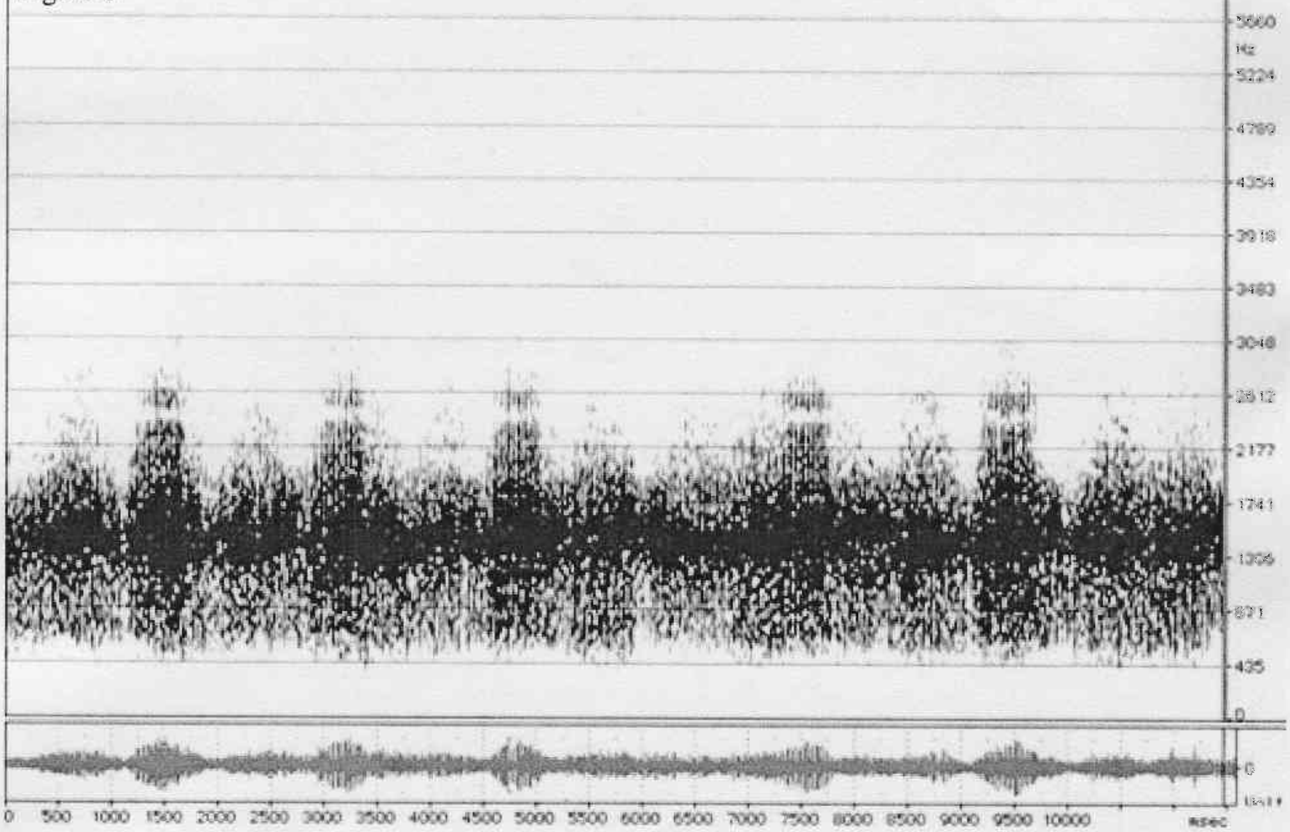


Figure 6



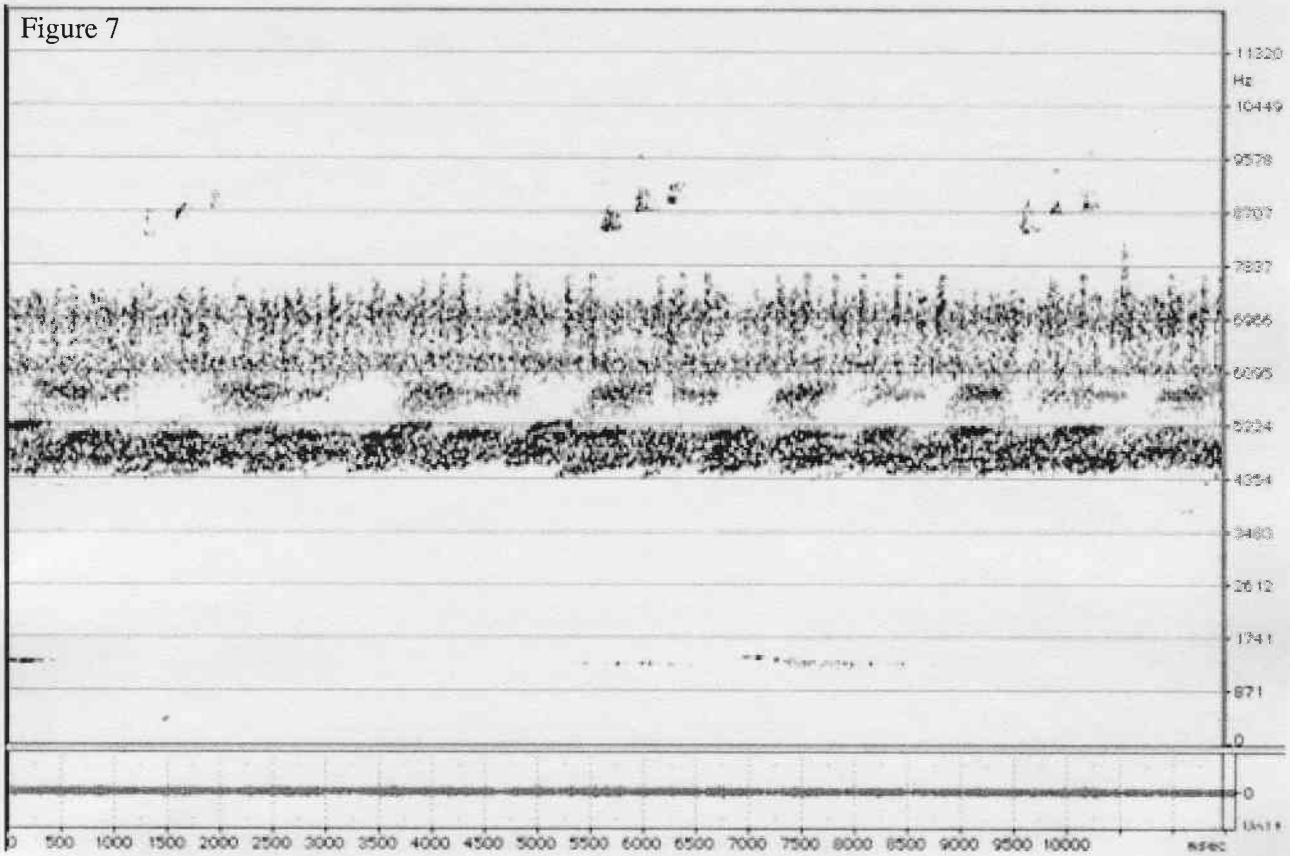


Figure 7
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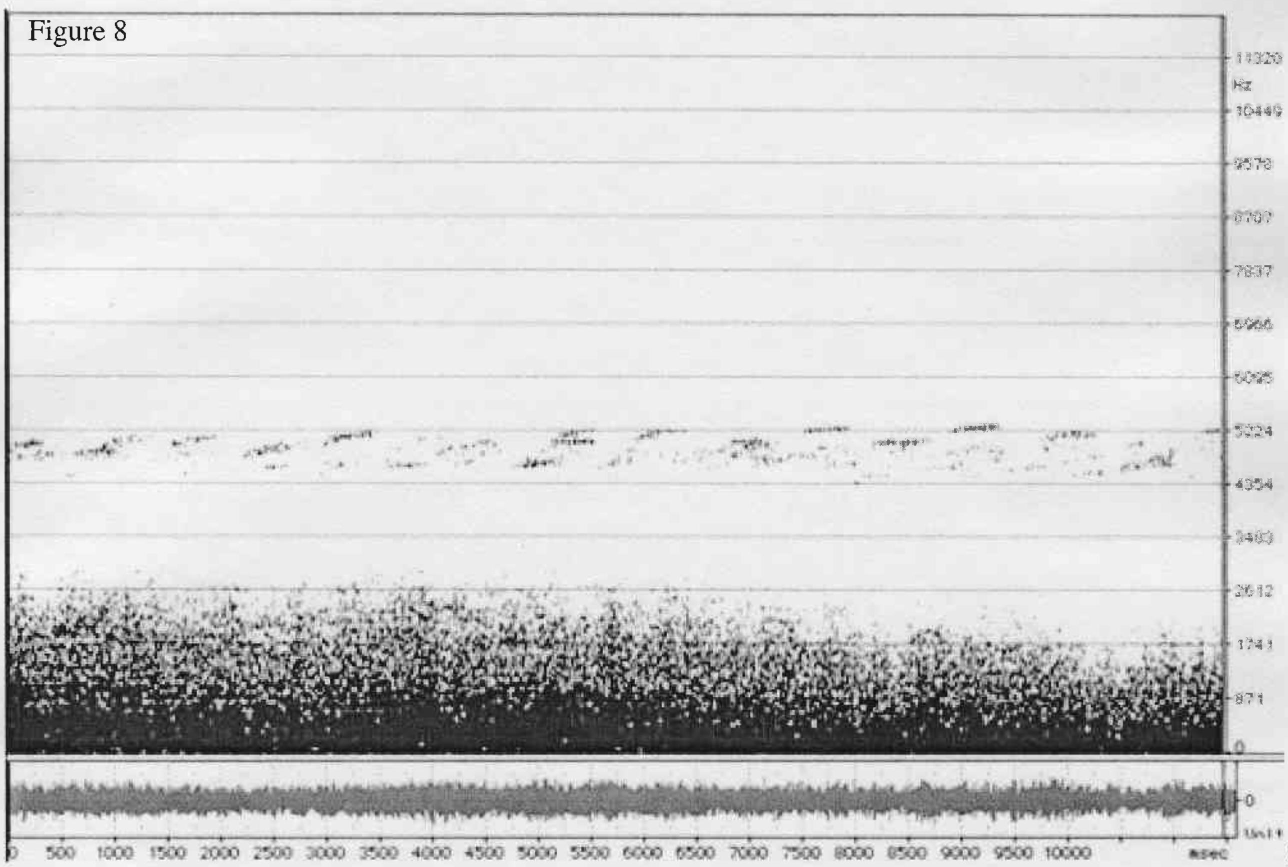
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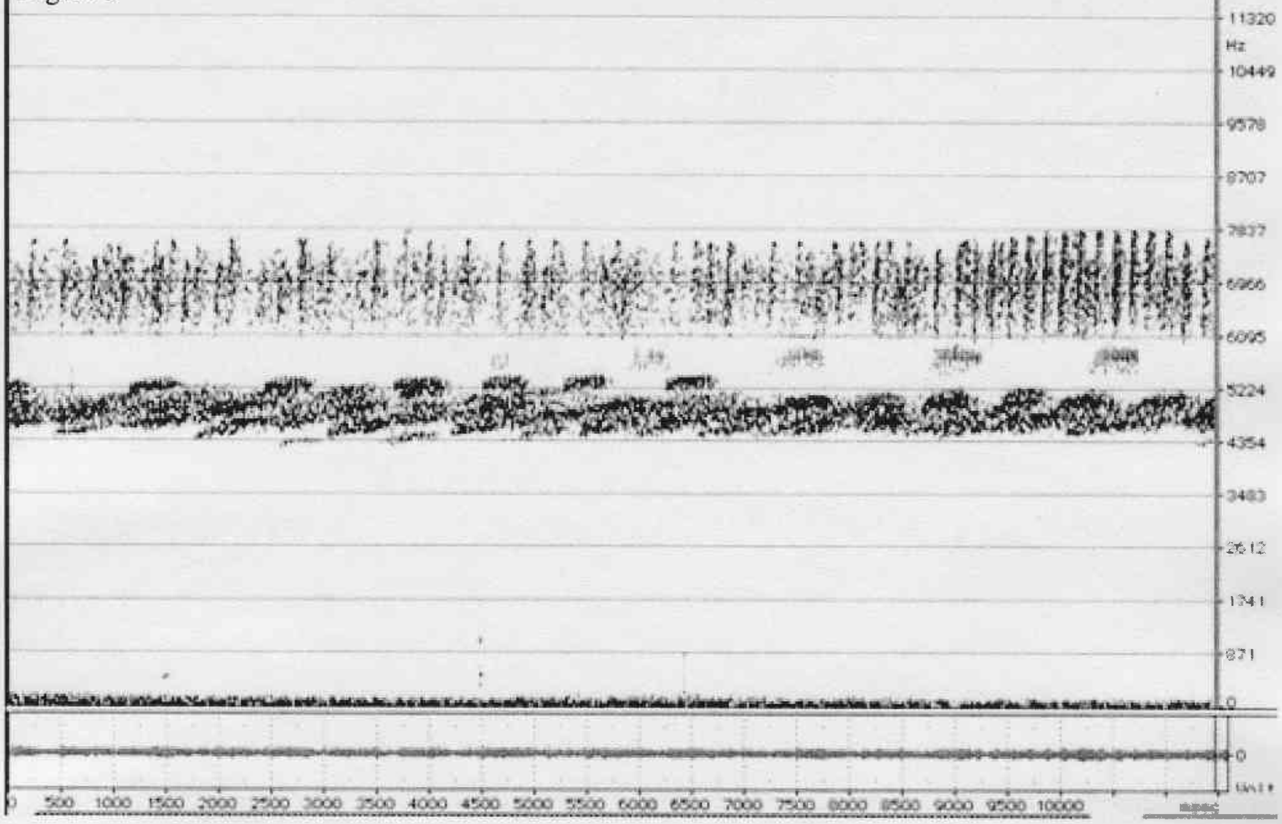
Figure 9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