Paper No. 14

NOISE IMPACT ON WILDLIFE: AN ENVIRONMENTAL IMPACT ASSESSMENT

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ABSTRACT

Various biological effects of noise on animals are discussed and a systematic approach for an impact assessment is developed. Further research is suggested to fully quantify noise impact on the specie and its ecosystem.

INTRODUCTION

The Environmental Impact Statement (EIS), which was born out of the National Environmental Policy Act (NEPA) of 1969, is a basic planning and management document. As such, it should cover all probable environmental impacts associated with a proposed action.

In the past, very little attention has been given to the effects of noise pollution on wildlife. Though seemingly insignificant, closer examination of noise impact on animals reveals possible adverse effects. Noise pollution could conceivably disrupt stable ecosystems and contribute to the extinction of an endangered specie. Due to the complex interaction between organisms, the impact on one specie could affect others, including man.

In an effort to improve management and protection of our natural resources, the NEPA mandated that an EIS be prepared for actions which significantly affect the quality of the human environment. One of the screening criteria put forth by the Environmental Protection Agency (EPA) is the degree to which an action disrupts stable ecosystems, especially when an endangered specie is involved. An increase in the background noise level of natural habitats can interfere with wildlife life patterns. Potential sources of such disturbances are vehicular traffic, construction activities, blasting, and aircraft noise.

There are few documented accounts regarding the effects of noise on wildlife. However, it has been shown through various studies on laboratory animals that they are affected in a manner similar to humans. These effects include auditory, physiological, and behavioral modifications. Laboratory animals have been subjected to acute high level noise inputs (well above 100 dB) in a confined area. Since these laboratory conditions do not accurately represent circumstances in the natural environment, innovative approaches to conducting noise stimuli-response research in the field are needed.

In the preparation of some EISs there have been attempts to evaluate noise impacts on wildlife in situ. The Alaskan Pipeline study included extensive consideration of noise effects based both on field observations and inferences drawn from laboratory data.[1] This was one of the first EIS efforts to focus attention on the gravity of this neglected environmental problem.

Although auditory and physiological reactions were not quantified, the study did assess behavioral modifications (especially avoidance type behavior) associated with responses to various noise inputs.

The following discussion describes various effects of noise on animals. Most of the examples cited describe results obtained with animals under laboratory conditions. A few documented accounts of wildlife impacts are included.

Auditory Effects

Laboratory exposure of mice, dogs, and cats to sound levels from 100-135 dB sound pressure level (SPL) has produced histological changes in the organ of Corti. All animals experienced a threshold shift, some temporary and some permanent.[2] Chinchillas exposed to an octave band of noise centered at 500 Hz with a SPL of 95 dB for a period of 48 to 72 hours developed a threshold shift of 78 dB, with recovery requiring about 5 days.[3] Cats exposed to noise levels of 115 dB SPL for periods of 15 minutes and 8 hours experienced permanent threshold shifts of 5.6 dB and 40.6 dB respectively.[4] In general, the extent of hearing loss depends on the magnitude, frequency, duration, and individual sensitivity of the organism. It is unlikely that wildlife would be subjected to conditions such as those produced in the confines of a laboratory. However, these studies do indicate some of the potential auditory harm intrusive noise may inflict on wildlife.

Physiological Effects

To date, stress has not been quantified for animals in their natural habitats. Adrenal hypertrophy, related to increased background noise, was used as an index of stress in field mice.[5] Stress is associated with certain neural and endocrine activities resulting in increased blood pressure and available glucose. Such physiological reactions are perfectly normal under various circumstances, but prolonged exposure to noise, such as experienced from a snowmobile driven through a wilderness area or from a low flying aircraft, will place an excessive burden on the energy resources of the animal as it attempts to avoid the noise source. Such energy losses by the organism will make it more susceptible to prey or disease, or may even result in death. For example, since the age at which wild sheep attain sexual maturity is dependent on nutritional state, energy losses as a result of avoidance reactions from low flying aircraft may affect their reproductive process.[1]

Behavioral Modifications

The most apparent results of noise impacts are in the modification of the normal behavioral pattern of the organism. A noise source whose frequency is in the range of the auditory sensitivity of the organism could interfere and mask the communication signals of that specie. Many animals depend on acoustical signals to find their young, mate, establish territorial boundaries, and locate prey. Interference with these acoustical signals can endanger the well being of that organism. Intrusive noise could cause temporary or permanent abandonment of a particular habitat. Some organisms may eventually adapt to new background noise levels, but migration may result in decreased utilization of a habitat in one area and increased use in another area. As

animals are driven away from the noise source, the decrease in available habitat creates greater competition for food and space. In some cases, the result may be a reduced population of a particular specie. In extreme cases, the eventual result can be the elimination of an endangered specie. Aircraft noise, vehicular noise, or sonic booms resulted in condors (endangered specie) abandoning their nests, never to return.[6] The massive hatching failure of sooty terns in Florida was attributed to noise from low flying aircraft.[7] Birds, once disturbed, abandon their nests leaving their eggs as easy prey for predators.

Ecological Implications

Changes in the homeostasis of individual organisms manifest themselves as changes in the total stability of an ecosystem. Various single specie and ecosystem effects are identified in Table 1. In every ecosystem there is a continuous interaction between organisms and their environment. Pollutional inputs interfere with these interactions and disturb the natural cycle of events.

The remainder of this paper sets forth a systematic approach, illustrated in Figure 1, for assessing the impact of noise from a proposed project. Areas where additional research is required to fully implement the approach are identified.

APPROACH TO ASSESSING NOISE IMPACTS ON WILDLIFE

Step 1: Project Description

Identify noise source(s) and determine magnitude, duration, frequency, and spatial extent. The latter should be represented graphically with noise level contours (isobels); see Step 2. Following is a standard formula for the measurement of noise decay over a given distance.

$$dB = dB_O - 10 \log_{10} \left(\frac{d}{d_o}\right)^2$$

dB = sound level at distance d in decibels
dB_O = sound level at unit distance d_o from source
d = distance between source and receiver (ft)
d_O = unit distance

Note: This model assumes low wind velocity and no muffling effects from surrounding vegetation.[8]

Step 2: Extent of Impact

Define the geographic area affected by the project. Prepare the isobel diagram of Step 1 to the scale of an area map. Overlay the diagram on the map and identify the outermost contour corresponding to the ambient noise level. This outer contour circumscribes the affected area with respect to noise impact. This area represents a potential loss of habitat utilization. An example of a map depicting noise impact is provided in Figure 2.

Table 1. Noise effects on wildlife

SINGLE SPECIE		ECOSYSTEM
AUDITORY	• Complete hearing loss • Threshold shift	Disturbance of natural selection process: * Reduction in number of a specie * Change in the natural patterns of animals * Increased inter and intra specific competition as a result of habitat loss * Reduction in specie diversity * Migration * Loss of endangered specie * Change in predator-prey relationship
PHYSIOLOGICAL	Prolonged stress resulting in: • Metabolic change • Loss of reproductive capacity • Hormonal changes	
BEHAVIORAL	• Masking of acoustic signals • Avoidance type behavior	

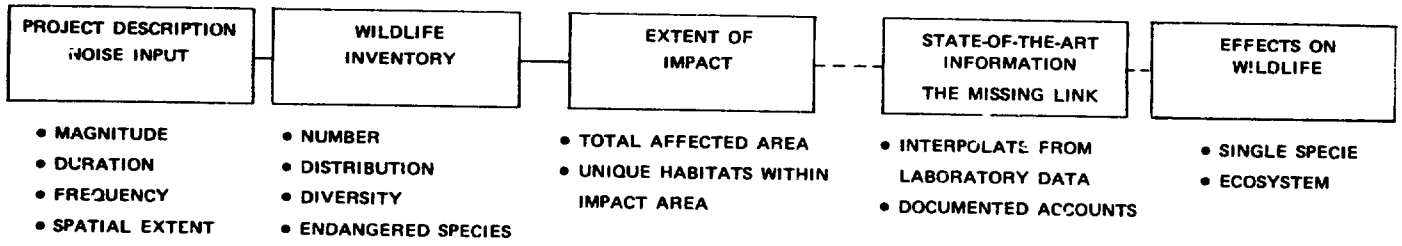

Figure 1. Impact assessment steps

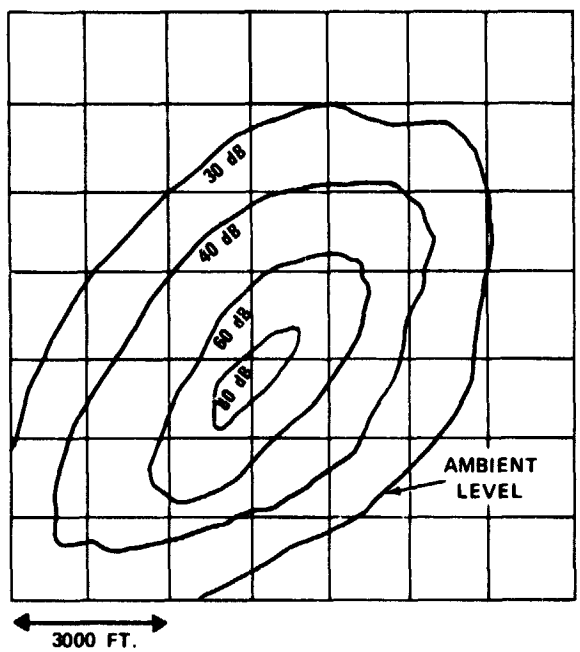

Figure 2. Spacial extent of noise impact

Step 3: Wildlife Inventory

Conduct a survey of the wildlife population in the impacted area defined in Step 2. The survey should include the number and type of animals and their spatial distribution. The techniques for such a survey are well documented.[9] Wildlife populations, unique habitats, and endangered species should be identified on the map with respect to the various noise contours, as shown in Figure 3.

The total area impacted by the noise may be calculated using the graph. Area 1 (A_1) is severely affected, with noise levels 50 dB above ambient. Area 2 (A_2), which has a noise level 30 dB above ambient, contains some endangered species and is also a nesting area.

The wildlife inventory should also relate some of the possible indirect effects on the various trophic levels. Table 2 illustrates a typical predator-prey relationship. The migration of one or more species from the impacted area will create an imbalance in this relationship, resulting in an overabundance or a loss of certain animals. In essence, a functional niche in the affected area may be lost.

Step 4: State-of-the-Art Information on Noise Effects on Wildlife; the "Missing Link"

Assemble data on threshold limit (TL) for noise tolerence for each specie in the affected area. The TL is necessary in making an accurate assessment of probable adverse effects. Unfortunately, data for natural environments are not available. The best we can do currently is to interpolate and infer from studies conducted on laboratory animals.[2] Great care, however, must be taken in the interpolation of such data. As previously indicated, most of the laboratory experiments subjected animals to unusually high noise levels while confined to their cages.

Step 5: Assessment of Noise Effects on Wildlife

Incorporate information obtained in Steps 1 through 4 into an assessment of the various direct and indirect impacts on the wildlife in the project area. Complete appropriate sections of the EIS; e.g., project description, existing environment, probable impacts, and mitigating actions for avoiding adverse impacts on wildlife.

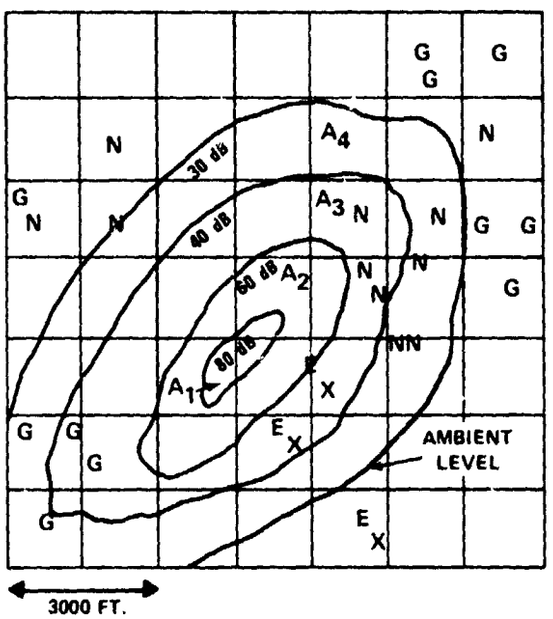

Figure 3. Spatial extent of noise impact on wildlife habitats

Table 2. Predator-prey relationships in impacted area

SPECIE	BOBCAT	RABBIT	RAT	HAWK	RACOON
BOBCAT	0	+	+	0	+
RABBIT	–	0	0	–	–
RAT	–	0	+	–	+
HAWK	0	+	+	0	+
RACOON	–	+	+	0	0

NOTE: SYMBOLS INDICATE RELATIONSHIP OF ANIMAL LISTED IN LEFT HAND COLUMN TO ANIMALS LISTED IN TOP ROW.

LEGEND

+ PREDATOR

– PREY

0 NEUTRAL

SUMMARY

When projects are proposed for pristine or near pristine environments, the EIS should include consideration of noise effects on wildlife. Sufficient attention has not been given to this problem area. This is partly due to the scarcity of data. Further detailed research is needed to clearly define the effects of noise. Each organism hears differently and has varying auditory sensitivities. What may be irritating to one organism may have no apparent effect on another.

A systematic approach for the analysis of a noise impact on a wildlife habitat has been described. The missing information, which impedes the complete and accurate analysis of a given impact, is accurate knowledge of how animals react to various noise levels of varying frequencies. This information is not presently available. The best that can be done at this juncture is to interpolate from laboratory experiments and limited field observations.

Experiments should be performed in the natural habitat of organisms to develop a threshold limit of noise tolerance for wildlife. Conduct of field investigations may eventually be possible using dosimeter type devices and telemetric monitoring to measure the heart rate of animals in response to varying noise intensities. A threshold limit of noise tolerance for different wildlife species may then be determined, based on a correlation between noise input and stress, as indicated by increased heart rate. Noise inputs should attempt to simulate magnitude, duration, and spectral characteristics associated with construction and vehicular noise and other intrusive noise sources associated with man's encroachment into nature.

It is obvious that we can be faced with a problem affecting the quality and well being of our frail ecosystems. In keeping with the spirit of the NEPA, efforts should be made to bring noise effects on wildlife into proper perspective, and then make an effort to resolve them.

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