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ASSESSMENT OF NOISE IMPACTS ON THREATENED AND ENDANGERED SPECIES

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1. INTRODUCTION

In the United States there are significant regulations that apply to noise impacts on threatened and endangered species (TES). The National Environmental Policy Act (NEPA) requires federal agencies to assess the impact of planned activities on the environment and to make the assessment available to the general public. The decision-making procedures are documented by either an Environmental Assessment (EA) or an Environmental Impact Statement (EIS). Noise and TES are often important issues in these.

The Endangered Species Act (ESA) requires all federal agencies to carry out programs for the conservation of threatened and endangered species. Agencies must ensure that their actions do not jeopardize the continued existence of listed species or adversely modify critical habitat. The ESA requires agencies to conduct biological assessments to evaluate the impacts of their activities on listed species. This assessment serves as the basis for consultation with the U.S. Fish and Wildlife Service, which issues a biological opinion and species management recommendations. Many states have regulations similar to the ESA, with state level counterparts of the Fish and Wildlife service charged with enforcing the regulations.

Often insufficient information is available to assess the impact of noise immission on an animal species. Regulators at the state and national level have legal responsibility to preserve TES. In the absence of definitive information, they may make conservative management recommendations. Activities, including military training, are sometimes curtailed because of potential impacts.

Relatively few noise (especially blast and helicopter) impacts on wildlife studies have been done. A high quality study requires substantial expertise in both acoustics and the biological sciences. There is little information in the literature to guide the conduct of such studies. Bowles [3] has summarized much of what is known about responses of wildlife to noise and has compiled a bibliography on the topic. There are other studies in progress or recently completed. This includes studies which the U. S. Air Force has sponsored on the effects of noise from low-flying high-speed jet airplanes on caribou, desert bighorn sheep, desert tortoise, raptors [2], kit fox and desert kangaroo rat. The Army, Air Force and US Forest Service are jointly investigating the effect of helicopter overflights (and comparative impact of chain saw noise) on spotted owls [4]. The Army has studied impacts of artillery noise on bald eagles [5]. A recent civilian study [1] has investigated the effect of traffic noise on territory selection by the golden-cheeked warbler.

2. IMPACT ASSESSMENT

The author is a member of a research team engaged in the assessment of impacts of military activities on TES. The following is an outline of the impact assessment protocol that has been adopted for these studies. Selection of impact criteria is a critical issue. Criteria for noise impact on humans include annoyance, sleep disturbance and hearing damage. The annoyance studies typically utilize community surveys or require test subjects to judge the relative annoyance of various sounds. Assessment of noise impacts on other animal species requires different methodology. For domesticated species the issue may be damage to individual animals or impacts on production and profits. For TES the primary issue is survival of the species. The challenge is to determine or infer long-term impacts on survival in a short-term study.

Response is characterized by measurement of proximate effects, that is the direct and immediate response of the animal to the noise stimulus. A proximate effect could be a behavioral (e.g. flight) or a physiological (e.g. change in heart rate) response. The ultimate level of effect is whether the stimulus causes significant changes in the number of individuals in the population. The connection between proximate effects and populational effects can be made by means of an intermediate level of effect, "individual fitness," which is typically evaluated in terms of mortality or reduced reproductive success. The relation between proximate effects and individual fitness can be established by extensive monitoring of the animals. The connection between individual fitness and populational effects is made by means of a population model that relates such factors as individual mortality and reproductive success to population dynamics. Development of a population model is not a trivial task. The TES research team at USACERL is currently developing an improved population model which will include effects of military impacts (including noise) as well as demographic variables and will also allow for utilization of any required time scale.

As a specific example, consider that a bird might flush from a nest (a proximate response) as a result of noise. It is possible that this could lead to failure of the nest, especially if it occurred repeatedly. Monitoring is required to determine reproductive success of disturbed and of undisturbed nests. A population model is required to determine if failure of some nests has impact on survival of the species.

The relation between the noise stimulus and the proximate response is expressed by a dose-response model, expressed as a graph or equation relating the probability of occurrence of a response to the value of a suitable noise metric. An example familiar to acousticians is the "Schultz curve," which relates the percent of exposed subjects that report being highly annoyed to aircraft noise level. The dose-response model is developed by observing proximate responses to noise stimuli of known level. A useful refinement is the addition of a habituation function that expresses the change in probability of response as a function of number and temporal spacing of exposures.

3. RESEARCH METHODOLOGY

Military noise sources of concern include blast noise from artillery and explosions, small arms, airplanes, helicopters and vehicles. The noise from these sources varies widely in level, duration, spectral energy distribution, and suddenness of onset. Experience with humans and animals has shown that the dose-response relation is different for each type of noise. Also, the selected noise metric must be appropriate to the type of noise. Thus a separate study and resultant dose-response relation will generally be needed for each important combination of noise type and species. On the other hand, because research funds are limited and there are many combinations of species and noise of potential interest, it is important to apply research results as broadly as possible.

Another important consideration of noise impact assessment is "frequency weighting." When assessing noise impact, only noise that is audible to the animal should be accounted for in the noise metric. An example is the familiar "A" weighting, which discriminates against noise energy according to human hearing range and sensitivity. Frequency weighting designed for humans will in general not be appropriate for animal species, since audiograms are known to vary widely among species. It will be useful to obtain at least a reasonable estimate of the audiogram of each study species and use this information to derive an appropriate weighting function.

Laboratory experiments can provide essential information, using either real or simulated noise events and captured or surrogate species animals. A surrogate species is a species that is believed to exhibit a response similar to the species of primary interest. Such studies may lack some degree of applicability to response in the wild, but offer the chance to study a large number of responses at reduced cost. Lab studies also facilitate monitoring of physiological responses and auditory thresholds.

Field work should be preceded by stimulus (noise level) definition. Parameters of interest include the number of animals exposed and the type, level, time frame and number of repetitions of noise exposure. One source of information is comparison of animal distribution and density information with noise level contours.

Field studies of the in-situ response of the actual animal to the actual noise events are essential. Observation of many individuals is required for statistical validity (as opposed to "anecdotal evidence") and to avoid habituation contamination of the data. A range of noise level will of course be required to establish the dose-response relation. The difficulty of field studies is compounded by unique difficulties of working with TES and by large numbers of field study ecological and behavior variables. Determination of baseline behavior, as a standard of comparison for judgement of impact, may require more resources than the impact experiments. A definitive study may have to be three to five years long to determine if significant effects are present.

4. REFERENCES

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