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Synthesis of noise effects on wildlife populations

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Abstract

This report contains a partial summary of a literature review dealing with the effect of noise on wildlife emphasizing the effects on birds. Beginning with studies in the Netherlands and, later, in the United States, a series of studies have indicated that road noise has a negative effect on bird populations (particularly during breeding) in a variety of species. These effects can be significant with 'effect distances' (i.e., those within which the density of birds is reduced) of two to three thousand meters from the road. In these reports, the effect distances increase with the density of traffic on the road being greatest near large, multilane highways with high densities. A similar effect has been reported for both grassland and woodland species. It is important to note that 1) not all species have shown this effect and 2) some species show the opposite response, increasing in numbers near roads or utilizing rights-of-way. It is important to determine the cause of this effect and to utilize additional or alternative methods beyond population densities as the sole measure of effect distance, because the latter is susceptible to variation due to changes in overall population density. Recommendations for further study are given, including alternative measures of disturbance in birds.

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Synthesis of Noise Effects on Wildlife Populations

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Abstract: This report contains a partial summary of a literature review dealing with the effect of noise on wildlife emphasizing the effects on birds. Beginning with studies in the Netherlands and, later, in the United States, a series of studies have indicated that road noise has a negative effect on bird populations (particularly during breeding) in a variety of species. These effects can be significant with 'effect distances' (i.e., those within which the density of birds is reduced) of two to three thousand meters from the road. In these reports, the effect distances increase with the density of traffic on the road being greatest near large, multilane highways with high densities. A similar effect has been reported for both grassland and woodland species. It is important to note that 1) not all species have shown this effect and 2) some species show the opposite response, increasing in numbers near roads or utilizing rights-of-way. It is important to determine the cause of this effect and to utilize additional or alternative methods beyond population densities as the sole measure of effect distance, because the latter is susceptible to variation due to changes in overall population density. Recommendations for further study are given, including alternative measures of disturbance in birds.

Introduction

This presentation summarizes part of a larger report that reviewed literature dealing with the effect of noise on wildlife on a wide variety of species (Kaseloo and Tyson 2004). Here, the responses reported for bird species are summarized, because they have been reported to show the most dramatic negative response to road noise of any group and this response appears proportionate to the level of traffic on the road. According to a recent estimate, 20% of the land area of the United States may be ecologically affected by public roads (Forman 2000). This estimate is based, in part, on findings of the effect of road noise on the density of bird populations. In these studies "effect distance" is defined as the distance from the road to the point at which reduced density was no longer recorded.

Effect of Road Noise on Bird Species

In an early study (a re-analysis of previous work), avoidance of roads was found for at least two species (lapwing and black-tailed godwit) of grassland birds (van der Zande et al. 1980). A subsequent study of grassland birds found seven of 12 species had reduced breeding densities near roads and that the effect distance increased from 20-1,700 m at 5,000 vehicles/day to 65-3,530 m at 50,000 vehicles/day (Reijnen et al. 1996). A longer-term (five-year) study near Boston found that, at least for two species of grassland birds studied (bobolinks and meadowlarks), the effect distances increased from no effect at 3,000-8,000 vehicles/day to 1,200 m at traffic densities of 30,000 vehicles/day or more (Forman et al. 2002).

In a study of woodland species, 26 of 43 (60%) were found to show a decrease in population densities with effect distances that also increased with the amount of traffic. The effect distances ranged from 50-1,500 m at 10,000 vehicles/day and increased to 70-2,800 m at 60,000 vehicles/day (Reijnen et al. 1995b). A further, multi-year study found that 17 of 23 species showed a reduction in breeding bird density in at least one year of the study (average 40,000-52,000 vehicles/day) (Reijnen and Foppen 1995a). This effect was reduced in years of high overall population density. The authors concluded that high overall population densities led to an underestimation of the quality of the habitat as the numbers of birds were forced into poorer-quality areas under these conditions (Reijnen and Foppen 1995a; see also Reijnen et al. 1997, figure 1).

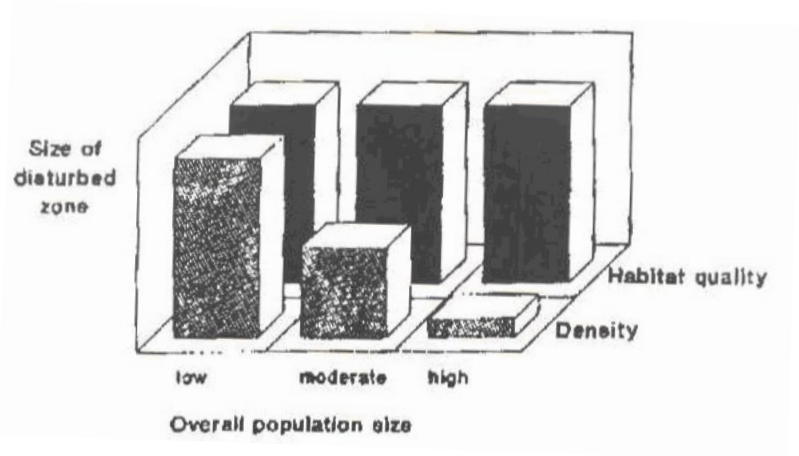

Figure 1. Schematic representation of the effect of disturbance by traffic on habitat quality (solid) and density (hatched) of breeding birds in relation to overall population size. (Reprinted with the kind permission of Springer Science and Business Media from Reijnen et al. 1997.)

Based on these results, sound levels above 50 dB(A) could be considered potentially deleterious, and the effect distance was estimated to be an average of 1,000 m (Reijnen et al. 1997). The existing model of the effect on birds assumes that noise is the presumptive major causative factor (see figure 2) because of the distances involved in the effect. However, it is important to consider that no multi-species study has found all species to be sensitive. In several studies that cover a wide range of habitat types it has been shown that while some species become less common near the road, others show the opposite effect, and the importance of these (ecotonal) species may also need to be considered in evaluating the impact of roads (Michael et al. 1976; Clark and Karr 1979; Ferris 1979; Adams and Geis 1981). It should be noted that noise was not the focus of these studies, but the fact that population densities vary dramatically between species merits consideration. Other species have been shown to breed in exceptionally noisy environments such as near roads and airports (e.g., Awbrey et al. 1995). Finally, a number of studies have found that rights-of-way can provide breeding habitat for some species and that management of this area can be important, particularly in areas where disturbance (e.g., from agricultural activity) farther from the road may preclude the use of alternative areas (Oetting and Cassel 1971; Voorhees and Cassel 1980; Laursen 1981; Warner and Joselyn 1986; Warner 1992). Again, it should be noted that noise was not the focus of these studies, but the close proximity of significant numbers of breeding birds of various types (pheasants, ducks, passerines) to the road (interstate highways) indicates that noise from the road is not an absolute barrier to breeding, particularly if alternative areas are not readily available.

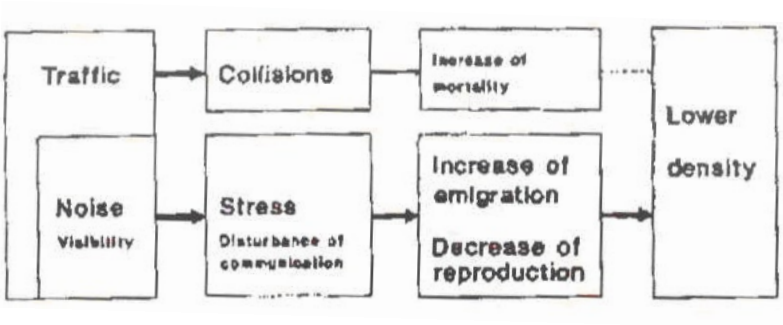

Figure 2. Probable relationship between traffic and density of breeding birds. (Reprinted with the kind permission of Springer Science and Business Media from Reijnen et al. 1997.)

The fact that the reduction in density of some species is proportional to traffic density supports the idea that noise is having a significant effect on these species. However, the effect is not universal and needs to be considered in terms of the surrounding habitat as well as species in question.

Recommendations for Future Study

Because the effect attributed to road noise can be extremely significant and has been shown to occur in a number of studies and across a wide variety of species, this effect must be investigated further. One central question that has yet to be resolved is whether noise in isolation is sufficient to cause this effect. To this point it has been assumed that noise is the cause because of the large effect distances and because other potential sources (e.g., visual disturbance, pollution, etc.) are unlikely to have an influence at such distances (Forman et al. 2002). If noise can be established as the cause of this effect, then mitigation efforts that are able to reduce noise alone can be expected to produce the desired response (i.e., may make habitat more attractive to species that had been avoiding these areas). In addition, the time for such a response to occur needs to be evaluated (i.e., over what time frame does a study need to be conducted to see a response). Because birds can be territorial it may take some time for them to reoccupy an area, even if acoustic conditions are more favorable.

The proximate effects of traffic noise on avian physiology have not been quantified. Since density alone can be a misleading indicator as to habitat quality (see also van Horne 1983), additional measures need to be employed to evaluate the stress the bird is experiencing. Such factors could include physiological measures of stress such as hormone levels or behavioral or activity measures that would indicate a bird is experiencing less or more favorable conditions. In breeding birds, the fecundity or fledging success might be useful indicators as well. Finally, areas of noise mitigation exist, and, although many of these may be near heavily populated regions, careful examination of these areas may reveal test sites that can be used for comparison to other (non-mitigated) areas so long as sufficient similarities (e.g., community composition, patch size, etc.) for comparison remain. These areas may present an opportunity for study without the need to construct or modify existing roads for such comparisons, although creation of controlled sites with high and low noise levels may ultimately prove necessary.

An accurate assessment of the impact of road noise will only be possible once the nature of the effect of road noise on birds is determined so that predictions as to the magnitude of the disturbance can be made.

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Biographical Sketch: Dr. Paul Kaseloo is currently an assistant professor in the Biology Department at Virginia State University. He has a Ph.D. in zoology and physiology from the University of Wyoming, where his research involved the energy costs of diving and digestion in ducks. His broader research interests include the physiological ecology of vertebrates. He authored a review of the effects of noise on wildlife through the Federal Highway Administration Minority Institutions of Higher Education Competitive Assistance Program.

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