

ANIMAL POPULATIONS AND ROADS

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Abstract:

The purpose of this paper is to summarize what is known about the effects of roads on persistence of wildlife populations and to highlight areas requiring further research. By definition, populations decline before they go extinct. Small populations are known to be more susceptible to extinction (Wilcox and Murphy 1985). Therefore, the question "how do roads affect persistence of wildlife populations?" is equivalent to the more tractable question "how do roads reduce wildlife populations?" Figure 1 summarizes the ways in which roads reduce wildlife population sizes and thereby reduce population persistence.

Roads directly reduce population size through mortality (Fahrig et al. 1995) and habitat loss (Forman 2000). Habitat loss is further reduced for species that avoid habitats near roads (Reijnen et al. 1996). In addition to these direct effects on population size, roads reduce movement of animals through the landscape, which can fragment populations, thus reducing their sizes. Reduced movement can also restrict access of individuals to required resources. This limited access may result in death (e.g., through starvation) or lack of reproduction (e.g., inability to access a mate), both of which can ultimately reduce population sizes.

An important question is "what is the relative importance of habitat loss, resource inaccessibility, habitat fragmentation, and road mortality on population persistence?" This question has important implications for determining what mitigation measures should have priority. For example, Jaeger and Fahrig (2001) suggest that direct road mortality generally has a larger and more immediate effect than reduced movement on population persistence. This suggests that, when a species has a high risk of mortality from a road, fencing the road is a good interim measure until proper mitigation structures such as overpasses or underpasses (Clevenger 2001) can be built.

The relative effects of the four factors depend to a large extent on knowledge about species responses to roads. Animals with low reproductive rates, low density and high space requirements will be susceptible to all road effects. Animals that avoid roads and require several different kinds of habitats will be susceptible to the effects of habitat inaccessibility. Highly vagile animals that are habitat generalists (Carr and Fahrig 2001) and species that are attracted to roads (e.g., reptiles for basking) will be particularly susceptible to traffic mortality. Species with high road avoidance and forest interior specialists (Ortega and Capen 1999) will be more susceptible to habitat loss and fragmentation effects.

Although the linkages in Figure 1 seem logical, in many instances there is little or no actual research to provide evidence or estimate the magnitude of the effect. For example, although there are a large number of studies documenting numbers of animals killed by roads, very few studies document an effect of this mortality on population size (van der Zee et al. 1992; Fahrig et al. 1995; Vos and Chardon 1998). The degree of road avoidance is a critical piece of information required for accurately estimating habitat loss due to roads and possible effects of roads on population fragmentation. Relatively little information is available on road avoidance. Reduced population densities near roads do not necessarily indicate road avoidance, since they could also result from road mortality. Radio-telemetry studies have been conducted on large animals (e.g., Mace et al. 1996), but more such studies are needed on a wide range of species to determine the extent of road avoidance and how this depends on traffic volume. Documentation of the effects of roads on resource inaccessibility will require studies comparing population densities near roads in situations where both resources are available on the same side of the road vs. situations where required resources are available only on opposite sides of the road. Studies are also needed to determine whether population densities in areas

surrounded by (fragmented by) roads are actually lower than densities where roads do not fragment the landscape.

In summary, roads can affect population persistence through their effects on population density. There are several mechanisms for this effect. Research is needed to document the hypothesized linkages and to estimate their relative magnitudes.

Biographical Sketch: Dr. Lenore Fahrig, a Professor at Carleton University in Ottawa, studies the effects of landscape structure on abundance, distribution and persistence of organisms. In her research, Lenore uses spatial simulation modeling to formulate and test predictions using a range of different organisms. Her current work on road system ecology includes empirical studies of road impacts on small mammal and amphibian populations and movements, as well as generalized simulation modeling of population responses to road networks. Lenore obtained her Ph.D. in 1987 from the University of Toronto, Canada. Her postdoctoral fellowship was performed at the Virginia Coast Reserve LTER (University of Virginia, U.S.A.); she also previously worked as a Research Scientist in the Canadian Department of Fisheries and Oceans in Newfoundland, Canada.

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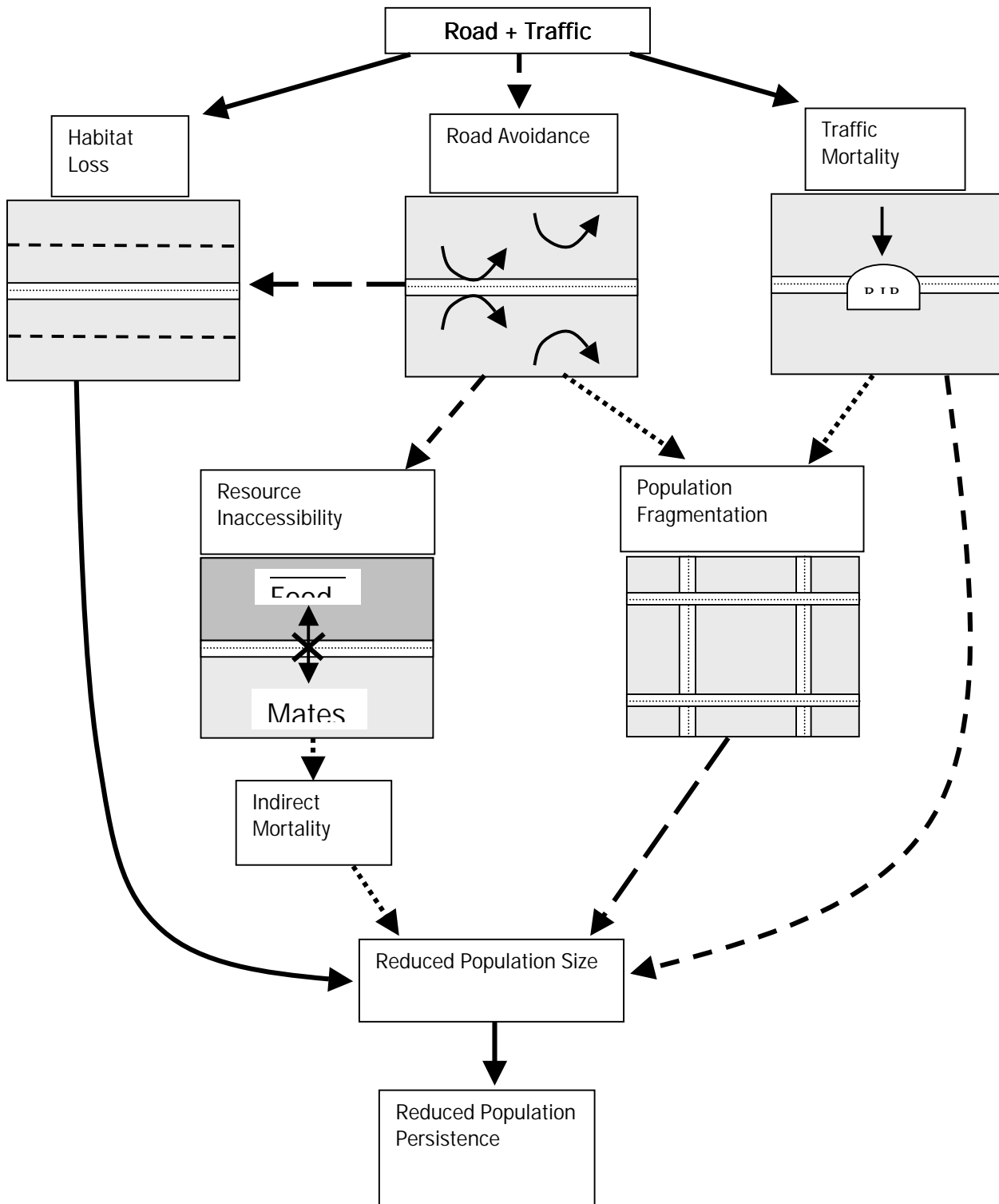


Fig. 1. Effects of roads and traffic on persistence of animal populations. Solid lines represent good evidence for the effect, dashed lines moderate evidence for the effect and dotted lines represent weak evidence, i.e., areas where further research should be a priority.