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Review

A meta-analysis of tropical forest edge effects on bird nest predation risk: Edge effects in avian nest predation

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ABSTRACT

Numerous studies have analyzed predation risk on bird nests along forest edges, but results are inconsistent and contributing factors not well understood. Few of these studies have been carried out in tropical regions, where predator communities and responses to edges may be different. In the face of ongoing forest fragmentation, understanding factors driving predation patterns along tropical forest edges are most likely crucial. We present a formal meta-analysis on tropical forest edge effects in nest predation, advancing the method applied by Batáry and Báldi (2004). We performed a meta-analysis of 20 tropical nest predation studies including data on more than 5000 artificial nests. We tested for edge effects on nest predation probability in relation to distance from a forest edge and assessed effects of forest cover, matrix type, geographic location and nest parameters. Further, we analyzed our data together with 13 nest predation studies from temperate forests (Batáry and Báldi, 2004) in a combined meta-analysis, summing up to evidence from almost 9000 nests. Our meta-analysis of the tropical nest predation studies did not provide evidence of a forest edge effect on nest predation probability, while the result of the combined meta-analysis suggested a higher nest predation probability along forest edges. However, heterogeneity was extreme in both analyses (I^2 = 85% and 90.1%), indicating that each study, with its unique characteristics, may result in varying nest predation patterns. Landscape context, here: forest cover, appeared to modulate nest predation risk in relation to edge distance. Conservation managers should be aware that a standard formula for conservation actions might be of little help, since edge effects seem to vary with study site settings and landscape context. We further point out that standardized reporting guidelines for primary research might help to interpret high variation in field data.

Contents

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1. Introduction

Numerous studies have evaluated the influence of edges on nest predation and avian breeding success. Although evidence of increased nest predation along forest edges has frequently been reported, results are inconsistent (Paton, 1994; Murcia, 1995; Heske et al., 2001; Lahti, 2001; Batáry and Báldi, 2004), and contributing factors not well understood (Chalfoun et al., 2002b). In particular, the edge type and landscape context are believed to influence the prevalence of edge effects in avian nest success (Andrén, 1995; Donovan et al., 1997; Hartley and Hunter, 1998; Marzluff and Restani, 1999; Lahti, 2001; Thompson et al., 2002). Indeed, increased nest predation has more often been detected along "sharp" forest-farmland edges than "soft" old forest-young forest edges (Angelstam, 1986; Marzluff and Restani, 1999; Lahti, 2001), possibly because open farming landscapes tend to support high densities of generalist predators which may opportunistically forage at the edge of adjacent forests (Andrén, 1995; Marzluff and Restani, 1999). Thus, higher densities of generalist predators would be expected in an agriculturally dominated landscape as compared to a forest dominated landscape. Accordingly, several authors have found that forest cover affects predation patterns along forest edges; edge effects tend to be more commonly found in moderately to highly fragmented landscapes (Donovan et al., 1997; Hartley and Hunter, 1998; Lahti, 2001; Thompson et al., 2002).

However, most evidence of edge effects in avian nest predation is derived from studies conducted in the temperate and boreal zones (Paton, 1994; Andrén, 1995; Murcia, 1995; Hartley and Hunter, 1998; Batáry and Báldi, 2004). Edge effect studies from the tropics are less common (Söderström, 1999; Lahti, 2001; Batáry and Báldi, 2004) and data on natural nests rare (Newmark and Stanley, 2011). Yet it might be especially important to learn more about factors driving predation patterns in tropical forest edges considering the recent and fast progressing deforestation and fragmentation in the tropics. It is unclear if our understanding of edge effects, derived from boreal and temperate forests, can be transferred to tropical ecosystems. Tropical forests differ from temperate and boreal forests in disturbance regime and biodiversity (Báldi, 1996); also the nest predator fauna can be expected to be more diverse in the tropics (Söderström, 1999). Tropical predator communities might respond differently to edges and fragmentation than predators from temperate and boreal zones (Söderström, 1999) and therefore produce different edge effects than would otherwise be expected.

Numerous edge effect studies are based on experiments with artificial nests. Artificial nest predation studies have received substantial criticism in the past (Zanette, 2002; Thompson and Burhans, 2004; Robinson et al., 2005b), because artificial nests may attract different predator sets than natural nests, resulting in different spatial patterns and predation rates. However, artificial nests may still be of interest in some cases and should not be condemned completely. Villard and Pärt (2004), for example, argue that "we should not throw the baby out with the bathwater" and that artificial nests might be an appropriate method under supervised conditions. Artificial nests may provide additional data to that from natural nests (Mezquida and Marone, 2003) or, if no data are available, provide surrogate information which "may be better than no data at all" (Faaborg, 2004). We are aware of the problems in interpreting artificial nest predation studies and the possibility of biases. However, our objective was to compare nest predation patterns in tropical and temperate forests and we were faced with a severe lack of natural nest predation data in the tropics (see below). Given the current data situation, we believe that our meta-analysis on tropical forest edge effects in nest predation serves as a first step in understanding differences in predation patterns between tropical and temperate forests. If marked differences do exist in nest predation patterns between these zones, they should also be reflected in artificial nests. Detailed distinctions, however, cannot be made until sufficient data on natural nest predation in tropical forests exist. We caution our readers to interpret the results of our meta-analysis with regard to the limitations intrinsic to artificial nest predation studies.

Several reviews have summarized existing studies on edge effects in nest predation (Paton, 1994; Andrén, 1995; Hartley and Hunter, 1998; Söderström, 1999; Lahti, 2001; Chalfoun et al., 2002b; Batáry and Báldi, 2004). However, to our knowledge we present the first formal meta-analysis on tropical forest edge effects in nest predation, advancing the method applied by Batáry and Báldi (2004) in their meta-analysis on nest predation in temperate regions. Following current conceptual understanding of forest edge effects on avian nest predation, we expected patterns similar to those described for temperate and boreal zones, namely higher predation risk at forest edges as compared to interiors, and greater prevalence of edge effects in moderately to highly fragmented landscapes. We further assessed effects of matrix type, geographic location and nest parameters. In this article, we use the term "edge effect" if nest predation risk is higher at the forest edge. We refer to a "reverse edge effect" if nest predation risk is lower at the edge compared to interior forest.

2. Methods

2.1. Literature search

We searched the Web of Science and BIOSIS databases in November 2009 and again in October 2012 for topics including the following combination of search terms: edge* AND forest* AND nest* AND (subtropic* OR tropic* OR neotropic*). We then manually searched through the title, abstracts and, if necessary, the full text of each article to decide whether the article matched our selection criteria. References cited in these articles were also checked. We included studies from a wide range of (sub-)tropical forest ecosystems. We only selected nest predation studies that provided amount or percent of predated nests in relation to distances from a forest edge. In order to generate effect sizes, the currency of a meta-analysis, we compiled a database with the overall number of nests and the number of predated nests in relation to distance from edge for each study (Appendix A). Data were often extracted from figures. If an author reported more than one