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Bird sensitivity to disturbance as an indicator of forest patch conditions: An issue in environmental assessments

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ABSTRACT

An Environmental Assessment (EA) is one of the steps within the Environmental Impact Assessment process. Birds are often used in EA to help decision makers evaluate potential human impacts from proposed development activities. A "sensitivity to human disturbance" index, created by Parker III et al. (1996) for all Neotropical species, is commonly considered an ecological indicator. However, this parameter was created subjectively and, for most species, there have been no rigorous field test to validate its effectiveness as such. Therefore, in this study, we aim to: (1) evaluate if, at the local scale, birds from forest patches in a human-modified landscape (HML) may differ in sensitivity from Parker's sensitivity classification; (2) evaluate the effectiveness of the species richness value at each sensitivity level as an ecological indicator; (3) gather information on how often and in which manner Parker's classification has been used in EA. To do so, bird sampling was performed in eight forest patches in a HML over one year. Then, we created a local sensitivity to disturbance using information about threat, endemism, spatial distribution and relative abundance of all species in the study area. We found that 37% of the forest birds showed different local sensitivity levels when compared with Parker's classification. Our results show that only the richness of high-sensitivity species from our local classification fitted the ecological indicator assumptions helping the environmental conditions evaluation of the studied patches. We conclude that species richness of each Parker's bird sensitivity levels do not necessarily perform as an ecological indicator at the local scale, and particularly in HML. Nevertheless, Parker's Neotropical bird sensitivity classification was used in 50% of EA we reviewed. In these, 76% assumed that it was an accurate ecological indicator of the local forest conditions for birds. The lack of clear criteria used in Parker's classification allows diverse interpretations by ornithologists, and there is no agreement about the ecological meaning of each sensitivity level and what environmental conditions each level may indicate of. Therefore, the use of Parker's classification in EA may jeopardize accurate interpretations of proposed anthropogenic impacts. Furthermore, because a bird species' sensitivity often varies between locations, we argue that Parker's generalized classification of bird sensitivity should not be used as an indicator of forest environmental conditions in EA throughout HMLs in Neotropics. Rather, local bird ecological indices should be explored, otherwise, erroneous predictions of the anthropogenic impacts will continue to be common.

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1. Introduction

Human impacts on natural ecosystems are ubiquitous, environmentally damaging, and likely to continue for the foreseeable future (Vitousek et al., 1997; Foley et al., 2005). One important tool to minimize and regulate these impacts is the Environmental Impact Assessment (hereafter EIA) (Glasson and Salvador, 2000; Carroll and Turpin, 2002; Slootweg and Mollinga, 2010; Sánchez and Croal, 2012). An EIA is a multidisciplinary and systematic process of evaluating and mitigating the impacts of proposed human development actions, such as industries, housing, infrastructure, mining, agriculture, etc. (Kolhoff et al., 2010; Sánchez and Croal, 2012). An EIA typically includes a multidisciplinary Environmental Assessment (hereafter EA), which includes an assessment of the biodiversity occurring in a given area where a potential impact will occur (CONAMA Resolution 001/86, CONAMA Resolution 237/1997, SMA Resolution 49/2014 but see Glasson and Salvador, 2000). In Brazil, as in many countries (Rajvanshi et al., 2010), this biodiversity assessment component is meant to help decision makers evaluate the possible environmental consequences of development activities (Glasson and Salvador, 2000; Silveira et al., 2010; Sánchez and Croal, 2012).

The EA is often limited by funding and time constraints (Thompson et al., 1997; Vasconcelos, 2006; Rajvanshi et al., 2010; Silveira et al., 2010). Thus, the selection of ecological indicator species can help to expediently assess the ecological condition of the environment under study (e.g., Temple and Wiens, 1989; Dale and Beyeler, 2001; Niemi and McDonald, 2004; Syrbe et al., 2013), as they may act as a surrogate measurement of other biological groups not accessed (Carignan and Villard, 2002; Niemi and McDonald, 2004). Birds are frequently used as indicator species (Byron, 2000; Vasconcelos, 2006; Silveira et al., 2010; Straube et al., 2010; Chang et al., 2013), because they are relatively easy to sample in the field (Gardner et al., 2008), and they are good indicators of habitat quality (e.g., Temple and Wiens, 1989; Stotz et al., 1996; Bradford et al., 1998; Canterbury et al., 2000; Carignan and Villard, 2002; Sutherland et al., 2004; Sekercioglu, 2006, 2012; Chambers, 2008). The landmark book "Neotropical Birds: Ecology and Conservation" by Stotz et al. (1996) includes a database with a variety of biological and ecological parameters for all bird species in the Neotropics (see database A, hereafter referenced as Parker III et al., 1996, as recommended by the authors). Herein, the authors highlight that species are differentially vulnerable to human disturbance. They rank each Neotropical bird species' "sensitivity to disturbance", as "high", "medium" or "low". A common interpretation of this parameter is to deem the occurrence of birds of high-sensitivity at a given site as an indication of good environmental conditions (e.g., Anjos, 2006; Anjos et al., 2009, 2010; Loures-Ribeiro et al., 2011). Consequently, this theoretical assumption fits the requirements of the Brazilian environmental legislation (item I, article 5° IBAMA Normative Instruction n.146/2007), which suggest biodiversity inventories in EA use ecological indicators (CONAMA Resolution 001/86, Straube et al., 2010). However, there is uncertainty as to how the "sensitivity to disturbance" parameter is representative of the ecological condition of a given site when used in this manner.

The "sensitivity to disturbance" parameter was created over 25 years ago. It was based on the authors' expertise, as well as reports and experience from other ornithologists about the relative frequency (high, medium, or low) of each species found in association with disturbed patches of its preferred habitat (J.W. Fitzpatrick personal communication, but see "Guide to the databases" on Parker III et al., 1996). While it was a groundbreaking and highly instructive work in 1996, there is considerable subjectivity in the rankings, and there is now significant evidence that it may be outdated or flawed. For example, some species listed as medium-sensitivity (e.g., Picazuro Pigeon – *Patagioenas picazuro*; Flavescent Warbler – *Myiothlypis flaveola*) and high-sensitivity (e.g., Gray-necked Wood-Rail – *Aramides cajaneus*; Uniform Finch – *Haplospiza unicolor*; Pavonine Cuckoo – *Dromococcyx pavoninus*; Red-crowned Ant-Tanager – *Habia rubica*) are frequently reported at highly impacted sites such as cities and agricultural landscapes (e.g., Willis and Oniki, 1987, 2002; Pozza and Pires, 2003; Franz et al., 2010; Cruz and Piratelli, 2011; Ferraz et al., 2012; Alexandrino et al., 2013). Thus, in order to assess the validity of using Parker's classification, it is important to evaluate whether species respond to human disturbance as expected from this parameter. Besides, taking into consideration that a species conservation status may vary at different geographical scales (Milner-Gulland et al., 2006; Brito et al., 2010), we may question whether the pan-Neotropical scale used in Parker's classification can efficiently reflect the status of a species' population at regional or local scales.

Henle et al. (2004) warn that interactions of species traits and environmental conditions must be considered to predict species sensitivity to human disturbance or habitat fragmentation, a procedure not used in Parker's classification. Only two studies have tested the consistency of Parker's "sensitivity to disturbance" classification in representing the effects of forest habitat loss and fragmentation on birds in Atlantic Forest patches (Ribon et al., 2003; Anjos, 2006). Besides, there is relatively little research assessing the variability in sensitivity of forest birds to anthropogenic disturbances and fragmentation effects at local scales in human-modified landscapes (HML) (e.g., Ribon et al., 2003; Anjos, 2006; Piratelli et al., 2008; Anjos et al., 2009, 2010, 2011; Loures-Ribeiro et al., 2011). This contributes to uncertainty about using Parker's classification in EAs.

Therefore, we test if, at the local scale, forest bird species from patches in a HML may show different levels of sensitivity to disturbance than Parker's classification. To do so, we developed a local metric of sensitivity to disturbance using threat status, endemism, spatial distribution and relative abundance of the species in the study area. We then evaluate the effectiveness of using Parker's classification as an ecological indicator of the effects of the forest habitat loss and fragmentation, by comparing the two classifications. Finally, we review the frequency and manner of use of Parker's classification in EA from a wide range of projects that were environmentally licensed in the last two decades. We conclude with a discussion of the shortcomings of and risk associated with using Parker's classification in EA.

2. Materials and methods

2.1. Study site selection

Field surveys were conducted in the Corumbataí River basin, in east-central São Paulo State (22°04′46″ S to 22°41′28″ S; 47°26′23″ W to 47°56′15″ W), Brazil (Fig. 1). This river basin was originally covered by semi-deciduous seasonal forest (Atlantic forest biome) and sparse savannah woodland (Cerrado biome). However, after years of human modification, it is now composed of small (e.g., Charqueada with around ~15,000 inhabitants) to medium cities (e.g., Rio Claro with ~200,000 inhabitants) (IBGE, 2015) surrounded by a predominantly agricultural mosaic. Of the 1710 km^2 in the river basin, 44% is cattle pasture (located mostly in the north), 26% is sugar cane (mostly in the south), 11% is native forest, and 0.7% is savannah woodland (Valente and Vettorazzi, 2003). The native forest is in small, isolated patches throughout the basin (Valente and Vettorazzi, 2003; e.g., Ferraz et al., 2014). This region is representative of the Brazilian agricultural landscapes that are found within the original boundaries of the Interior Atlantic Forest biome