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Technical quality of fauna monitoring programs in the environmental impact assessments of large mining projects in southeastern Brazil

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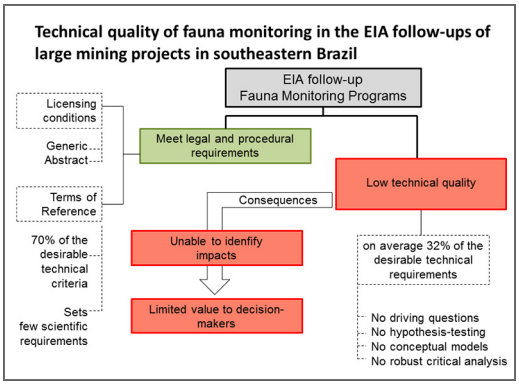
HIGHLIGHTS

- Fauna monitoring is an important part of EIA follow-up programs.
- Current fauna monitoring has strong limitations.
- Fauna monitoring reports have limited value to decision-makers and stakeholders.
- Findings indicate the need for regulatory change.

GRAPHICAL ABSTRACT



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ABSTRACT

Biodiversity monitoring is a key element of impact assessment follow-up activities, as it has the potential to generate relevant information about the actual impacts of approved projects on the environment. However, the effectiveness of such monitoring programs depends on issues such as technical quality. The extent to which this issue actually affects biodiversity monitoring is unclear. This knowledge gap was addressed in this study, whose main objective was to analyze the technical quality of fauna monitoring, using empirical data from large-scale mining enterprises in the state of Minas Gerais in southeastern Brazil. More specifically, this study aimed at analyzing: 1) whether license conditions related to fauna monitoring programs were being met by mining companies; 2) the extent to which fauna monitoring programs met a set of technical quality criteria; 3) whether there were significant differences among taxonomic groups; and, finally, 4) how fauna monitoring programs can be made more meaningful to decision-makers. A total of 236 fauna monitoring reports were analyzed. Findings indicated that, while companies complied with all license conditions, their fauna programs met, on average, 32% of the desirable technical requirements, and there were no significant differences among taxonomic groups. The main technical quality gaps were found to be lack of driving questions, hypothesis-testing and conceptual models, as well as lack of comparisons between control and impacted areas. Overall, findings indicated that the data generated in such programs have very limited value to decision-makers as they do not shed

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sufficient light on the actual impacts of mining activities on biodiversity. The study discusses a number of barriers to more meaningful fauna monitoring programs, and highlights the urgent need for revising current Terms of Reference.

1. Introduction

Population and economic growth are putting enormous pressure on the world's ecological systems (WWF, 2016). Natural habitats destruction has become the main cause of decline of many wildlife species and populations (Mace et al., 2005). To address this problem, both public and private actors have been increasingly adopting biodiversity monitoring programs under a variety of frameworks and formats. For instance, such monitoring programs are now a key component of environmental impact assessment (EIA) follow-up activities, as decision-makers want to make sure that approved projects are able to mitigate and compensate the actual impacts of new developments on biodiversity.

EIA is arguably the world's most widespread environmental policy tool used in the decision-making of proposed projects and strategic undertakings (Morgan, 2012). While EIA has been improving since it was first regulated in the United States in 1969 (Glasson et al., 2005), it still faces many challenges (Fischer and Noble, 2015; Anifowose et al., 2016). A long-persistent concern has been the treatment of biodiversity in EIAs (Buckley, 1995). However, such concerns are often associated with problems in the pre-approval stages of EIA, related, for example, to screening (Slootweg and Kolhoff, 2003) and impact statements (Geneletti, 2006). Very few studies have addressed the challenge of evaluating biodiversity in EIA follow-ups, when approvals have already been granted.

EIA follow-up has been defined as "the monitoring and evaluation of the impacts of a project or plan (that has been subject to EIA) for management of, and communication about, the environmental performance of that project of plan" (Morrison-Saunders and Arts, 2004, p. 4). In the context of mining projects, which are often located in remote areas, the inclusion of biodiversity monitoring programs among the many EIA follow-up activities is essential to ensure sound environmental management.

Biodiversity monitoring program is an umbrella term for a variety of activities that encompass the collection and analysis of data in order to characterize environmental conditions over time (Elzinga et al., 1998; Yoccoz et al., 2001) and identify changes and trends (Thompson et al., 1998). Among its potential benefits are: a) understand the extent to which stressors affect the environment; b) determine the effectiveness of existing control and mitigation measures; c) enable predictions of various kinds; and d) educate decision-makers as to what needs to be done to enhance environmental management and conservation (Noon, 2003). Sound biodiversity monitoring programs should emerge from critical thinking (Lindenmayer and Likens, 2009, 2010a) and extensive discussions over three key questions: why, what and how to monitor? (Yoccoz et al., 2001). Monitoring programs that are carefully thought-out to answer scientific questions and guided by conceptual models have also a higher chance of achieving objectives (Lindenmayer and Likens, 2009).

The effectiveness of EIA follow-up programs have long been preoccupying scholars and analysts both globally and in Brazil (*e.g.* Dipper, 1998; Morrison-Saunders et al., 2003; Noble and Storey, 2005; Sánchez and Gallardo, 2005; Garcia and Fonseca, 2018). Among the main concerns are legal compliance, public participation, regulatory design, policy enforcement, among others. However, very few studies, if any, have addressed the specific issues involved in biodiversity monitoring programs, in spite of its widespread use and importance for project managers worldwide.

Few countries provide in-depth technical guidance and technical criteria for implementing biodiversity monitoring (Dipper, 1998). That is certainly the case in Brazil, where guidance is mainly provided through Terms of Reference (ToR) issued by environmental authorities in the EIA/licensing process. However, such ToRs tend to be excessively vague and generic (Sanchéz, 2013). The lack of regulation and detailed guidance often leads to the use of a plurality of discretionary solutions by both developers and government authorities. The content and reach of current biodiversity monitoring programs are further obscured by the lack of public information systems on EIA information. Dias et al. (2017), realizing this context of limited guidance and transparency, argued that mining companies and government agencies could be wasting both time and money into monitoring programs that, although playing an administrative role in the EIA process, were not clearly affecting decisions and translating into wildlife conservation on the ground.

The objective of this study was to analyze the technical quality of biodiversity monitoring programs in the follow-up stages of impact assessments, using empirical data from fauna monitoring records generated by licensed large-scale mining projects in the state of Minas Gerais in southeastern Brazil. More specifically, this study aimed at analyzing: 1) whether license conditions related to fauna monitoring programs were being met by mining companies; 2) the extent to which fauna monitoring programs met a set of technical quality criteria; 3) whether there were significant differences among taxonomic groups; and, finally, 4) how fauna monitoring programs can be made more meaningful to decision-makers. While the empirical data were collected in southeastern Brazil in connection with fauna monitoring of mining enterprises, findings are likely to appeal to a broad international audience concerned with the effectiveness of biodiversity monitoring programs. EIA, as previously mentioned, is present in virtually every country on Earth. Moreover, the analytical framework presented further below in the Methods section can be useful to scholars and practitioners interested in the design of biodiversity monitoring programs, in the context of EIA follow-ups and other of environmental policies.

2. Methods

2.1. Study area

The state of Minas Gerais, in southeastern Brazil, is the country's most traditional mining jurisdiction, a fact hinted by its Portuguese name "Minas Gerais", which, in English, means "vast mines". Its territory, which is larger than countries such as Spain or Poland, houses more than 20 million people (IBGE, 2017), and ranked 2nd in national mineral production in 2015 (DNPM, 2016). The present study arbitrarily selected licensed mining projects which operated in an iron-rich region, known as Iron Quadrangle, which is about 7000 km^2, and has long been addressed in many scientific studies (see Fig. 1).

The Iron Quadrangle houses priority areas for biodiversity conservation (Drummond et al., 2005) and for ecosystem services provision (Duarte et al., 2016). Endemic amphibians and plants, particularly in "campus rupestres" (a particular rocky outcrop), are part of the iron quadrangle, making it a relevant and unique ecological system (Drummond et al., 2005). However, mineral developments and their respective logistical, industrial and housing infrastructure have long and increasingly been affecting natural habitats. Not only mitigation, but also restoration and rehabilitation actions are seen as fundamental in the state's biodiversity policies (Drummond et al., 2005). Minas Gerais has a mandatory EIA/licensing systems since the early 1980s. While important, as Viana and Bursztyn (2010) pointed out, the effectiveness of