This is the author's final version of the work, as accepted for publication following peer review but without the publisher's layout or pagination. The definitive version is available from the jornal Impact Assessment and Project Appraisal; https://doi.org/10.1080/14615517.2022.2084231

Translating Best Practice Principles into criteria for evaluating the consideration of biodiversity in SEA practice

Amarilis Lucia Casteli Figueiredo Gallardo (corresponding author)
Smart and Sustainable Cities Program at University Nove de Julho (Uninove)/ Polytechnic School, University of São Paulo (USP), São Paulo, Brazil – amarilisgallardo@usp.br
https://orcid.org/**0000-0002-5169-997X**

Cintia Aparecida da Conceição dos Santos
University Nove de Julho (Uninove), São Paulo, Brazil – cintia489@hotmail.com

Alan Bond
School of Environmental Sciences, University of East Anglia (UEA), England, UK; Research Unit for Environmental Sciences and Management, North-West University, Potchefstroom South Africa – alan.bond@uea.ac.uk
https://orcid.org/**0000-0002-3809-5805**

Evandro Mateus Moretto
School of Arts, Sciences and Humanities, University of São Paulo (USP), São Paulo, Brazil – evandromm@usp.br
https://orcid.org/**0000-0002-8082-387X**

Marcelo Montaño
Sao Carlos School of Engineering, University of São Paulo (USP), Brazil – minduim@usp.br
https://orcid.org/**0000-0003-0001-8801**

Simone Athayde
Department of Global and Sociocultural Studies and Kimberly Green Latin American and Caribbean Center, Florida International University (FIU), Miami, USA - sathayde@fiu.edu
https://orcid.org/**0000-0002-3820-6595**

Translating Best Practice Principles into criteria for evaluating the consideration of biodiversity in SEA practice

Abstract

Biodiversity is a core issue in the quest to achieve sustainable development. Although Strategic Environmental Assessment (SEA) includes biodiversity as an environmental component to consider in decision-making, its inclusion remains a challenge. Since the beginning of SEA practice, several guides have been proposed to address this challenge, but evaluating their success remains problematic. This paper, therefore, aims to develop an easily applied, criteria-based approach for evaluating the biodiversity assessment that takes place within SEA. A test application of the evaluation framework, based on the International Best Practice Principles on Biodiversity and Ecosystem Services in SEA, demonstrates its success in identifying whether the main elements of biodiversity were considered in a SEA report. However, the criteria focus on inclusion or exclusion of specific details, rather than the substance of the biodiversity consideration, and so further studies need to develop evaluative approaches for the substantive inclusion of biodiversity in SEA practice.

Keywords: Strategic Environmental Assessment; Biodiversity; Best Practice Principles; Ecosystem Services; Brazil

1. Introduction

Biodiversity is a complex and a multifaceted environmental component (Rozas-Vásquez et al., 2019). It has a pivotal place in international policies and conventions for promoting sustainable development (Geneletti, 2003) because economic progress has invariably affected biodiversity (Groves et al., 2012; Gunasekaran et al., 2014). The importance of including considerations of biodiversity in decision-making processes supported by Impact Assessment (IA) have long been acknowledged (Treweek et al., 2005; Gontier et al., 2006; de Witt et al., 2019; Fornara et al., 2020). And, since the agreement of the Convention on Biological Diversity (CDB) in 1992, increased emphasis has been placed on integrating biodiversity considerations within decision-making guided by IA processes (Gutierrez et al., 2021).

International Best Practice Principles for embracing biodiversity in IA, including both project-level Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA), were first published by the International Association for Impact Assessment (IAIA) in 2005 (IAIA, 2005); these were updated in 2018 (Brownlie and Treweek,

2018). These principles are compatible with the aims and objectives of the main milestones of international biodiversity protection that also are aligned with the performance standards and requirements of international finance institutions (Brownlie and Treweek, 2018).

Whilst many researchers agree that biodiversity should be explored through project-level EIA (Geneletti, 2003; Slootweg and Kolhoff, 2003; Gontier et al., 2006; Söderman, 2006; Karlson et al., 2014; Bueno and Peres, 2020; Mandai and de Souza, 2021; Bond et al., 2021; Gannon, 2021), others argue that better outcomes are possible where biodiversity is considered through the SEA of plans and programs (Byron and Treweek, 2005; Gontier et al., 2006; Mörtberg et al., 2007; Rajvanshi et al., 2011; Honrado et al., 2013). This is because SEA embeds the main sustainability issues in the decision-making associated with the development of policies, plans and programmes (Morrison-Saunders and Thérivel, 2006; Partidário, 2012; Fischer and Onyango, 2012), which is a scale better suited to address the major threats to biodiversity, which are habitat loss and fragmentation (Gontier et al., 2006). SEA, therefore, also has a role in ensuring that developments are consistent with the CDB, and other international agreements protecting biodiversity, including the Ramsar Convention and the Convention for Migratory Species (Treweek et al., 2005).

Many proposals have been made that biodiversity and ecosystem services should be embedded into SEA practice (e.g., Partidário and Gomes, 2013; Honrado et al., 2013; Geneletti, 2011; Geneletti, 2015), and some applications have been documented (e.g., Karjalainen et al., 2013; Kumar et al., 2013; Rosa and Sánchez, 2016; Rosa et al., 2018; Geneletti, 2016; Gallardo et al., 2022). But according to Treweek (2001), Slootweg (2021), Rajvanshi et al. (2010), Rajvanshi et al. (2011), Honrado et al. (2013) and Slootweg (2016), biodiversity remains poorly considered in SEA leading to failures in integrating biodiversity in decision-making and in ensuring its protection. That is, the practice of SEA fails to meet its potential with regards to the consideration, and subsequent protection, of biodiversity. Given this as our problem statement, in this paper we aim to develop an approach for evaluating the biodiversity assessment that takes place within SEA through the development of easily applied criteria, and a test application in Brazil.

In this paper we focus on Brazil because a large part of the world's biodiversity is represented in the Brazilian biomes that play a significant role in preserving climate stability (Fernandes et al., 2017). Brazil is ranked first in terms of global megadiversity, hosting between 15% and 20% of all the world's biodiversity, the largest number of endemic species, the biggest tropical forest (the Amazon) and two of the 19 world hotspots (the Atlantic Forest

and the Cerrado) (Prates and Irving, 2015). The signatories of the CBD (there are now 196 signatories' countries – Hoban et al., 2021) established, in 2010, the Strategic Plan for Biodiversity 2011-2020, and agreed 20 targets (known as the Aichi biodiversity targets) for reducing the loss of biodiversity on a global scale (Lima Junior et al., 2018). Brazil established ambitious targets to achieve these Aichi Targets in the Brazilian Biodiversity Resolution (Pacheco et al., 2018).

Following Pinto et al. (2019), we advocate that a set of simple and objective criteria can encourage their application and consequently contribute to improving the protection of biodiversity at the planning level. The benchmark principles will be the International Association for Impact Assessment's (IAIA) Best Practice Principles for Biodiversity and Ecosystem Services in Impact Assessment (Brownlie and Treweek, 2018). To demonstrate the utility of these criteria, they will be applied to a representative sample of Brazilian SEA reports. This additionally provides an opportunity to evaluate the discretionary SEAs to develop a better process which can form the basis of a legal system in the future.

This approach sets out a process for benchmarking current practice, and therefore acts as the first step in improving that practice. The paper is structured as follows. In the next section, the methods introduce and justify our case application of Brazil and, after a literature review of the procedures available, we present the selected criteria for evaluating biodiversity assessment within the SEA process and explain how to implement them. The criteria are applied and the results presented in section 3, before discussing the wider implications of the research, and concluding, in section 4.

2. Methods

Given the aim of the research to develop an approach for evaluating the biodiversity assessment that takes place within SEA through the development of easily applied criteria, and a test application in Brazil, this section introduces the relevance of the Brazilian context for the proposed analysis (section 2.1), describes the characteristics of the selected Brazilian sample (section 2.2) that comprises the test application, and presents the proposed framework developed from previous literature (section 2.3).

2.1 Case application – Brazil

IA instruments (including EIA and SEA) are considered key to biodiversity protection in Brazil given that landscapes rich in biodiversity cover multiple societal values which need to

be balanced in development planning (Heiner et al., 2019). Brazil has great experience of applying EIA to projects (Gallardo and Bond, 2011a; Cruz et al., 2018; Duarte and Sánchez, 2020; Moretto et al. 2021) including evaluating the impacts on biodiversity (Rosa and Sánchez, 2016; Souza and Sánchez, 2018; da Silva Dias et al., 2019; Falavigna et al., 2020; Pimenta and Fonseca, 2021) and understanding the basis for good practice (Gallardo and Bond, 2011b; Duarte et al., 2017), but SEA has not yet been mandated in Brazil (Sánchez, 2017; Gallardo et al., 2016; Malvestio and Montaño, 2019; Siqueira-Gay and Sánchez, 2019). Nevertheless, since 1994, some attempts, mainly at the state level, have been carried out to formalize SEA processes for planning (Gallardo et al., 2021), mainly under the sponsorship of the multilateral finance banks (Pellin et al., 2011). Consequently, about 60 SEAs have been undertaken in the country on a discretionary basis (Tshibangu and Montaño, 2019).

The absence of a formal legal process for adopting SEA in Brazilian planning reinforces procedural weakness in those that do take place (Montaño and Fischer, 2019; Malvestio and Montaño, 2019). As an example, even with a well-founded national climate change policy, Brazilian SEA reports do not adequately address climate change issues. Therefore, SEA suffers from a lack of mandate, and a lack of capacity to influence strategic decisions in Brazilian planning where it is implemented on a discretionary basis (Nadruz et al., 2018).

Considering the Brazilian biodiversity richness (Fearnside, 2016; Meli et al., 2017), the commitments assumed by Brazil in protecting biodiversity (Fernandes et al., 2017; Pacheco et al., 2018), and the threats to biodiversity (Ferrante and Fearnside, 2019; Ferrante et al., 2021; Siqueira-Gay et al., 2020; Siqueira-Gay and Sánchez, 2020), Brazil represents an appropriate case study to develop an exploratory research aiming to identify how the best principles for biodiversity assessment can be embedded into the emerging SEA system (Tshibangu and Montaño, 2019).

2.2. Brazilian SEA Report sample

There is no official repository of SEA planning initiatives in Brazil (Montãno et al., 2014; Rizzo et al., 2017). The most recent survey of Brazilian SEA cases reports a limited experience comprising about 60 cases (Tshibangu and Montaño, 2019). Considering this population of SEA cases, the sample of SEA reports was selected using the same criteria established by Nadruz et al. (2018), that it should: a) cover a wide temporal sequence (1997 to 2014); b) cover different sectors; c) secure a geographical representativeness throughout the country and its six biomes; and d) present an evident link with biodiversity.

Thirty-five SEA reports were selected, covering four development sectors (energy, regional development, transport, and tourism) and distributed throughout the country and including all types of Brazilian biomes (Amazon, Atlantic Forest, Caatinga, Campos Sulinos or Pampas, Cerrado and Pantanal) (Table 1 and Figure 1).

Table 1 – Brazilian SEA reports selected, year of publication (in parenthesis) and related sectors.

Strategic Environmental Assessment Report	Sector
1.Brazil-Bolívia Gas Pipeline (1997) – national (program)	Energy
2.Chopim River Basin (2002) – sub-regional (plan)	
3.Areia River Basin (2002) – sub-regional (plan)	
4.Oil & Natural Gas Sector (2003) – sub-regional (plan)	
5.Rural Electrification Program (2005) – sub-regional (program)	
6.Verde River Basin (2007) – sub-regional (plan)	
7.Hydropower Program (2007) – state (program)	
8.Petrobras Program - Guanabara Bay (2009) – local (program)	
9.Turvo River Basin (2009) – sub-regional (program)	
10.Port, Industrial, Naval Offshore Planning (2010) – sub-regional (plan)	
11.Eucalyptus Forestry and Biofuel (2011) – sub-regional (plan)	
12.Portfolio of National Axes (2003) – national (program)	Regional Development
13.Social and Environmental Program - Manaus (2004) – local (program)	
14.Sustainable Development Program for the Sergipe Semi-Arid (2005) – sub-regional (program)	
15.Program for Improving the Urban Environmental Quality of Amapá (2006) – local (program)	
16.Alto Paraguai River Basin Development (2008) – sub-regional (plan)	
17.Corumbá Mining-Industrial Pole and Influences on the Pantanal Plain (2008) – local (program)	
18.Industrial Development Plan for Espírito Santo (2008) – state (plan)	
19.Conservation and Sustainable Management Planning for the Caatinga Biome (2010) – sub-regional (plan)	
20.Transportation Program by IDB II, 1st Phase (2002) – local (program)	Transport
21.Road Ring Program Mário Covas (2004) – sub-regional (program)	
22.Accessibility Program for Small-Scale Municipalities (2006) – sub-regional (program)	

23.São Paulo Road Recovery Program (2005) – state (program)	
24.Minas Gerais Road Program (2007) – state (program)	
25.Integrated Brasilia Transport Program (2007) – state (program)	
26.Açu Industrial and Port Complex (2009) – sub-regional (program)	
27.Multimodal Transport and Mineral-Industrial Development Program (2010) – sub-regional (program)	
28.Metropolitan Arch of Rio de Janeiro (2010) – local (plan)	
29.Regional Integrated Development Plan - Capricorn Axis Bioceanic Corridor (2011) – regional (program)	
30.North Coast Tourism Development Plan (2007) – regional (plan)	Tourism
31.Tourist Poles of the State of Rio de Janeiro - Coastal Area (2011)– sub-regional (program)	
32.Tourist Poles of the State of Rio de Janeiro - Mountain Area (2011)– sub-regional (program)	
33.Plan for the Integrated Development of Sustainable Tourism (2011) – sub-regional (plan)	
34.Regional Tourism Development Programs of the Campo Grande Area (2014) – sub-regional (program)	
35.Regional Tourism Development Programs of the Serra da Bodoquema Area (2014) – sub-regional (program)	

Note – after the title of each SEA document, information is presented on the type of plan (Plan or Program) and its governance level (local, subregional – more than one city, state - inside only one state, regional – more than one state, national) is presented. Governance level was determined by the identification and objective of the SEA.

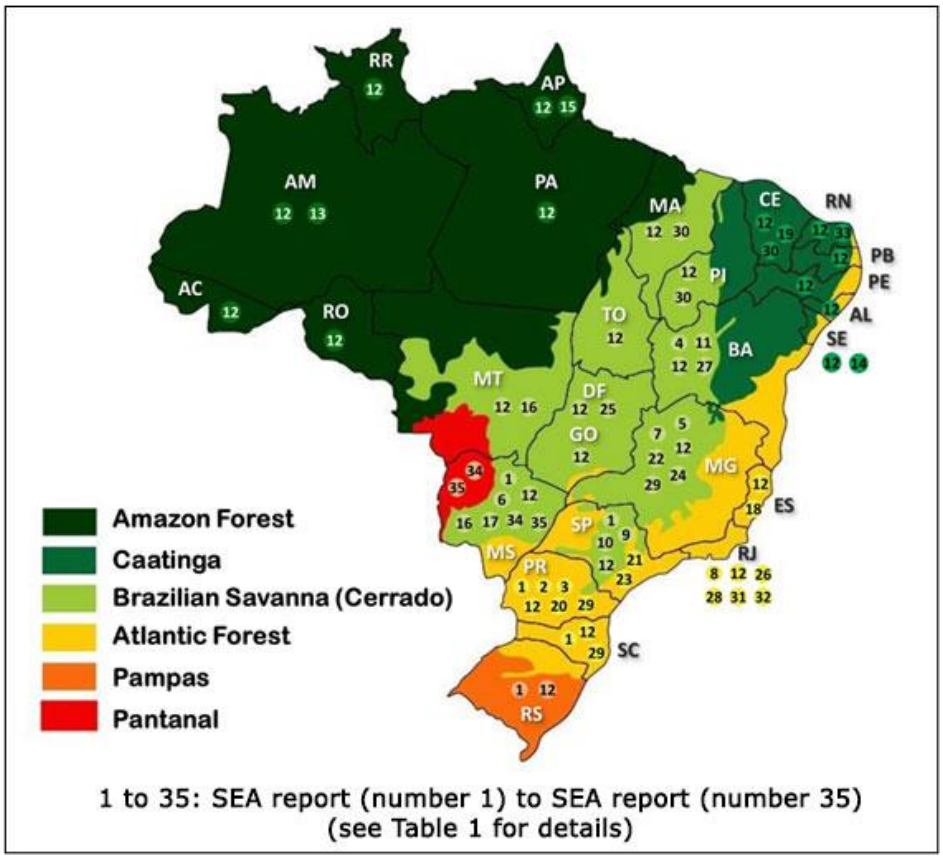

Figure 1 – Spatial distribution of Brazilian SEA reports selected (referred by numbers related to Table 1) by states and biomes.

2.3. Establishing a framework comprising a set of criteria for Best Practice SEA embedding biodiversity

In order to develop criteria in line with best practice principles, we have been cognisant of other attempts to develop evaluative criteria for the biodiversity element of impact assessments. Mandai and de Souza (2021) proposed guidelines with 60 indicators for embedding biodiversity in EIA using CBD recommendations, systematic review, and perceptions of EIA practitioners. These are comprehensive, but too time consuming for application to multiple case studies when trying to gain an overview of issues with practice. In particular, following Pinto et al. (2019, p.4), "the set of criteria should be succinct and easy to apply in practice on the basis that this will increase the likelihood of gaining traction and uptake with practitioners". Regarding biodiversity in SEA, Rajvanshi et al. (2011) set out criteria for evaluating the implementation of biodiversity enhancement measures in SEA. Therefore, these have a different goal which, whilst we regard it as important, is secondary to attempts to meet the obligations imposed by the CBD. Gutierrez et al. (2021) derived 26 criteria to evaluate the nine Principles from the IAIA Best Practice Principles on Biodiversity and Ecosystem Services (see Brownlie and Treweek, 2018, p.2 for a list of these nine principles) through application to six Australian SEAs for urban development plans, also arguing that they are suitable for

application to SEAs conducted elsewhere in the world. However, we regard many of the IAIA Best Practice Principles as evaluating environmental assessment process elements rather than focussing on biodiversity, therefore these have a broader scope than biodiversity. Whitehead et al. (2017) proposed an assessment approach for dealing with cumulative biodiversity impact only in SEA, which is too restrictive in focus for our purpose. Frameworks and criteria have also been developed to assess the integration of ecosystem services in SEA (Partidário and Gomes, 2013; Honrado et al., 2013; Geneletti, 2015) and even to assess green infrastructure supported by SEA (Chanchitpricha and Fischer, 2022) which we regard as having merit, but again with a focus that does not match with our focus on biodiversity outcomes consistent with the CBD.

Specifically, the key principle of the IAIA Best Practice Principles on Biodiversity and Ecosystem Services in Impact Assessment is "Principle 5, Design baseline surveys and assessments to generate the information and understanding needed to support an evidence-based approach to assessment of impacts on biodiversity and ecosystems" (Brownlie and Treweek, 2018, p.4) as this addresses the evidence base that should be considered in relation to biodiversity and ecosystem services and provides the main focus of our criteria.

The previous version of the IAIA Best Practice Principles for Biodiversity (IAIA, 2005) gave some clarity over the specific questions that would need to be asked to fully address biodiversity in the impact study. Following the CBD as signed in 2005, three biodiversity levels were adopted – genetic, species and ecosystem – as proposed by Treweek et al. (2005). According to the Brazilian Ministry of Environment (MMA, 2022) biodiversity represents the number of different biological categories (wealth) on the planet and the relative abundance of these categories (equitability), including variability at the local level (alpha diversity), biological complementarity between habitats (beta diversity) and variability between landscapes (diversity range). According to the US Council on Environmental Quality CEQ (1993) and Treweek et al. (2005), biodiversity can be better understood considering genetic diversity (which explains variations within species), the species diversity (which explains variations across individual species) and ecosystem diversity (which explains the variation of ecosystem types in each area). For Verma (2016) protecting these three levels of biodiversity is essential to safeguard biodiversity, its values, and human race survival. Some authors also highlighted relationships between levels of diversity and success for conservation planning initiatives (Gugerli et al., 2008; Di Minin and Moilanen, 2012).

As discussed in Treweek et al. (2005) the genetic level is difficult to directly measure at the strategic level, but it can be captured through the evaluation of the other two levels. Indeed, reference to the genetic level has been removed from the revised Best Practice Principles on Biodiversity and Ecosystem Services in Impact Assessment (Brownlie and Treweek, 2018).

Therefore, our evaluation of the literature review indicated that the most appropriate criteria for the evaluation of the consideration of biodiversity in Brazilian SEAs were established in the now superseded criteria published in Treweek et al. (2005). These provide sufficient detail for evaluation against principle 5 of the revised Best Practice Principles on Biodiversity and Ecosystem Services in Impact Assessment (Brownlie and Treweek, 2018), which no longer provide specific evaluation criteria. But the genetic level has been excluded as being unlikely to be represented in any SEA (thereby honouring the aim to deliver simple criteria to encourage their application, after Pinto et al., 2019). Kolhoff and Slootweg (2005) and Söderman and Saarela (2010) also explored the consideration of biodiversity in SEA using the biodiversity levels as proposed by IAIA (2005) applied to spatial plans in the Netherlands and Finland, respectively. Following this example, our criteria are different from those proposed previously to explore biodiversity in SEA, but sufficiently simple to use that we might expect more practical application globally.

Table 2 presents the set of criteria synthesized from Treweek et al. (2005) that we use to evaluate biodiversity in SEA.

Table 2 – Criteria for evaluating SEA practice against IAIA Best Practice Principles for Biodiversity and Ecosystem Services in IA.

Criteria
How will the plan affect the species level of biodiversity? At the species level, to what extent will the proposal: 1. change the species-richness or species-composition of communities or habitats in the study area? 2. change the species-composition of communities? 3. cause some species to be lost from the area? 4. affect species identified as priorities in National Biodiversity Strategies and Action Plans? 5. increase the risk of invasion by alien species?

How will the plan affect the ecosystem level of biodiversity? At the ecosystem level, to what extent will the proposal: 6. change the amount, quality or spatial organization of habitats? 7. affect plans to enhance habitat availability or quality? 8. damage ecosystem processes and services, particularly those on which local communities rely?
How will the plan consider alternatives and opportunities, respectively, to offer habitat to support species populations and to connect habitats? To what extent will the proposal consider: 9. if habitats will be lost or altered, is alternative habitat available to support associated species populations? 10. the opportunities to consolidate or connect habitats?

Applying the criteria does require some consideration of semantics. That is, there needs to be some understanding that text can make reference to the elements listed in the criteria, but perhaps using different wording. Therefore, to apply the criteria, some basic coding of the text in the sample of SEA reports is required. Therefore, a qualitative content analysis based on Osgood (1959) and Mayring (2014) was applied to characterize how the different levels of biodiversity were considered in the SEA reports as follows:

a) definition of the *registry units*, which are keywords that represent the two biodiversity levels (species and ecosystem levels). To avoid bias, we also used derived words and keywords, which resulted in 47 registry units (for example, biodiversity/diversity, richness/rich; all 47 registry units in Portuguese are provided in supplementary data);

b) choice of the *context units* (identification of the relevant chapter of the SEA to analyse, based on the summary of each SEA report). Then context units represent one chapter or more chapters that addressed biodiversity issues in each analyzed SEA. For example, in SEA report number 13, chapter 7, called Prognosis, was analyzed and in SEA report number 24 one of the analyzed chapters was called Scenarios for the development of the study area. The supplementary material presents the context units for all studied SEA reports);

c) *codification*, which in our case included the verification of the relationship between *registry units* and the biodiversity levels after reading the topics chosen in the previous step (*context units*), in order to answer the questions presented in Table 1 in each of the 35 SEA reports**.**

Table 3 indicates, using one hypothetical example, how the qualitative analysis was undertaken.

Table 3 – Qualitative analysis.

SEA report	Identifying each *registry unit* in the selected *context units*	Analysing which criterion this codification matches by answering questions from Table 2	Quantifying how many times each criterion is matched
4	"biodiversity" and "species" and "rich" in Chapter 4	Criterion 1	6 times
7	"species" and "individual" in part of the Chapter 4 and Chapter 6	Criterion 3	3 times
18	"species" and "habitat" and "alternative" in Chapter 2 and Chapter 3	Criterion 6	15 times
33	"adaptation" and "adapt" and "amount" and "population" and "plan" in Chapter 3, Chapter 4 and Chapter 5	Criterion 9	1 time

3. Results

Table 4 presents the results for applying the criteria to the sample of Brazilian SEA reports.

Table 4 – Results

	SEA reports	Year	Biomes	Level of governance	Type of plan	Authors of SEA reports	Species					Ecosystem			Alternatives and opportunities		sum of mentions of criteria for SEA report	number of criteria mentioned/ total number of criteria
							1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**		
1	1. Brazil-Bolívia Gas Pipeline (Mato Grosso do Sul, São Paulo, Paraná, Santa Catarina, Rio Grande do Sul)	1997	2PAFCE	N	PR	O	0	0	0	0	0	10	2	1	0	0	13	3/10
2	2. Chopim river basin, (Paraná)	2002	AF	S	PL	Q	3	0	0	0	0	2	1	3	0	0	9	4/10
3	3 Areia river basin (Paraná)	2002	AF	S	PL	Q	1	0	0	0	0	0	0	0	0	0	1	1/10
4	4. Oil & Natural Gas Sector (Bahia)	2003	AF	S	PL	B	15	0	1	0	1	11	4	0	0	0	33	5/10
5	5. Northwest of Minas Gerais Rural Electrification Program (Minas Gerais)	2005	CE	S	PR	D	5	0	0	0	0	10	0	0	0	0	15	2/10
6	6. Verde river basin (Mato Grosso do Sul)	2007	CE	S	PL	Q	8	0	1	1	0	16	5	0	0	0	31	5/10
7	7. Minas Gerais hydropower generation program (Minas Gerais)	2007	AFCC	I	PR	A	0	0	0	0	0	15	0	0	0	0	15	1/10

8	8. Petrobras Investment Program in the Guanabara Bay (Rio de Janeiro)	2009	AF	L	PR	B	7	1	1	0	0	11	4	3	0	0	27	6/10
9	9 Turvo river basin (São Paulo)	2009	AF	S	PR	N	0	0	0	0	0	1	2	0	0	0	3	2/10
10	10. Planning of the Port, Industrial, Naval Offshore Dimension on the São Paulo Coast (São Paulo)	2010	AF	S	PL	A	11	1	1	0	0	23	3	0	0	0	39	5/10
11	11. Expansion Plans of Eucalyptus Forestry and Biofuel in the Extreme South of Bahia (Bahia)	2011	AF	S	PL	B	0	0	0	0	0	38	0	0	0	0	38	1/10
12	1. Portfolio of National Axes - Ministry of Planning (different states in Brazil)	2003	All	N	PR	U	1	0	0	0	0	13	0	0	0	0	14	2/10
13	2. Social and Environmental Program of the Manaus Igarapes (Amazonas)	2004	ZF	L	PR	E	1	0	0	0	0	4	0	0	0	0	5	2/10
14	3. Sustainable Development Program for the Sergipe Semi-Arid (Sergipe)	2005	CA	S	PR	J	3	0	0	0	0	2	0	0	0	0	5	2/10
15	4. Program for Improving the Urban Environmental Quality of Amapá (Amapá)	2006	ZF	L	PR	L	0	0	0	0	0	9	0	0	0	0	9	1/10
16	5. Alto Paraguai river basin development (Mato Grosso e Mato Grosso dos Sul)	2008	PNCE	S	PL	V	13	0	0	0	0	22	3	0	0	0	38	3/10
17	6. Corumbá Mining-Industrial Pole and Influences on the Pantanal Plain (Mato Grosso do Sul)	2008	PN	L	PR	B	13	0	0	0	0	24	0	0	0	0	37	2/10
18	7. Industrial Development Plan for Espírito Santo (Espírito Santo)	2008	AF	I	PL	C	2	0	0	0	0	5	0	0	1	0	8	3/10
19	8. Conservation and Sustainable Management Planning for the Caatinga Biome (Ceará)	2010	CA	S	PL	W	6	0	0	0	0	12	0	0	0	0	18	2/10
20	1. Transportation Program by IDB II, 1st phase (Paraná)	2002	AF	L	PR	T	3	0	0	0	0	25	0	0	0	0	28	2/10
21	2. Road Ring Program Mário Covas (São Paulo)	2004	AF	S	PR	P	0	0	0	0	0	27	0	0	0	0	27	1/10
22	3. Accessibility Program for Small-Scale Municipalities with Low Human Development by IDB (Minas Gerais)	2005	AFCC	S	PR	I	9	0	0	0	0	4	0	0	0	0	13	2/10
23	4. São Paulo Road Recovery Program (São Paulo)	2005	AFCE	I	PR	G	26	0	0	2	0	24	0	0	0	0	52	3/10
24	5. Minas Gerais Road Program (Minas Gerais)	2007	AFCC	I	PR	X	3	0	0	0	0	59	0	0	0	0	62	2/10
25	6. Integrated Brasilia Transport Program (Distrito Federal)	2007	CE	I	PR	Y	10	0	0	3	0	9	4	0	0	0	26	4/10
26	7. Açu Industrial and Port Complex (Rio de Janeiro)	2009	AF	S	PR	A	6	1	0	0	0	12	1	0	0	0	20	4/10
27	8. Multimodal Transport and Mineral-Industrial Development Program of the Cacao Region (Bahia)	2010	AF	S	PR	B	18	2	3	3	5	40	18	5	0	1	95	9/10
28	9. Metropolitan Arch of Rio de Janeiro (Rio de Janeiro)	2010	AF	L	PL	S	6	0	0	0	1	8	1	0	0	0	16	4/10
29	10. Regional Integrated Development Plan for the Capricorn axis bioceanic corridor (some states)	2011	AF	R	PR	H	8	0	0	0	0	11	0	0	0	0	19	2/10
30	1. North Coast Tourism Development Program (Ceará, Maranhão and Piauí)	2007	AFCA	R	PL	R	2	0	0	0	0	11	1	0	0	0	14	3/10
31	2. Tourist Poles of the State of Rio de Janeiro (coastal area) (Rio de Janeiro)	2011	AF	S	PR	M	1	0	0	0	0	4	0	0	0	0	5	2/10
32	3. Tourist Poles of the State of Rio de Janeiro (Mountain area) (Rio de Janeiro)	2011	AF	S	PR	M	2	0	0	0	0	3	0	0	0	0	5	2/10
33	4. Plan for the Integrated Development of Sustainable Tourism, (Rio Grande do Norte)	2011	AFCA	S	PL	B	1	0	0	0	0	3	4	0	0	0	8	3/10
34	5. Regional Tourism Development Programs of the Campo Grande area (Mato Grosso do Sul)	2014	PNCE	S	PR	K	26	0	0	0	0	2	0	0	0	0	28	2/10
35	6. Regional Tourism Development Programs of the Serra da Bodoquema area (Mato Grosso do Sul)	2014	PNCE	S	PR	K	0	0	0	0	0	33	35	0	0	0	68	2/10
sum of mentions of each criterion in all SEA reports							210	5	4	9	7	506	86	12	1	1		
number of the SEA reports the criterion is mentioned/total number of SEA reports							28/35	4/35	4/35	4/35	3/35	35/35	15/35	4/35	1/35	1/35		

Biomes in SEA reports: Atlantic Forest – AF; Amazon Forest – ZF; Caatinga – CA; Campos Sulinos or Pampas – PP; Cerrado – CE; Pantanal – PN; Atlantic Forest + Cerrado + Caatinga = AFCC; Atlantic Forest + Caatinga =

AFCA; Atlantic Forest + Cerrado = AFCE; Pantanal + Cerrado = PNCE; Pantanal + Cerrado + Atlantic Forest + Pampas = 2PAFCE; 6 biomes = all
Type of planning: plan (PL); program (PR)
Level of governance: local (L); subregional (S) – more than one city; state (I) - inside only one state; regional (R) – more than one state; national (N)
Authors of SEA reports: A to Y (the codes are associated with specific authors in the supplementary data)
In the table: cells marked in red represent the worst relationship between number of criteria mentioned/total number of criteria; cells marked in yellow represent the best relationship between number of criteria mentioned/total number of criteria; cells marked in blue represent both the sum of mentions of each criterion in all SEA reports and the sum of mentions of criteria for each SEA report. The coloured cells in the SEA report column represent the four different sectors analysed following the key in Table 1.

From Table 4 it is clear that the SEA reports have a focus on three of the criteria (#1, #6 and #7), to the exclusion of most of the others. Indeed, the Brazilian SEA reports largely ignore two of the main aspects expected to protect biodiversity in SEA – habitat loss and fragmentation as highlighted by Gontier et al. (2006). This calls into question the extent to which biodiversity and ecosystems are evaluated within the SEAs, and a particular point of note is the lack of consideration of any alternatives that might mitigate some of the species-level impacts or provide other opportunities for biodiversity improvement (criteria 9 and 10, except for one mention only in SEA report 18 and SEA report 27, respectively).

Whilst this research does not evaluate the extent to which criteria are satisfied in the SEA report (rather it reports the extent to which elements included in the criteria are mentioned), it is clear that no SEA addressed all ten criteria, although one case did present data associated with 9 out of 10 criteria, another SEA report presents 6 of 10 criteria and 3 other SEA reports 5 of 10 criteria; that means only 14% of the sample addressed more than 5 criteria; 86% addressed fewer than 4 out of 10 criteria, and 57% addressed fewer than 3 criteria. Whilst all the criteria are not relevant to all cases (e.g., criterion 8 on potential damage to ecosystem services on which local communities rely), it is still clear that, with the exception of the SEA report (number 27), the focus is very much on quantifying baselines at the expense of considerations of the implications of any changes. This undermines (or at least contributes little to) the safeguarding of Brazilian biodiversity in sectoral and regional planning.

The year in which the SEA report was published has no apparent influence on the extent to which the criteria are addressed. Therefore, there is no evidence of a temporal vector for strengthening biodiversity in the practice of Brazilian SEA reports, as might be expected from the ongoing establishment and development of major biodiversity milestones worldwide. Nor could any meaningful patterns be identified in relation to the consultancy company responsible for the SEA, the biome in which the plan was situated, the level of governance, the type of planning or the sector covered.

Table 5 presents some examples for applying the criteria presented in Table 2 and explained in Table 3 to two of the 35 Brazilian SEA reports. As examples, Table 5 indicates text extracts which have been coded against the first ten criteria for two example SEA reports. Full coding data (in Portuguese) are provided as supplementary data. Table 5 provides insights into how SEA reports embrace proposals to deal with species and ecosystem levels of biodiversity mainly related to the context of the affected ecosystem. Many ways are found to address the criteria by not only identifying and featuring important species and ecosystems but also identifying and understanding threats to them and proposing ways to address them in planning. The wealth of details about species and ecosystems can provide the necessary elements to represent the magnitude of planning impacts and guide decision making. One way to deal with these threats and promote opportunities to integrate biodiversity in planning is achieved by proposing specific actions inside the program and the plan guided by SEA.

Table 5 – Results of qualitative analysis.

Criteria	Examples	
	SEA report (number 27)	**SEA report (number 8)**
1	18 times (1 example): "Reduction of connectivity between protection areas" (p.357)	7 times (1 example): "… due to the cumulative impact caused by the projects, an increase in the population declines of fish and crustaceans, among other species dependent on these environments…" (p.414)
2	2 times (2 examples): "Changes in land use … should decisively and irreversibly alter the vegetation formations associated with the riverbanks, the lagoon and estuary" (p.310) "Effects on the quantity and quality of water drained into the marine environments of the region, reducing the fish population" (p.336)	1 time (1 example): "The increase in vessel traffic and the cumulative impact resulting from the sum of the projects will cause greater contamination by polycyclic aromatic hydrocarbons in the biota …" (p. 414)
3	3 times (1 example): "Increase in the number of elements of fauna and flora on the state list of endangered species, as well as migration of species from lower to higher levels of criticality" (p. 447)	1 time (1 example): "Tendency towards the elimination of forest fragments around the Arch … and consolidation of the physical isolation of remnants of vegetation…" (p. 441)
4	3 times (1 example): "an increase in the pressure on game fauna — which includes several species threatened with extinction …" (p. 61)	Without data
5	5 times (1 example): "Significantly increased risk of introduction of exotic species/pathogens" (p. 336)	Without data
6	40 times (1 example) "Definitive alteration of plant formations associated with the banks of rivers, the lagoon and the estuary, as a result of changes in land use …" (p. 334)	11 times (1 example):

		"The Arch will be responsible for reducing the area of remaining vegetation, as well as for the fragmentation of important forests in the lowland region…" (p. 411).
7	18 times (1 example): "Improved environmental management with the implementation of Management Plans for protected areas, with the support of environmental compensation arising from new ventures (airport and others) and from the oil sector, although the lack of environmental inspection persists" (p. 256)	4 times (1 example): "New preservation requirements due to PLANGAS projects, especially those that directly affect sustainable use protection areas, such as the Cabiúnas-REDUC Gas Pipeline" (p. 441)
8	5 times (1 example): "Reduction or elimination of ecological processes in aquatic environments due to silting, eutrophication and contamination" (p. 358)	3 times (1 example): "Despite efforts to hire local and regional labor, there is no way to ensure that new urban groups do not form, causing further degradation of environments such as mangroves, especially those in the Guapimirim environmental protection area, a system on which countless species depend. of crustaceans, resources that socially and culturally maintain crab collectors" (p. 415)
9	Without data	Without data
10	1 time (1 example): "implementation of programs for environmental quality recovery and reintroduction of native species" (p. 357)	Without data

Note – Table 5 provides examples only, with all cases provided for two selected EISs up to a frequency of 2 mentions in the EIS, otherwise just one example is provided. The full dataset corresponding to the results presented in Table 4 below are supplied as supplementary data.

4. Discussion and conclusions

The proposed criteria demonstrated that it is possible to identify whether the main elements of biodiversity were considered in the content of an SEA report, albeit the analysis does not fully evaluate the substance of the consideration of biodiversity. This is in line with most quality review approaches in environmental assessment which largely focus on absence or inclusion of elements, rather than comprehensive evaluations of the substance of the content (Bond et al., 2017). Nevertheless, it does provide a framework which non (biodiversity) experts can utilize to identify the major omissions in practice and/or to identify good practice examples.

Thus, the proposed criteria were used successfully to assess the scope of biodiversity coverage in a number of SEA reports. The criteria make it possible to establish a comparative rule between the SEA reports and what is expected to meet good biodiversity practices. At the same time, some pitfalls must be avoided when applying the criteria. The fact that the same criterion is identified several times more in one SEA Report than another, does not necessarily make it better. The next steps to advance the assessment of the depth of biodiversity inclusion could focus on proposing a quality scale derived from these criteria, along the lines of those used in the well-known Lee et al. (1999) review package for Environmental Impact Statements.

However, such quality scales are generally designed to be used by non-experts and so can fail to register the use of poor techniques.

The application of the criteria to the diverse sample of SEA reports worked as a magnifying glass to highlight central aspects of biodiversity coverage in planning. The results from the Brazilian sample confirm the failure to honour the commitments assumed by Brazil as a signatory of the main conservation treaties, eventually conditioning a better assessment of biodiversity in planning guided by the Brazilian SEA cases. Thus, this research diverges from the instrument's expectations, highlighted, in 2006, by Gontier et al. (2006, p.282) that "SEA could provide an opportunity to determine whether proposed developments, when considered in their entirety, are compatible with national or international goals for biodiversity"; and it points to a lack "of a consistent quality in current biodiversity assessments" that was also identified by Gontier et al. (2006, p.282). Thus, the findings suggest that SEA practice needs to develop if, according to Ives et al. (2015), SEA can provide a framework for contributing to achieving conservation feasibility with the legislation support.

Except for one report (SEA report 27), SEA reports currently focus on specific issues related to the biodiversity baselines and, to a much lesser extent, questions aimed at an integrated and in-depth analysis of biodiversity. Although the purpose of this paper was not to analyse the individual quality of the selected set of SEA reports, some aspects can be identified in SEA report 27 that helps to explain why it stands out among the others. This SEA was an initiative of the Environment Secretariat concerned with the intended investments for the cocoa region of the state of Bahia (Brazil), with a focus on avoiding conflicts between biodiversity conservation, tourism activities and a set of planned ventures. Therefore, sustainability and biodiversity play a leading role in the scope of this SEA. This SEA report was carried out by a consulting firm that is based within a postgraduate group at one of the most renowned Brazilian public universities, which produced 6 of the 35 SEA reports analysed in this work. The final SEA report was supported by public participation to evaluate its draft SEA report. Brazilian studies that also used this SEA as an object of study identified some evidence of procedural/substantive effectiveness on SEA (Tshibangu and Montaño, 2019) and good practices for including issues related to climate change in planning guided by SEA (Nadruz et al., 2018).

Even in a context with a strong focus on biodiversity conservation, Gutierrez et al. (2021) using comprehensive criteria identified widely varying levels of biodiversity inclusion in SEA reports analyzed and room to improve the integration of biodiversity into the SEA. This

reinforces the value of a simple tool to assess the inclusion of biodiversity in current SEA practice. Brazilian SEA reports results show that SEA practice undermines, or at least fails to contribute to, the proposal for safeguarding the protection and conservation of Brazilian biodiversity in sectoral and regional planning guided by the SEA tool. This tallies with the findings of Söderman and Saarela (2010) who considered that SEA applied to spatial plans was very baseline-oriented, with a narrow biodiversity view, that failed to fully embed biodiversity into planning. In this sense, Mörtberg et al. (2007), Ives et al. (2015) and Whitehead et al. (2017) recommend approaches for broadening the perspective of biodiversity in SEA that can be used as pathways to strengthen the consideration of biodiversity in SEA practice.

The geographical location, or sectoral focus of the plans subjected to SEA had no discernable influence on the results. Although there are two hotspots among Brazilian biomes, it was not verified that the type of biome led to a more detailed analysis of biodiversity. In this sense Guerra et al. (2021) discussed some advances and gaps in ecological restoration works in Brazilian biomes and verified important regional knowledge gaps for the Pantanal, Caatinga and Pampa. According to these authors the Atlantic Forest is the most cited biome, however, data from temporal monitoring is more frequent in the Amazon, Cerrado, Caatinga and Pampa. This reveals a need to understand how to integrate the specific characteristics of particular biomes in SEAs.

Regarding sectoral and regional development, except for one case that stood out among the others, there are no results that indicate any type of planning that is strategic in the integration of biodiversity. The fact that one SEA does, however, appear to meet the majority of the criteria suggests that good practice is possible, and there is potential to properly consider biodiversity through SEA. Thus, aspects such as who requests the SEA, the scope of the SEA, experience and technical quality of the group that carries out the SEA, the context of its realisation and effective public participation can be some elements to be explored in the practice of SEA to guarantee good results regarding the inclusion of biodiversity in the planning. The issue may be, therefore, a need to develop capacity amongst SEA practitioners in Brazil as also revealed by understanding this outstanding case. According to Almeida et al. (2022) the teaching of SEA in Brazil is still very incipient.

These findings further reinforce what has been revealed in previous research (Montaño and Fischer, 2019; Tshibangu and Montaño, 2019), that Brazilian SEA practice, in the absence of directed guidance, adds little to providing strategic safeguards to relevant sustainability issues, adding a failure to integrate biodiversity to the existing knowledge of failure to integrate

climate change (Nadruz et al., 2018). Finally, the findings of this work are relevant beyond the Brazilian case study and the framework may be useful in the analysis of other contexts in which SEA has been applied, made possible using these objective ex-post criteria that allow the identification of ways to strengthen the integration of biodiversity into SEA practice.

Acknowledgments

After revision.

6. References

Almeida M RR. Malvestio AC, Veronez FA. 2022. Teaching impact assessment: applying indicators of best practice principles to Brazil. Impact Assessment and Project Appraisal. 40(1):27-37. https://doi.org/10.1080/14615517.2021.1968263

Bond A, Fischer TB, Fothergill J. 2017. Progressing quality control in environmental impact assessment beyond legislative compliance: An evaluation of the IEMA EIA Quality Mark certification scheme. Environmental Impact Assessment Review. 63:160-171. https://doi.org/10.1016/j.eiar.2016.12.001

Bond A, Pope J, Morrison-Saunders A, Retief F. 2021. Taking an environmental ethics perspective to understand what we should expect from EIA in terms of biodiversity protection. Environmental Impact Assessment Review. 86:106508. https://doi.org/10.1016/j.eiar.2020.106508

Brownlie S, Treweek J. 2018. Biodiversity and Ecosystem Services in Impact Assessment International Best Practice Principles. Special Publication Series Nº 3. International Association for Impact Assessment, Fargo, USA. [accessed 2022 Jan 20] https://www.iaia.org/uploads/pdf/SP3-Biodiversity-Ecosystem-Services.pdf

Byron H, Treweek J. 2005. Guest Editorial: Strategic Environmental Assessment—Great Potential for Biodiversity? Journal of Environmental Assessment Policy and Management. 7(2):v-xiii. http://www.jstor.org/stable/enviassepolimana.7.2.v.

Bueno AS, Peres CA. 2020. The role of baseline suitability in assessing the impacts of land-use change on biodiversity. Biological Conservation. 243:108396. https://doi.org/10.1016/j.biocon.2019.108396

Council on Environmental Quality (CEQ US). 1993. Incorporating biodiversity considerations into environmental impact analysis under the National Environmental Policy Act. Council on Environmental Quality, Executive Office of the President. [accessed 2022 Jan 22] https://ceq.doe.gov/docs/ceq-publications/Incorporating_Biodiversity_1993.pdf

Chanchitpricha C, Fischer TB. 2022. The role of impact assessment in the development of urban green infrastructure: a review of EIA and SEA practices in Thailand. Impact Assessment and Project Appraisal. 1-11. https://doi.org/10.1080/14615517.2022.2027075

Cruz FB, Veronez FA, Montaño M. 2018. Evidence of learning processes in EIA systems. Impact Assessment and Project Appraisal. 36(3):242-252. https://doi.org/10.1080/14615517.2018.1445177

da Silva Dias AM, Fonseca A, Paglia AP. 2019. Technical quality of fauna monitoring programs in the environmental impact assessments of large mining projects in southeastern Brazil. Science of The Total Environment. 650:216-223. https://doi.org/10.1016/j.scitotenv.2018.08.425

de Witt M, Pope J, Retief F, Bond A, Morrison-Saunders A, Steenkamp C. 2019. Biodiversity offsets in EIA: Getting the timing right. Environmental Impact Assessment Review. 75:1-12. https://doi.org/10.1016/j.eiar.2018.11.001

Di Minin E, Moilanen A. 2012. Empirical evidence for reduced protection levels across biodiversity features from target-based conservation planning. Biological Conservation. 153:187-191. https://doi.org/10.1016/j.biocon.2012.04.015

Duarte CG, Dibo APA, Sánchez LE. 2017. What does the academic research say about impact assessment and environmental licensing in Brazil? Ambiente & Sociedade. 20:261-292. https://doi.org/10.1590/1809-4422ASOC20150268R1V2012017

Duarte CG, Sánchez LE. 2020. Addressing significant impacts coherently in environmental impact statements. Environmental Impact Assessment Review. 82:106373. https://doi.org/10.1016/j.eiar.2020.106373

Falavigna TJ, Pereira D, Rippel ML, Petry MV. 2020. Changes in bird species composition after a wind farm installation: A case study in South America. Environmental Impact Assessment Review. 83:106387. https://doi.org/10.1016/j.eiar.2020.106387

Fearnside PM. 2016. Brazilian politics threaten environmental policies. Science. 353(6301): 746-748. https://www.science.org/doi/10.1126/science.aag0254

Fernandes GW, Vale MM, Overbeck GE, Bustamante MM, Grelle CE, Bergallo HG, Magnusson WE, Akama A, Alves SS, Amorim A, et al. 2017. Dismantling Brazil's science threatens global biodiversity heritage. Perspectives in Ecology and Conservation. 15(3):239-243. https://doi.org/10.1016/j.pecon.2017.07.004

Ferrante L, Fearnside PM. 2019. Brazil's new president and 'ruralists' threaten Amazonia's environment, traditional peoples and the global climate. Environmental Conservation. 46(4): 261-263. https://doi.org/10.1017/S0376892919000213

Ferrante L, Andrade MB, Fearnside PM. 2021. Land grabbing on Brazil's Highway BR-319 as a spearhead for Amazonian deforestation. Land Use Policy. 108:105559. https://doi.org/10.1016/j.landusepol.2021.105559

Fischer TB, Onyango V. 2012. Strategic environmental assessment-related research projects and journal articles: an overview of the past 20 years. Impact Assessment and Project Appraisal. 30(4):253-263. https://doi.org/10.1080/14615517.2012.740953

Fornara F, Molinario E, Scopelliti M, Bonnes M, Bonaiuto F, Cicero L, Admirall J, Beringer A, Dedeurwaerdere T, de Groot W, et al. 2020. The extended Value-Belief-Norm theory predicts committed action for nature and biodiversity in Europe. Environmental Impact Assessment Review. 81:106338. https://doi.org/10.1016/j.eiar.2019.106338

Gallardo ALCF, Bond A. 2011a. Capturing the implications of land use change in Brazil through environmental assessment: Time for a strategic approach? Environmental Impact Assessment Review. 31(3):261-270. https://doi.org/10.1016/j.eiar.2010.06.002

Gallardo ALCF, Bond A. 2011b. Investigating the effectiveness of environmental assessment of land use change: A comparative study of the approaches taken to perennial biomass crop planting in São Paulo and England. Biomass and bioenergy. 35(5):2285-2297. https://doi.org/10.1016/j.biombioe.2011.02.050

Gallardo ALCF, Duarte CG, Dibo APA. 2016. Strategic environmental assessment for planning sugarcane expansion: a framework proposal. Ambiente & Sociedade. 19(2):67-92. http://dx.doi.org/10.1590/1809-4422ASOC127007V1922016

Gallardo ALCF, Machado DMM, Kniess CT. 2021. Strategic Environmental Assessment in Brazilian Academic Research. Ambiente & Sociedade. 24:1-26. https://doi.org/10.1590/1809-4422asoc20200022r3vu2021L5AO

Gallardo ALCF, Rosa JCS, Sánchez LE. 2022. Addressing ecosystem services from plan to project to further tiering in impact assessment: Lessons from highway planning in São Paulo, Brazil. Environmental Impact Assessment Review. 92:106694. https://doi.org/10.1016/j.eiar.2021.106694

Gannon P. 2021. The time is now to improve the treatment of biodiversity in Canadian environmental impact statements. Environmental Impact Assessment Review. 86:106504. https://doi.org/10.1016/j.eiar.2020.106504

Geneletti D. 2003. Biodiversity impact assessment of roads: an approach based on ecosystem rarity. Environmental impact assessment review. 23(3):343-365. https://doi.org/10.1016/S0195-9255(02)00099-9

Geneletti D. 2011. Reasons and options for integrating ecosystem services in strategic environmental assessment of spatial planning. International Journal of Biodiversity Science, Ecosystem Services & Management. 7(3):143-149. https://doi.org/10.1080/21513732.2011.617711

Geneletti D. 2015. A conceptual approach to promote the integration of ecosystem services in strategic environmental assessment. Journal of Environmental Assessment Policy and Management. 17(04):1550035. https://doi.org/10.1142/S1464333215500350

Geneletti, D. 2016. Handbook on biodiversity and ecosystem services in impact assessment. Cheltenham (UK). Edward Elgar Publishing.

Gontier M, Balfors B, Mörtberg U. 2006. Biodiversity in environmental assessment—current practice and tools for prediction. Environmental impact assessment review. 26(3):268-286. https://doi.org/10.1016/j.eiar.2005.09.001

Groves CR, Game ET, Anderson MG, Cross M, Enquist C, Ferdana Z, Girvetz E, Gondor A, Hall KR, Higgins J, et al. 2012. Incorporating climate change into systematic conservation planning. Biodiversity and Conservation. 21(7):1651-1671. https://doi.org/10.1007/s10531-012-0269-3

Guerra A, Reis LK, Borges FLG, Ojeda PTA, Pineda DAM, Miranda CO, Maidana, DPFL, dos Santos TMR, Shibuya PS, Marques MCM, et al. 2020. Ecological restoration in Brazilian biomes: identifying advances and gaps. Forest ecology and Management. 458:117802. https://doi.org/10.1016/j.foreco.2019.117802

Gugerli F, Englisch T, Niklfeld H, Tribsch A, Mirek Z, Ronikier M, Zimmermann NE, Holderegger R, Taberlet P, IntraBioDiv Consortium. 2008. Relationships among levels of biodiversity and the relevance of intraspecific diversity in conservation–a project synopsis. Perspectives in Plant Ecology, Evolution and Systematics. 10(4):259-281. https://doi.org/10.1016/j.ppees.2008.07.001

Gunasekaran A, Jabbour CJC, Jabbour ABLDS. 2014. Managing organizations for sustainable development in emerging countries: an introduction. International Journal of Sustainable Development & World Ecology. 21(3):195-197. https://doi.org/10.1080/13504509.2014.915439

Gutierrez M, Bekessy SA, Gordon A. 2021. Biodiversity and ecosystem services in strategic environmental assessment: An evaluation of six Australian cases. Environmental Impact Assessment Review. 87:106552. https://doi.org/10.1016/j.eiar.2021.106552

Heiner M, Hinchley D, Fitzsimons J, Weisenberger F, Bergmann W, McMahon T, Milgin J, Nardea L, Oakleaf J, Parriman D, et al. 2019. Moving from reactive to proactive development planning to conserve Indigenous community and biodiversity values. Environmental Impact Assessment Review. 74:1-13. https://doi.org/10.1016/j.eiar.2018.09.002

Hoban S, Campbell CD, da Silva JM, Ekblom R, Funk WC, Garner BA, Godoy JA, Kershaw F, MacDonald AJ, Mergeay J, et al. 2021. Genetic diversity is considered important but interpreted narrowly in country reports to the Convention on Biological Diversity: Current actions and indicators are insufficient. Biological Conservation. 261:109233. https://doi.org/10.1016/j.biocon.2021.109233

Honrado JP, Vieira C, Soares C, Monteiro MB, Marcos B, Pereira HM, Partidário MR. 2013. Can we infer about ecosystem services from EIA and SEA practice? A framework for analysis and examples from Portugal. Environmental Impact Assessment Review. 40:14-24. https://doi.org/10.1016/j.eiar.2012.12.002

IAIA (International Association for Impact Assessment). 2005. Biodiversity in Impact Assessment. Special Publication Series Nº. 3, International Best Practice Principles. International Association for Impact Assessment. Fargo. USA. 4 pages. [accessed 2022 Jan 19] https://www.iaia.org/uploads/pdf/SP3_pt.pdf

Ives CD, Biggs D, Hardy MJ, Lechner AM, Wolnicki M, Raymond CM. 2015. Using social data in strategic environmental assessment to conserve biodiversity. Land use policy. 47:332-341. https://doi.org/10.1016/j.landusepol.2015.04.002

Lima Junior DPL, Magalhães ALB, Pelicice FM, Vitule JRS, Azevedo-Santos VM, Orsi ML, Simberloff D, Agostinho AA. 2018. Aquaculture expansion in Brazilian freshwaters against the Aichi Biodiversity Targets. Ambio. 47(4):427-440. https://doi.org/10.1007/s13280-017-1001-z

Karlson M, Mörtberg U, Balfors B. 2014. Road ecology in environmental impact assessment. Environmental impact assessment review. 48:10-19. https://doi.org/10.1016/j.eiar.2014.04.002

Karjalainen TP, Marttunen M, Sarkki S, Rytkönen AM. 2013. Integrating ecosystem services into environmental impact assessment: an analytic–deliberative approach. Environmental Impact Assessment Review. 40:54-64. https://doi.org/10.1016/j.eiar.2012.12.001

Kolhoff A, Slootweg R. 2005. Biodiversity in SEA for spatial plans—experiences from the Netherlands. Journal of Environmental Assessment Policy and Management. *7*(02):267-286. https://doi.org/10.1142/S146433320500202X

Kumar P, Esen SE, Yashiro M. 2013. Linking ecosystem services to strategic environmental assessment in development policies. Environmental Impact Assessment Review. 40:75-81. https://doi.org/10.1016/j.eiar.2013.01.002

Lee N, Colley R, Bonde J, Simpson J. 1999. Reviewing the Quality of Environmental Statements and Environmental Appraisals. Occasional Paper 55 (EIA Centre, University of Manchester, Manchester) 72. [accessed 2022 Jan 19] http://blogs.ubc.ca/environmentalimpactassessment/files/2015/11/Colley-Bonde-Simpson_1999_Reviewing-the-quality-of-environmental-statements-and-environmental-appraisals.pdf

Malvestio AC, Montaño M. 2019. From medicine to poison: how flexible strategic environmental assessment may be? Lessons from a non-regulated SEA system. Impact Assessment and Project Appraisal. 37(5):437-451. https://doi.org/10.1080/14615517.2019.1574390

Mandai SS, de Souza MMP. 2021. Guidelines for the analysis of the inclusion of biodiversity in Environmental Impact Statements. Environmental Impact Assessment Review. 87:106523. https://doi.org/10.1016/j.eiar.2020.106523

Mayring P. 2014. Qualitative content analysis: theoretical foundation, basic procedures and software solution. Klagenfurt. [accessed 2022 Jan 22] https://nbn-resolving.org/urn:nbn:de:0168-ssoar-395173.

Meli P, Herrera FF, Melo F, Pinto S, Aguirre N, Musálem K, Minaverry C, Ramírez W, Brancalion, P. H. 2017. Four approaches to guide ecological restoration in Latin America. Restoration Ecology. 25(2):156-163. https://doi.org/10.1111/rec.12473

MMA (Ministério do Meio Ambiente). 2022. Biodiversidade Brasileira. [accessed 2022 Jan 15] https://antigo.mma.gov.br/biodiversidade/biodiversidade-brasileira.html#:~:text=O%20termo%20biodiversidade%20diz%20respeito,diversidade)%20e%20variabilidade%20entre%20paisagens

Montaño M, Oppermann PA, Malvestio AC, Souza MP. 2014. Current state of the SEA system in Brazil: a comparative study. Journal of Environmental Assessment Policy and Management. 16:1450022. https://doi.org/10.1142/S1464333214500215

Montaño M, Fischer TB. 2019. Towards a more effective approach to the development and maintenance of SEA guidance. Impact Assessment and Project Appraisal. *37*(2):97-106. https://doi.org/10.1080/14615517.2018.1550185

Moretto EM, Athayde S, Doria CRDC, Gallardo ALCF, Araujo NCD, Duarte CG, Branco EA, Pulice SMP, Roquetti DR. 2021. Gestão Adaptativa na Etapa de Acompanhamento da Avaliação de Impacto Ambiental. Estudos Avançados. 35:201-218. https://doi.org/10.1590/s0103-4014.2021.35103.011

Morrison-Saunders A, Therivel R. 2006. Sustainability integration and assessment. Journal of Environmental Assessment Policy and Management. 8(03):281-298. https://doi.org/10.1142/S1464333206002529

Mörtberg UM, Balfors B, Knol WC. 2007. Landscape ecological assessment: A tool for integrating biodiversity issues in strategic environmental assessment and planning. Journal of environmental management. 82(4):457-470. https://doi.org/10.1016/j.jenvman.2006.01.005

Nadruz VN, Gallardo ALCF, Montaño M, Ramos HR, Ruiz MS. 2018. Identifying the missing link between climate change policies and sectoral/regional planning supported by Strategic Environmental Assessment in emergent economies: lessons from Brazil. Renewable and Sustainable Energy Reviews. 88:46-53. https://doi.org/10.1016/j.rser.2018.02.006

Osgood, Ch. E. (1959). The representational model and relevant research methods. In I. d. S. Pool (Ed.), Trends in content analysis (pp. 33 - 88). Urbana: University of Illinois Press.

Pacheco AA, Neves ACO, Fernandes GW. 2018. Uneven conservation efforts compromise Brazil to meet the Target 11 of Convention on Biological Diversity. Perspectives in Ecology and Conservation. 16(1):43-48. https://doi.org/10.1016/j.pecon.2017.12.001

Partidario MR. 2012. Strategic environmental assessment better practice guide. Lisboa (Portugal). Agência Portuguesa do Ambiente e Redes Energéticas Nacionais.

Partidario MR, Gomes RC. 2013. Ecosystem services inclusive strategic environmental assessment. Environmental Impact Assessment Review. 40:36-46. https://doi.org/10.1016/j.eiar.2013.01.001

Prates APL, de Azevedo Irving M. 2015. Conservação da biodiversidade e políticas públicas para as áreas protegidas no Brasil: desafios e tendências da origem da CDB às metas de Aichi. Revista Brasileira de Políticas Públicas. 5(1):27-57. https://doi.org/10.5102/rbpp.v5i1.3014

Pellin A, Lemos CCD, Tachard A, Oliveira ISDD, Souza MPD. 2011. Avaliação Ambiental Estratégica no Brasil: considerações a respeito do papel das agências multilaterais de desenvolvimento. Engenharia Sanitária e Ambiental.16:27-36. https://doi.org/10.1590/S1413-41522011000100006

Pimenta MA, Fonseca A. 2021. To what extent are threatened plant species considered in impact assessment decision-making? Insights from southeastern Brazil. Environmental Impact Assessment Review. 86:106516. https://doi.org/10.1016/j.eiar.2020.106516

Pinto E, Morrison-Saunders A, Bond A, Pope J, Retief F. 2019. Distilling and applying criteria for best practice EIA follow-up. Journal of environmental assessment policy and management. 21(02):1950008. https://doi.org/10.1142/S146433321950008X

Rajvanshi A, Arora R. 2010. Mainstreaming biodiversity and gender in impact assessment for human well-being. Biodiversity.11(1-2):25-30. https://doi.org/10.1080/14888386.2010.9712643

Rajvanshi A, Brownlie S, Slootweg R, Arora R. 2011. Maximizing benefits for biodiversity: the potential of enhancement strategies in impact assessment, Impact Assessment and Project Appraisal.29(3):181-193. https://doi.org/10.3152/146155111X12959673796245

Rizzo HB, Gallardo ALCF, Moretto EM. 2017. Strategic environmental assessment and transportation sector planning in the state of São Paulo. Engenharia Sanitária e Ambiental. 22: 1-10. https://doi.org/10.1590/S1413-41522017128060

Rosa JCS, Sánchez LE. 2016. Advances and challenges of incorporating ecosystem services into impact assessment. Journal of environmental management.180:485-492. https://doi.org/10.1016/j.jenvman.2016.05.079

Rosa JCS, Sánchez LE, Morrison-Saunders A. 2018. Getting to 'agreed' post-mining land use–an ecosystem services approach. Impact Assessment and Project Appraisal. 36(3):220-229. https://doi.org/10.1080/14615517.2018.1445175

Rozas-Vasquez D, Fuerst C, Geneletti D. 2019. Integrating ecosystem services in spatial planning and strategic environmental assessment: The role of the cascade model. Environmental Impact Assessment Review. 78:106291. https://doi.org/10.1016/j.eiar.2019.106291

Sánchez LE. 2017. Por que não avança a avaliação ambiental estratégica no Brasil?. Estudos Avançados. 31:167-183. https://doi.org/10.1590/s0103-40142017.31890015

Siqueira-Gay J, Soares-Filho B, Sanchez LE, Oviedo A, Sonter LJ 2020. Proposed Legislation to Mine Brazil's Indigenous Lands Will Threaten Amazon Forests and Their Valuable Ecosystem Services. One Earth. 3(3):356-362. https://doi.org/10.1016/j.oneear.2020.08.008

Siqueira-Gay J, Sanchez LE. 2019. Mainstreaming environmental issues into housing plans: the approach of Strategic Environmental Assessment. Environmental Impact Assessment Review. 77:145-153. https://doi.org/10.1016/j.eiar.2018.12.005

Siqueira-Gay J, Sanchez LE. 2020. Keep the Amazon niobium in the ground. Environmental Science & Policy. 111:1-6. https://doi.org/10.1016/j.envsci.2020.05.012

Slootweg R, Kolhoff A. 2003. A generic approach to integrate biodiversity considerations in screening and scoping for EIA. Environmental Impact Assessment Review. 23(6): 657-681. https://doi.org/10.1016/S0195-9255(03)00114-8

Slootweg R. 2016. Ecosystem services in SEA: are we missing the point of a simple concept? Impact Assessment and Project Appraisal. 34(1):79-86. https://doi.org/10.1080/14615517.2015.1096039

Slootweg R. 2021. Ecosystem services in strategic environmental assessment: an integrating concept in a world of silos. In: Fischer TB, González A, editors. Handbook on Strategic Environmental Assessment. Cheltenham: Edward Elgar Publishing; p. 266-282.

Söderman T, Saarela SR. 2010. Biodiversity in strategic environmental assessment (SEA) of municipal spatial plans in Finland. Impact Assessment and Project Appraisal 28(2):117-133. https://doi.org/10.3152/146155110X498834

Söderman T. 2006. Treatment of biodiversity issues in impact assessment of electricity power transmission lines: A Finnish case review. Environmental Impact Assessment Review. 26(4):319-338. https://doi.org/10.1016/j.eiar.2005.10.002

Souza BA, Sánchez LE. 2018. Biodiversity offsets in limestone quarries: Investigation of practices in Brazil. Resources Policy. 57:213-223. https://doi.org/10.1016/j.resourpol.2018.03.007

Treweek J, Therivel R, Thompson S, Slater M. 2005. Principles for the use of strategic environmental assessment as a tool for promoting the conservation and sustainable use of biodiversity. Journal of Environmental Assessment Policy and Management. 7(02):173-199. https://doi.org/10.1142/S1464333205002043

Tshibangu GM, Montaño M. 2019. Outcomes and contextual aspects of strategic environmental assessment in a non-mandatory context: the case of Brazil. Impact Assessment and Project Appraisal. 37(3-4):334-343. https://doi.org/10.1080/14615517.2019.1603715

Verma AK. 2016. Biodiversity: Its different levels and values. International Journal on Environmental Sciences. 7(2):143-145. [accessed 2022 Feb 2] https://www.researchgate.net/profile/Ashok-Verma-20/publication/342638063_Biodiversity_Its_Different_Levels_and_Values/links/5efde526a6fdcc4ca444bc1c/Biodiversity-Its-Different-Levels-and-Values.pdf

Whitehead AL, Kujala H, Wintle BA. 2017. Dealing with cumulative biodiversity impacts in strategic environmental assessment: A new frontier for conservation planning. Conservation letters.10(2):195-204. https://doi.org/10.1111/conl.12260