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# Environmental Impact Assessment Follow-Up of Seismic Survey Offshore Activities in Brazil

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## Abstract

Follow-up of environmental impacts is an integral part of the Environmental Impact Assessment (EIA) process, closely related to the effectiveness of the instrument. EIA follow-up has been receiving a lot of interest from scientists and practitioners, though it is recognized as one of the weakest points of EIA systems globally. Also, EIA follow-up is influenced by the context, mainly in terms of the types of projects or activities and their related impacts on the environment. Therefore, the present paper is focused on the investigation of the follow-up stage applied to the activity of seismic survey coupled with offshore oil & gas exploitation in Brazil. Research was based on a qualitative approach that included document analysis and semi-structured interviews with analysts involved in EIA processes, and sought to generate evidence of effectiveness of the EIA follow-up as conducted by the Federal Environment Agency (Ibama) in order to situate the practice of follow-up in the broader context of international best practice principles. Based on the findings, it was concluded that, due to the peculiarities of offshore seismic survey, it is necessary to promote adaptations in the procedures for monitoring impacts in order to ensure proper alignment with the principles and conceptual foundations that guide EIA practice. Specifically, the timing of the execution of the activity imposes challenges for its integration into the "conventional" cycle that has guided the monitoring of the impacts in the EIA of projects.

## Keywords

Environmental Impact Assessment Follow-Up, Follow-Up Effectiveness, Oil and Gas Offshore, Seismic Survey

## 1. Introduction

Environmental Impact Assessment (EIA) follow-up is internationally known and

considered essential to determine the outcomes of the project performance through evaluation [1] [2].

Follow-up is broadly recognized as an integral part of the EIA process and is usually related to the post-decision phase. According to [3] and [1], EIA follow-up encompasses four main activities: 1) monitoring; which is the data collection and comparison with project standards, to verify if they meet the forecasts and expectations established in environmental impact statement studies; 2) evaluation; which is directed to evaluate the environmental performance of the project with the standards, forecasts and expectations, 3) management; which takes appropriate decisions or actions in response to the questions identified in the monitoring and evaluation, during the project implementation; 4) communication; which provides feedback or information in the implementation of the project to all stakeholders and other interested parties and the general public.

The feedback from EIA follow-up programs is key for improving project implementation and its related environmental performance, allowing learning processes to occur as a result of the cumulated experience from practice [1], and assisting consultants and analysts to improve the effectiveness of mitigation measures and the overall EIA practice [4] [5].

The EIA follow-up has been receiving increased attention from experts and practitioners, given that it is widely recognized as the weakest stage in many EIA systems, which seems to be particularly more critical in developing countries [6]. In Brazil, EIA follow-up programs have long lacking of effectiveness [7] [8].

Seismic survey is a pivotal aspect in researching hydrocarbon sources; it uses the geophysical method to diagnose the characteristics of the seabed to infer about the possibility of oil accumulations. Therefore, throughout the years, the number of marine seismic surveys has grown exponentially and, as a consequence, so with impacts on the environment caused by the offshore oil and gas industry [9] [10].

Marine seismic surveys use air guns, which are responsible for generating sound pulses, and then a specific volume of air is released under high pressure, the expansion and contraction of released air bubbles create sound bubbles [11]. The noise produced during the air shots is highly concerning, particularly for marine mammals, which use sound for almost every fundamental biological activity—navigation, orientation, capture and location of prey, prevention of predators and communication, especially during migration and reproduction [12].

The impacts of seismic survey activities on certain marine species are frequently related in the literature, though there is still no consensus regarding particular processes that might affect the fauna [11] [13]. Nevertheless, impacts on sea turtles [14] and on cephalopods [15] are quite known. In order to respond to the need for management measures, national and regional guidelines have been edited and put at the disposal of decision-makers [16].

The literature recognizes an implementation gap between follow-up planning and execution stages [17], which indicates the potential contribution of empiric

research that helps to understand the positive and negative aspects of its practice. Thus, the present paper is focused on the investigation of the follow-up stage applied to marine seismic survey activities coupled with offshore oil & gas exploitation in Brazil, as practiced by the Federal Environment Agency (Ibama), evaluating the adherence to international principles of best practice as recommended in scientific literature.

## 2. Methodological Approach

The paper has adopted predominantly a qualitative, exploratory and descriptive research approach following [18], using a mixed set of techniques for data gathering such as literature review, semi-structured interviews and document analysis.

In this sense, publicly accessible documentation regarding the EIA processes coordinated by Ibama was consulted and analyzed in order to comprehend the procedures and, more relevant, the arguments applied to support the permission granted by the agency.

Semi-structured interviews were carried out with key actors in EIA follow-up processes: environmental analysts from Ibama (eight interviews), and both the marine mammal's observers and the Passive Acoustic Monitoring (PAM) operators (three interviews), which were responsible for the implementation of environmental programs during the survey campaigns, as requested by the environmental agency.

A total of 4 randomly selected EIA processes were reviewed and evaluated against the best practice principles framework presented by [19], considering the main stages of the follow-up process: 1) Determination of the need; 2) Follow-up program design; 3) Implementation of follow-up; 4) Evaluation of the findings. The processes include seismic survey activities executed in the sedimentary oil basins of Santos and Campos, located offshore from Rio de Janeiro and Sao Paulo states in southeastern Brazil, as shown in **Figure 1**.

Aiming to achieve its objectives, the research was divided into 3 stages, each with its specific objectives and methodological approach.

Stage I: Characterization of the follow-up in seismic research activities conducted by CGMAC, seeking to verify the implementation of environmental impact mitigation and management programs. It was supported by a broad review of scientific and technical literature, which included a search for articles published in international journals of reference in the area of knowledge, as well as academic books and technical documentation, such as environmental reports associated with seismic research activities, maritime reports and technical opinions issued by the environmental agency responsible for conducting the assessment of impacts in environmental licensing processes.

Based on the literature, it was sought to establish a reference framework for identifying good practices associated with the effectiveness of EIA follow-up, taking into account the specificities of the context in which it is practiced at

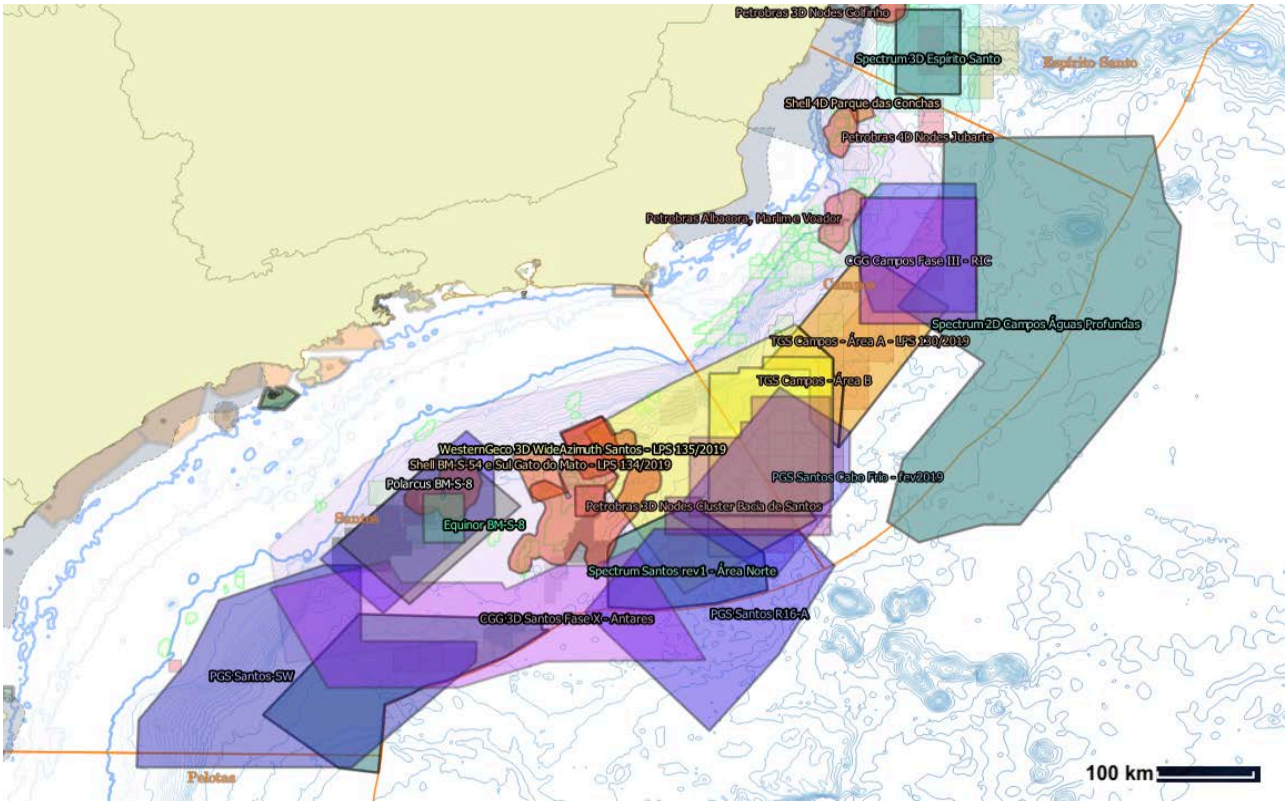


**Figure 1.** Seismic survey projects as located in the basins of Santos and Campos. Source: Ibama.

CGMAC when focused on seismic research activities.

Stage II: Identification of the factors that hinder the coupling of traditional follow-up models in EIA oriented towards seismic research activities, to assess the effective implementation of impact mitigating measures. It is important to emphasize that marine seismic research activities are ephemeral and last on average 3 to 6 months (maximum up to 1 year).

Thus, based on the analysis of the documentation, interviews were carried out with five environmental analysts from CGMAC's staff who is involved in EIA of marine seismic surveys. Furthermore, taking into account that the implementation of specific mitigation programs focused on marine fauna are carried out by onboard observers and passive acoustic monitoring operators, three system operators who worked in both functions were also interviewed.

Stage III: To analyze and interpret the practice of follow-up based on the principles and foundations of good international practices recommended for this stage of the EIA, and verify the occurrence of organizational learning.

This stage was oriented based on the results of previous ones, seeking a more robust analysis following the 17 principles of international best practices of EIA follow-up proposed by [2], presented in **Table 1**. As mentioned by the authors, it is expected that the principles serve as practical guidance to design EIA follow-up programs that involves monitoring, evaluation, and management of environmental issues during the implementation of a project.

**Table 1.** International best practice principles for EIA follow-up. Source: Based on [2].

| | |
|---|---|
| 1 | Actions must be defined to minimize adverse impacts and maximize positive impacts |
| 2 | Stakeholders must be informed and involved in the follow-up process |
| 3 | Follow-up programs must be designed in the pre-decision phase and conducted in the post-decision phase |
| 4 | The project proponent must be responsible for mitigating adverse impacts and communicating follow-up results to other stakeholders |
| 5 | It is up to the environmental agency to determine monitoring tasks and verify their implementation |
| 6 | The community should be informed of the results of the follow-up and, ideally, should participate in the formulation and implementation of the programs |
| 7 | There must be agreement between the parties on methodological and procedural approaches |
| 8 | Procedures must be adapted to the legal and administrative, socioeconomic and cultural context |
| 9 | Follow-up measures must be applied beyond the individual project level |
| 10 | Monitoring and evaluation actions must be frequent and generate useful information for stakeholders, seeking to achieve the objectives of the follow-up programs |
| 11 | There must be good communication mechanisms between different stakeholders to maximize learning through experience |
| 12 | Stakeholder roles and responsibilities should be defined in pre-decision documentation |
| 13 | Follow-up objectives must be clearly defined and established |
| 14 | Actions must be proportional to the expected environmental impacts and adaptable to changes in the environment |
| 15 | Follow-up activities must generate information and results that can be measured and evaluated in relation to well-defined criteria |
| 16 | Follow-up must respond to short- and long-term environmental changes, covering all phases of the project |
| 17 | Time, financial, human and capacity resources must be considered in advance, that is, in the design phase of follow-up programs |

## 3. Results and Discussion

Given that one of the main goals of EIA follow-up is to ensure that unacceptable environmental impacts are corrected, this goal must be achieved through proposed mitigation measures or through follow-up management actions, which means program management is important not only for regulators and the affected public, but also for the proponent.

Furthermore, proponents need to understand that there can be important fi-

nancial savings achieved through environmental management, with the application of follow-up principles. In this sense, the literature recognizes the complementary role between key principles of EIA follow-up as a reference to guide the practice, and the existence of legal requirements as seen in several countries [19].

The literature revealed that the coordination of the follow-up process by the regulatory body mainly complies with institutionalized legal procedures, which to a large extent are oriented towards verifying compliance with the conditions stipulated in the environmental permits and in the adoption of measures and strategies, or environmental management mechanisms whenever needed by the project's requirements along its life cycle.

The information provided by the interviews and from document analysis of the EIA processes allowed to verify the added value of follow-up, which suggests that the organization of the process is not simply oriented towards controlling measures of projects, but there is still concern with the adaptive management approach and improvement of scientific and technical knowledge.

In another context, the literature reports that the approach adopted in the Netherlands clearly identifies the added value of follow-up and is focused on three key elements: control; information and communication [20] [21]. However, when determining the need for follow-up, one must also consider the time, human and financial resources involved, as well as the values of the affected public [22].

EIA follow-up must necessarily promote an adaptive management approach and maintain a certain flexibility in decision-making [23], thus, feedback from follow-up programs must provide opportunities to the technical staff of regulatory agencies to respond to changes caused by an activity in the environment, or even in the socio-political context. From this perspective, the research carried out with CGMAC revealed an internal organizational structure divided into working groups that are responsible not only for managing the EIA process, but also for the post-implementation evaluation of mitigation measures, and when necessary in implementing new corrective measures that promote adaptive management and improving practice.

Furthermore, it was possible to verify that whenever certain relevant issues are identified through the monitoring mechanisms adopted internally by its technical staff, additional information is requested, or the execution of complementary environmental programs or even the adoption of new management mechanisms. In this sense, CGMAC, playing its role of coordinating and managing the EIA process, may choose to open discussions with the project proponent, also involving other interested parties in the search of joint solutions.

The design of follow-up programs is characterized by the definition of roles and responsibilities, therefore it requires a crucial understanding from all interested parties involved in the process for the effective implementation of follow-up schemes, focusing on the scope defined to the follow-up programs, as well as the definition of the methodology and tools for implementing follow-up

programs [19]. This was observed in the licensing process conducted by CGMAC, there is a clear definition of the roles and responsibilities of all stakeholders involved in the process, which was evidenced from the internal documents that guide the licensing process. It was verified, for example, the existence of legislation to detail the EIA process in general, and the post-decision phase in specific, with well-defined criteria and guidelines for the environmental programs that are part of the environmental licensing process of marine seismic surveys.

The role of the environmental agency in managing the EIA process must be highlighted, notably in evaluating the implementation of the follow-up programs and establishing communication with all involved parties, considering the need of compliance with mandatory requirements. Although specific legislation applied to seismic surveys preconizes two forms of follow-up (in-person and documentary), there's no clear and well defined monitoring objectives (a good practice recognized by [1] and [2]), and there is a need to establish more systematic monitoring procedures that allows the analysis to be met in time to provide feedback to next steps and, also, direct the next projects, which is not happening accordingly.

Evidence that the environmental agency was sensible to that issue can be found on the existence of guidelines to environmental licensing of marine seismic surveys, prepared by Ibama. However, there are only generic references to follow-up, with few conditions of a positive influence on the effectiveness of EIA at this stage. Interestingly, similar requirements are found in EIA legislation regarding follow-up in countries such as Portugal, Australia, China (Hong Kong), Canada and the USA. In the Netherlands, the follow-up programs clearly define the roles and responsibilities between the regulator and the proponent, who discuss the programs in the pre-decision stage with broad participation of the communities involved [21].

### 3.1. Deepening the Comprehension—Follow-Up of Marine Seismic Surveys in the Santos and Campos Oil Basins

As an evidence of learning promoted by the cumulated experience with follow-up programs, a regionalized approach was adopted to guide the programs that have been implemented in the Santos and Campos Oil Basins, as shown in **Table 2**.

The demand for licensing of marine seismic surveys in the Campos and Santos basins has grown exponentially in recent years. Considering only the biennium 2019-2020, a total of 17 environmental licensing processes for 3D seismic surveys were applied in the two main offshore oil and gas producing basins of the country. This demand poses practically a continuous coverage of the maritime territory, with the aggravating factor that some survey polygons present significant overlaps with each other, resulting in areas with 5 simultaneous licensing requests. This situation creates an impasse in Ibama's licensing portfolio in these basins, so the agency has encouraged companies with ongoing EIA processes with overlapping areas to cooperate with each other in order to sup-

port the management of projects and activities, based on operational adjustments, avoiding conflicts and agreeing on joint operations.

### 3.2. Evaluation of the Findings

Evaluation is an important step that will determine and identify the lessons learned occurred from the EIA follow-up programme and should be used to give feedback to the next projects [19]. In this regard, [24] found in a previous study that in Brazil the final verification of adherence to the terms and conditions of projects has not been verified and evaluated. On the other hand, [19] emphasizes

**Table 2.** Description of EIA follow-up programs in the Santos and Campos oil basins.

| Environmental program | Implementation | Programme evaluation |
|---|---|---|
| Humpback whale telemetry project (PTBJ) | Operation phase of the project | Evaluate the incidence of acoustic impacts that contributed continuously, in terms of spatial-temporal synergy, of the different seismic research activities on the humpback whale, this project is evaluated with information every 15 days |
| Marine biota monitoring project, and Passive Acoustic Monitoring (PAM) | Operation phase of the project | Evaluate the results in the activity reports should present an analytical discussion of the visual and acoustical projects; they are evaluated after the execution of the programs (agency evaluation is performed after project completion) |
| Environmental acoustics modeling project and sound decay in situ verification project | Project operation phase and post-project phase | Evaluate the sound and horizontal dispersion of the acoustic level received by marine biota at different distances and depths (agency evaluation is carried out after completion of the project) |
| Cetaceans telemetry project | Project operation phase (implemented before, during and after the project) | Assess behavioral patterns of diving, vocalization, and foraging for short-term responses and any changes due to acoustic impact (agency evaluation is conducted after the project is completed) |

that evaluation results are necessarily useful information that should be extracted to improve the follow-up process and made it available to all stakeholders and the scientific community. Also, in this context, examples from other jurisdictions show that the results of follow-up programs in Hong Kong (China) are evaluated by a third party [25]. In Canada, the independent monitoring agency that has in its composition the government, proponent and members of the aboriginal community to be the overall evaluators of the follow-up programs, this arrangement is unique and evaluates not only the actions of the regulatory agencies as well as the proponent [19]. Finally, studies compiled by [8] [26] have shown that without a systematic EIA follow-up evaluation process, the effectiveness of mitigation measures and management plans remain unverified compromising the entire IA process.

The findings have shown that the evaluation of follow-up programs coordinated by Ibama/CGMAC includes the preparation of technical appraisals focused on the compliance with the conditions relating to the implementation of environmental programs for offshore seismic research activities. This appraisal covers a variety of issues, such as the quality of the environmental reports, information regarding the implemented activities of the environmental programs approved in the environmental license, and the analysis of compliance with the guidelines of the previously approved programs.

Post-license monitoring conducted by the regulatory body takes place in a documentary and in-person manner. The documentary form consists of analyzing activity reports prepared by companies (entrepreneurs) licensed for each operation. This form of monitoring not only allows the verification of the effectiveness of the required projects, but also allows the application of legally stipulated sanctions and punishments, whether the measure has been properly implemented during the seismic survey.

In-person monitoring includes, in its simultaneously preventive and supervisory nature, the possibility of adjusting conduct before the generation of environmental impacts, as well as the action of flagrant infractions. As raised in the interviews, "*The analysis of post-license processes is completely linked to good licensing, and we should focus much more on post-license. As soon as we started, we detected* 100% *non-compliance with biota conditions, when we started doing these analyzes and sending these reports to the companies, soon after they started to slightly improve the execution of the projects*" (verbal information).

This documentary analysis is basically oriented to evaluate the implementation of environmental programs approved in the license conditions, as stated by another interviewee: "*We carry out technical analysis to meet the conditions of the usual projects, let's say the marine biota monitoring project and now the passive acoustic monitoring project, they have the implementation biota guide that governs this project, right, so there you have it. all the procedure descriptions and the guidelines that they have to follow, so what we do is basically com-*

*pare, right, so compare the data that is presented and with what the guide establishes, what the guide asks for, right, so when there is We have to point out things that are not in compliance in the technical opinion and send it to DIPRO and they make the more technical assessment of how much the fine will be and how serious it will be*" (verbal information).

In-person assessment is usually carried out with the deployment of a field team to investigate the situations that are reported in the documentation: "*We followed the execution of beach monitoring whenever we thought it was important to go there and check how it was being carried out, generally we go to give some guidance and need to see what is good and what is not good and see a little about the project moving forward, then we end up evaluating all the projects being carried out there… but it's been a while since we went for a vessel inspection, the financial situation has worsened field trips*" (verbal information).

Broadly speaking, the evaluation phase needs to identify lessons learned from EIA follow-up programs, more specifically, the evaluation of EIA follow-up results must determine the adequacy of the information provided. The results must be compared with the environmental baseline information collected before project execution, as well as with impact study predictions, and thus assess whether the expected results correspond with the initial predictions, otherwise, adopt new ones measures for correction and adequacy in order to ensure the effectiveness of mitigation measures [19]. Therefore, without a systematic follow-up process, the effectiveness of mitigation measures and management plans remain largely unverified [8] [26].

### 3.3. Evidence of Principles for Best Practice of EIA Follow-Up for Seismic Survey Activity in Brazil

In order to illustrate the adherence of the follow-up practice in the studied context to the international principles of good practices, we chose to adopt the analytical structure proposed by [27], which allowed us to evaluate the effectiveness of the follow-up practice adopted by CGMAC. In order to simplify the evaluation scale, three grade levels were adopted: satisfactory, partially satisfactory and unsatisfactory, as illustrated in **Table 3**.

Based on the evidence collected and after the established comparison, the outcomes of the research clearly demonstrate that the follow-up process for the seismic survey projects in Brazil is at critical stage with a sign of drawbacks in the advances achieved, although the efforts of the actors involved to improve the practice and its alignment with the best practice of the EIA follow-up in this type of projects, and these efforts may also drive to the continuous improvement of the practice of the EIA follow-up for seismic survey acquisition in Brazil.

## 4. Conclusions

Although several problems are pointed out in the literature, it demonstrates concern with the practice of EIA follow-up projects in many jurisdictions, however,

**Table 3.** Evaluation of the EIA follow-up practice adopted by the CGMAC for seismic survey against international best practice principles.

| International principles of good practices | Evaluation of the good practices in the context of CGMAC | Justification and comments |
|---|---|---|
| P1 EIA follow-up is important to determine the results of the process | | Seismic projects are submitted for follow-up, but do not necessarily fulfill their real potential to determine the results |
| P2 Transparency and openness in the EIA follow-up process | | Although the information is available, it is still difficult to access, especially for the communities involved in the process |
| P3 Commitment is part of EIA's follow-up | | Commitment among stakeholders has been demonstrated |
| P4 The proponent is responsible for implementing the follow-up | | The proponent hardly ever strictly performs the terms and conditions as stipulated in the commitment |
| P5 Regulator is responsible for ensuring follow-up | | Although the regulator guarantees the follow-up, however, it is a critical step, the final verification is hardly performed |
| P6 The community must involved in EIA follow-up | | Communities Participation is weak, but fishing communities in the decision making process needs to be improved |
| P7 Stakeholders involved in process should establish cooperation | | There is cooperation between regulator and proponent, they discuss all environmental programs to find consensus on the approach; methodology, techniques, and technology |
| P8 Follow-up must align with the social and cultural context | | EIA follow-up programs are aligned within the social, economic, and cultural context |
| P9 Follow-up should make reference to cumulative effects and sustainability | | The regional approach considers cumulative and synergistic impacts in the programs, although there is no data available yet on the results |
| P10 Follow-up must be flexible, adaptable, action-oriented and focused | | Efforts to adapt follow-up programs are identified, but execution is not always on schedule |
| P11 Follow-up should promote learning from the result of accumulated experience | | Although, several instruments were identified that demonstrate the feedback, however, the lack of verification and use of the information to direct the next projects somehow compromises the process |
| P12 Follow-up should clearly define the roles, goals, the tasks and responsibilities | | Roles, tasks and responsibilities are well defined in the pre-decision phase and have their scope outlined in the programs |

**Continued**

| | | |
|---|---|---|
| P13 Follow-up should be guided with clearly defined objectives and goals |  | The programs are presented with their goals and objectives in the guidelines requested by CGMAC, for example; in the PEAT, PCP, PMBM, PCS, PEAT, etc. |
| P14 Follow-up should be case-specific |  | The programs are adapted according to their particularities, and supported by environmental studies, through issues identified in the early stage of the process |
| P15 Follow-up should establish well-defined performance criteria |  | We verified guidelines that help in the elaboration of the programs and with criteria to evaluate their performance |
| P16 Follow-up must occur during the life cycle of the project |  | The approved programs are targeted for the duration of the project's data acquisition activity |
| P17 Follow-up must have compatible resources for its execution |  | Financial resources in the pre-decision stage are evident in the proponent for payment the fees collected for the regulator, and lack of information from the proponent about financial expenses for the execution of the programs approved in the follow-up, and the regulator, has budget restrictions and lack of hiring people that make the follow-up difficult |

Source: Based on [27]. Legend: Fully satisfactory, Partially satisfactory, Not satisfactory.

the lack of systematic evaluation of the EIA follow-up has been compromising the effectiveness of the monitoring of mitigation and management measures of the established plans that have not been evaluated, verified, and their monitoring remains deficient.

Despite several initiatives to improve control and inspection mechanisms in the follow-up of marine seismic surveys in Brazil, the current institutional capacity of the coordination does not allow for the execution of these activities, due to the impact of budget reduction and the low human resource capacity of the institution's technical staff.

The institutional capacity has demonstrated a concerning condition with a low number of employees that have not capable to keep up with the demand of pre-licensing within the deadlines in some processes, and leaving aside the post-licensing for late analysis. However, taking into account the political context in Brazil at the time of the research, there was a clear trend towards weakening the environmental licensing process at the federal level, which has been driven by business sectors in conjunction with the political class pushing hard for streamlining the federal environmental licensing process and putting at risk the potential of the instrument to ensure environmental protection and, thus, to

achieve effectiveness.

Despite the initiatives and efforts to improve public participation in the environmental licensing process for maritime seismic surveys, there has been a weakening of this important stage in the process, taking into account that currently the environmental projects that are legally bound to public participation are scarce in shallow waters or environmentally sensitive waters framed in class 1. Although there are efforts to include communities in the plans of monitoring and control of impacts, mostly in projects to compensate for the impacts of fishing activities, this initiative is considered incipient, since not even these communities have access to the results of these activities.

Finally, it is relevant to recognize that, due to its peculiarities, the follow-up practice in the context of marine seismic surveys poses environmental analysts and decision-makers with a need for an agile and adaptive management system, mainly to feed the process in a timely manner.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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