

Article

Challenges of Participatory Community Monitoring of Biodiversity in Protected Areas in Brazilian Amazon

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Abstract: Participatory community monitoring programs (PCM) have become an important methodological innovation for the management of biodiversity conservation in protected areas. Based on the participation of the local communities, they are presented as less costly programs than conventional ones. However, in practical terms, such programs pose serious implementation challenges. In this article, we identify the achievements, obstacles, and perspectives of four PCM implemented in the state of Amazonas, Brazil. Based on bibliographical and documentary research, direct observations and in-person interviews with program managers and specialists, we qualitatively evaluated these programs with respect to participation, data production and retrieval, and financing. We found that the performances of these programs were not yet adequate to their protected areas management priorities and that they had not yet generated perceptible benefits enough to enhance community trust and full appropriation of the programs' outcomes by resource users and by conservation unit management teams.

Keywords: participatory monitoring; biodiversity management; conservation units; Amazonas

1. Introduction

In general terms, there has been an increasing emphasis on monitoring as a process to evaluate the quality of results from different biodiversity conservation management strategies [1]. The major reasons for such a process include international agreements and the relevance of sharing information on biodiversity for political decision-making processes [2,3].

Participatory community monitoring (PCM) programs are valuable sources of information to improve the management of protected areas created to promote the in situ conservation of biodiversity. These programs are part of an increasing effort on the part of many countries that have begun to adopt actions to monitor the “tendencies of their biodiversity” [2] (p. 3) with the aim of minimizing human impacts on threatened biodiversity, which has been a major global issue over the past few decades [4].

Monitoring is a data collection process on a given subject, over a considered or estimated period of time, during which the effectiveness of changes in behavior of what had been monitored is verified, that is, revealing differences between “before” and “after” [5,6]. Thus, it involves two complementary procedures: the collection and systematic analysis of data [7,8].

Dissemination of monitoring programs has brought about some dilemmas regarding their viability. Initially, as an instrument of exclusive scientists' use, it proved viable in developed countries since its operation implies an expensive activity involving technological sophistication and the use of highly qualified personnel [9]. In developing or less developed countries, the existence of numerous basic

social issues has led to a lack of budget resources reflecting the absence of monitoring programs among government priorities [10]. Such a context favored the emergence of non-governmental organizations who hire researchers to develop local programs funded by international donors. However, the effectiveness of these programs, especially those inside protected areas, is deeply conditioned towards the acceptance and direct participation of local residents in monitoring data acquisition [11].

This concept was reinforced by the Convention of Biological Diversity (CDB) approval, which was established by member countries to integrate their local populations in biodiversity monitoring processes [12]. If, on the one hand, the participation of local communities or those which directly use the biodiversity has an eminently pedagogical purpose, on the other hand, it makes the management of protected areas more dynamic and democratic [13,14]. A differential of this new approach would be the capacity to promote a dialogue and effective interaction between scientific knowledge and local knowledge, resulting in improved debates and decisions regarding biodiversity management [15,16]. For these reasons, participatory monitoring became an alternative that has been adopted in several global initiatives.

Clearly, the participative nature of monitoring programs covers the capacity to deal with both convergent and divergent interests between the local communities as well as between these and other social agents and groups of interest surrounding biodiversity conservation [17–20]. These observations may be favorable for participatory monitoring; however, they do not prevent the critics and acknowledgment of its limitations since in most experiences, the distance between what is desired and what is achieved is remarkable [5].

Amazonas is the largest Brazilian state and occupies an area of over 1.5 million square kilometers, corresponding to 36% of the Brazilian Amazon. Most of its native forests remain preserved (97%) and 87.6 million hectares (55% of its territory) are Protected Areas [21]. Fifty-one percent of this total surface area corresponds to Indigenous Lands, 25% to Federal Conservation Units, and 21.4% encompass 42 State Conservation Units that shelter 26,000 families distributed in 1030 communities [22]. Such numerous territories of protected and inhabited forests represent a huge potential for biodiversity participatory monitoring programs. In this context of great territorial proportions, the implementation of PCM programs is expected to face some of the obstacles seen in other parts of the world, in addition to those resulting from local demands and peculiarities. The results presented here constitute part of an ongoing larger study named “Programs of Participatory Monitoring as instruments for adaptive management of state conservation units in the Amazonas”, which has been carried out since 2014 by the Center for Environmental Sciences of Federal University of Amazonas (UFAM).

Based on participatory monitoring principles already established in specialized literature, the objective of this paper was to discuss the consistency of four programs currently held in the Brazilian Amazon region, more specifically, in the Brazilian state of Amazonas.

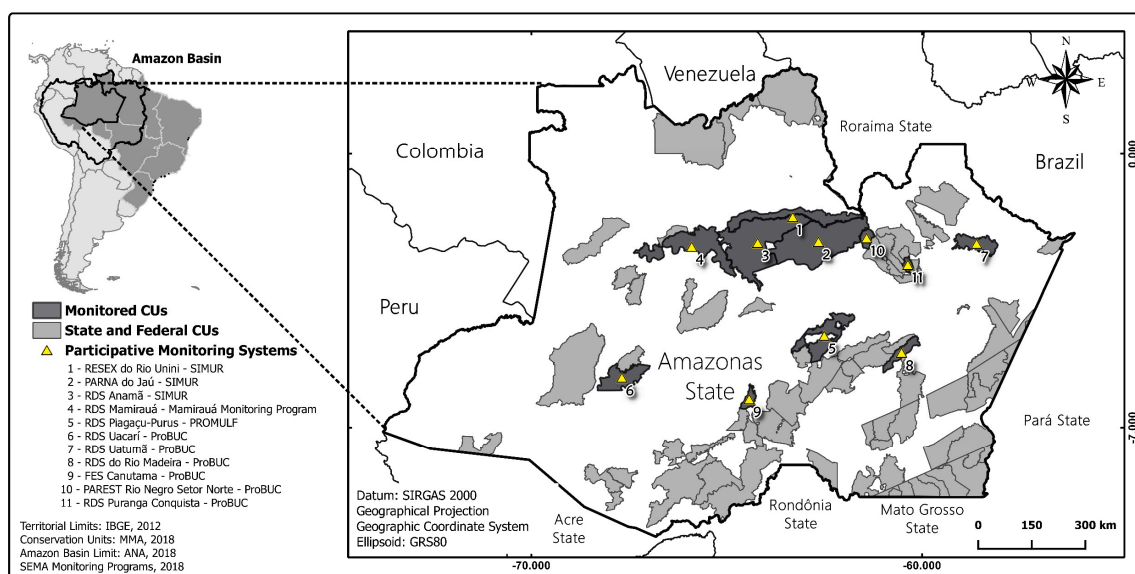
2. Materials and Methods

We developed a participatory qualitative assessment of four participatory monitoring programs held in the Brazilian state of Amazonas, seeking to understand their limitations and peculiarities. Qualitative research seeks to understand interests and strategies guiding the motivation and relationship of social agents surrounding such issues [23,24]. We conducted in-person interviews and direct observations using pre-defined interview questions (Table S1). Personal interviews also allowed us to obtain additional fundamental information not directly addressed in the questions. The interviewees' statements became the object of content analysis [25,26] to reveal the main aspects of the assessed PCM programs.

We interviewed professionals involved in four PCM programs: Program of Biodiversity Monitoring and Use of Natural Resources (ProBUC); Monitoring System of Natural Resources Use of Unini River (SIMUR); Monitoring Program of Fauna Use (PROMUF), and the monitoring programs of the Sustainable Development Reserve of Mamirauá (RDS Mamirauá) (Table 1), which together encompass the territories of 11 conservation units (Figure 1).

Table 1. Main characteristics of four participatory community monitoring (PCM) programs implemented in Amazonas State, Brazil.

	Monitoring Programs			
	ProBUC	SIMUR	PROMUF	Mamirauá
Implementation year	2005	2008	2009	1998
Number of monitors	58	43	18	300
Responsible organization	State level public environmental agency	Local non-governmental organization	Local non-governmental organization	Federal research organization
Main monitored resources and activities	Aquatic chelonians; vessel transit; game, agriculture and fishery surveys	Fishery; Aquatic chelonians; extraction of non-timber forest products; agriculture	Fauna; game; terrestrial birds	Forest management; agriculture and Piracuru fishery

**Figure 1.** Localization map of the Conservation Units (CUs) of Amazonas State, Brazil.

Selection of these programs followed pre-established criteria such as reasonable length of time in operation, existence within state conservation units, and presence of participatory methodology in monitoring activities. Initially, to understand the main aspects of these programs' historical implementation and the obtained results and products, we consulted documents available on websites of managing organizations as well as in academic publications. Next, we conducted a bibliographical research on PCM and its implications in the management of protected areas, to assess the state of art of both the theoretical debate and critiques to its practical results.

Interviewed individuals were divided in two groups: (1) managers who deal with the daily function of the programs; and (2) specialized personnel involved in data retrieval and interpretations and program evaluation activities. The group of managers refers to members of non-governmental organizations who administer the monitoring programs of SIMUR and PROMUF as well as the programs of Mamirauá, in addition to a state government manager who operates ProBUC. The group of specialized personnel, in turn, was composed of research staff from the National Institute of Amazon Research (INPA) and the Federal University of Amazonas (UFAM), who have developed investigations into some of above-mentioned programs or on the theme of participatory monitoring in the Amazon in general. We interviewed 15 professionals in total including six managers (at least one from each PCM Program) and nine specialized personnel (including former consultants hired to develop one of the PCM programs and former managers), between July and November 2017.

This study had authorization #CAAE 23250113.2.0000.5020 from the human research ethics committee of the Federal University of Amazonas and permission #064/2013 from the Center of Conservation Units of the State of Amazonas.

2.1. Brief Characterization of Participatory Monitoring Programs Analyzed

2.1.1. Monitoring System of Natural Resources Use of Unini River—SIMUR

SIMUR is maintained by the Fundação Vitória Amazonica (FVA), a non-governmental organization, and encompasses an area of 2.6 million hectares, where approximately 190 families live [27] (p. 3). SIMUR covers portions of the following conservation units: The Extractive Reserve Unini River (RESEX Unini), the National Park of Jaú (PARNA Jaú), and the Sustainable Development Reserve of Amanã (RDS Amanã).

The program's origin is associated with the elaboration of National Park of Jaú's management plan, which started in 1998 when FVA and technicians from the Brazilian Institute of Environmental and Renewable Natural Resources (IBAMA) along with other institutions began an intensive debate on the methodologies to be adopted for monitoring the newly-created National Park [28].

SIMUR has been developed since 2008 based on the monitoring of aquatic chelonians, game, fishery, gathering of non-timber forest products, crop production, and deforestation. More than 30,000 records with georeferenced data and over 7000 interviews with community members have been registered by the program [27] (p. 9). In 2014, 16 monitors and 159 interviewees (information providers) were involved in the program.

2.1.2. Monitoring Program and Fauna Use in RDS Piagaçu Purus—PROMUF

PROMUF is managed by the non-governmental organization Instituto Piagaçu Purus (IP), and is restricted to the Sustainable Development Reserve Piagaçu Purus (RDS Piagaçu Purus). Initiated in 2006, it only became a participatory monitoring program in 2009, as it was on this occasion that residents of four communities received training to become monitors [29].

Its origin is related to the context of the creation of RDS Piagaçu Purus. This CU was created as a response by the Amazonas state government to a group of concerned researchers and local communities regarding the protection of a complex of wetlands located on the borders of two Indigenous Lands and the National Park of Jari. Such concerns referred to a long history of the poaching of aquatic chelonians in the region [30] (p. 7). Thus, both the RDS and program creation are considered important measures to suppress and regulate such predatory game consumption and commerce in that region.

Up until 2013, PROMUF incorporated three sets of monitoring themes: the community monitoring of fauna; participatory monitoring of hunting as well as the use and conservation of terrestrial birds. In the following year, two new sets enlarged the program: the conservation of big cats in the context of protected areas in the Upper Purus River and hunting in the barreiros (natural salt licks) [29].

2.1.3. Monitoring Program of the Sustainable Development Reserve Mamirauá

This set of participatory monitoring programs implemented in the Sustainable Development Reserve Mamirauá (RDS Mamirauá) results from a long process of promoting community participation in the management of biodiversity. Thus, it is the lengthiest experience of PCM ever recorded in the recent history of Amazonas State. Residents participate in several stages of Conservation Unit management including the monitoring of biodiversity components. These monitoring programs are managed by the Instituto de Desenvolvimento Sustentável Mamirauá, a social organization promoted by the Brazilian Ministry of Science and Technology [31].

Among the current monitoring programs, fishery monitoring has attained the greatest social and political visibility, especially that of Pirarucu (*Arapaima gigas*) fishery. This monitoring methodology was developed from the traditional knowledge of local fishermen that allows the estimation of fish stock by visual counting, possibly thanks to the species' habit of aerial respiration. Approximately 300 fishermen had already been participating in fishery management [32] (p. 38) and the program reached the direct participation of five communities [33]. RDS Mamirauá programs also include community forest management, which has enabled a great number of management plans to be exploited and involves forest timber resource monitoring as well as the monitoring of agrosystems, which produces data on land use and land change impact in the reserve's native vegetation cover.

2.1.4. Monitoring Program of Biodiversity and Use of Natural Resources of Conservation Units in Amazonas State—ProBUC

Conception of the ProBUC has been associated with the creation of institutional mechanisms aiming to consolidate the State System of Conservation Units of Amazonas (SEUC). ProBUC is a program that aims to support the management of state CUs with biodiversity data collected by the communities themselves. It is managed directly by the State Secretariat of the Environment, initially through its former State Center of Conservation Units (CEUC) and is currently named the State Department of Conservation Units Monitoring (DEMUC) [34].

ProBUC is implemented only in six State Conservation Units of Amazonas, from a total of 42. In its initial phase, the program was implemented at the Sustainable Development Reserve Uacari (RDS Uacari) in the municipality of Carauari, where since 2005, the monitoring of fauna, crocodilians, and turtles have been implemented; the State Park Rio Negro North Sector (PAREST Rio Negro Setor Norte), located within the municipality of Novo Airão, where the program was implemented in 2007 with the monitoring of turtles in partnership with other monitoring projects such as the “Pé de Pincha” project from the Federal University of Amazonas and that from the Chico Mendes Biodiversity Institute (ICMBIO); and the Sustainable Development Reserve of Uatumã (RDS Uatumã), encompassing areas of the municipalities of São Sebastião do Uatumã and Presidente Figueiredo, where since 2009, the monitoring of fauna and turtles has existed. In 2014, we registered the participation of 41 monitors and of 16 community residents frequently interviewed [34].

From the above-mentioned period until today, ProBUC has expanded to the following CUs: the Sustainable Development Reserve Puranga Conquista (RDS Puranga Conquista) in the rural area of Manaus municipality; the Sustainable Development Reserve Madeira (RDS Madeira) encompassing the municipalities of Manicoré and Novo Aripuanã as well as the Extractive Reserve of Canutama (RESEX Canutama), located in the municipality of Canutama.

3. Results

Key Findings from Content Analysis of Interviewees Response and from Direct Observations in the Field

We synthesized and organized the main messages (interpretations) obtained from the analysis of the responses registered into four themes (Table 2): Local contexts; Participation effectiveness; Data generation and retrieval, and Funding. These “key findings” can be considered as visions of consensus among these social actors.

Table 2. Key findings of participatory qualitative assessment of the four PCM programs of Amazonas, Brazil.

Thematics	Key Findings
Local Contexts	<ul style="list-style-type: none"> • Programs have produced reasonable amount of data with potential to subsidize management decisions. • All programs present imperfection in their implementation. • Data quality (consistency, accuracy) is questionable. • Monitoring targets do not correspond to priorities in the present UC's management decision processes. • Monitoring should be linked to resource use plans and economic incentives. • The 2014 International Seminar held in Manaus was essential to bring together experiences and to allow the networking of knowledge. • Monitoring implemented by State environmental agencies should be incorporated into the upcoming program to be implemented by the federal government in the entire Amazon biome.
Participation effectiveness	<ul style="list-style-type: none"> • All programs formally performed participatory approaches during their negotiation and implementation phases. • Program self-maintenance depends more on the direct engagement of local leaderships rather than that of a broader part of the community residents. • The level of engagement of residents is greater when monitored resource is important to local food and nutritional security, such as fish and aquatic chelonians. • To enhance participation, programs should be more frequently evaluated during community meetings and management council assemblies.
Data generation and retrieval	<ul style="list-style-type: none"> • In general, data are underutilized in terms of management feedback, with the exception of that from Pirarucu fisheries. • Data are used mainly by researchers for individual publications or made available to public institutions upon request. • Communication to communities in the form of oral presentations during meetings are considered ineffective and poorly absorbed and interpreted as useful knowledge by most residents. • There is no agreement with respect to data public access policies. • Data anonymity is crucial to attain the trust of community residents and managers towards the program. • High turnover rate of personnel in operating teams compromises data management.
Financing	<ul style="list-style-type: none"> • Most funding came from international donations to the Amazonas government in the 2000s during a phase of great expansion in the creation of Conservation Units. • No program is self-sufficient in terms of funding, being chronically dependent on external sources (national or international).

4. Discussion

We have presented the viewpoints of individuals from different interest groups who the considered individual concrete cases of PCM in the Brazilian Amazon region. Based on these viewpoints, we can summarize some the collective (or systemic) challenges faced by PCM programs, especially in the Amazonian context. Below, we expand on three themes that affected the consistency of the PCM programs investigated: participation, generation and retrieval of data, and financing.

4.1. Participation

The existence of traditional practices of monitoring by communities themselves prior to official programs, seemingly, has favored the establishment of PCM programs. Such initiatives are derived from the communities' autonomous perception on whether they should create means by which to assure the conservation of highly valued natural resources and species essential to their survival such as aquatic chelonians and fish.

According to the obtained reports, such pre-conditions occurred in at least two CUs: RDS Uacari, with ProBUC, and RDS Mamirauá, where practices previously established have facilitated a fishery monitoring program. First, communities which had already been conducting several practices of monitoring turtles accepted the incorporation of the program more easily, while second, as reported by one of the specialists, the occurrence of monitoring under the responsibility of fishers' associations also favored community residents to approve of monitoring programs conceived by scientists.

Participation, though, did not occur automatically nor generally. The first resistance faced by the programs is gaining the communities' trust regarding technical teams responsible for program implementation. A gradual effort was made to convince residents that data provided on natural resources consumption would not be the object of prohibitions, inspections, or sanctions by environmental governmental agencies, but would guide the use of resources to assure their survival. Trust is an assumption for any learning process involving communities along with specialists and managers [35]. Therefore, it was fundamental that the program's technical teams created convincing strategies to prevent the community residents from feeling as objects of inspections. Nonetheless, it is worth emphasizing that community participation was greater only at the approval phase of the programs. Afterwards, information on the development of works remained restricted to the monitors, interviewed residents, and leaders.

Both the managers and specialists attributed the obligation to repost and transmit information and analyses on PCM programs exclusively to community leaders and members of managing councils. In order to enable such a task, technical teams publish newsletters to reach as many communities and families as possible. Therefore, managers transfer their co-responsibility of socializing knowledge produced through the programs to local representatives under the justification of by doing so they would not be interfering in the autonomy of community organizations.

4.2. Data Generation and Retrieval

The data generation and retrieval issue was solidly considered by the groups of interviewees as a major obstacle or limitation to the investigated PCM programs. The main polemic involved in data generation per se is the skepticism of part of the specialists due to the margin of error or even possible fraud, which is why scientific supervision is indispensable to verify the reliability of the collected data [36].

In contrast to such a general opinion, the managers and specialists of SIMUR in particular claimed not to carry any suspicions regarding the data provided by the monitors, sustaining that a trust relationship built with community residents is the safety ground for data to be as close as possible to a feasible reality. Contributing to such an idea, according to these social agents, is the fact that the program's technical team varied minimally over time, in addition to the confidential nature of the data declared to the monitors.

Nonetheless, if data generation is to be questioned regarding its consistency, the most serious fault can be identified in the data retrieval processes. This return to support the management of the CUs does not exist in the case of the ProBUC, but is present in the SIMUR and Mamirauá cases, although precariously. The SIMUR reveals a specific value, such as the aforementioned. Regarding Mamirauá, feedback for management decision making seems to exist only for the scope of fisheries.

However, data retrieval is a fundamental operation to be developed for PCM programs if they have to effectively return valuable information to communities and induce modification on the use patterns of pressured resources. One of the specialists considered that the closure of data for an indefinite time was bad for further use since it may imply outdated information or represent a mere exercise in power.

We observed that all studied programs had their respective databases whose access was only partially available and authorized depending on each case and according to solicitations by governmental agencies or academic organizations. Nevertheless, there were no operating mechanisms to enable access to data continuously and easily to members of the communities of residents and

users of the CUs monitored or to the public in general. A proper data policy would require accessible systems to fully meet the public interests, and not be restricted to managers who control and make private use of the information generated [11].

Indeed, data feedback does not depend solely on monitoring programs functioning. If programs are not integrated into a larger context referent to the CU's management, we concluded that they could never be effectively tuned to the management demands of these protected areas. A cause of such a gap may be divergences between the researchers and managers, worsened by a lack of policies able to integrate often contrasting interests regarding biodiversity management processes including monitoring programs. While the first group was worried about environmental issues which require long-term investigations with uncertain results, the second group was subject to immediate responses, as mandated by the political arena. It is necessary to establish a dialogue to reach a balanced management for both sides [37]. In this context, monitoring programs need to be seen as processes and instruments that would benefit both the development of scientific knowledge and the improvement of protected areas management.

4.3. Financing

In general, participatory monitoring programs suffer from a chronic lack of financial continuity. More specifically, this characteristic results from failures when implementing PCM programs regarding the production of long-term results, which frustrates the interests of funders who are driven by more immediate motivations [3] (p. 290). Another possible reason for financing difficulties are the high costs at the implementation phase, which would be compensated with a tendency of lower management costs until reaching a hypothetical situation of financial independence from the funders [5].

According to one of the specialists interviewed, in Amazonas state, the North-American Moore Foundation has been directly responsible over the past few years for financing many of the state environmental policy actions such as the creation of conservation units, inspection programs, and monitoring, among others. Later, as highlighted by another specialist, that sponsor relocated its interests to the African continent, which compromised the development of many local projects.

Among the programs researched, ProBUC and SIMUR were identified as dependent on resources derived from the Moore Foundation. In SIMUR, the lack of resources led to the shutdown of some monitoring components and delayed the training of monitors, even though, in general, the program has persisted. In 2017, financing was actually interrupted, leading the FVA program manager to appeal for alternative funds to maintain the program's financial obligations such as the salaries of the technical team, equivalent to 60% of the total expenses, which represents R\$120,000 annually.

Regarding ProBUC, the state government did not meet its obligations set in the contract established with the fund donors, which would have been the reason for the sponsors to withdraw from financing. Since then, the program has remained quite limited and more focused on monitoring turtles. It has continued to work thanks to resources from the federal program ARPA (Protected areas of the Amazon), which are oriented towards the consolidation of a national biodiversity monitoring program in situ [38].

PROMUF financing was carried out with resources from the Petrobrás Sociambiental program through IP's project "Fish from the Forest". With the income restriction of 2015, ranging from R\$5 million, the institute entered a financial crisis, which contributed to the program's shutdown. Likewise, financial subordination was also a clear characteristic of the monitoring programs of RDS Mamirauá, still far from the perspective of self-sufficiency recommended in the theoretical guidelines of participatory monitoring.

5. Conclusions

Experiences of participatory monitoring in the Brazilian Amazon herein analyzed demonstrate that major challenges must still to be addressed to achieve greater conservation successes. To address both the data collection and retrieval and financial issues, programs must improve their technical and

logistic aspects. For that, program designers and operators need to adopt more efficient protocols and methodologies of data collection with a better cost–benefit relationship. It is necessary to incorporate instruments for data collection, registration, and transmission to minimize miscommunication and improve the quality of stored data such as Android-based tablets. Such an improvement would facilitate data analysis and enable the production of more reliable information in a desirable frequency.

In a sociopolitical and strategic scope, creators, sponsors, and operators should consider that each program needs to be fully integrated into the management of conservation units in which it acts. The hitherto autonomous functioning of these programs has contributed little to the effectiveness of biodiversity conservation actions. The absence of feedback mechanisms has hampered public participation and social control, which has resulted in a loss of interest by the communities that use the resources in question.

Likewise, important decisions regarding both the development and improvement of these programs require a deeper discussion with resident communities to ensure that the programs incorporate local interests on terms equal to those of other stakeholders, i.e., researchers, public managers, or financiers.

Overcoming participation and financial challenges will clearly demand long-lasting political commitment and more significant investments by the state and federal governments and donors as well as a more determinant political role of the local communities and research organizations, which are the main social agents directly involved in biodiversity conservation processes. These are inseparable and complementary aspects of successful PCM programs.

Supplementary Materials: The following are available online at <http://www.mdpi.com/1424-2818/10/3/61/s1>, Table S1: Interview questionnaire script.

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