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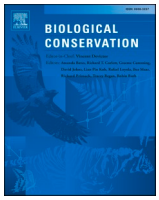

Organising and enacting inter-organisational coordination in long-term social-ecological monitoring

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ABSTRACT

This article focuses on the coordination of long-term social-ecological monitoring programmes between different organisations. Effective long-term social-ecological monitoring (LTSEM) is considered to be of crucial importance to inform conservation policies in an era of accelerating global changes. However, many LTSEM programmes are led by individual organisations with a narrow thematic and spatial focus, and fail to provide an integrated understanding of the trajectories of social-ecological systems. Inter-organisational coordination is increasingly presented as a promising way to overcome this limitation of LTSEM programmes, but in practice it remains limited. Our article contributes to understanding this situation by empirically documenting how inter-organisational coordination of LTSEM programmes is organised and enacted in practice. It proposes a working heuristic framework to characterise patterns of inter-organisational coordination based on two criteria: the degree of monitoring centrality and the degree of verticality of inter-organisational coordination. This framework can be used to compare patterns of inter-organisational coordination both across cases and over time. The article also proposes recommendations for the coordination of LTSEM programmes led by different organisations, especially in the early stages of the coordination process.

1. Introduction

In an era of accelerated global change, effective long-term monitoring is essential for informing public policies and taking appropriate action to halt biodiversity loss. Monitoring programmes aim to 'gather information about some system state variable(s)… at different points in time for the purpose of assessing system state and drawing inferences about changes in state over time' (Yoccoz et al., 2001: 446). They are considered long-term if they allow signals of environmental change to be distinguished from background noise (Parr et al., 2002), which often requires the active involvement of programme partners over multiple decades. Long-term monitoring promises to help detect early signals of change in a system, disentangle anthropogenic changes from background noise, track the change trajectory over time, inform future predictions and help avoid the occurrence of the predicted worst-case scenarios (Parr et al., 2002; Lindenmayer et al., 2015; Haase et al., 2018; Dirnböck et al., 2019). The increasing entanglement of ecological and human dimensions in conservation issues has gradually highlighted the

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need to consider social-ecological systems (SESs) (Preiser et al., 2018) and to move towards long-term social-ecological monitoring (LTSEM) (Haberl et al., 2006; Mollenhauer et al., 2018; Rai et al., 2021), defined as the systematic recording of social and environmental indicators over an extended period (Carilla et al., 2023: A2).

Coordination of existing LTSEM programmes conducted by individual organisations appears to be a promising way to achieve an integrated understanding of SES trajectories, which is crucial given the high level of complexity and uncertainty of conservation issues. Inter-organisational coordination is increasingly being presented as a top priority in LTSEM (Navarro et al., 2017; Kühl et al., 2020). Examples of inter-organisational coordination include the Global Network for Observations and Information on Mountain Environments (GEO-GNOME), the Pan-European Common Bird Monitoring Scheme (PECBMS) and the Scottish Biodiversity Information Forum (SBIF, 2015). These initiatives have proved particularly useful for measuring progress towards internationally or nationally agreed-upon targets, such as the Aichi Targets and the Sustainable Development Goals (SDGs). For example, GEO-GNOME provides policy-relevant information on mountain regions to help achieve the SDGs (Adler et al., 2018), and the PECBMS has highlighted the negative impacts of agricultural intensification (https://pecbms.info; Kühl et al., 2020). However, many individual LTSEM programmes with a narrow topical and spatial focus on SESs continue to coexist (Haase et al., 2018; Mollenhauer et al., 2018; van der Hel, 2019; Kühl et al., 2020). This article contributes to the understanding of why inter-organisational coordination in LTSEM remains limited and suggests avenues for its development.

Coordination in science has been broadly defined as 'the establishment or strengthening of a relationship among the activities in a system, with the aim to enhance their common effectiveness' (Hessels, 2013: 322). It is increasingly understood as a multifarious and fragile process that unfolds to varying degrees and evolves over time. Inter-organisational coordination is expected to surpass what stand-alone organisations can achieve by building on their respective results while harnessing their complementarities and differences (Manning, 2017).

Individual LTSEM programmes have characteristics important for inter-organisational coordination. First, they have a low degree of mutual dependence (Jappe, 2009; van der Hel, 2019), which is known to negatively affect the need for inter-organisational coordination (Whitley, 2000). Participants in such programmes may monitor a particular species, ecosystem or activity in a geographical area without establishing links with monitoring programmes interested in other components of the SES in the same area. The same applies to participants in programmes monitoring the same component in different areas (Jappe, 2009). Participants in a given LTSEM programme may have little motivation to invest time in integrated LTSEM and inter-organisational coordination, as they can access resources, publish high-impact papers and be considered successful. Second, individual LTSEM programmes often fail to agree upon goals due to the involvement of various organisations with different statuses (e.g. research organisations, non-governmental organisations [NGOs]) and various participants with their own practices, interests and values (e.g. research actors with different epistemic cultures, state authorities, NGOs, local communities and citizens) (Holzer et al., 2018). This high degree of organisational heterogeneity has been described as hindering inter-organisational coordination (Provan and Kenis, 2008; Wardenaar et al., 2014). However, the organisations running individual LTSEM programmes often have highly stable activities and interactions, in contrast to the high rate of formation and dissolution of linkages in other scientific fields, such as biotechnology (Powell et al., 2005). Indeed, the ability to produce continuous data series over time despite the many organisational, political, financial, scientific and technological changes that occur continuously contributes to the value of long-term monitoring (Ribes and Jackson, 2013). Given these characteristics, it can be expected that inter-organisational coordination in LTSEM will be difficult to establish but, once established, will be long lasting.

These characteristics of LTSEM programmes raise two important questions that we aim to address in this article: first, how organisations involved in inter-organisational coordination relate to each other, and second, what activities they undertake together, which is likely to influence the outcomes and effectiveness of inter-organisational coordination (Hessels, 2013; Bernard de Raymond, 2018). We therefore seek to investigate how inter-organisational coordination in LTSEM is organised and enacted. More specifically, we compare two cases of inter-organisational coordination of LTSEM to address the following research questions: Can patterns of organisation and enactment of inter-organisational coordination of LTSEM programmes be identified and characterised? How can we explain the development of a particular pattern of inter-organisational coordination?

The paper is structured as follows. Section 2 presents our two case studies and our methods. Section 3 describes the characteristics of the organisations involved and how inter-organisational coordination was organised and enacted in both case studies. Section 4 discusses the similarities between the case studies and proposes a working heuristic framework for characterising patterns of inter-organisational coordination. The paper concludes by outlining the operational implications of our study.

2. Materials and methods

We studied inter-organisational coordination in LTSEM empirically, through a case study approach. Case studies aim to investigate contemporary phenomena within their real-life contexts and to understand how and why these phenomena occur (Yin, 2009). They can produce generalisable results and can be used to develop theories and heuristic frameworks (Yin, 2009). We studied two cases that developed within the same organisation (the French Zone Atelier Alpes [ZAA]) but had different internal characteristics. Both organisations were still in their early stages, with one already established and the other still under construction. Their similarities and differences allowed for a meaningful comparison. We present their contexts before outlining the criteria that we used to characterise the organisations involved, their relationships and the activities coordinated. We then describe our data collection and analysis methods.

2.1. Case studies

Created by the National Centre for Scientific Research (CNRS)[1] in the early 2000s, the Zones Ateliers (ZAs) are the French version of the long-term social-ecological research platforms that exist at the international level (Mirtl et al., 2018). ZAs have members that are research labs, primarily in ecology and Earth sciences, and partners from outside academia (Arpin et al., 2023). The ZAA seeks to study the interactions among climate, biodiversity and human societies in the French Alps. It is characterised by a strong tradition of collaboration among researchers, protected area managers and other practitioners. The ZAA is involved in two cases of inter-organisational coordination: the Sentinelles des Alpes (SDA) programme and the Lautaret-Oisans project (LOP) (see Fig. 1 for an overview of the two cases).

The creation of SDA was initially conceived by the managers of two protected areas that are heavily involved in long-term monitoring programmes. In 2016, they persuaded other programme managers to jointly call for the creation of 'an Alpine cooperation platform for a coherent strategy for biodiversity knowledge and conservation at the scale of the French Alps', which they called SDA. Their key motivations were to secure more funding for monitoring programmes and to avoid the duplication of effort and competition. The main potential funder at the time was the French Biodiversity Agency (OFB), which was willing to support monitoring programmes as long as they demonstrated their

[1] See https://www.cnrs.fr/en.

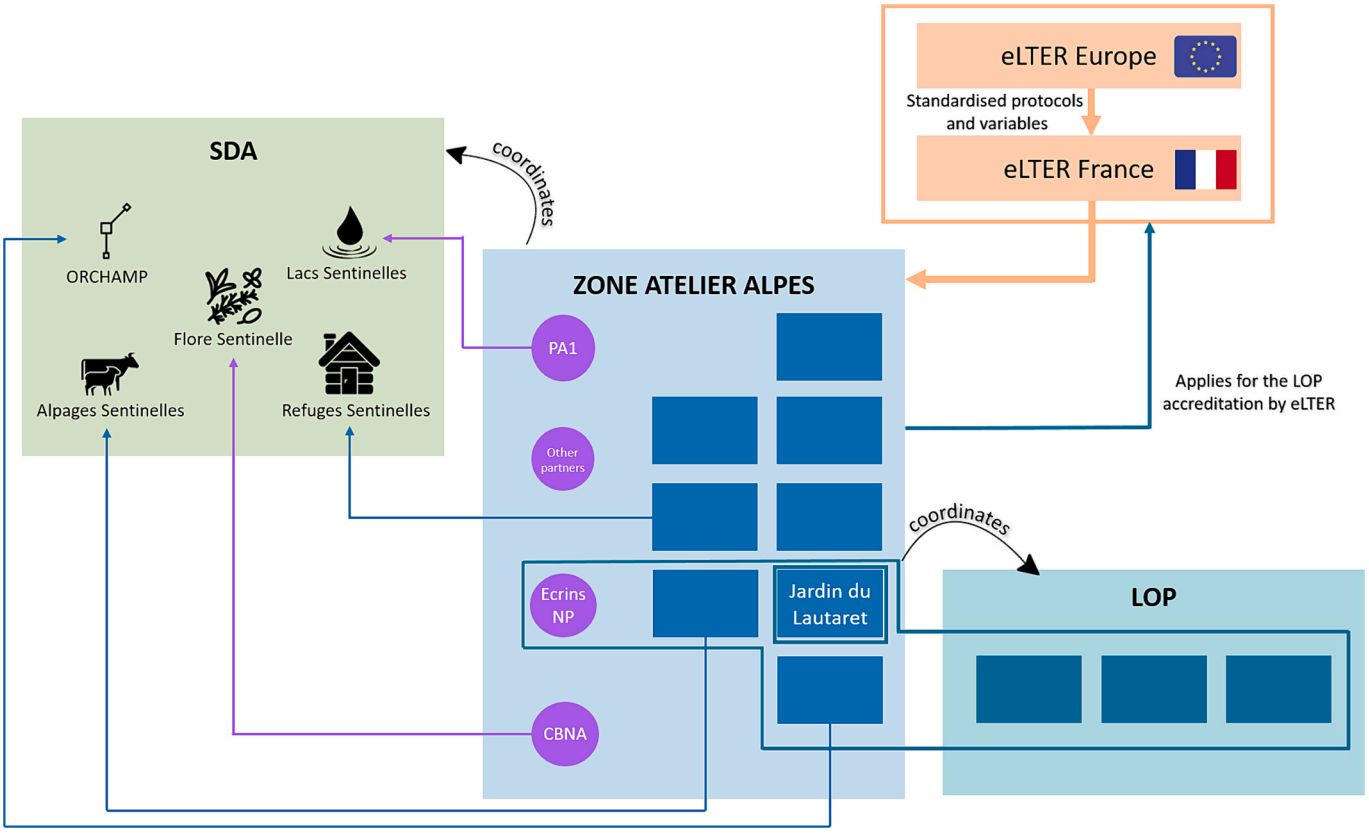

Fig. 1. Actors involved in the two cases of inter-organisational coordination studied. Blue rectangles represent research labs. Purple circles represent societal actors. SDA: Sentinelles des Alpes; LOP: Lautaret-Oisans project; PA: protected areas; CBNA: Alpine National Botanical Conservatory; NP: National Park. For the sake of visibility, funders are not represented. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

capacity to work together. The ZAA was identified as a suitable coordinating actor that would offer the project scientific credibility and was asked to submit a full project to the OFB. SDA was officially launched in 2018 as a loose entity managed by the ZAA leadership team. A steering committee composed of the leaders of each member programme and the ZAA was established at the time of its creation. Two people were recruited successively on fixed-term contracts to help manage both SDA and the ZAA, one from 2018 to 2020 and the other in 2021. The OFB funded both contracts, and the second was co-funded by a government organisation that manages the design and implementation of sustainable development policies for the French Alps.

The LOP was developed as a potential platform for eLTER, a hierarchically structured pan-European research infrastructure currently under construction (Mollenhauer et al., 2018). The aim of eLTER is to 'understand the complex interactions between people and nature over the long term'[2] by implementing a 'whole-system approach' to SESs (Zacharias et al., 2021). This approach combines the perspectives, methods and data of the natural sciences; Earth system sciences; and, to a lesser extent, human and social sciences. The eLTER infrastructure is part of the drive to transform science in Europe into European science (Nedeva and Stampfer, 2012), which is expected to surpass the achievements of individual European countries and attain a level of global excellence. The goal is also to transform ecology into 'big science' (Zimmerman and Nardi, 2010), meaning large-scale science that can process large amounts of data and is comparable to prestigious and well-funded disciplines such as nuclear physics. One major action of eLTER is the establishment of a network of complementary sites across Europe where 'essential variables' of SESs will be monitored over the long-term across five spheres: the geosphere, hydrosphere, atmosphere, biosphere and sociosphere.

The ZAA has been involved in eLTER since 2018, with the crucial support of one of its members, the Jardin du Lautaret. The Jardin du Lautaret is a 'service unit' of the CNRS that manages the scientific facilities and equipment at the Lautaret pass (2058 masl) and provides researchers with technical and logistical support for their scientific work and their stays at the Jardin. A major asset that the Jardin du Lautaret offered to a potential eLTER platform was its involvement in several research infrastructures, allowing for integrated monitoring of SESs. For the LOP, the ZAA acted as both a coordinating and a coordinated organisation. In addition, it sought to bring together research teams with different disciplinary backgrounds and potentially other actors to monitor an area according to eLTER's requirements. It was also one of the numerous organisations willing to submit a project for eLTER accreditation. In this article, we focus on how inter-organisational coordination was experienced by the ZAA as a coordinating organisation.

2.2. Characterisation criteria

We characterised the organisations involved in the two cases according to four criteria (Gulati, 1995; Provan and Kenis, 2008; Wardenaar et al., 2014; Bernard de Raymond, 2018; Kühl et al., 2020; Hickey et al., 2023): i) their type and status (e.g. research organisation, state authority, NGO, private sector company, citizens); ii) the existence of a shared history and the level of inter-organisational trust; iii) size, both in terms of the number of organisations involved and the geographical distance covered; and iv) power distribution. Given the various conceptions and definitions of trust and power, it is important to clarify our understanding of these concepts in this paper. Following Provan and Kenis (2008: 9), we define trust as positive expectations about another's

[2] https://elter-ri.eu/mission-vision, consulted on 4 October 2022.

intentions that lead to the acceptance of vulnerability. Our focus is on inter-organisational trust, as this is more critical than inter-individual trust for inter-organisational coordination (Shrum et al., 2001; Provan and Kenis, 2008). We are interested in the relational dimension of power, defined as the visible, invisible and hidden capacity to enforce one's own intentions over those of others (Vallet et al., 2020). This capacity is referred to as 'power over' in the literature (Vallet et al., 2020; Osinski, 2021).

We characterised the relationships between the organisations involved as i) vertical, in which the coordinating organisation wants and is able to impose strategic decisions on the coordinated organisations, particularly about joint activities, or ii) horizontal, in which the coordinating organisation wants or needs to negotiate the activities that will and will not be coordinated (Manning, 2017).

We characterised the activities coordinated as i) monitoring centred, if they concern the monitoring activities themselves (Hessels, 2013; Bernard de Raymond, 2018), or ii) as monitoring enabling, if they aim to create the necessary conditions for monitoring, such as community-building, resource management or profile-raising (Bernard de Raymond, 2018). We also paid attention to which activities were *not* coordinated (Bernard de Raymond, 2018).

The criteria we used to characterise the organisations involved their relationships and the activities coordinated, which have both been discussed in the literature as important factors in inter-organisational coordination in science and have emerged as significant themes in the material we collected (see below). Thus, we adopted a deductive and inductive approach.

2.3. Data collection and analysis

We studied the two cases from within and in a collective manner. All co-authors were involved in the cases studied. They included researchers from various disciplines (ecology, soil science, sustainability science, sociology, geography) as well as societal actors. The study was led by a sociologist who fits the definition of a deep insider researcher: 'a person who has been a member of the organisation or group under research for at least five years' (Edwards, 2002). Indeed, she has had a dual role as a participant and observer in the activities of the ZAA since its inception in 2008 and has co-directed the ZAA since 2020. She decided to reflect with her colleagues and informants on the two cases of intra-organisational coordination in which she and they were involved, rather than considering them as mere informants. Being an insider researcher is known to offer both advantages (e.g. better and faster access to data, practical and experiential knowledge and affects, greater reflexivity and capacity for change in research collectives) and disadvantages (e.g. risks of bias due to the desire to present the studied process or group positively and to avoid internal tensions, blindness to the ordinary) (Bonner and Tolhurst, 2002; Unluer, 2012; Chammas, 2020). We used two classic strategies to counter these disadvantages: clarifying the role of the insider researcher and reflexivity (Bonner and Tolhurst, 2002; Unluer, 2012; Chammas, 2020). Due to the long-standing interest of the lead author in the processes at work in the ZAA and related organisations, her dual role was clear and well accepted from the outset. Reflexivity was exercised at her own level, through personal note-taking and discussion of the case studies with outsider researchers (Bonner and Tolhurst, 2002; Unluer, 2012; Chammas, 2020), but also at the level of the group of co-authors.

2.3.1. Data collection

Case studies rely on the triangulation of multiple sources of information (Yin, 2009). In order to collect rich data and enhance our understanding of inter-organisational coordination, we used a combination of qualitative methods: participant observation, semi-directed interviews and documentary analysis. Participant observation was a key method for producing written accounts and descriptions of joint activities and interactions that could then be reviewed and reflected upon (see e.g. Zimmerman and Nardi, 2010). In our case, this task was delegated to the lead author, who took extensive notes on the formal and informal meetings for SDA and the LOP. She was also able to draw on a wealth of documents, including minutes of SDA and LOP meetings, reports, articles, funding applications and emails, which amounted to dozens of pages for each case. This material provided detailed knowledge of the organisations that initiated or participated in joint activities and how they evolved over time.

In addition, she conducted 14 semi-structured interviews in the autumn of 2022 with 18 participants in the two cases of coordination, including all co-authors. She targeted the scientific or technical managers of monitoring programmes and, if different, the head of their managing organisation, as well as administrative staff (see Table 1 for an overview). The interview guide included questions about their involvement in the cases, the contribution of the different organisations to the emergence and development of the two cases and their interactions, the joint activities that had been planned and (not) carried out and the main sources of difficulty in achieving coordination. All interviews were recorded and transcribed.

2.3.2. Data analysis

The lead author used qualitative analysis software (MAXQDA) to code the interviews according to the above criteria. She used the documents and her field notes to check some facts and understand the interviews. For example, her field notes helped to contextualise the coordination difficulties mentioned in the interviews. In this manner, she developed a preliminary interpretation of the content and organisation of inter-organisational coordination in the two case studies and of the factors that seemed to influence them. She discussed the preliminary findings in two meetings with her co-authors. These discussions helped to clarify what had shaped the relationships between the organisations and had led to the prioritisation of certain joint activities over others. They also allowed for an exploration of how both the relationships and the joint activities might develop in the future and thus had a transformative dimension.

Table 1
Interview details.

	Interview (date, number of informants, duration in minutes)	Roles of interviewees
1	2 November 2022, 1, 50	Scientific director of a sentinel programme
2	3 November 2022, 1, 105	Former member of the SDA and ZAA management team
3	4 November 2022, 2, 52	1: Scientific director; 2: Technical manager of a sentinel programme
4	4 November 2022, 1, 92	Member of the SDA and ZAA management team
5	4 November 2022, 1, 42	Scientific director of a sentinel programme
6	9 November 2022, 2, 57	1: Manager of a sentinel programme; 2: Director of the structure administering this programme
7	10 November 2022, 2, 53	1: Manager of a sentinel programme; 2: Director of the structure administering this programme
8	2 December 2022, 1, 76	Member of the Jardin du Lautaret
9	6 December 2022, 1, 50	Scientific manager of a structure involved in all sentinel programmes
10	14 December 2022, 1, 60	Member of the Jardin du Lautaret
11	20 December 2022, 1, 113	Member of the Jardin du Lautaret
12	23 December 2022, 1, 49	Member of the SDA and ZAA management team
13	9 January 2023, 2, 46	1 and 2: Members of the Jardin du Lautaret
14	12 January 2023, 1, 59	Former member of the SDA and ZAA management team

3. Results

3.1. Characterising coordinated organisations

3.1.1. Type and status

The monitoring programmes involved in SDA were developed separately by entirely independent organisations, each with their own objectives, status, participants, activities and resources (see Table 2 for an overview). The LOP involved research labs; the Jardin du Lautaret, which was a component of academia despite not being a conventional research lab; and one non-academic organisation, Écrins National Park.

3.1.2. Shared history and trust

Although the organisations involved in SDA were aware of each other's existence, not all of them had previously collaborated and built close and trusting relationships with the ZAA. Therefore, shared history and trust within SDA were heterogeneous. We found that these factors depended on inter-organisational distance in terms of both action orientation and discipline (see Fig. 2). At the inception of SDA, the action-oriented organisations suspected that the organisations focused on scientific production would prioritise an academic approach to LTSEM over their operational and policy objectives. Similarly, the organisations with a strong social science orientation were initially concerned that those with a strong natural science orientation would impede their ability to co-construct their objectives and methods with societal actors. The case of the LOP differed from that of SDA in two ways. First, there was less heterogeneity in shared history and inter-organisational trust. Second, these factors depended mainly on geographical distance from the Jardin du Lautaret. The Jardin du Lautaret had close and mostly trusting relationships with the research teams working in its immediate vicinity. This was due to the long summer stays of the scientists at the Jardin and the contribution of its staff to their fieldwork. The Jardin also had a close relationship with the ZAA, as many researchers involved in the ZAA worked in or near the Jardin. Additionally, a former director of the ZAA served as the Jardin's scientific director.

3.1.3. Size

SDA coordinates five monitoring programmes run by specific organisations, which cover the entire ZAA. The nature and number of the coordinated organisations appeared to be very stable, as expected in a field with a high degree of standardisation and routine. For the LOP, the number of actors involved and the geographical coverage of the project were still being discussed at the time of writing. The original plan was to define a vast area encompassing the Jardin du Lautaret and to coordinate multiple labs and organisations conducting monitoring activities in various scientific fields, such as ecology, SES science, hydrology, climatology and glaciology. However, as the requirements and associated logistical constraints and costs of eLTER became clearer, the project was reduced to the immediate surroundings of the Jardin du Lautaret. The decision to downsize the LOP was made because of the difficulty of involving geographically distant labs in joint discussions and activities. In both cases, therefore, only a few organisations were involved. The geographical area covered ranged from a few or tens of square kilometres in the case of the LOP to around 40,000 km^2 in the case of SDA.

3.1.4. Power distribution

In SDA, the distribution of 'power over' was uneven, with human and financial resources, as well as academic prestige, significantly influencing the capacity of organisations to exert power over others. Academic prestige itself was influenced by the disciplines involved, with ecology having a higher status than the social sciences (see Fig. 2). Monitoring programmes were run by either research teams or non-academic organisations or by a combination of both. ORCHAMP was led by a successful ecology research team with access to funding sources at the local, national and European levels. Refuges Sentinelles was initiated and led by social scientists and faced funding challenges. The other programmes had an intermediate level of access to funding and resources. It is important to note that certain monitoring programmes had greater financial and human resources than the ZAA itself. The distribution of 'power over' was less uneven in the LOP. The Jardin du Lautaret had as much 'power over' as the research labs because it was one of the few places in France that could meet the stringent requirements of eLTER. As a result, it received much attention at the national level. Écrins National Park had a strong scientific department, was an important partner of the ZAA and maintained close relationships with all the labs involved in the LOP.

In summary, the LOP exhibited less heterogeneity than SDA in terms of the organisations involved, their shared history and inter-organisational trust. Furthermore, 'power over' was more evenly distributed among the organisations. Now, let us examine how inter-organisational coordination was organised in both cases.

3.2. Organising inter-organisational coordination

Initially, the SDA management team had a vertical relationship with the monitoring programmes, attempting to steer their activities to fulfil the agreement with the OFB. However, this approach caused some tension. The programme managers emphasised that SDA should not interfere in the financial management of the programmes or take an excessive share of the total funds available. The leaders of SDA had to abandon their initial plan to take the lead in organising the annual meetings of the programmes. Similarly, the idea of bringing all the programmes together at 'master sites' to work together and achieve joint monitoring was seen as an imperative that could be decided not by SDA but by the programmes themselves. Respect for the 'identities' of the programmes, as articulated by their leaders and managers, was another issue discussed. Action-oriented organisations, in particular, emphasised their differences from research labs. In the words of a manager of a programme with a strong action orientation:

'The red line would be to try to turn us into something we are not.… We can work with researchers, but we still have a strong orientation towards public policy and providing practical and operational answers to managers. And we will keep that' (interview 6, interviewee 1).

SDA's role was primarily viewed as making suggestions and facilitating joint discussions, thereby leaving programme leaders and managers to make decisions according to their own objectives and agendas. Horizontal rather than vertical relationships were thus quickly established between SDA and the monitoring programmes.

In the LOP, inter-organisational coordination was, in practice, shared between the ZAA and Jardin du Lautaret. For example, they both participated in the eLTER-related meetings organised regularly at the national level, communicated decisions at the European level about what and how to monitor in eLTER and jointly planned meetings with local research teams to discuss their potential involvement in the project. Their relationship with these teams was clearly horizontal. The only way to involve the teams in the project was to convince them that meeting the requirements of eLTER was possible. However, the LOP leaders relayed eLTER's decisions on what and how to monitor to the research teams interested in the project. They therefore had a role of 'transmission belt', which gave a certain vertical dimension to the organisation of the LOP (see Fig. 1).

In summary, there were some differences in the organisation of intra-organisational coordination between the two cases. After a brief initial attempt to establish a vertical organisation, the relationships had become essentially horizontal in SDA. They were somewhat more vertical in the LOP, due to its integration in a hierarchically structured European project. There were more marked differences in the way inter-organisational coordination was enacted in the two cases.

Table 2
Description of the five member programmes of Sentinelles des Alpes.

Monitoring programme (year of creation)	Main objectives and *position on a science–policy gradient*	Managing organisation and *programme managers*	Participants in the programme (academic and *societal*)	Degree of co-construction between academic and societal actors and *main activities of the programme*	Funders	Sources
Alpages Sentinelles (2007)	To understand climate change in mountain pastures and its consequences for pastoral systems; to identify adaptation strategies for pastoral systems *Intermediate position on a science–policy gradient*	Interdisciplinary lab on mountain SESs *Scientific manager: sustainability scientist from this lab Technical manager: staff from a grazing organisation recruited on a short-term and part-time basis*	Ecologists, agronomists, sociologists, climatologists, sustainability scientists *Mountain pasture and farming experts, farmers, shepherds, protected area managers*	High degree of co-construction with a broad range of societal actors *Monitoring vegetation, recording grazing practices, developing/conducting agroclimatic analyses, jointly assessing grazing pressure at the end of the grazing season, hosting transdisciplinary working groups and seminars*	Regional programmes, National Fund for Regional Planning and Development as part of the interregional agreement for the Massif des Alpes, European Regional Fund mobilised as part of the Massif des Alpes interregional programme, French Biodiversity Agency (OFB)	Dobremez et al., 2014; https://www.alpages-sentinelles.fr/
Lacs Sentinelles (2009)	To improve knowledge of the functioning of high-altitude lakes; to identify threats to these lakes and to define management actions *Intermediate position on a science–policy gradient*	Haute-Savoie Natural Spaces Conservatory *Scientific manager: researcher from a limnology lab Technical manager: staff from the natural spaces conservatory and from OFB recruited on a long-term basis*	Aquatic ecologists, hydrologists, palaeoecologists, environmental chemists *Protected area managers, local authorities, Electricité de France (EDF), fishing federations, OFB*	High degree of co-construction between academic actors and protected area managers *Compulsory protocols: measuring water transparency, taking multi-parameter probe profiles of the entire water column, recording temperatures at the bottom of the lake and below the water surface Various optional protocols*	OFB, National Fund for Regional Planning and Development, EDF, Caisse d'Epargne Foundation, European funds	Birck et al., 2013; https://www.lacs-sentinelles.org/
Flore Sentinelle (2009)	To develop knowledge and skill exchanges and to implement common monitoring protocols and concerted actions for conservation of flora *Close to the policy end of the science–policy gradient*	Alpine National Botanic Conservatory *Scientific and technical managers: staff from the conservatory recruited on a long-term basis*	Botanists, ecologists *Staff from Alpine and Mediterranean National Botanical Conservatories, protected area managers, nature protection associations*	High degree of co-construction between academic actors and botanists working in action-oriented organisations *Monitoring 30 species and four habitats at two spatial scales*	Regions, OFB, European Regional Fund mobilised as part of the Massif des Alpes interregional programme, National Fund for Regional Planning and Development as part of the interregional agreement for the Massif des Alpes	Bonnet et al., 2015; https://floresentinelle.fr/
ORCHAMP (2016)	To understand the coupled dynamics among climate, land use and the biodiversity of mountain ecosystems over time and space *Close to the science end of the science–policy gradient*	Research team from the Alpine Ecology Lab *Scientific manager: internationally renowned senior ecologist leading this team Technical manager: recruited on a long-term basis and hosted by this lab*	Ecologists specialising in different aspects of ecosystems (soil, forests, fauna, flora), meteorologists, entomologists *Protected area managers, national botanical conservatories, local authorities, Natura 2000 site managers*	Intermediate degree of co-construction between academic actors and protected area managers *Compulsory protocols: measuring soil biodiversity through environmental DNA; monitoring vegetation (pin-point, forest inventories, deadwood); passive acoustic monitoring (birds, insects); camera traps (mammals); measuring soil physicochemical properties, temperature and humidity; measuring soil–vegetation profile and changes in land cover and vegetation structure through remote sensing Optional protocols: mapping ancient land use, monitoring macroinvertebrates (pitfalls, nests)*	International, European and national research programmes; OFB; Labex OSUG; Regions (Auvergne Rhône Alpes, Occitanie); EDF; Rhône Méditerranée Corse Water Agency; 'Département' of Isère; Community of Communes of the Chamonix-Mont-Blanc Valley; Grenoble Alpes Métropole	Calderón-Sanou et al., 2022; https://orchamp.osug.fr/
Refuges Sentinelles (2017)	To understand the relationships among humans, climate and biodiversity; to develop methods of observation and intervention adapted to the high mountains and to use the refuges as places for research and the co-construction and dissemination of	Research team from a social sciences lab *Scientific leader: senior geographer from this lab Technical manager: recruited on a short-term basis and hosted by this lab*	Geographers; geomorphologists; ecologists; botanists; education, communication, marketing and management scientists *Mountain guides, hut keepers, protected area managers*	High degree of co-construction with a broad range of societal actors *Monitoring overnight stays in refuges, recording destinations daily, recording key facts and weak signals seasonally, inter-professional debriefing at the end of summer Participatory monitoring of biodiversity around the*	Labex ITTEM, Petzl Foundation, research programme funded by the Swiss National Science Foundation and French National Research Agency, Écrins National Park, French Federation of Alpine and Mountain Clubs	Clivaz et al., 2021; https://refuges-sentinelles.org/

(*continued on next page*)

Table 2 (*continued*)

Monitoring programme (year of creation)	Main objectives and *position on a science–policy gradient*	Managing organisation and *programme managers*	Participants in the programme (academic and *societal*)	Degree of co-construction between academic and societal actors and *main activities of the programme*	Funders	Sources
	scientific culture *Intermediate position on a science–policy gradient*			*refuges; study of the phylogeny, taxonomy, historical ecology and ecological conditions of high-altitude plants*		

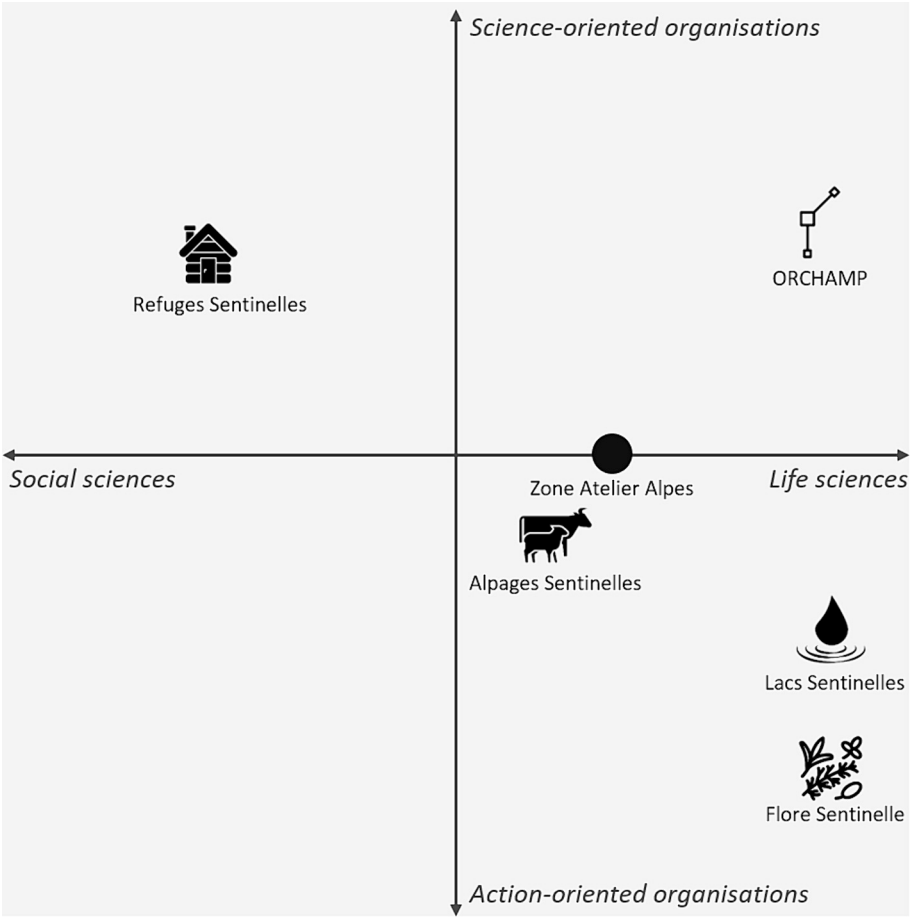

Fig. 2. Positions of the five programmes of SDA in terms of action orientation and discipline. The scales of the two axes are arbitrary.

3.3. Enacting inter-organisational coordination

3.3.1. Monitoring-enabling activities

In both cases, inter-organisational coordination involved three types of monitoring-enabling activities – resource management, community-building and profile-raising – but to different degrees and with different levels of difficulty.

In SDA, inter-organisational coordination of resource management involved submitting joint funding applications and organising a biennial partner conference for presenting achievements, perspectives and future needs. In both the applications and the partner conference presentations, the monitoring programmes wrote and presented their own sections, while SDA managers collected and collated the programmes' contributions in due course, presented SDA's specific activities and discussed financial issues with the funders. Community-building consisted of formal and informal inter-programme meetings and workshops held several times a year. These meetings mainly involved the discussion of peripheral issues, such as the meaning and modalities of observation, communication or the role of emotions in long-term monitoring programmes, rather than monitoring activities. They never took place in the field despite the time devoted to fieldwork in each programme, as one programme leader lamented: 'Too bad, but we never meet in the field' (interview 5). Inter-organisational coordination of profile-raising began when the former manager of SDA wrote a white paper describing SDA, the programmes and their monitoring protocols. It spurred the design of a visual aid depicting a mountainside with the five programmes stylised to highlight their similarities and complementarities. An animated video was then produced to showcase the objectives and main methods of the monitoring and SDA programmes, with the aim of raising awareness of the programmes beyond a limited circle of specialists. The production of the video also allowed for the harmonisation of the programmes' logos and the creation of one for SDA. SDA and monitoring programmes were shown on numerous occasions, and the video was distributed widely.

In the LOP, resource management activities were instead about human resources. In particular, the LOP leaders sought to fill the vacant manager position at the Jardin du Lautaret, as they believed that

meeting eLTER standards would be impossible without a new manager. As a result, they jointly decided to temporarily withdraw from eLTER activities to persuade the CNRS headquarters to grant them a position, which was challenging given the scarcity of positions in the French academic world. Initially, the LOP leaders were enthusiastic about building a large monitoring community around the Jardin du Lautaret. However, the endeavour was deemed unsuccessful, and there was growing support for the idea of retreating to the immediate surroundings of the Jardin du Lautaret, as explained by a member of the Jardin du Lautaret staff:

> 'I liked the idea of a large platform that would bring together all the scientific partners. But it doesn't work very well, and it's complicated to get all these people together and get them to agree. We've tried to get them to come, but they've got their sites on the other side of the [Lautaret] pass or elsewhere and they just don't come.… Things are much easier with the teams that have long worked with us'.
>
> (interview 10)

Community-building also entailed establishing relationships with the leaders of similar projects in France and other European countries. This also proved to be difficult. The LOP leaders had no direct links to other eLTER platform project leaders. Participation in the monthly remote eLTER meetings at the national level was unattractive due to the complex organisation and terminology of eLTER and the rotation of French eLTER representatives. As a result, several people became discouraged and stopped participating. Profile-raising activities included presenting the project at various local and national meetings and writing an application that had to be revised multiple times to reflect design changes in the eLTER platforms and sites at the European level. A member of the Jardin du Lautaret expressed disappointment and frustration with the process of writing the application, noting the difficulty of involving scientists and research team leaders beyond those closely related to the Jardin du Lautaret:

> 'We have written a lot of applications. It's been going on for three years.… It's a slow and sluggish process. The first shared Google document stayed up for three months without any comments. There are still a lot of people who have barely read it'.
>
> (interview 11)

3.3.2. Monitoring-centred activities

Inter-organisational coordination of monitoring-centred activities was not a primary focus of SDA. Its initial objective to share sites, protocols and data among programmes had not been achieved at the time of writing. While there was some coordination regarding equipment, each programme continued to make autonomous decisions about its sites, protocols and data. This was fully acknowledged by the programme leaders and managers:

> 'Frankly, I have the impression that we have a real weakness here, that we have managed to talk to each other, to get to know each other, to have really fruitful discussions. But, on the other hand, I have the impression that we don't have many concrete activities in common and that it remains very complicated because of the differences in culture, objectives and approaches. So, I think we are still largely each in our own lane'.
>
> (interview 6, interviewee /2)

In contrast, inter-organisational coordination was mainly about what and how to monitor in the LOP, with the goal of meeting the requirements of eLTER while also considering local interests and resources. The LOP leaders brought together the Jardin du Lautaret's closest partners to collectively select the essential variables of SESs that they could reasonably commit to monitoring in the long-term.

In summary, inter-organisational coordination primarily involved monitoring-enabling activities in SDA and monitoring-centred activities in the LOP. However, there was less asymmetry between the two types of activities in the LOP. Interestingly, the participants in both cases reported starting with the easier activities and abandoning or postponing the more difficult ones. This is illustrated by the following two quotes, the first from a programme manager in SDA and the second from a scientist involved in the LOP:

> "I pushed hard to say, 'Well, if we're going to work together, let's work on things that are less scientific but that we have in common.' And I put communication forward quite quickly because it's easy to see that we have common problems in terms of communication.... It was very unifying, and so we were less technical. At the end of the day, the technical aspects are very specific to each programme. And I had the impression that it would take a bit longer to find the technical meeting points".
>
> (interview 6, interviewee 1)

> 'It was easy to take the variables and protocols suggested by eLTER and see which ones we would follow. It raises questions, but it's relatively straightforward work. You quickly get the feeling that you can meet the requirement. It's quite simple: there's a list; we'll do the measurements'.
>
> (interview 4)

4. Discussion

We compared the organisation and enactment of inter-organisational coordination in two cases related to LTSEM that developed simultaneously within the same French organisation. We paid particular attention to the joint activities conducted by the organisations. Below, we discuss the similarities between the cases and propose a working heuristic framework for characterising the patterns of inter-organisational coordination in LTSEM.

4.1. Similarities

In both cases, establishing inter-organisational coordination proved to be challenging, as anticipated in a field with low mutual dependence among scientists, such as LTSEM. We expected that there would be fewer difficulties in the LOP than in SDA, given the greater heterogeneity of the organisations in SDA. However, this was not the case. The LOP leaders had to retreat to the immediate surroundings of the Jardin du Lautaret and managed to involve only research teams that already had a close collaboration with the Jardin. At this stage, achieving more integrated SES monitoring on a larger scale seemed impossible. We also expected that collective action would be sustainable once coordination was established. Considering the early stage of inter-organisational coordination in both cases, it would be premature to take a definitive stance on this matter. However, collective action in the case of SDA was still very fragile and entirely reliant on the ability to secure the position of an SDA manager. In the case of the LOP, sustainable inter-organisational coordination should be ensured if the project proceeds, given the low heterogeneity of the organisations involved and the project's inclusion in a European research infrastructure that requires a long-term commitment.

Another similarity between the two cases is the dynamic nature of inter-organisational coordination. Initially, various strategies were attempted to promote collective action. The SDA leaders transitioned from vertical to more horizontal relationships, while the LOP leaders significantly reduced the initially planned size of the integrated monitoring area. Furthermore, inter-organisational coordination gradually modified the relationships among the organisations, allowing for the coordination of a broader range of activities. This was particularly evident in SDA. Indeed, programme managers had recently considered the possibility of joint internships and field meetings to discuss their practices and the possibility of sharing monitoring sites and protocols

since they had recently become familiar with each other. In summary, community-building led to a shift towards monitoring-centred activities. However, there was no intention to revert to more vertical relationships, and it was generally assumed that SDA would continue to suggest and facilitate but not direct. The LOP also showed some subtle changes, such as plans to visit other candidate platforms in France and abroad, indicating a move towards monitoring-enabling activities. In both cases, therefore, the coordination patterns were somewhat mutable. However, despite the similarities, there were significant differences in the coordination patterns of the two cases. We have developed a heuristic framework based on our results and the literature to characterise these patterns.

4.2. Patterns of coordination: a working heuristic framework

We propose characterising inter-organisational coordination in LTSEM using two criteria: the degree of monitoring centrality and the degree of verticality. The former refers to the degree to which inter-organisational coordination targets monitoring-centred activities or monitoring-enabling activities such as resource management, community-building and profile-raising. The latter refers to the degree to which the coordination involves vertical or horizontal relationships. SDA exhibited low levels of both monitoring centrality and verticality. The LOP, in contrast, had a high level of monitoring centrality and an intermediate level of verticality.

Given the genericity of these two criteria, we believe that this heuristic framework can be applied to analyse the organisation and enactment of inter-organisational coordination in LTSEM in a broad range of cases. For example, the PECBMS and SBIF, which were launched in 2002 and 2011, respectively, appear to engage in both monitoring-centred and monitoring-enabling activities and to have an intermediate level of monitoring centrality (see Fig. 3). Inter-organisational coordination appears to be more vertical in the PECBMS than in the SBIF (Kühl et al., 2020). The PECBMS indeed has a central coordination unit that communicates with national coordinators responsible for operating the monitoring schemes in their respective countries (https://pecbms.info). Our framework could also be tested for cases of inter-organisational coordination in other scientific domains. The degree of monitoring centrality should then be replaced by the degree of research centrality. However, coordination patterns are likely to be influenced by factors that depend on the scientific domain. For example, geographical proximity may play a more important role in inter-organisational coordination in LTSEM than in non-place-based scientific activities.

Our framework shows that there is no unique path to inter-organisational coordination. It can be used to reflect on the path chosen in specific cases and to discuss the dynamics of inter-organisational coordination (see Fig. 3). For example, in the case of the SBIF, a coordinating organisation was established at the national level to achieve maximum cohesion and effectiveness (Wilson et al., 2018). As a result, the organisation of the SBIF is evolving towards more vertical relationships (see Fig. 3). Making such changes explicit is useful for anticipating and preparing for their potential effects.

Our framework also invites reflection on the factors that influence coordination patterns: Why did vertical relationships and the plan to conduct monitoring-centred activities have to be abandoned in SDA, while they remained possible in the LOP? Similarly, why were monitoring-enabling activities problematic for the LOP but not for SDA? The heterogeneity of the organisations involved is an important clue. In SDA, programme managers felt that they had major differences, which they often expressed in terms of the science–policy divide. The action-oriented organisations feared that coordination by the ZAA, which they perceived as academically driven and oriented, could jeopardise their identities and distract them from their goals. This made monitoring-centred activities and vertical coordination difficult. Conversely, the geographical proximity and shared attachment to the Alps and their SESs made it easier to organise face-to-face meetings within SDA. This facilitated monitoring-enabling activities and horizontal relationships. In the LOP, no organisation felt threatened by the project as long as eLTER permitted some leeway in the selection of variables to be monitored. This facilitated monitoring-centred activities and a more vertical pattern of coordination. Our study therefore suggests that horizontal relationships and monitoring-enabling activities are better suited to the early stages of coordination between highly heterogeneous organisations with little shared history, low trust and significant power asymmetries. Vertical relationships and/or monitoring-centred activities, in contrast, can be envisaged from the outset when coordinating similar organisations with a long shared history, high trust and limited power asymmetries.

5. Conclusions

Effective LTSEM is crucial for informing conservation policies and depends especially on the capacity to achieve inter-organisational coordination. We explored how inter-organisational coordination in

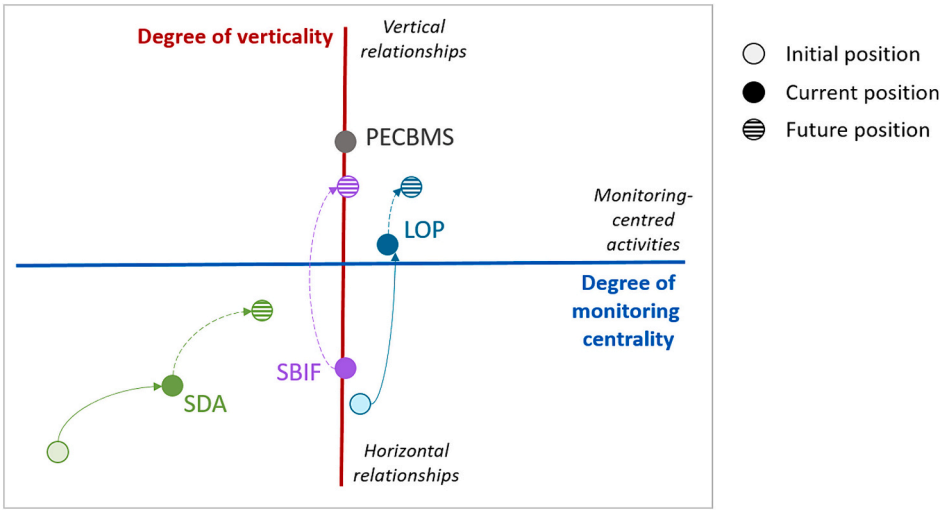

Fig. 3. Our working framework showing the initial, current and future positions of four cases of inter-organisational coordination in LTSEM, including our two case studies (SDA and the LOP). The scales of the two axes are arbitrary. SDA: Sentinelles des Alpes; LOP: Lautaret-Oisans project; PECBMS: Pan-European Common Bird Monitoring Scheme; SBIF: Scotland Biodiversity Information Forum. The trajectory of the PECBMS could not be documented.

LTSEM is organised and enacted in practice by comparing two contrasting cases from a French organisation committed to the long-term study of mountain SESs. Based on this empirical study, we have developed a working heuristic framework that allows patterns of inter-organisational coordination to be analysed and compared both across cases and over time. Our framework is based on two criteria: the degree of monitoring centrality and the degree of verticality of inter-organisational coordination. Further empirical studies are needed to refine it; to test its ability to account for a variety of cases of coordination; and to better understand the complex factors and dynamics of coordination patterns, both in and beyond LTSEM.

Based on our findings, we argue that it is crucial to characterise the organisations involved in inter-organisational coordination in LTSEM in terms of status, shared history, trust, size and power distribution. Analysing these characteristics before the coordination process begins should help to anticipate, discuss and overcome the difficulties of inter-organisational coordination. It should also help in the early stages of the coordination process to choose between different paths to coordination. In particular, it may be counterproductive to try to impose joint monitoring-centred activities from the outset, especially when coordinating a large number of highly heterogeneous organisations with little shared history, low inter-organisational trust and significant power asymmetries. In such cases, it may be more appropriate to initiate inter-organisational coordination with monitoring-enabling activities and lateral relationships. Inter-organisational coordination in LTSEM is a long-term and dynamic process that aims to enhance the effectiveness of a monitoring system. As a result, initially impossible activities may become possible as the process unfolds. Coordinating organisations should therefore adopt a 'tentative' (Kuhlmann and Rip, 2018) approach to inter-organisational coordination, that is, one involving experimentation, learning, reflexivity and reversibility (Kuhlmann and Rip, 2018; Schot and Steinmueller, 2018). Here, reversibility refers to a careful and cautious approach to coordination that considers the reactions of coordinated organisations and remains continuously open to revising choices according to their effects. Finally, the coordination process may be slow to produce tangible results, such as the sharing of monitoring sites, standardised protocols and datasets across programmes and joint analyses of SESs. It may then be seen as ineffective, especially if it tends to prioritise monitoring-enabling activities over monitoring-centred activities. Thus, coordinating organisations should be patient and should not expect their efforts to be immediately rewarded.

This leads us to make the following recommendations for developing inter-organisational coordination and achieving the more integrated long-term monitoring of SESs that is critically needed to support conservation efforts:

- Analyse the characteristics of the organisations to be coordinated in terms of status, shared history, trust, size and power distribution;
- Consider initiating the coordination process with monitoring-enabling activities and lateral relationships when coordinating highly heterogeneous organisations with little shared history, low trust and/or significant power asymmetries;
- Adopt a tentative approach to coordination that includes experimentation, learning, reflexivity and reversibility; and
- Allow sufficient time for inter-organisational coordination to develop before expecting tangible results.

CRediT authorship contribution statement

Isabelle Arpin: Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jérôme Poulenard:** Writing – review & editing. **Mathilde Ratouis:** Writing – review & editing. **Carole Birck:** Writing – review & editing. **Richard Bonet:** Writing – review & editing, Conceptualization. **Philippe Choler:** Writing – review & editing. **Emilie Crouzat:** Writing – review & editing. **Hermann Dodier:** Writing – review & editing. **Jérôme Forêt:** Writing – review & editing. **Noémie Fort:** Writing – review & editing. **Virginie Girard:** Writing – review & editing. **Bertrand Liénard:** Writing – review & editing. **Lucie Liger:** Writing – review & editing. **Christian Schwoehrer:** Writing – review & editing. **Wilfried Thuiller:** Writing – review & editing. **Jean-Gabriel Valay:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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