Biological Conservation 219 (2018) 153–160

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

What the ecosystem approach does to conservation practices

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1. Introduction

Species have long loomed large in nature conservation. For example, the Endangered Species Act (1973) in the USA and the French nature protection law (1976) formed the legal foundations for the notions of endangered species and protected species, which have remained without equivalent for ecosystems, at least until very recently.

This supremacy of species in conservation started to be criticized in the late 1980s, when biodiversity loss seemed to accelerate and became a public problem (Grumbine, 1994). The ecosystem approach (EA) to conservation appeared as a promising, more effective and less costly response to the biodiversity crisis (Koontz and Bodine, 2008). It was adopted by numerous American agencies involved in the management of natural resources (Koontz and Bodine, 2008; Martin et al., 2016). Major international environmental institutions have gradually endorsed it, including the WWF, IUCN and the Convention on Biological Diversity (CBD) (Castro and Ollivier, 2012; Waylen et al., 2014), which decided in 1995 that "the ecosystem approach should be the primary framework of action to be taken under the Convention". The CBD (2009) later recognized ecosystem-based adaptation as a useful approach to climate change. The EA has thus become the cornerstone of biodiversity conservation global policies. Aldo Leopold, who invited to learn to "think like a mountain" as soon as 1949, appears as its prestigious forerunner (Callicott, 2000).

Whereas the EA has flourished in restoration ecology since the beginning of this discipline in the early 1990s (see e.g. Hobbs and Harris, 2001), it long had relatively little room in conservation practices (Fee et al., 2009). Ecological corridors have been created over the last twenty years, but, in protected areas and in national parks in particular, field staff still dedicate most of their time to so-called heritage animal and plant species. Ways of justifying their conservation have changed – their role as keystone, umbrella or flagship species is now frequently underlined (see Simberloff, 1998) – but they remain at the heart of monitoring, surveillance and communication activities of many conservation institutions.

Most studies about the EA either defend it or criticize it, without exploring what it changes in practice, except few studies focusing on institutional and organizational factors (see Brunner and Clark, 1997; Cortner et al., 1998; Koontz and Bodine, 2008; Castro and Ollivier, 2012; Behnken et al., 2016). Very scant attention has been paid to its concrete consequences on the work of conservation practitioners, in the field. We contend that this is also where the reason for the slow dynamics of the implementation of the EA lies.

EA implementation is all but straightforward, notably because of conceptual confusion. The notion of ecosystem as defined by Tansley in 1935 was already very broad.[1] It has become even broader, as ecosystems have gradually been seen as disequilibrial, open, hierarchical, spatially patterned and scaled (O'Neill, 2001: 3276). Raffaeli and Frid (2010: 1–2) state that it is an all-things-to-all-people notion and O'Neill (2001) even wondered whether it should not be buried. According to Goldstein (1999), the idea that ecosystems have emergent properties such as ecosystem integrity, health and resilience and exert functions is too vague to orient management effectively. Also very different interpretations of the EA exist, between "panacea and Trojan horse" of conservation (Simberloff, 1998: 253–254), and there is no simple mechanism for delivering it (Frid and Raffaeli, 2010:155). Conservation practitioners, then, have no well-established and stable conceptual basis to refer to when implementing the EA. Exploring how they go about this implementation and how it changes their work is all the more important. We do this by drawing on an empirical study of a specific conservation programme, the Sentinel Mountain Pastures Programme, presenting most features of the EA. This programme is implemented in French alpine protected areas, where practitioners have so far been principally involved in species conservation. We aim to grasp the stakes and effects of the transition towards a more ecosystem-based approach to conservation, by exploring its consequences on three dimensions –cognitive, interactional, and emotional– of the practitioners' work. Developing such a sociological perspective remains uncommon among conservationists but it is important to become aware of the concrete consequences of theoretical proposals, and identify and overcome obstacles to their implementation.

The paper unfolds as follows. Section 2 presents the EA and its recent evolution. Section 3 examines the three dimensions of conservation practices on which we focus. Section 4 introduces the Sentinel

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[1] Tansley defined the ecosystem as "the whole *system* (in the sense of physics), including not only the organism-complex, but also the whole complex of physical factors forming what we call the environment of the biome—the habitat factors in the widest sense. (…) It is the systems so formed which, from the point of view of the ecologist, are the basic units of nature on the face of the earth. (…) These *ecosystems*, as we may call them, are of the most various kinds and sizes. They form one category of the multitudinous physical systems of the universe, which range from the universe as a whole down to the scale of the atom" (Tansley, 1935: 299).

https://doi.org/10.1016/j.biocon.2018.01.027
Received 20 July 2017; Received in revised form 16 January 2018; Accepted 24 January 2018

mountain pasture programme that we chose as case study. Section 5 explains how we collected and analyzed the data. Section 6 details the programme's cognitive, interactional and emotional effects on the work of conservation practitioners. We discuss our results in Section 7. Our conclusion highlights the need to provide conservation practitioners adopting the EA with a multi-dimensional and tailored support.

2. The ecosystem approach in the Anthropocene era

The EA notion first appeared in the titles of academic articles in the 1950s (Waylen et al., 2014) but it really gained ground in the early 1990s, stemming from that of ecosystem management (Castro and Ollivier, 2012). Drawing on a literature review, Grumbine (1994, 1997) identified several principles of ecosystem management, including the systemic perspective, the impossibility to separate humans from nature, adaptive management, data collection, monitoring, and interagency cooperation. Recommendations about the implementation of the EA were elaborated soon afterwards (see Brussard et al., 1998). In 2000, the CBD adopted the EA to achieve "the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way" (CBD, 2000).

The EA has lately received renewed interest as a potential means of helping society adapt to climate change and tackle its uncertainties (Fee et al., 2009; Mori et al., 2013), as well as a response to the increase in "wicked problems", characterized notably by the complexity and interdependency of components, and divergence in values and decision-making power of multiple stakeholders (DeFries and Nagendra, 2017: 266). Following a post-normal science perspective (Funtowicz and Ravetz, 1993) that insists on complexity, uncertainty, and the plurality of legitimate viewpoints, Ibisch et al. (2010) called for "a more radical EA approach". This 21st version of the EA concerns also national parks, which are increasingly grasped as socio-ecological systems (DeFries, 2017). New paradigms are currently being proposed for their management, in order to enable their ecosystems to follow trajectories adapted to changes, particularly climate change, but also to transform them according to predicted future conditions (Beissinger and Ackerly, 2017).

Despite this new impetus and strong institutional support, the EA has not been as widely adopted as could be expected (Secretariat of the Convention on Biological Diversity, 2009), not only in the case of Southern countries analyzed by Castro and Ollivier (2012), but also in Northern countries (Fee et al., 2009; Waylen et al., 2015). Fee et al. (2009) state that it remains "stuck" in the political arena. Political, societal, cultural, legal, and institutional obstacles have been identified to account for this implementation deficit (e.g. Koontz and Bodine, 2008; Fee et al., 2009), while factors intervening at the level of conservation practices have hardly been touched upon.

Yet, Lipsky (1980) has demonstrated that the making of public policies cannot be grasped at the sole level of policy planners and top managers: how the people responsible for the public service delivery –the "street-level bureaucrats" – actually perform their tasks contributes a lot to the implementation and construction of public policies. While street-level bureaucrats designate workers interacting with clients or patients, Lipsky's invitation to adopt a more bottom-up perspective when analyzing policy implementation can be extended to the case of nature conservation policies. Attending to the work of conservation field practitioners is also in line with authors defining conservation as work and as a set of socially and materially situated practices (Lippert et al., 2015; Denayer et al., 2016). Inspired by these two bodies of literature, we sought to capture how conservation practitioners implement the EA in their everyday work to refine catch-all responses such as "resistance to change" and further the analysis by identifying so far overlooked types of obstacles as well as changes perceived as positive.

3. Conservation as multidimensional work

Literature has shown that multiple dimensions (conceptual, ethical, cognitive, interactional, and affective) are entangled in conservation work. While all of them are important, we chose to concentrate here on the cognitive, interactional and affective dimensions as they are very present in our material and were found to be particularly important in inter- and transdisciplinary projects (Boix et al., 2015; Parker and Hackett, 2012).

3.1. Cognitive dimension

Previous literature has investigated the making of knowledge in species-based conservation (e.g. Lorimer, 2015). It has shown how practitioners learn to identify, classify, count, survey, map, and calculate (Lorimer, 2015), as well as less expected things, such as how to relate to others and to master administrative tasks (Denayer et al., 2016). Whereas ecosystem-based conservation apparently rests on the same tasks (identify, classify, survey, etc.), responding to the problems it raises requires systems thinking, and hence profound changes in science and knowledge systems (e.g. Cornell et al., 2013). Thus, shifting from species- to ecosystem-based conservation is more about inventing novel ways of knowing than transferring usual ways of knowing from species to ecosystems (Waylen et al., 2014).

3.2. Collaborative dimension

Far from being cut from local actors, naturalists and conservation practitioners have always collaborated with them (Star and Griesemer, 1989; Kohler, 2006). But the goal and meaning of involving actors in conservation work have evolved over time. It is now commonly assumed that grappling with wicked environmental problems requires engaging with actors beyond conservation scientists and practitioners, not only to collect data and solve practical and social difficulties, but also to grasp the socio-ecological complexity and uncertainty of such problems and learn together through collaborative problem solving (Van Kerkhoff, 2014).

The notion of community of practice (COP) has been found useful to grasp this collective dimension. Coming from theories of social learning, it analyzes how people sharing a concern or a problem actively interact to deepen their knowledge and expertise in this area (Wenger et al., 2002). The notion of transdisciplinary COP (TDCOP) was then elaborated to designate COPs characterized by a high level of heterogeneity (Cundill et al., 2015). TDCOPs form when actors with a broad range of disciplinary backgrounds and operating in different areas of practice seek to tackle a common problem.

3.3. Affective dimension

In most cases, conservation attracts passionate people and affective aspects play a major role in their work. Lorimer (2015) defines conservation as "a set of embodied and skillful processes of learning to be affected by the environment". This includes becoming sensitive to the environment through an education of senses and feelings that requires learning and hence time.

While processes of learning to be affected by species have been much studied over the last years, much less is known about if and how practitioners learn to be affected by ecosystems. Following Atran (1990), Lorimer (2015: 67–69) considers that humans spontaneously identify species and that species-based conservation consequently has an obvious and spontaneous character, whereas ecosystems would be more abstract and difficult to delineate (Brussard et al., 1998: 11) and attune to. If conservation primarily continues to target species, this is because we would more easily think like a duck (Mathevet and Guillemain, 2016), a fish (Bear and Eden, 2011) or a rat (Despret, 2009), than like a mountain (Leopold, 1949). Yet, the affective relation

Table 1
The SMPP is implemented in two contrasted cases.

	VNP	ENP
Date of creation	1963	1973
Economic sectors in the parks' area	Intensive touristic and farming activities	Extensive touristic and farming activities
Interactions between the park and other actors	2 communities (8%) have adopted the park's charter; tense relationships with farming professionals; limited integration in scientific networks	53 communities (90%) have adopted the park's charter Long-standing tradition of collaboration with farming professionals and with scientists (notably landscape and ecosystem ecologists)
Situation and climate	Northern Alps: as yet no droughts on mountain pastures; harsh weather conditions more frequent	Southern Alps: recurring summer droughts on mountain pastures; milder weather conditions

to ecosystems has probably been less investigated by social scientists than the affective relation to species.

4. The Sentinel Mountain Pastures programme (SMPP)

The SMPP was initiated in the early 2000s following several consecutive years of summer drought in the Écrins national park. The field staff of the Park were concerned over the consequences of overgrazing on alpine meadows biodiversity. Anxious to address this concern and to avoid deteriorating the relationships with the farming world, the Park's farming commission, along with its scientific service, launched a research programme bringing together the various actors involved in the management of mountain pastures (shepherds, farmers, staff of protected areas and pastoral and farming organizations) and scientists from several disciplines (agronomy, ecology, climatology) and laboratories. The goal was to document climate changes locally and to study the capacity of agro-pastoral socio-ecosystems to adapt to these changes. A dozen of mountain pastures, selected for the length and quality of the relationships with shepherds and farmers, became sentinel mountain pastures. The programme has since been extended to other French mountain ranges and has inspired similar programmes ("sentinel lakes" and "sentinel huts").

The SMPP is a long term programme adopting a systemic approach to the entity formed by a mountain pasture and the farm(s) using it in summer. It claims the willingness and possibility to reconciliate grazing with biodiversity conservation and the good ecological health of the mountain pasture. It supposes that human activities and natural phenomena cannot be separated: grazing practices are considered as important as climate change to the evolution of the agro-pastoral system. It endorses adaptive management: its goal is not only to observe and document changes but also to intervene if needed, e.g. by modifying watering equipment or the flock circulation on the pastures. It rests on the collection of a mass of socio-economic and ecological data. Finally, it hinges on the collaboration between actors and organizations: joint activities are organized (circuits at the end of the grazing season, thematic working groups, seminars, etc.), and all the participants contribute to knowledge production. For instance, shepherds are given rain gauges to collect rainfall data and must write down their herding practices and observations throughout the grazing season; park rangers evaluate the fodder resource before grazing; grazing experts organize circuits at the end of the grazing season to evaluate grass consumption by the flocks; farming organizations monitor the farms, and researchers elaborate protocols, e.g. to evaluate the biomass just before the grazing season, and carry out thorough analyses, e.g. of the links between climatic data and vegetation or between fodder and farming and grazing practices. Collective databases are gradually being elaborated and shared. When presenting the programme, their promoters and facilitators insist on its co-construction and collective learning dimension (Dobremez et al., 2014). For them, the programme is primarily a space of dialogue and knowledge sharing.

Systemic perspective, unseparated-ness between humans and nature, adaptive management, data collection, monitoring, interagency cooperation, long term dimension and close links with the rising concern over adaptation to climate changes: the SMPP perfectly embodies the current version of the EA (see Section 2). Unlike many projects claiming to adopt the EA (Waylen and Blackstock, 2017), it seriously monitors socio-economic as well as biophysical aspects, genuinely seeks to understand systemic connections, and strives to mobilize both scientific and local knowledge and capacities. It is for that matter considered exemplary. Protected areas strongly advertise it and it has been spotted by the recently created French Agency for Biodiversity, which decided to support it financially. Yet, its implementation triggers contrasted and sometimes ambivalent reactions from parks' agents.

5. Material collection and analysis

We employed a qualitative research approach to gain an in-depth understanding of the changes brought by the SMPP in the conservation practitioners' work. We focused on the first two protected areas involved in the programme: the Écrins national park (ENP) in the Southern Alps, and the Vanoise national park (VNP) in the Northern Alps. We chose these two parks because they offer contrasted cases of implementation of the SMPP (see Table 1) and because we already had extended knowledge of their history, conservation practices and relationships to local communities through our doctoral studies in the VNP (refs) and a series of empirical in-depth studies we carried out in both parks over the last twenty years (refs). In 2015–16, we conducted twenty-five semi-directed interviews, lasting from one to more than 2 h, concerning specifically the SMPP. We interviewed members of all the groups deeply involved in the programme, including agents from the two parks (4 in VNP and 6 in ENP) in a one-on-one, face-to-face setting. We used a common interview guide to explore our informants' experiences as participants in the programme. We invited them to explain how they became involved in it, if and how it modified their tasks and partnerships, as well as their related expectations, satisfactions and disappointments. All interviews were recorded, integrally transcribed, and deposited on the interview database of our institute.

In addition, we participated in two late-summer circuits in the ENP, which gathered together scientists, field staff of the park and staff from grazing organizations. We also attended the programme's yearly seminars and several presentations of the programme to its participants or other audiences such as the national parks' scientific councils. Finally, we participated in a working group aiming to elaborate a joint method to analyze the vulnerability of mountain pastures to climate changes. We took notes during all these presentations and meetings, writing down formal as well as informal exchanges.

We focused our analysis on the consequences of being involved in the SMPP for the work of the parks' agents. We concentrate on these participants as they first learned to do species-based conservation. Thus, their case sheds much light on the multiple changes brought by the transition towards the EA. We mobilized a mixed deductive and inductive approach: we used the dimensions of conservation described in the literature to identify themes in our data but we also followed the principles of grounded theory (Strauss and Corbin, 1998), which seeks to gradually produce an understanding of a phenomenon based on systematic interpretation of the empirical data collected. We coded all

Table 2
Changes into conservation practices brought by the adoption of the ecosystem approach.

Dimensions of conservation	Species-based conservation	Ecosystem-based conservation
Cognitive	Thorough knowledge of a limited number of individual species	Extended knowledge fields (vegetation at large, grazing practices, etc.); intricate relationships between climate, ecosystems, and human activities
Interactional	Potentially conflictual relationships but revolving around shared objects of interest	Relationships with a broader range of actors around less circumscribed topics and objects
Emotional	Deep attachment to individual species and strong capacity to attune to these species	Strong interest in new biophysical data
	Belief in the usefulness for conservation	Pride to contribute to ambitious and collective undertakings
	Strong immediate affective reward	Doubts about usefulness for conservation
		Long-term perspective requires altruism and confidence in future
		Lack of immediate affective reward

the passages of our interviews and notes concerning changes related to the abovementioned dimensions of conservation practices, through MaxQDA, a qualitative data analysis software.

6. Pluridimensional changes

The cognitive, interactional and emotional changes brought into the conservation practitioners' work by a programme with a clear EA are presented in this section and summarized in Table 2.

6.1. From lists of species to intricate interactions

Since the parks' creation in 1963 for VNP and 1973 for ENP, their staff have developed thorough knowledge of well-circumscribed topics. For instance, rangers must learn to identify a list of 80–100 “remarkable” plant species and most of them are specialists of a small number of animals (principally ungulates and raptors and, to a lesser extent, other birds, bats, etc.). Even if the evolution of any species is already very complex and uncertain, the degree of complexity and uncertainty increases when one considers mountain pastures. They are a clear instance of ecosystems prone to multiple and largely unpredictable disturbances, the interaction of which is as yet poorly understood (Sasaki et al., 2015). The SMPP implies producing knowledge about vegetation, climate, grazing practices, the functioning of farms, their interactions and coevolution. It is thus an opportunity for learning. For instance, parks' agents have learned to evaluate the biomass on a mountain pasture by coarsely measuring the height of grass. The programme can also trigger their interest in grazing practices and in the functioning of farms with which they were little familiar.

But informants find it extremely difficult to grasp how the mountain pastures evolve and know them as well as they know certain individual species, because of the difficulty to disentangle confounding factors and to interpret the mass of heterogeneous data collected. They fear that clarifying interactions between grazing practices, climatic factors and ecosystems will be extremely difficult and that the problem raised is actually untractable:

> “A concern that is inherent in the programme is that we have acquired many data. We accumulate data, we know more and more things. But (…) the SMPP addresses a particularly intricate and shaggy issue because the mountain pasture is an ecosystem, and a socioecosystem, and we study it along with the farm, which is important but makes things even more intricate.”

Monitoring mountain pastures in a changing climate, i.e. the interaction between grazing practices, the alpine meadows, and the climate is very different from surveying, say, an ibex population. Moreover, learning opportunities are limited both by the multiplicity of the agents' daily tasks, which still mostly revolve around species conservation, and the degree of specialization of the knowledge to be acquired. An agent in charge of agricultural issues notes that he is unable to have technical discussions with farmers. Most of the knowledge is actually produced by a few specialists and Master and PhD students. For instance, the monitoring of vegetation along transects is entrusted to professional botanists (the park's botanist in VNP and a self-employed botanist in ENP).

6.2. A renewal and extension of professional networks

Naturalists have long occupied a major place among the broad range of actors with whom the parks' agents have developed relationships. To give but one example, the botanist of VNP collaborates closely with moss specialists. All informants state that the SMPP has strengthened and diversified their relationships, and contributed to inserting them into renewed and extended networks. However, the VNP and ENP cases must be distinguished, as the ENP has developed a long-standing tradition of collaboration with the farming and academic worlds, whereas the VNP has long had limited and tense relationships with the former and is much less inserted in scientific networks than the ENP.

6.2.1. Interactions with farming professionals

The parks already had relationships with farming professionals when the SMPP was launched. In particular, the programme continued agro-environmental measures that had enabled the parks to establish tight relationships with farmers and grazing services. Almost all the farmers involved in the programme had contractualized such measures and were thus well known by the parks' staff.

Nevertheless, the programme strengthened the relationships with the farmers, for instance to agree on when to intervene on the pastures. It also modified these relationships as the stake is above all financial in agro-environmental measures while it is about coproducing knowledge in the SMPP. Bridging the parks and the farmers is considered extremely beneficial, including by those who are rather critical towards the programme. In VNP, the staff hopes that the programme will demonstrate their willingness and capacity to engage with the farming world in new ways and relational expectations are particularly high.

However, the informants underline two limits of the programme's relational input. First, it concerns a minority of farmers, described as “the cream of the crop”, selected precisely because of their already good relationships with the parks:

> “Participation in the programme is voluntary. Thus, we continue talking to those we already talked a lot to. I'm not sure we seek to improve the dialogue with the others.”

Second, the farmers' involvement in the programme is not sufficient to guarantee good relationships and avoid conflicts about e.g. farmers' projects such as the construction of a pastoral track in the park. Even in ENP, the park's staff do not consider that the programme could prevent conflicts over very controversial issues such as wolf predation on domestic flocks:

> “I'm concerned about the risk of wolf predation. I saw what happened on one of the mountain pastures involved in the programme [after a wolf attack]: despite the really friendly relationship we have with them, things can become tough very quickly because it's tough

for them. So I have this concern."

6.2.2. Interactions with researchers

National parks being endowed with interdisciplinary scientific councils since their creation, their managers are accustomed to discussing with researchers from various backgrounds. However, most scientific programmes in the parks have so far been disciplinary and the SMPP is one of the very first ones associating ecologists, climatologists, agronomists and the parks' staff.

In VNP, it is seen as a means of reinserting the park in the scientific community:

> "I think that we have been cut from research for ten, fifteen or twenty years. So all the programmes that will help to narrow the gap with universities and researchers are really helpful. This is something that can contribute to restarting a positive move. This is also what motivates me to collect the data."

In ENP, the SMPP has helped the park collaborate with new labs, in particular in climatology and ecology. New collaborations have also been established to discover and master instruments to measure biophysical parameters. They are extremely appreciated by those who are the closest to the researchers:

> "It pushes us, it forces us to raise many questions, it brings us loads of information. It's incredible, it's just great to work with researchers."

But some of the parks' agents less involved in the programme hardly collaborate with the researchers, or not at all:

> "My contribution is limited; I act as a technician collecting field data. I met M (a PhD student involved in the SMPP) once. We were there to collect plant data on a transect; we met by chance and we exchanged a bit but that's it."

6.3. Loving to monitor ecosystems?

Many rangers have chosen to work in national parks out of love for nature and more precisely wildlife. Over the years, the conservation status of several species (e.g. ibex, bearded vultures, wolves) has improved and rangers have interpreted this evolution as the results of their efforts. We have often stated that they consider a field day all the more successful that they could observe more specimens of various species such as ibex, chamois, eagles, bearded vultures or, if particularly lucky, wolves. Involvement in the SMPP hardly provides them with opportunities to satisfy their quest for close encounters with wildlife and hone their capacity to attune to the species they appreciate most.

Yet, informants involved in the production of biophysical data about habitats, which makes them rediscover the park, as it were, are genuinely enthusiastic about the programme:

> "We know when the transect is covered in snow because, you can really see it, you have the temperature curve and when the snow falls, the curve goes flat. We could check it because this very day, the camera trap recorded the snowfall. It's the same when the snow goes. It's really incredible. So we have these two key dates that we didn't have before. Even with the satellite, we only had weekly images at a rough scale. So this is much more precise, it's directly on the sites where we measure the biomass. It makes fantastic data. It takes us years forward!"

Those who evaluate the fodder biomass or inventory plants along transects do not share this enthusiasm. Succeeding in involving them in the long term requires a patient and ongoing motivation work:

> "Involving people is difficult because measuring the grass height is quite a pain. If you tell them: you can choose between measuring the fodder biomass and capturing bats, they look at you and say: well, bats because measuring the biomass…"

Moreover, some doubt that the programme will be useful for biodiversity conservation, which is their essential motivation:

> "The programme demands much time, much energy. It's not always much fun. These plant inventories along the transects are tiresome and, to speak the truth, some of them are a real pain in the ass. That is, at lower elevations, when the vegetation is quite high and thick, inventorying the plants takes two hours, two hours and a half, once you have reached the site and found the stones. When it's sunny and warm, it's fine, you sit in the grass. When it's cold and wet, after two hours and a half, you start asking yourself: what the hell am I doing here and what is the use of this? I carry out these inventories with our agricultural technicians and I feel that they share the same doubts about the usefulness of this investment."

Finally, the long or very long term dimension of the programme also raises concern. The practitioners are convinced that it should be continued over decades, given the slow evolution of plant communities at high elevations and the complexity of the questions raised. But they state that they find it difficult to collect data that will most likely be interpreted by others and, in some cases, doubting that these data will someday be interpreted and useful at all. Staying involved in the programme demands a form of altruism and confidence, while they consider the future of protected areas to be very uncertain:

> "It's great to tell oneself: I work on the long term. But actually, it's difficult to admit that you will never see the results of your work. So you hope somebody will see them. And this is not obvious because it means that the Park will still function, that it will still have the means and willingness to support this kind of programme. You don't want the days you spent on this to be wasted. And I find it hard to believe that it will be useful at some point, and useful to improve nature conservation in the park."

7. Discussion

Drawing on case studies in Canada and Germany, Fee et al. (2009) concluded that the EA is "stuck in the clouds" and has not even reached the national large protected areas. The SMPP is an example of a programme where the EA did reach the ground, which enabled us to analyze how it transforms the work of conservation field practitioners, and to enrich the understanding of its implementation dynamics. We adopted what we may call a "field-level bureaucrat" perspective: we interviewed the field practitioners and accompanied them while they were carrying out various tasks related to the programme. This allowed observing how they experience the EA in practice and implement it.

The EA requires the constitution of a transdisciplinary community of practice (TDCOP) that gathers together professionals from various areas of practice to learn about a shared issue (Cundill et al., 2015). In the SMPP case, ecologists, agronomists, staff from national parks and pastoral and farming organizations, farmers and shepherds combine their efforts to study and enhance the capacity of mountain grazing systems to adapt to climate change. In this section, we discuss two aspects of the constitution of this TDCOP: i) the "legacy effects" (Waylen et al., 2015) that prior conservation approaches implemented in national parks exert on the three dimensions (cognitive, interactional, emotional) we consider here; ii) its power effects on the practitioners, depending on their degree of involvement in the programme and their position in the TDCOP.

7.1. Legacy effects of prior conservation approaches

The EA is implemented in organizations that already have a long history and have previously adopted other conservation approaches

based on single issues and in particular single species. Waylen et al. (2015) suggest that the implementation of the EA is impeded by previous ways of thinking and related institutional and organizational arrangements, which they interpret in terms of "legacy effects". The authors distinguish between institutional, organizational, and cognitive legacy effects. Our study enriches their findings by identifying legacy effects at the level of the work practices. It could be furthered by investigating other case studies as well as material and ethical changes brought by the EA, which we could not consider here for lack of room.

It confirms the existence of strong cognitive legacy effects. Thinking in terms of systems is all the more difficult that the notions of ecosystem and EA have no well-established conceptual basis, that species-based conservation remains at the heart of the field practitioners' work, and that the interactions between both types of conservation are unclear. Like Waylen and Blackstock (2017), we found that practitioners have difficulties communicating about the SMPP and the intricate relationships it investigates. This can be interpreted as an indirect cognitive legacy effect: the public has learned to associate the parks with species-based conservation and expects practitioners to communicate about species rather than about the uncertain evolution of grazed mountain pastures under climate change. Having to implement a range of policies designed at different periods of time and corresponding to diverging practices and interactions with other actors is a classical problem faced by street-level bureaucrats (Lipsky, 1980). It is particularly difficult to overcome since, as mentioned by Fee et al. (2009: 221), the introduction of the EA in conservation work takes place in a context of capacity constraints and staff cuts.

Our approach also suggests the existence of both positive and negative interactional legacy effects. The SMPP has clearly built on prior relationships, in particular as regards farming professionals (positive effect). But it has so far failed to help establish relationships with the numerous farmers and shepherds with few or no interactions with the parks. This is in line with previous studies (Fee et al., 2009; Waylen et al., 2015) that point to the persisting lack of staff trained to engage with a diversity of partners and hence of capacity to engage with actors from other different areas of practice, beyond the well-disposed actors (negative effect).

Finally, it suggests that emotional legacy effects are more negative than positive. One could have expected that conservation practitioners, having learned to be affected by (some) species (Lorimer, 2008), would also be affected by ecosystems such as mountain pastures, and would be predisposed to learn to feel how they evolve and attune to them. It is not necessarily the case. Except for those involved in the collection of unprecedented biophysical data, our informants did not show the enthusiasm and excitement they express when monitoring their favourite species. In addition, dealing with a "wicked" problem generated specific affects. DeFries and Nagendra (2017) point to two opposite risks when addressing such problems: i) oversimplification, and ii) inaction due to inability to identify an incremental, partial solution. The latter is much more present than the former in the SMPP and weighs heavily on the practitioners' morale.

Fee and coauthors (2009: 215) assume that it should be easier to implement the EA in large protected areas such as national parks. Focusing on the field practitioners helps understand why the opposite may be true: in national parks more than elsewhere, species-based conservation has deeply shaped the ways of thinking, interacting and being affected by the environment of field practitioners. They must therefore substantially modify their work practices to realign them with the EA.

Moreover, the comparison between the two parks suggests that the cognitive, interactional and emotional legacy effects of prior conservation approaches on the practitioners' work interact with natural processes and systems, as suggested by Waylen et al. (2015), and also with the parks' history and current situation. For both socio-economic and natural reasons (see Table 1), the ENP is a more conducive setting to the implementation of the EA than the VNP. For instance, the long habit to exchange and collaborate with landscape and ecosystem ecologists in ENP makes it easier for practitioners to adopt novel ways of thinking. They are more prone than their VNP colleagues to grasp the mountain pastures as complex and unstable socio-ecosystems, and conceive of their intervention as a form of stewardship that must be constantly adjusted to newly acquired data and understanding. Moreover, staff cuts have not been as severe in the ENP than in the VNP, because a much higher proportion of communities chose to adopt the park's charter. This suggests the need to pay close attention to the various circumstances that may influence how the EA modifies the practitioners' work and how they implement it.

7.2. Power effects of the EA on conservation practitioners

COPs are characterized by differential levels of participation (Cundill et al., 2015): they contain a small core group of highly involved participants and numerous much less involved ones. The SMPP shows such a multi-layered organization, which has differentiating effects on the conservation practitioners. Core members, who can dedicate a major part of their time to the programme, are those who benefit most from the learning opportunities it opens up. For instance, the EA led the ENP to recruit a person to develop biophysical measurements; she had a background in ecology and embarked on a professional retraining to acquire new competences and skills. Learning opportunities are much narrower for those who actually have few interactions with other participants and little time to invest in new knowledge fields. Similarly, only few conservation practitioners actually diversify their relationships with actors with other disciplinary backgrounds and from other areas of practice.

Cundill et al. (2015) underline the importance of creating opportunities for peripheral participants to better know the activities of the core group. Such opportunities exist in the SMPP, whose facilitators organize workshops and yearly seminars at the headquarters of the ENP in which the parks' staff are invited. Yet, because of financial restrictions and work overload, only two to three persons per park actually participate in these events, whereas more are willing to. These participants are the same from year to year and are the most involved in the programme. In addition, some opportunities to meet in the field are missed because of lack of communication between the members. Overall, peripheral participants in the programme have little chance to enter the core group, and are less likely to modify their work practices and relationships according to the EA principles (Cundill et al., 2015). Over the years, differences of viewpoints and practices between the practitioners tend to deepen. Fostering a diversity of conservation approaches is definitely necessary but there is a risk of dividing practitioners converted to the EA from those who remain essentially preoccupied with species-based conservation. This could generate strong internal tensions. It is then important to take into account not only existing power imbalances between the various groups, which are likely to influence the TDCOP performance (Cundill et al., 2015), but also the power imbalances that the TDCOP constitution itself generates.

8. Conclusion

While the EA implementation remains relatively limited (notably) in national parks, these are increasingly considered socio-ecosystems to which a "radical version of the EA" should be applied. Previous literature has essentially examined institutional and organizational obstacles to this situation. We suggest that this is insufficient. Providing that the EA "(pours) down to the practice oriented levels with unprecedented speed" (Fee et al., 2009: 225) will not automatically improve EA implementation, as there are also difficulties at these levels that must be identified and overcome. Obstacles must be attended to across all levels of institutions, including that of work practices (Waylen and Blackstock, 2017).

The "field-level bureaucrat" perspective we adopted shows that the EA substantially modifies the practitioners' work to extents and in ways

that depend on which aspects (cognitive, interactional, emotional) are considered and on the parks' and individuals' histories and situations. This multidimensionality and this variability of changes contribute to explaining why the EA has not had the fast and generalized success that could be expected from its strong institutional support.

For Berkes (2012), ecosystem-based management is a revolution rather than a mere evolution. This "revolution" takes place under severe financial and human constraints. We think that the following recommendations can help experience and face it in a time of both environmental and economic crisis in better conditions, and avoid the risk that it generates two-tier conservation practices:

- anticipate the EA's manifold effects on the practitioners' work, by taking into account the specificities of their institutions and their positions within these;
- identify potential difficulties before launching programmes based on the EA, especially where species-based conservation remains at the heart of the practitioners' work and exerts strong legacy effects on all their dimensions;
- address emerging difficulties without delay, which requires a high degree of reflexive (Waylen et al., 2015) and deliberative practice;
- lend close attention to the power imbalances generated by EA implementation between and within conservation organizations;
- enable peripheral participants in EA-based programmes to observe and contribute to related activities;
- provide field practitioners unfamiliar with the EA with a multi-dimensional support that must be tailored to their specific personal and institutional situations.

Acknowledgments

We are grateful to our informants for sharing insights about their involvement in the Sentinel Mountain Pastures Programme. We also thank Céline Granjou, Taru Peltola and anonymous reviewers for helpful comments on an earlier version of this paper. This work was supported by the LABEX ITEM (ANR-10-LABX-50-01), within the program "Investissements d'Avenir" operated by the French National Research Agency (ANR).

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