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The influence of ecological knowledge on biodiversity conservation policies: A strategic challenge for knowledge producers

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Abstract

Within a context marked by widespread biodiversity decline, researchers in ecology often express their willingness to contribute to the definition of new policy solutions. However, producing ecological knowledge and making research results available for decision makers cannot guarantee by itself that conservation policies will be improved. Knowledge producers have to develop robust strategies to make their expertise count in public decision-making. In the implementation of such strategies, ecological knowledge is a critical resource that can be used to support ambitious environmental initiatives. To bring some new insights for researchers and practitioners, we therefore analysed different tactics for the production and use of knowledge to improve biodiversity conservation. Our case study involved two organisations, an ecology research team and a conservation NGO. Both of them adopted a proactive knowledge-based strategy in an attempt to directly influence biodiversity conservation. Their scientific and expert knowledge was partially taken into account in the definition and implementation of public conservation policies. However significant progress was achieved only when they developed a strong advocacy in favour of biodiversity conservation in addition to knowledge production. Finally, we show that knowledge producers can adopt three knowledge-based tactics to improve biodiversity conservation – bridging the knowledge gap, complying with a scientific imperative or helping to prevent an environmental decline. The effectiveness of such strategies depends on their adequacy to the local decision context.

1. Introduction

As ecological knowledge is accumulating and as biodiversity loss is increasingly perceived as an urgent issue to solve, researchers in ecology often express their need to engage into decision making processes (Walters, Brosnan, Reed, & Scott, 2014; Wright, 2015). Researchers and other knowledge producers (e.g. conservation non-governmental organisations and natural areas managers) are therefore continuously developing new methods and frameworks to facilitate the use of ecological knowledge for conservation purposes at science-policy interfaces (e.g. evidence based conservation and adaptive management; Mathevet & Mauchamp 2005; Schreiber, Bearlin, Nicol, & Todd, 2004). Ecological knowledge here designates a wide range of knowledge: data relative to the presence or absence of species, an understanding of population dynamics, land information on habitats and their ecological quality, but also knowledge concerning the functionality of ecosystems and evaluations of management measures. It also designates empirical knowledge of both regional natural habitats (and their management) and conservation policies implemented locally. Ecological knowledge thus differs from pure scientific theory and from science-policy implementation.

The close links between ecological knowledge and conservation policies have been widely studied at scales ranging from local to global (Brand & Vadrot, 2013; Cowell & Lennon, 2014; Waylen & Young,

2014). Various typologies (such as instrumental, conceptual, political, and social use) have been used to explain how ecological knowledge can influence public policies, be it for agenda setting, design of policy tools, policy implementation or impact assessment (e.g. Haines-Young & Potschin, 2014). However, such typologies do not reveal much about which strategic interests are at stake, which environmental changes are desired by those producing or using knowledge for public policies and how such knowledge is involved in negotiations and power relationships to increase the environmental impact of biodiversity and sectorial policies (McKenzie et al., 2014; Sabatier, 1998; Weible, Heikkilä, de Leon, & Sabatier, 2012). Biodiversity conservation is however a fully strategic endeavour in the sense that stakeholders trying to solve this issue are negotiating with other stakeholders whose objectives are, if not antagonistic, at least divergent (Mermet, 2011). If knowledge producers want to contribute effectively to biodiversity conservation, they have to develop, like other stakeholders, strategies to achieve their environmental objectives (Guillet, Mermet, & Roulot, 2016).

Moreover, we have observed, both from experience and the literature, that ecological knowledge producers can be naïve about the interactions between knowledge production and its use in decisionmaking arenas (van den Hove, 2007). That naivety can be expressed as the view that “producing adequate knowledge to solve decision makers’ problems is enough to bridge the science-policy gap” (Bradshaw & Brochers, 2000; Loreau, 2006). Such a vision of the science-policy interface has been described as “a ‘technical-rational model’, based on a positivist epistemology” (Adelle, Jordan, & Turnpenny, 2012, p. 401), or as a “knowledge deficit model” (Fernandez 2016). This vision can be understood as the reproduction of a constructed social world (Kinchy & Kleinman, 2003), but we make the hypothesis that it may prevent knowledge producers to be fully aware of strategic difficulties at science-policy interface.

Knowledge producers cannot indeed take for granted that ecological knowledge will always have a positive impact on biodiversity conservation. Ecological knowledge may be ignored by decision-makers, which can place researchers in the position of having to endorse policies and actions which they do not fully agree with (Guillet & Mermet, 2013). Also, ecological knowledge can be used by opponents in attempts to postpone or cancel environmental action (Mermet & Benhammou, 2005). How can researchers and other ecological knowledge producers have a greater impact when their aim is to improve conservation policies? Could strategies based on knowledge production be counterproductive? How can knowledge producers improve their reading of contexts in order to adapt their knowledge use strategies, and have more impact on biodiversity conservation? To bring new insights to researchers and practitioners, we analyse the different tactics for production and use of knowledge as means of improving biodiversity conservation, situating our research in the field of strategic management (Mermet, 2011).

Studying the effectiveness of the production and use of knowledge requires a focus on real situations. We need to thoroughly understand the negotiations, conflicts and collaborations between all actors involved with a given conservation issue (Juntti, Russel, & Turnpenny, 2009). Therefore, our

understanding needs to be based on in-depth case studies at the science-policy interface of biodiversity conservation. To explore the strategic processes in the production and use of knowledge, we focused on a case study involving two organisations dealing with the same strategic context: an ecology research team and a conservation non-governmental organisation (NGO). Both produce and use knowledge to support public authorities in developing and implementing biodiversity conservation policies and are partners in some of these actions.

We first explore the impact of the strategic choices made by the research team and the conservation NGO. Showing that these choices mostly failed to have a significant direct positive impact on biodiversity, despite the inclusion of ecological knowledge in policies, we then examined indirect impacts to assess the effectiveness of the strategy implemented by knowledge producers in our case study. Finally, we derived three possible explanations for the effectiveness of the production and use of ecological knowledge as a strategic way to influence biodiversity conservation, depending on the political context.

2. Methods

2.1. Theoretical framework: environmental strategies and modes of action

The field of management sciences focuses on how individuals and organisations, such as non-governmental organisations, private companies or public authorities, design and implement plans to achieve their objectives (Laroche & Nioche, 1998). In this academic field, strategy can be defined as a combination of specific intentions with the aim of changing a given situation (Lorino & Tarondeau, 2006). Every strategy is embedded in a negotiation context in which fundamental antagonisms and oppositions among actors are inevitable, be they explicit or covert. Strategic action aims to bypass, mitigate or suppress such antagonisms (Crozier & Friedberg, 1980). The paradox of strategic action is that its success depends on its ability to simultaneously change the management context, which is responsible for the problem to be solved, and also be adapted to it, in order to avoid stalemates and identify effective levers.

Strategic environmental management analysis aims to understand the strategies of stakeholders dealing with environmental problems (Mermet, 2011). Actors who want to change the management of socioecological systems in order to resolve environmental problems are referred to as “environmental actors” (Mermet, 2011). They strive to make other actors improve their practices or modify their projects that have an environmental impact, as some ecological knowledge producers do when they try to improve conservation policies. Environmental actors interact with “sector-based actors” whose strategies are mainly based on non-environmental objectives (e.g. industrial companies, farmers) and with “regulating actors”, whose function is to find acceptable solutions, taking into account the positions of all other stakeholders (e.g. local public authorities).

To design and implement their strategy, each actor makes choices from a range of possible actions according to the strength of their power relationships, the uncertainties and elements they cannot control and their strategic resources and competences (e.g. knowledge, staff, budget...; Lorino & Tarondeau, 2006). An organisational strategy then has a better chance of being effective when it relies on the optimisation of critical resources into a diversity of possible initiatives. The modes of action of a particular actor or organisation represent the types of initiatives they can choose from their repertoire in order to take action (Guillet et al., 2016; Mintzberg, 1990). An organisation can use several modes of action simultaneously to achieve its objectives. Modes of action, both in diversity of options and specific intent, are thus a crucial component of an organisation’s strategy and are used as an analytical tool in our case study.

2.1.1. Modes of action based on ecological knowledge

For knowledge producers wanting to influence biodiversity policies, ecological knowledge is a critical resource because other actors cannot easily

generate this resource themselves and therefore depend on knowledge producers (Amit & Schoemaker, 1993).

Several modes of action based on the use of ecological knowledge are employed by ecological knowledge producers involved into decision-making processes: (1) Knowledge producers publish scientific and natural history knowledge in peer review papers, databases, technical reports, management guidelines or communication leaflets. These documents can influence conservation policies, whether intentionally or not (e.g. Cook, Possingham, & Fuller, 2013); (2) They work with scientific advisory boards, public agencies or natural areas management bodies at local, national or international levels and contribute their scientific advice and expertise to support biodiversity conservation (e.g. Sutherland et al., 2010); (3) They help public or private decision-makers to design, implement or assess conservation policies and are involved in natural area management (e.g. Mace & Baillie, 2007); (4) Some knowledge producers publically advocate for nature conservation, sometimes with the help of conservation NGOs, and may act as ‘whistle-blowers’ to alert the media over issues of particular concern (e.g. Gordon, 2006).

However, some modes of action may be incompatible: for instance, it may be difficult for knowledge producers to help private companies write environmental impact assessments while simultaneously belonging to a public advisory body whose role is to review the scientific robustness and pertinence of those assessments.

2.2. Case study

2.2.1. Ecological knowledge producers

The research team we studied is part of an ecology research centre, which has been carrying out theoretical and field studies in population dynamics, functional ecology and evolutionary ecology since the 60 s (“research team” hereafter). It is mainly composed by ecologists and produced scientific knowledge, based on rigorous protocols, published in peer-reviewed journals. For the last fifteen years, its focus on sciencesociety interactions has increased. To integrate ecological knowledge into biodiversity conservation policies, it has developed a close relationship with local and regional public authorities since several years (the research team leader is for instance invited to present some research results to local authorities and in participatory bodies). The scientists involved in our case study were thus used to work in partnership with local authorities and NGOs. This was not the official position of the whole research centre. We however generally observed that several scientists (or teams) were working in this way in ecological or conservation laboratories in France. Notably, this kind of partnership was encouraged in the national science policy, as shown through the funding programme discussed here.

The second organisation is a civil society organisation for biodiversity conservation (“environmental NGO” hereafter). The environmental NGO generally used two modes of actions: (1) natural areas management and (2) production and use of species and habitat data (published mainly in open-source databases) to improve biodiversity policies in collaboration with public authorities. In the partnership studied here, only the second mode of action was mobilized. Members of the environmental NGO participating in the projects were (1) the director having empirical knowledge of local conservation policies and (2) biodiversity technical experts producing data, developing assessment methods and having precise local knowledge about natural area management. The environmental NGO was thus working closely with local stakeholders and other natural area managers, while also being itself directly involved into natural area management on some areas.

Both the research team and the environmental NGO aim to improve Mediterranean biodiversity conservation through significant involvement in public policies: they can therefore be considered as environmental actors, which strategies were analysed as such. They shared a similar mode of action: the production of ecological knowledge and its input for biodiversity conservation policies. Therefore, rather than competing, both organisations developed a partnership around this particular mode of action which led to several projects, each using knowledge to influence a specific public policy

(Table 1). Among those actions, most examples used hereafter will concern the four projects described in Table 1, specifying the type of ecological knowledge and the knowledge producers involved.

Our motivation for this case study was twofold. First, even if their status and activities are different, both organisations share the objective of influencing local biodiversity conservation policies by the production of scientific (for the research team) and species and habitat (for the environmental NGO) ecological knowledge. Secondly, the research team and the environmental NGO were used to working as partners, and their partnership was strengthened by a joint application for research funding in 2012. This case study thus provides the opportunity on the one hand to study two different knowledge producers involved in joint actions and on the other hand to analyse projects explicitly designed to improve conservation policies (Table 1).

The funding organisation of the joint research project asked the project leader to involve a social scientist so as to facilitate the interactions between partners. The project leader asked one of the authors (AC) to play this role because of her main research interests on sciencepolicy interface for biodiversity conservation. She however never got involved in the critical decisions to keep an external viewpoint on what was going on.

2.2.2. Data collection

We implemented an action research approach (Susman & Evered, 1978; Winter, 2005). This consists in creating changes in the object under observation while also gathering information on this object so that the process of interaction between the analyst and his or her subject enables the construction of new knowledge. This is a common approach within the fields of strategy and organisational management (Mintzberg, Ahlstrand, & Lampel, 1998). During the action research process, we undertook a qualitative survey that links four complementary and crosschecked information sources (Olivier de Sardan, 1995), as follows:

- (1) The analysis of documents produced by both organisations (planning documents, research reports, slides for workshops, etc.) provided an understanding of their projects and the way these are described by the organisations themselves;
- (2) Two sessions of semi-structured interviews were conducted in June 2012 (14 interviews) and in October 2013 (21 interviews) with members of both organisations and their partners to analyse strategic use of ecological knowledge. Eight interviewees were involved in the two sessions, which gave a perspective of changes over time. Interviews were exhaustive for the research team and the NGO members involved in the projects we studied. We also interviewed other members of those organisations (president, director, member of the scientific council, etc.) and external partners (especially local authorities, other NGOs working in conservation and natural area managers [see Supplementary material for more information about interviews]). All interviews were registered and transcribed;
- (3) Regular conversations with the project leader in the research team, the director of the environmental NGO and their main partners were a means to keep in touch with the projects and to discuss our own analysis and its consequences;
- (4) A one-day workshop, where we presented and discussed our main results, aimed at fostering reflexive analysis by knowledge producers themselves (Friedberg, 1997). Workshop discussions enabled us to better understand the strategic position of the organisations and to consolidate preliminary results. For knowledge producers, the objectives of the workshop were to: (1) question their current approach of pressing for changes into public policies, in the light of the insights provided by our strategic analysis, and (2) design future prospects and initiatives that would be acceptable to both organisations and effective for biodiversity conservation.

The research material was analysed using a qualitative approach. Quotes (translated from French into English) have been selected from the interviews to illustrate and clarify some points of the analysis.

3. Results

3.1. Limited direct impact on biodiversity conservation

The shared mode of action was viewed by interviewees as being very effective for knowledge producers who wish to contribute to biodiversity conservation. Its contribution can be broken down into two steps. First, knowledge must be taken into account in biodiversity policies and second, these policies must have proven impact on biodiversity conservation. The projects we studied had a rather high success rate for the first step but a low one for the second (Table 2).

In the “invasive species project” (Crochet, Eble, & Mansier, 2011), the distribution of endangered species and the nature of threats to them were not well known. Knowledge producers preferred then not get involved in the design of conservation areas or management measures without first investing in knowledge production. Knowledge was produced but not included into policies because the timing was not good (Table 2):

Table 1

Knowledge production and associated conservation actions and policies for some projects conducted jointly by the research centre and the environmental NGO.

Project	Description	Knowledge production and mobilisation	Objectives for conservation policies
Agricultural biodiversity project	Contribution to the identification of agricultural biodiversity issues to enrich a regional green and blue infrastructures planning document	Developing a method based on indicators to prepare the green and blue infrastructure document (research team)	Direct involvement in biodiversity policy design for regional public authorities
Conservation status project	Development of assessment guidelines about the conservation status of natural habitats for a local public authority	Analysis of species and habitat data and implementation of the results to improve biodiversity indicators for agricultural areas (environmental NGO) ⇒ <i>Analysis of existing knowledge</i>	⇒ <i>Public policy design</i>
		Analysis of existing species and habitat data to derive general recommendations (environmental NGO)	Assessment of the impact of management plans on the conservation status of habitats in protected areas managed by a local public authority
		⇒ <i>Diffusion of existing knowledge</i>	⇒ <i>Public policy assessment</i>
Invasive species project	Design of a protocol to identify two endangered species and an invasive species (amphibians)	Design and testing of field protocols to develop genetic knowledge and to specify the spatial distribution of three species (research team) Citizen science project to improve spatial distribution maps (environmental NGO) ⇒ <i>Knowledge production</i>	Identification of threats due to the presence of an invasive species as an argument for future conservation actions
Reintroduction project	Definition and implementation of a protocol for the reintroduction of an endangered plant species	Design of a reintroduction protocol (research team) based on species and habitat data and field-based scientific knowledge (environmental NGO) ⇒ <i>Diffusion of existing knowledge</i>	⇒ <i>Agenda setting</i>
			Multiplication at the research centre and reintroduction in a suitable area. Monitoring of the experiment. ⇒ <i>Implementation of conservation measures</i>

“The assessment of the current distribution is crucial for conservation and here we are delivering tools for such assessments. I am using genetic methods, but this is not basic research, this is 100% applied research. The tool is based on knowledge, which is only relevant for the species we study. [...] However, I must confess that I still do not know which kind of conservation initiatives would be relevant.” Member of the research team

But even if knowledge exists (as it was the case for other projects), decision makers complained that they lacked access to it, especially at very local scales (interviews, public authorities). Collaboration with policymakers would then be a means to ensure accurate knowledge was available when initiating a policy process (interviews, knowledge producers). In a political context where decision makers want to improve biodiversity conservation policies but lack accurate and available knowledge, the mode of action chosen by knowledge producers could be particularly well suited to achieving significant changes to conservation policies later on (Haas & Stevens, 2011; Jordan & Russel, 2014).

In the other projects we studied, the research team and the environmental NGO did manage to get their knowledge taken into account for the development of conservation policies. But inclusion of knowledge in policy did not translate to clear conservation outcomes

chosen reintroduction site) or with political reasons (lack of political will for the implementation of the tools prepared by knowledge producers, dilution of the results into a more general framework).

There were indeed two main reasons why the mobilisation of ecological knowledge might not directly have led to improved conservation policies in our case study. The first reason is that ecological knowledge was already available for decision-makers: things were not new. Ecological knowledge is indeed progressing rapidly (Graham & Dayton, 2002) and its access is facilitated by an increasing number of sciencepolicy interfaces, especially in France (e.g. websites, dedicated research funding calls, private foundations such as <http://www.fondationbiodiversite.fr/en/>, scientific advisory councils [cf. also Coreau, Nowak, & Mermet, 2013]). In our case studies, the relevance and availability of ecological knowledge was not the main limiting factor: both the research team and the environmental NGO have been involved into policy-making processes for a decade or more and they have produced accurate ecological knowledge accordingly. Moreover, most actors acknowledged the effective role already played by scientific advisory bodies, such as the regional scientific council for nature conservation. The members of the research team, which was one of the most prominent in France, were beside well connected to public policies, as exemplified by the projects we studied (Table 1).

Impacts of the projects in our case study on (1) the inclusion of ecological knowledge in biodiversity policies and (2) on biodiversity conservation outcomes.

Table 2

	Is ecological knowledge taken into account for public policies?	Has biodiversity conservation benefited from this inclusion?
Agriculture biodiversity project	Species distribution and agricultural habitat data have been used to generate scientific indicators which have been included in the final planning document.	Farmers' representatives, as well as environmental NGOs, remain dissatisfied because agricultural issues are not visible enough in the results, despite their important role for biodiversity conservation in Mediterranean areas.
Conservation status project	Knowledge about species and natural habitats was formatted as simplified guidelines for assessing conservation status.	The guidelines have been tested with stakeholders on some case studies but there is no real implementation schedule at a larger scale.
Invasive species project	New knowledge can be used to identify possible actions to protect the endangered species but they have yet to be taken into account.	There is no conservation measure planned yet for the studied species, despite growth in the population of the invasive species, but knowledge produced could be used later as new arguments for conservation.
Reintroduction project	The reintroduction protocol is based on scientific and field knowledge.	The reintroduction site proved to be unsuitable for the target species. Another site, far closer to the initial population, was chosen, thus transforming the reintroduction project into a reinforcement project.

(Table 2). Interviewees explained such a result with technical or organisational arguments (e.g. lack of relevant options, ecological characteristics of the

The second reason was that conservation policies were not only driven by scientific progress but also by political negotiations (Demeritt, 1994).

However, researchers involved in the projects we studied often had difficulty incorporating into their strategic thinking the fact that other actors might not share the same interest for biodiversity conservation (interviews, researchers). They sometimes seemed stuck with the “naïve” vision of science-policy interface, and this could explain misunderstandings and ineffective strategies:

“I was a little disappointed by the first study we did to build the regional protected area strategy: all the new places we suggested to include because they were of high conservation value were finally not included into new protected areas. [...] And we were not asked to participate in the last step for the final choice. The schedule was tight [...], but they did not try to take more time so that we could also be associated with this step.”
Member of the research team

In the end, our analysis shows that knowledge producers were convinced that bringing ecological knowledge into decision making was an effective way of influencing biodiversity policies but in fact their direct impact on biodiversity conservation remained limited. However, this issue became less of a paradox when we looked at strategic indirect impacts.

3.2. Strategic indirect influence on biodiversity conservation

To be able to identify indirect impacts, we have to enlarge our perspective and to understand the roles played by the research team and by the environmental NGO in a broader context.

Historically, the NGO had been greatly involved in biodiversity conservation policies. Until the mid-2000s, some of the NGO members had their offices in the same building as one of the local public environmental authorities. This allowed for informal relationships and access to some decision-making arenas. However, over the last decade, some interviewees reported that public environmental authorities had become steadily less reliant on NGOs to contribute to and implement environmental policies. According to the interviews, these changes can be explained by (1) a decrease in funds dedicated to environmental issues by public authorities, who relied on their own expertise rather than on NGOs; (2) a delegation of some responsibilities to smaller local authorities (especially the management of the European Natura 2000 network by groups of municipalities); (3) changes in the management of public funds which favour private contractors at the expense of NGOs. In the studied region, public funds for NGOs decreased by 25–30% in 2012–2013 according to the interviewees. All these changes led to more competition for fewer public funds between NGOs and private consultancies but also among NGOs themselves.

Members of public authorities also presented strategic reasons for their withdrawal (interviews, public authorities). In some cases, environmental services and transportation, housing and land use planning services had recently been merged. Whereas some decisions were previously taken by a director specialized in environmental issues, they were at the time of our study taken by a director with a broader range of responsibilities. Some environmental services officials explained the reduced support for NGOs (and the increased collaborations with researchers) as a desire to convince their colleagues that they were reliable public officials whose policies should be as credible and legitimate as any others, despite their role in advocating for environmental change (interviews, public authorities).

The public authorities also claimed that they needed to consolidate a strong, independent environmental movement as a counter to actors pushing for economic development at the expense of biodiversity, especially in stakeholder dialogues which are increasingly numerous in Europe (Reed, 2008). Decreasing funding was then a way for decisionmakers to encourage NGOs to express diverging opinions in multipartite consultative bodies (interviews, public authorities; cf. also Young et al., 2013). However, members of the NGO we studied had difficulties in defending their opinion in such consultative bodies because they felt torn between their conservation values and their willingness to increase their legitimacy through an investment in scientific expertise (interviews, environmental NGO). Such an investment

would require the NGO to appear neutral in participatory forums, according to interviews with members of the environmental NGO.

In this context, the research team was able to occupy the vacant space for the provision of expertise for local authorities. Their scientific legitimacy enabled them access to policy decision processes: they were offered a seat in consultative bodies, they developed personal relationship with elected officials, they got funding to contribute to policy design. The members of public authorities we interviewed acknowledged that they focused on scientific knowledge to “harden” their arguments towards politicians and other stakeholders. They were seeking credibility, which was previously based on the defence of public interests and conservation values together with NGOs, but which was, at the time of our study, based instead on scientific neutrality and objectivity. Researchers appeared to be more “reliable” than NGOs because they could act as a “guarantor” (interviews, public authorities).

“The research centre is more legitimate because of its skills and also because of its stance which cannot be criticized: the research centre will never have to manage a protected area. It has a clear role and again, with a clear question [from us] and a limited and clear role. When the research centre gives us its conclusions, I can put my ‘public authority’ hat back on and choose between options, based on the conclusions of the research centre, but also based on other parameters which might include what the NGO is saying...or what the local representative of the government is saying.” Member of public authority.

For the environmental NGO as well as for the research team, ecological knowledge production was therefore a way of gaining access to decision-making spheres. The partnership was thought to consolidate their legitimacy among public authorities and therefore their ability to collaborate with them, especially for the NGO which had been previously excluded from such decision-making spheres (interviews, environmental NGO). The environmental NGO was using the partnership with the research team in order to regain its former influence in policy design and implementation.

In the end, despite having little direct impact on biodiversity conservation, the mode of action chosen by the research team and the environmental NGO was indirectly effective because it facilitated their advocacy for more ambitious conservation policies via their capacity to supply a critical resource in the form of credible ecological knowledge. 3.3. A mode of action which gives ambivalent results

Having access to decision-making arenas cannot however guarantee that knowledge producers make an effective contribution towards biodiversity conservation, especially when the political context is unfavourable. Our case study showed that the political will to conserve biodiversity might indeed be jeopardized and could counter-balance the efforts made by knowledge producers.

In 2012–2013, the socio-economic context in France was still influenced by the Global Financial Crisis which began in 2008. Regional policy makers had become increasingly reluctant to carry out environmental policies and preferred to focus on regional development. Environmental actors were weakened by this unfavourable political context. Compared to the political context a decade ago, most interviewees perceived the current situation as a slow, uncertain but probably severe drawback to progress. Conservation actions might be more “scientific” but they seemed also to have been slowed down. For example, despite the fact that the local public authority involved in the “conservation status project” (Table 2) had worked with the research team for several years, funding small studies with different topics every year, public officials were unable to explain the practical effects such studies might have on their policies and recommendations in most studies had not been implemented (interviews, public authority). It is thus reasonable to consider whether these small studies were just a token means of demonstrating that environmental issues were important for the public authority, but without requiring them to implement pragmatic measures.

“We produced a first draft of the guidelines and we went to test it with field agents to see what happens when you are in the field. It didn’t go badly

but we saw that they really need us [researchers], that their ability to work in the field was rather weak [...] We wanted to go further on this project but it wasn't accepted for next year. [...] There was a command coming from above to work on climate change. [...] The subjects we are working on are changing every year. [...] On the habitat guidelines, it is going to be on standby, waiting for another opportunity." Member of the research team In such a context, the results of projects involving ecological knowledge production and use were of equivocal value to the environmental NGO. At the end of the study, according to our interviews, decision makers still preferred dealing directly with the research team and did not acknowledge the role played by the NGO. Moreover, the wide mobilisation of researchers was of concern to the environmental NGO, who found it increasingly difficult to obtain public funding and had to justify most of its choices in front of scientific bodies; more often than necessary according to our interviewees. Its involvement with the research team had increased, but it did not gain legitimacy nor real access to decision processes for biodiversity conservation "We had got used to some financial support, we have to reorganise". Member of the environmental NGO

The "agricultural biodiversity project" (Tables 1 and 2) indicates that the political context was equally ambivalent for the research team. During the process leading up to the green and blue infrastructures planning document (the final objective of the project), on the basis of a scientific diagnosis, political negotiations concluded that only a small proportion of the area would be designated as "natural core areas" or "ecological corridors". Researchers were disappointed but had difficulties convincing local authorities to improve the plan: the researchers themselves had produced the biodiversity state and pressure assessment used to design the green and blue infrastructures plan; local authorities claimed their process was robust because of its scientific basis. Only a clear protest by environmental actors finally led to a more ambitious planning document. The close involvement of the research team in the policy process did not prevent the public authorities from using the increased legitimacy of their partnership with researchers in a way that was incompatible with the researchers' conservation objectives.

In this context, the mode of action chosen by knowledge producers seems to be less robust than expected. However, while this mode of action did not necessarily lead immediately to more ambitious conservation policies, it contributed to the enrichment of the resources and internal competencies of both the research team and the environmental NGO (Lorino & Tarondeau, 2006), particularly in terms of new ecological knowledge, new stakeholders networks and, for the research team, facilitated access to decision-makers. For instance, in the "conservation status project", the conservation status assessment guidelines were identified by the environmental NGO as a new resource that could be used later with other partners, even if the local authority (which funded the project) only made limited use of the guidelines (Table 2):

"The objective is more to develop good relationships with researchers, to facilitate common work, to build a partnership [...]. For me, this is the main objective – to create stable relationships and make our methods change, to have access to information and also to a certain way of addressing our issues." Member of the environmental NGO.

These benefits could aid development of future initiatives when the context becomes more favourable. Indeed, this intention was an explicit objective for knowledge producers (interviews, research team).

3.4. In a context of change, knowledge producers questioned their modes of action

While improving resources and competences for use in later action is valid and important, it may not be fully satisfactory for environmental actors because of the delay in potential direct impacts.

The research team and the environmental NGO focused on ecological knowledge as their critical resource and a central pillar for environmental action, and their normative objectives remained tacit to comply with the

needs for scientific legitimacy expressed by public authorities. But if all NGOs propose neutral, science-based solutions and advocate policies for the "common good", rather than prioritising for biodiversity, then it is difficult for biodiversity conservation to stay at the top of the agenda. With this strategy they might have had little or no impact on biodiversity conservation policies (cf. previous section "A mode of action which gives ambivalent results"). The environmental NGO was becoming increasingly aware that the lack of a clear advocacy for biodiversity conservation was an obstacle to achieving its objectives (interviews, environmental NGO). Particularly in the unfavourable context we observed in our case study, some members of the environmental NGO considered whether they would have more impact on biodiversity conservation if they were more explicit about their values and interests:

"And then, typically, in this kind of meeting [organised by a regional public authority with all stakeholders], four members of the environmental NGO attended and found themselves in a big political arena with [...] socio-economic stakeholders who have [...] representatives defending their interests that we do not have in our own field [biodiversity conservation]. [...] We have a lack of representatives for our own interests [...]. Nobody raised their hands to say 'biodiversity' at this meeting. It confirms that nobody cares about biodiversity, doesn't it? [...] Therefore I think that this is a big, big problem. We lack a clear political-activist structure for our network". Member of the environmental NGO

Moreover, members of the research team felt betrayed when an actor used their ecological knowledge to draw conclusions they did not share (what they referred to as "misappropriation" of their knowledge). As for the environmental NGO, the researchers wondered whether they should put aside their neutrality and become more actively involved in effective conservation actions. For some interviewees, this involvement should be made explicit, even in scientific advisory bodies, where they could then act as "guardians of conservation values" in addition to being "guarantors for scientific integrity" (Coreau et al., 2013). As one of them said "*ecology is a combat sport*" and you cannot be "*just a researcher*".

However, displaying a more explicit, normative involvement in biodiversity conservation was not easy for either the research team or the environmental NGO. Both felt a tension between their willingness to contribute to biodiversity conservation and the need to remain neutral and to produce and disseminate knowledge without interfering with political issues. The interviewees were all opposed to being categorised as activists or militants, preferring the words "involved" or "engaged" to define their own stance towards decision makers, acknowledging however that "*data is in fact a weapon*" (Member of the environmental NGO).

For some researchers, a normative commitment appeared to be in contradiction with scientific integrity because the principle of neutrality is so deeply rooted in research practices (Porter, 1995). A strong personal commitment to a cause could then create a risk that they lose one of their main critical resources, namely their scientific legitimacy, which decision-makers considered was based on their supposed scientific neutrality.

For the environmental NGO, the situation was slightly different but just as uncertain. For a few years, they had been fully involved in the wide stakeholder consultation activities we described earlier. In the field of natural area management, the environmental NGO promoted regional participation and mediation with local stakeholders. This role would be made more difficult if they adopted a stronger and more explicit approach to biodiversity conservation. For the environmental NGO to advocate more clearly for biodiversity conservation in the public arena, some of its members proposed that it could contribute to an NGO federation as a means of maintaining a more consensual stance for the environmental NGO itself while also benefiting from stronger positions taken by the federation when necessary (Yanacopulos, 2005). This idea was welcomed by most of the environmental NGO members during interviews.

4. Discussion

4.1. Three ways for improving biodiversity conservation policies, based on ecological knowledge

Our aim was to understand how to increase the effective use of knowledge to improve biodiversity conservation policies. Given that we deliberately selected an in-depth case study, our results may not be generalizable. Our qualitative survey led however to a clear result: be it directly or indirectly, ecological knowledge is a resource for knowledge producers wanting to influence biodiversity conservation policies that almost all interviewees considered essential. Depending on the political context, it can enable knowledge producers to find new options for action, facilitate access to the decision-making process, or provide legitimacy and resources which can be used to take action later. We advance therefore three explanations to the effectiveness of using ecological knowledge to improve biodiversity conservation policies.

4.1.1. The “knowledge gap” explanation

The “knowledge gap” explanation follows the main perspective of the ecological research community, that decisions favourable to conservation should be based on a rational logic (e.g. Larigauderie & Mooney, 2010; Pullin & Knight, 2009). Knowledge enables the design of solutions to environmental problems and the rational choice of the best option to be implemented (e.g. Gosselin, 2009). It follows that it is fundamental for environmental actors to invest heavily in actions based on knowledge use as the most effective way of achieving results for conservation. Moreover, some policies, such as the development of green and blue infrastructures, are new and complex (Naumann, Davis, Kaphengst, Pieterse, & Rayment, 2011). The impacts of ecological corridors on biodiversity conservation remains controversial (Gilbert Norton, Wilson, Stevens, & Beard, 2010). Clearly, in some cases, a lack of ecological knowledge may prevent decision makers from taking action. The mode of action chosen by the research team and the conservation NGO was thus adapted to the context described by this explanation when knowledge is lacking to take action (“invasive species project” and “reintroduction project”) provided that it is produced in close relation with operational needs.

4.1.2. The “scientific imperative” explanation

The technical-rational model which is the basis of the “knowledge gap hypothesis” is however often questioned (Jasanoff, 2004; van den Hove, 2007). Lack of knowledge is not the only problem when the objective is to improve biodiversity conservation policies (as demonstrated for land-use planning policies by Cowell & Lennon, 2014). Environmental actors cannot therefore assume that bringing ecological knowledge into policy processes will lead by itself to ambitious biodiversity conservation actions.

The “scientific imperative” explanation considers that knowledge contributes to decisions in favour of biodiversity not only as “objective” data, but also as a way of communicating nature conservation values (Guillet & Mermet, 2013). Indeed, some authors defend the idea that environmental actors are increasingly facing a “scientific imperative” to gain access to public deliberative bodies, i.e. that stakeholders wanting to get involved in decision making processes – including NGOs and sector-based actors – have to detain a form of scientific expertise (Granjou & Mauz, 2007). When arguments based on advocacy for conservation objectives are less valuable for public authorities than scientific arguments, that are perceived as being neutral and legitimate, ecological knowledge becomes a critical resource for environmental actors to argue for conservation issues in negotiations with other stakeholders.

The mode of action chosen by the research team and the conservation NGO then becomes effective to improve biodiversity conservation policies, when they gain access to decision-making spheres and can take a position in negotiation procedures (as in the “agricultural biodiversity project” and “conservation status project”), even if there is no direct impact of ecological knowledge on biodiversity policies (Waylen & Young, 2014).

4.1.3. The “environmental decline” explanation

But not every decision maker can be convinced by scientific arguments, especially when the political context is unfavourable. According to the “environmental decline” explanation, the focus on the production and use of knowledge comes from stakeholders who do not want to tackle biodiversity conservation issues. Indeed, launching studies and research projects does not engage stakeholders to take action *a priori*. Knowledge production can therefore be considered as a win-win position. Knowledge producers are partly satisfied because they can maintain their activities and acquire new critical resources for the future, but also stakeholders who support other interests are not hindered by biodiversity issues in prosecuting their own initiatives (Mermet & Benhammou, 2005). Under such a context, the mode of action chosen by the research team and the conservation NGO may be part of a temporary “exit” strategy, involving the accumulation of resources and competences in order to be able to react rapidly if the political context becomes more favourable in the future.

In summary, there is no paradox between the predominance of ecological knowledge use in public policies and the limited technical improvement of such policies: when the political context is rather unfavourable for environmental actors, their strategies keep relying on knowledge production and use either to comply with a “scientific imperative” or to by-pass an environmental decline by increasing their future resources for action. These three explanations are however basic and archetypal: the context of action is rarely so unequivocal as in our case study (Weible et al., 2012). The explanations can therefore constitute an ‘analysis grid’ for studying the strategic role of how ecological knowledge producers can influence biodiversity public policies.

4.2. How can knowledge producers have more impact?

For knowledge producers, our results mean that direct involvement with public policies needs to be adapted to the prevailing scientific, political and organisational contexts. Is knowledge available and relevant for conservation? Are decision makers willing to promote biodiversity policies? Are environmental actors organised enough to be included in decision procedures? Even if a given mode of action proves to be effective at some point, it may become less effective subsequently if the context has changed. In particular, researchers have to be careful when entering the policy arena to not hamper effective existing environmental action (for example, by replacing other environmental actors, as in our case study).

Academic and administrative legitimacy relies heavily on the ability to produce and use expert knowledge (Granjou & Mauz, 2007). For a research team and an environmental NGO which based their legitimacy on their expertise, trying to change biodiversity policies without using ecological knowledge would make no sense. Even if this mode of action is ineffective in the short term, its impacts can be indirect. In our case study, producing ecological knowledge improved the critical resources and competences of both organisations that could prove useful when the political context becomes more favourable. Retaining adequate resources for future action is critical for the success of a strategy (Lorino & Tarondeau, 2006).

Moreover, in a context where the “scientific imperative” explanation is widespread, as it is the case in France, public authorities depend on ecological knowledge producers to design and implement legitimate biodiversity policies for instrumental or strategic reasons. This dependency can be strategically exploited by knowledge producers to influence biodiversity policies (Crozier & Friedberg, 1980), i.e. by knowledge producers who act themselves as environmental actors (Donner, 2014; Wright, 2015). We have seen in this paper that the normative dimension of environmental action is not easy to handle for knowledge producers who rely largely on their independence and supposed neutrality to establish their public legitimacy. Knowledge producers would however probably gain effectiveness if they acknowledged the normative dimension of biodiversity conservation and made known their normative objectives – not necessarily publicly, whereby it could place their scientific legitimacy at risk – but at least to potential allies, to individuals and

organisations sharing the same objectives (Mermet, 2011) and if they designed strategic action accordingly. This may be easier for conservation NGOs than researchers, but we have shown here that such issues were also relevant for researchers wishing to contribute effectively to biodiversity conservation.

Finally, the production and use of knowledge is compatible with a direct contribution to policy making and implementation, but also with other conservation initiatives. Some knowledge producers use their scientific legitimacy and ecological knowledge to act as whistle blowers, publishing articles in the media and reaching large audience for instance (Chan, 2008). Others produce counter-expertise reports rather than supporting policy makers, precipitating changes in focus of discussions. For example, this choice was made by nuclear energy researchers in the 1970s (Topçu, 2008) and by NGOs fighting deforestation in Brazil (Nicolle & Leroy, 2013). These are actually other modes of action consisting in producing external critics and speaking out for a part of the public opinion that is not taken into account in official democratic procedures. It may be costly to change from one mode of action to another (Guillet & Mermet, 2013) but knowledge producers would probably benefit from thinking thoroughly about the diversity of modes of action before choosing one. The possibilities are large enough to foster strategic thinking from knowledge producers who are prepared to go beyond the linear vision of expertise, and offer the prospect of exciting research directions and interdisciplinary collaborations between researchers in ecology and social scientists.

Conflict of interest

The Authors declare that there is no conflict of interest.

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