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Research Letters

Determining the location of protected areas in France: Does "scientific interest" matter?

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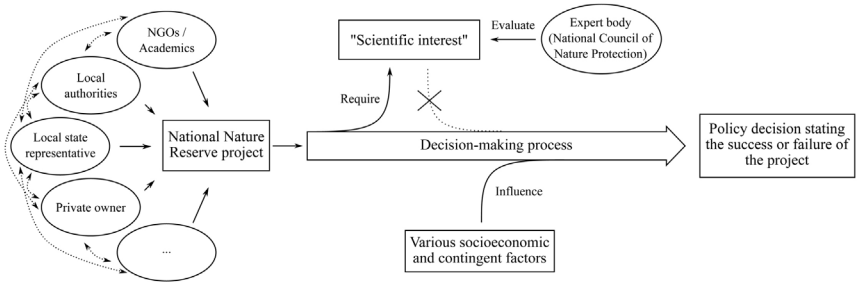
HIGHLIGHTS

- Scientific interest is necessary but insufficient when determining protected areas.
- French procedures for creating protected areas show various land-use conflicts.
- A clear understanding of implementation decisions is necessary to reach conservation goals.
- Local authorities can constitute a proxy to seize conservation opportunities.
- Social sciences and interdisciplinary research are necessary for resolving conservation issues.

GRAPHICAL ABSTRACT



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ABSTRACT

Protected areas are one of the main policy instruments used by policymakers to tackle the current biodiversity crisis. While numerous studies highlight the inability of such areas to protect the full range of biodiversity, the procedures by which protected areas are created nevertheless remain understudied. A better understanding of the related policy processes is necessary to overcome the "research-implementation gap" and, hopefully, decrease biodiversity loss. This article seeks to fill this blind spot in conservation by conducting interdisciplinary research at the crossroads of ecology and policy studies. We applied mixed methods (i.e. quantitative and qualitative analysis) to the historical archives of national nature reserve (NNR) projects to identify the weight of scientific statements and other factors involved in the decision-making process. Our results reveal a two-step process. Scientific opinion about NNR projects operates as the primary filter. Then, another triage is made under social, political and economic interests. Such situation challenges the idea that more evidence would lead to better conservation. In our opinion, the key issue is to determine the ways to improve the success of NNR projects rather than improving data and algorithms. In this sense, we call for the implementation of an "informed opportunism" approach and suggest some leads to favor its practical application. This research highlights the importance of interdisciplinary research to reach conservation goals.

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Introduction

It is evident that protected areas (PAs) are not chosen solely on the basis of scientific and technical criteria. This undoubtedly explains why many studies highlight the inability of PAs to cover the full range of biodiversity (see, for instance, Brum et al., 2017; Jenkins et al., 2015; Wiersma and Nudds, 2009). To explain such a mismatch, several studies have shown a bias in the location of PAs in "lands nobody wanted," i.e. higher elevations, steeper slopes, or lands of lower productivity (Joppa and Pfaff, 2009; Pressey, 1994; Scott et al., 2001). In addition to favoring the protection of particular species found in these areas, it also steers the protection toward the least threatened lands. Considering the limited resources available for conservation, this issue is of primary importance. However, little is known about the social mechanisms responsible for this bias. Most conservation research still focuses on purely biological research, giving considerably less attention to the associated decision-making processes (Mair et al., 2018). Studies on PA location are no exception, and most concentrate on the improvement of biological data or algorithms (see, for instance, Knight et al., 2008). They therefore tend to ignore what has been called the "knowing-doing gap" (Pfeffer and Sutton, 1999) or the "implementation crisis" (Knight et al., 2006): in other words, the gap between knowledge and achievements.

On this issue, we recently published a viewpoint arguing that producing conservation knowledge without an in-depth understanding of the way in which it is used during the implementation of related policy instruments can undermine the efforts of the scientific community (Chassé et al., 2020). In our opinion, solving the current biodiversity crisis is less related to the production and availability of biological knowledge than to the identification of obstacles responsible for the implementation crisis. It is now crucial for the scientific community to integrate the study of the relationship between knowledge and actors by questioning the role of expertise in policy decisions. To move in this direction, we call for the development of interdisciplinary research that combines the biological and social sciences. The present article wishes to implement and illustrate these points.

For a long time, policy studies have stressed that policy outputs result from a complex process involving many actors and considerations such as technical feasibility, tolerable cost, value acceptability, and scientific relevance. The weight of these variables, including the use of scientific expertise, is nevertheless highly dependent on public policy domains and socioeconomic contexts. This article seeks to fill an existing knowledge gap in the literature concerning the specific domain of biodiversity conservation, and particularly, the implementation of PAs in Western countries. Even now, the decision-making process by which the geographic location of PAs is selected remains understudied and consequently misunderstood. Little is known about how this process functions and the extent to which scientific knowledge and tools developed to improve the design of PAs are used by public policymakers. It is therefore worth understanding how the "scientific interest" of a project is defined and used, by whom and when, during the decision-making process leading to PA creation. More generally, for such an inquiry, it is necessary to accurately determine the type of factors (e.g. social, economic, political) likely to influence this process. This understanding is crucial for solving the implementation crisis and can improve the efficiency of conservation planning. Despite the increasing number of frameworks and models integrating "social" data (see, for instance, Ban et al., 2013; Knight et al., 2006; Knight and Cowling, 2007; Whitehead et al., 2014), they are still rare and often lack sufficient knowledge about decision-making to identify which kind of social factors matter and which need to be taken into account (Ban et al., 2013). A deeper understanding of the implementation process leading to PA creation is therefore crucial for the conservation scientific community.

This article seeks to fill this blind spot in conservation research by focusing on the implementation decisions of a specific kind of PA, namely the Natural Nature Reserves (NNRs) created in mainland France between 1970 and 1985. This period encompasses the creation of more than half of the current NNRs. In our view, it was necessary to conduct a detailed study of a long and continuous period of time. Considering the unavailability of detailed archives on this decision-making process after 2004, it seemed more relevant to focus on the early period of the NNR public policy. In France, all NNRs except for three[1] were set up after 1970. In the discussion, we consider the consequences of analyzing this 15-year period, which also integrates the implementation of decentralization in France.

Material and methods

NNR creation procedure and sources of information

The French network of PAs is composed of different types of protection elaborated at the national, European, or international scales: regulatory protection, land acquisition strategy, and contractual protection. The French regulatory network is constituted of NNRs (0.33% of the national territory, Fig. 1), regional nature reserves (0.08% of the national territory), biotope protection areas (0.3% of the national territory), national parks (0.66% of the national territory), and biological reserves[2] (0.08% of the national territory). Considering the area covered by NNRs compare to other PAs and the fact that along with national parks and biological reserves, they are the only instrument allowing for the active management of species and habitats, NNRs represent a key tool in France to protect biodiversity.

NNR creation followed a procedure summarized in Fig. 1. An NNR project was sent to the standing committee (SC) of the National Council of Nature Protection (NCNP)[3] in charge of validating the "scientific interest" of the project. Then, the Ministry of the Environment referred the matter to the local state authorities in charge of the area to proceed with a public inquiry and consultations. A new version of the NNR project was then submitted to the NCNP for a final non-binding opinion on the project. Finally, after ministerial consultation, the decree for the creation of the NNR was signed by the Minister of the Environment.

In this article, we focus mainly on the activity of the SC of the NCNP, which appears to be central in the decision-making process. The NCNP is an expert body that was reformed in 1978 to strengthen the representation of scientific institutions and nature conservation groups. Before the reform, SC meetings brought together three to five scientists (i.e. holding a teaching or research position in a university or research institution) who were specialized in ecology, botany, or zoology. After the reform, the SC was composed of ten members: seven scientists of whom four were also members of local or national nature conservation groups, one agricultural representative, and two representatives from the Ministry of Agriculture and Equipment, respectively. The SC is thus a relevant institution to understand the role of scientists and expertise in this particular decision-making process involving different actors, sectors, and interests. To better comprehend how scientific statements were integrated into the decision-making process leading to NNR creation, we studied the archives of NCNP meetings from 1970 to 1985 (see Appendix S1 for data availability and content).

[1] Created respectively in 1961, 1963 and 1969.
[2] This kind of PAs is specific to public forests.
[3] In French, "Comité permanent du Conseil National de la Protection de la Nature."

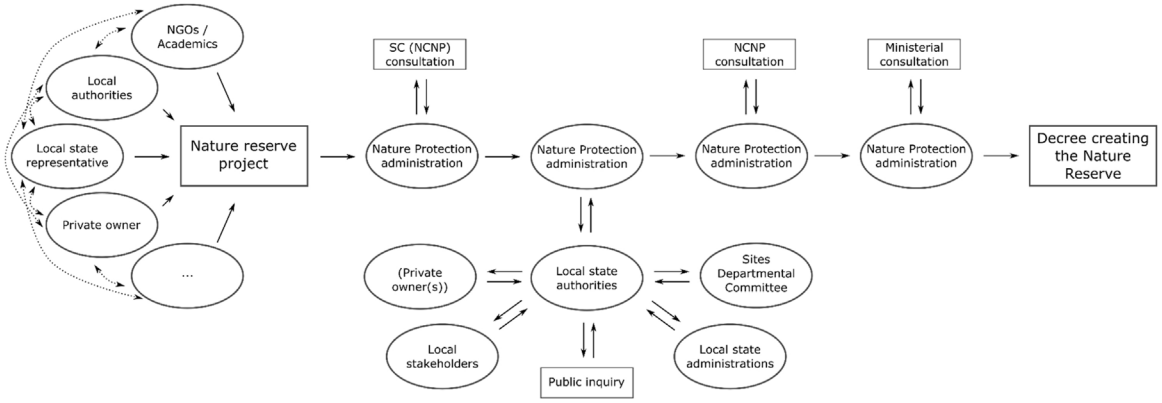

Fig. 1. French procedure for the creation of a national nature reserve. NCNP: National Council of Nature Protection; SC: standing committee.

Statistical analysis to assess the factors influencing the decision-making process

Our analysis was performed on 176 NNR projects, which led to the creation of 72 of the current NNRs. To assess the impact of scientific statements in the decision-making process, we used the detailed record of each NCNP meeting to determine the different variables that might influence NNR creation. From 1970 onwards, these meetings follow more or less the same procedure: a presentation of the "scientific interests" of the NNR project by a rapporteur (NCNP member or invited guest), possible threats to the site, insights into the local situation, and possible issues raised by the creation of the NNR, followed by a discussion among the SC members. A first qualitative analysis allowed us to identify three major components of the scientific interest: "biodiversity" (i.e. species or ecosystem richness) (yes/no), "remarkable species or ecosystems" (i.e. rare, endemic, or endangered) (yes/no), "representative species or ecosystem" (i.e. species or ecosystem characteristic to a region) (yes/no). We added another variable representing the "overall scientific interest" (i.e. the sum of the previous scientific features, with a score between 0 and 3). We also assumed that the policy process could be influenced by the existence of a threat (i.e. a development project in or around the project area that could alter the ecosystem) (yes/no), the level of conflict raised by the NNR project (i.e. number of stakeholders mentioned as against the presented NNR projects: 0; 1; 2 or more), the NCNP reform (pre-reform/post-reform), and the date of discussion at the SC (NNR projects were divided into four categories: 1970–1975; 1975–1978; 1978–1980; 1980–1985).

The influence of these factors was analyzed by logistic regression (glm procedure using a logit function with a binomial error). To assess the effect of the NCNP reform in the decision-making process, the interaction with NCNP reform and the other variables was also tested. Considering that "biodiversity", "remarkable" and "representative species and ecosystems" were not independent from the "overall scientific interest" and that the NCNP reform and the date of discussion were not independent, we performed logistic regression on four different models and showed only the model that best fit the data (based on AIC).

Case studies

To better interpret these quantitative results, we also performed a more detailed qualitative analysis on the archives of three NNR projects (Fig. 2; Table 1; see Appendix S1 for data availability). We chose three seemingly different projects to cover the diversity of mechanisms responsible for the success or the failure of a project. Archives are composed of the scientific dossier, letter exchanges between stakeholders, legal documents, and results of the consultations (i.e. public inquiry, local and ministerial consultations). We specifically examined: (i) the type of actors involved in the procedure, (ii) their relations, (iii) the arguments used against or for the project, and (iv) their methods and actions to influence the result of the procedure.

Results

Scientific features and the overall scientific interest do not increase NNR creation success

The main characteristics of the projects are summarized in Table 2.

In the first model (Table 3), time and level of conflict significantly influenced NNR creation. The likelihood that an NNR project was finalized decreased with time. Moreover, there was a significant increase in the likelihood of NNR creation in areas with more conflict (i.e. at least two actors opposing the project). Other factors were non-significant and were removed from the final model.

In the second model (Table 3), NCNP reform and its interaction with the existence of a threat significantly influenced NNR creation. The likelihood that a project led to NNR creation decreased after the NCNP reform. The first model that best fit the data would suggest that the significant effect of the NCNP reform on NNR creation was likely due to the effect of time. However, after the reform, the likelihood that a project led to NNR creation increased with the existence of a threat on the site. The level of conflict only had a positive marginal effect on the likelihood of NNR creation. Other factors were non-significant factors and were removed from the final model.

The variable "overall scientific interest" was not significant in the two other models (data not shown).

Key factors in NNR creation: personal relationships, organization of opposition, and local authority involvement

Marais de Bruges NNR

The creation of the Marais de Bruges NNR depended on the proactive role played by the local authorities in Bruges, specifically through the relationships between the mayor and a few key actors. Presented at the SC of the NCNP as one of the last wetlands of the region, this site was characterized by the rarity of its plant species and the diversity of its plant and bird species. Even though the project received a positive opinion from all those involved in the consultation, its creation almost failed because of the need to purchase the lands. Through the active communication of the Mayor of Bruges who personally knew and asked for the support of the then-President of the National Assembly and Vice-President of the

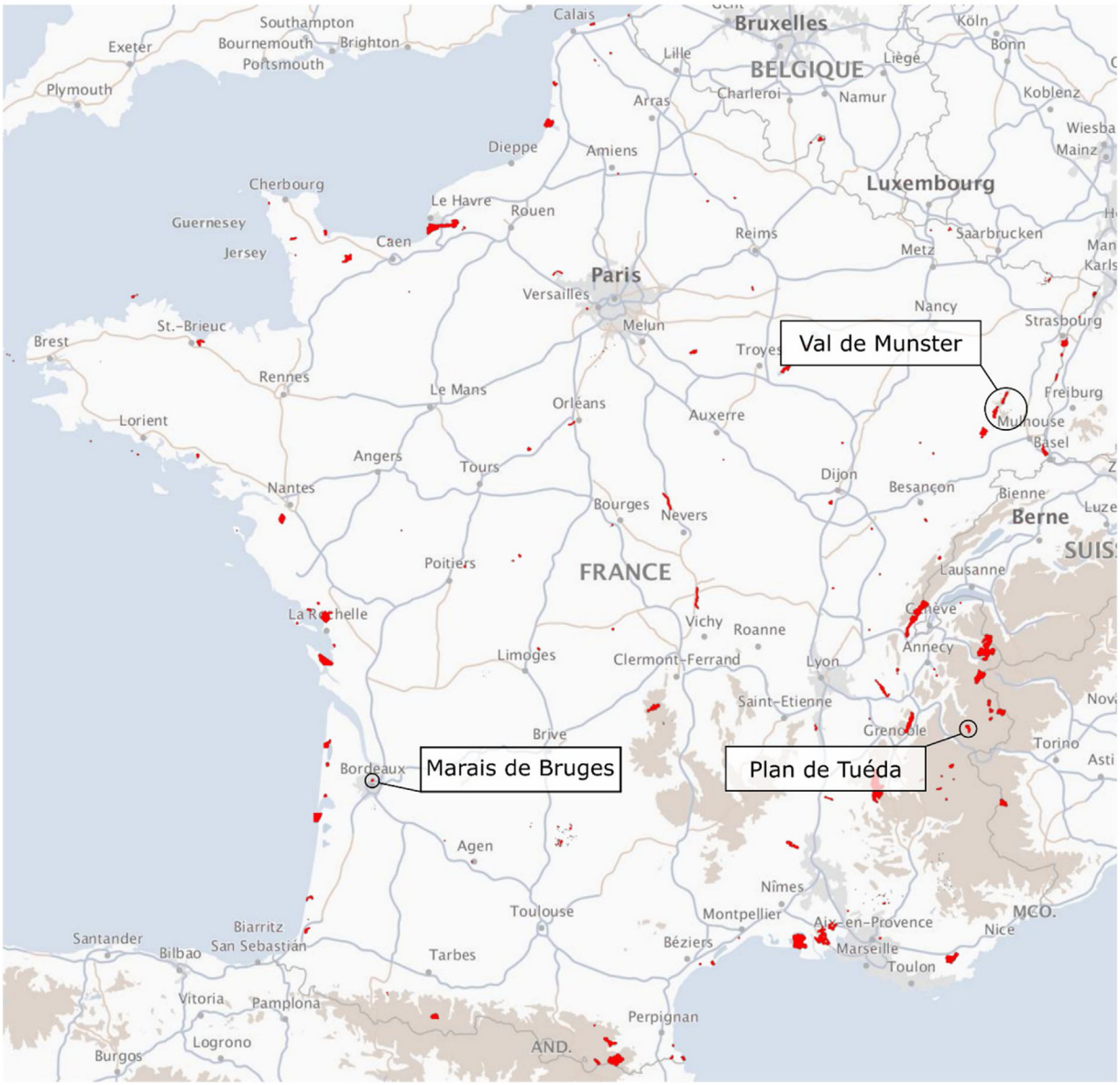

Fig. 2. Map representing the current natural nature reserves (NNRs) in France. NNRs are shown in red, while the three case studies used for the qualitative analysis are indicated. The NNRs located in the Val de Munster area on the map are part of more recent NNR projects than the one studied in this article.

Table 1
Main characteristics of the three case studies chosen for qualitative analysis.

Name of the NNR project	Origin	Discussion year (SC of NCNP)	Total area (ha)	Protected territory	Relevant scientific features	Local authorities involved	Number of owners	Major opponents	Creation of the NNR project
Marais de Bruges	Local authorities	1978	266–278	Wetlands	Remarkable species or ecosystem and biodiversity	1	11	Private owners (farmers) and the Land Development and Rural Establishment Company	February 24, 1983
Vallée de Munster	NGO	1978	9000–22 000	Medium mountain	Biodiversity	15–30	>30	Farmers, local tourism associations, and local authorities	–
Plan de Tuéda	State	1985	1533–1112	High mountain	Remarkable species or ecosystem	1	3	Hunters and private owners	July 12, 1990

Table 2
Main characteristics of the studied projects. Proportion of projects out of the 176 NNR projects used for quantitative analysis.

	Biodiversity	Remarkable species or ecosystems	Representative species or ecosystems	Combining at least 2 scientific features	No scientific features	Threats to the site	Opposition from at least one stakeholder
Proportion of projects (%)	36.4	47.7	17.6	27.3	32.4	60.8	46.6

Table 3
Factors influencing the creation of NNR. Results of the two logistic regression models after a stepwise regression analyzing the creation of national nature reserves as a function of time (*T*) or NCNP reform (NCNPr), scientific features (i.e. remarkable species or ecosystem (RSE), biodiversity, or representativeness), existence of a threat (Thr) and level of conflict (LOC). In the second model, the interactions of NCNP reform with scientific features and existence of a threat were also tested. Non-significant variables, except for marginal effects, do not appear in the table. The significance of each variable was verified using likelihood-ratio tests to compare the full model and the model without the tested variable. The *P*-value of the tests are indicated in *P*-value column (NS, not significant; * $P < 0.05$; ** $P < 0.01$). Improvements from the constant-only model and comparisons of the two models were assessed using a likelihood-ratio test.

Variables		Model 1		Model 2	
		Odds-ratio (CI)	*P*-Value	Odds-ratio (CI)	*P*-Value
Intercept		1.78 (0.84–3.92)		1.19 (0.54–2.71)	
T	2nd quartile	0.23 (0.09–0.56)	0.002 (**)		
	3rd quartile	0.21 (0.08–0.53)			
	4th quartile	0.37 (0.15–0.88)			
NCNPr	1978–1986			0.15 (0.05–0.44)	0.009 (**)
LOC	1	1.48 (0.70–3.14)	0.04 (*)	1.43 (0.68–2.97)	0.06 (NS)
	2+	3.03 (1.27–7.46)		2.76 (1.17–6.72)	
RSE	Presence	0.55 (0.28–1.05)	0.07 (*NS*)	0.56 (0.20–1.49)	0.32 (NS)
Thr	Presence				
NCNPr(1978–1986) × Thr				5.23 (1.37–21.1)	0.02 (*)
Residual deviance		216	220		
Improvement from constant-only model (*P*-value)		21.9 (**)	17.6 (**)		
Difference between the two models		4 (*)			

Senate along with the support of local state authorities, the funding plan elaborated by the municipality was finally accepted by the Minister of the Environment. The fact that the local authority was at the origin of the project, which was very rare, was recognized on multiple occasions during the exchanges between the Minister, the Ministry, and local state representatives. Despite the opposition of a few farmers who had obtained the right to use the land of the future NNR, the Marais de Bruges NNR was created in 1983 (see Appendix S2 for more details).

Val de Munster NNR

The Val de Munster project was initiated by a local environmental NGO, which wanted to protect 22 000 ha against the construction of ski and tourism infrastructure and forest roads. Although the local authorities contested some of the NNR regulations, the Ministry launched the NNR procedure in 1978. The SC recognized the area's specific interest for biodiversity and gave a favorable opinion on the project in December 1978, which resulted in the launch of a public inquiry. However, owing to well-organized opposition, the required local consultations never took place. Several weeks after the favorable opinion from the NCNP, a broad mobilization against the NNR project was launched by rural representatives (e.g. powerful local farmer unions, the Chamber of Agriculture, and several rural tourism associations). The project was abandoned by the Ministry in 1983 because of "the hostility of local elected officials" (see Appendix S2 for more details).

Plan de Tuéda NNR

The Plan de Tuéda project originates from an offsetting measure required by the state to a local authority for a ski development. The first problem, which took almost 3 years to solve, was to obtain funding for the required scientific study. It was only in 1985 that the project was discussed at the SC of the NCNP, which recognized the importance of protecting the remarkable features of the flora. During the consultation process, the SC of the NCNP sought to ban hunting from the NNR to better protect small game and reduce disturbance to fauna. This led to breaking the deal made by local authorities, which aroused strong local protests against the project itself. Through their personal relationships, private owners directly informed the Minister of the Environment about the situation, and an influential local hunting association pressured the local state representative to reinstate the hunting rights in the NNR project. Supported, among others, by the mayor, inquiry commissioner, and local state representative, the Minister of the Environment finally reinstated the hunting rights, leading to a compromise with the NCNP and the creation of the NNR in 1990 (see Appendix S2 for more details).

Discussion

Taking a historical perspective

The NNR creation procedure has barely changed since the studied period. However, the relationships, responsibilities, and balance of power between the actors have evolved over time. Most of the NNR projects studied here were created before the French decentralization law in 1982–1983. As this reform gave local authorities greater power and responsibility over land-use planning, this only reinforce their importance on NNR creation (see below). Some authors have also highlighted how environmental policy instruments used by worldwide state authorities have evolved from regulatory to incentive-based approaches (Jordan et al., 2003), which necessarily modify people's perceptions about regulatory instruments and thus their acceptance of them. This evolution also concerned PAs, while new non-regulatory instruments have been created to protect such sites, including sites of community interest based on the European Habitats Directive or the "blue and green ecological network." Acknowledging these differences, we can nevertheless discuss the general mechanisms most likely to influence the procedure for PA creation today.

As choices are made among scientifically interesting projects, we need a better understanding of the decision-making process

Our results show that the positive opinion of the NCNP was required for the creation of an NNR, which suggests that expert views were taken into account in the early phase of the NNR creation procedure. However, the scientific validation of a project was far from sufficient for the creation of an NNR. After acknowledging the scientific interest of the project, its success was independent of its ecological relevance. No specific or combination of scientific features significantly increased the probability of success of an NNR project (Table 3). According to our case studies, the positive outcome of a project was rather determined by the local balance of power. During the negotiations, opponents most often defended extreme positions – i.e. abandoning the project – not by refuting the scientific arguments but rather by contending other matters such as the violation of property rights, the loss of elected officials' independence, or economic development constraints. It would thus seem that scientific relevance and sociopolitical matters were examined separately and in different places and times during the procedure. Considering that only 45%[4] of the 159 projects that received a positive expert opinion were successful, the second part of the process seems to be decisive.

Our results thus reveal a two-step process. First, an expert body selects the NNR projects that deserve protection from among the proposals. Second, another selection is made based on social, political, and economic interests. Even though this process may not be optimal, as it fails to prioritize more relevant projects based on the expert body's opinion, it reveals that scientific opinion is still taken into account during the process. In our specific case, scientific interest operates as the primary filter. This means that all the current NNRs were considered to be sufficiently interesting by the experts. As revealed by the recent analysis of expert opinions (Chassé, in press), this filter values projects according to their taxonomic diversity (i.e. rare, endangered, or endemic species as well as species and ecosystem richness). While the taxonomic approach may be criticized (see, for instance, Cadotte et al., 2011; Rosauer et al., 2017) and the biological models improved, this is not, in our view, the most important issue at stake.

Our analysis of the decision-making process reveals that the limiting factor was not the scientific relevance of the projects or the availability of biologically interesting projects. The most important filter was the second phase that selects projects according to other criteria. Improving the biological models would thus only replace older projects without increasing their chance of success. This observation is particularly pertinent in order to overcome the "research-implementation gap." We are in agreement with Toomey et al. (2017) who considered that this gap suffers from a misconception of its problems and solutions. It is often perceived as the result of a lack of communication and the inability of intermediaries to translate science into policies. This is regularly accompanied by calls for a more evidence-based conservation approach. In our opinion, this reveals a misconception about what is happening in the "real world." First, it ignores research from different fields of the social sciences (for a review of the arguments, see Toomey et al., 2017). Second, our analysis of a particular decision-making process strongly supports the fact that more evidence would not lead to better conservation. To overcome this issue, we agree with several authors who maintain that the scientific community must favor "informed opportunism" (Game et al., 2011; Knight and Cowling, 2007; Noss et al., 2002). This approach does not mean abandoning systematic conservation planning but rather acknowledging that other considerations (e.g., social, economic, political) may also be legitimate and should be taken into account. Maintaining a simplistic vision of the decision-making process – i.e. the non-use of scientific opinions accompanied by a lack of political will – prevents reflections about other possible solutions, which can, in our opinion, improve the success of NNR projects.

Improving the success and efficiency of NNR projects: Implications for conservation strategies

Our results indeed provide insights into the factors influencing NNR creation. Increasing the percentage of successful projects by identifying and addressing these factors is of primary importance to improve the efficiency of the PA network for biodiversity conservation. Our quantitative analysis identified time, level of conflict, and after the NCNP reform, the existence of an on-site threat as the main factors influencing NNR creation (Table 3). In the following section, we discuss the potential mechanisms that explain their effects and several directions to improve the PA creation process.

First, the effect of time is most likely explained by the well-known issue of scarce resources being available for conservation policies (Bottrill et al., 2008). In France, the main income source for the NNR budget is the state budget. If public expenditure remains unchanged, the success of a new project decreases the budget per NNR. In a context of highly constrained public spending, this is probably responsible for the limited growth in the number of NNRs. While inadequate funding for PAs was found to be a detrimental factor for biodiversity conservation within PAs (Coad et al., 2019; Watson et al., 2014), our results also stress that the lack of public expenditure slows down the extension of the PA network. This shows once again the urgent need to increase and find innovative sources of funding for PAs (Watson et al., 2014).

Second, the positive effect of a high level of conflict surrounding NNRs is counterintuitive and somewhat difficult to interpret. It highlights that despite a possible bias toward lands with lower productivity, there are still conflicts over land use. Even if the case of the Val de Munster NNR shows that too much conflict can lead to the abandonment of the project, our quantitative inquiry also shows that these conflicts can be overcome. We assume that the success or failure of a project is less related to the number of actors opposing it than to their identity and strength (e.g. ability to use personal contacts). In our opinion, this last point is critical and offers some opportunities for conservation strategies. The failure of the Val de Munster NNR and the success of the Marais de Bruges and Plan de Tuéda mostly depended on the efforts of local authorities. In the first case, their opposition was explicitly mentioned in the abandonment of the project. In the second, the desire of the local authority of Bruges to create an NNR was rewarded despite the financial cost. Finally, the Plan de Tuéda was required by the state as an offset measure for a ski development and thus received the support of the local authority. Considering that PAs, especially in France, are frequently located in areas with disagreements over land use, the support of local authorities lends greater weight to the PA projects and helps to overcome conflicts. This result contributes to the call for providing insights into social attributes that matter in conservation planning processes (see, for instance, Ban et al., 2013; Knight et al., 2010; Pasquini et al., 2010).

In systematic planning, there is a growing recognition about the importance of assessing the social features of a given area. In our opinion, the social proxies that are currently used in such analyses are too general (see, for instance, Whitehead et al., 2014) and gathered without knowing if they really matter during the decision-

[4] This percentage is coherent with a recent evaluation of the French National Strategy for Protected Areas Creation, which aimed at increasing the PA network for the period 2010–2020. On the basis of the elaborated methodology to identify deficiencies in species and habitat protection in the PA network, only 41% of the 430 projects were finalized in 2019, which represents only 19% in terms of surface area (Léonard et al., 2019).

making processes. Even if social data collection is both time and money consuming (Knight et al., 2010) and with varying factors depending on the type of PA or the spatial scale (Guerrero et al., 2010; Pasquini et al., 2010), it is still necessary. By revealing the importance of local authorities in NNR creation, our research provides an interesting proxy to use for implementing the "informed opportunism" approach and tracking conservation opportunities. Conducting similar research is needed to help identify more relevant variables and improve the success of PA implementation.

Finally, the positive effect of the existence of a threat provides another interesting perspective about the decision-making processes that should be taken into account. This suggests that after the NCNP reform, NNR creation seemed to follow to an "ad-hoc process" based on an impact-driven approach. NNRs were more frequently located in areas subject to direct threats on biodiversity such as urbanization, wetland draining, or natural resource overexploitation. While the previous NCNP included almost exclusively scientists from Paris and its surroundings, the inclusion of regional nature conservation groups within the NCNP probably guides such strategy. This result implies that the procedure was often used as a tool to stop development projects. Considering the issue of scarce resources for conservation (see above), it necessarily diminishes the opportunity to build a science-based network. However, a purely scientific strategy of planning tends to ignore biodiversity impacts outside of the priority-set boundaries. If other instruments such as the environmental impact assessment procedure exist to ensure biodiversity conservation in these more common areas, their effectiveness is widely debated (Bigard et al., 2017; Weissgerber et al., 2019). Although NNRs were initially not designed to fulfill this role, we believe that the systematic conservation planning of PAs should not limit the possibility of initiating other actions to conserve biodiversity. In our opinion, such impact-driven strategy contributes fully to limit biodiversity loss and needs to be integrated in the implementation of the "informed opportunism" approach.

Conclusion

Our results have important implications for the conservation community, because they suggest that the production of conservation-oriented knowledge is far from sufficient to reverse the current trend of biodiversity loss. The reasons for the existence of a "research-implementation gap" are far more complex than the simple mistranslation of science into policy. The lack of data on conservation decision-making processes leads to the widely shared misconception about the problem and its solution, which can be counterproductive. More than ever, the causes of this gap need to be better understood and addressed. By applying and sharing the kind of research that we recently called for (Chassé et al., 2020), we hope to highlight the importance of social sciences for biodiversity conservation and demonstrate the value of an interdisciplinary approach.

Authors' contribution

PC conceived the idea and designed methodology, collected and analyzed the data and wrote the original draft. CB and NF supervised and validated the orientations of the work. All authors contributed critically to the drafts.

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Declaration of Competing Interest

The authors report no declarations of interest.

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Appendix A. Supplementary data

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