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PRACTITIONER'S PERSPECTIVE

Developing collaborative research to improve effectiveness in biodiversity conservation practice

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Introduction

Conservation planning, which includes characterizing local biodiversity, identifying spatial priorities, as well as both designing and applying conservation measures, is a process that is difficult to achieve in practice (Margules & Pressey 2000). Over the last decade, a growing literature has highlighted that management guidelines and conservation assessments published by scientists are rarely translated into action by resource managers either because they do not address key needs or they fail to come to the attention of end-users (Latta 2000; Pullin & Knight 2004; Sarewitz & Pielke 2007; Sutherland *et al*. 2009; Hart & Calhoun 2010). For example, two-thirds of conservation assessments published in the peer-reviewed literature do not deliver effective management actions (Knight *et al*. 2008). Thus, approaches to better convert scientific knowledge into conservation practice are needed to improve the effectiveness of conservation actions (Pickett *et al*. 1997; Sutherland *et al*. 2004; Pullin *et al*. 2004). With this goal in mind, we report a collaborative research initiative between scientists and managers which has been developed over 10 years to conserve native brown trout *Salmo trutta* threatened by genetic introgression arising from the large-scale introduction of non-native trout. The brown trout is an interesting model organism for conservation issues because it has a high level of ecological and genetic intraspecific biodiversity, which is threatened locally by human activities (environmental changes, overharvesting, stocking operations, invasion by non-native fish), and it is also of considerable socioeconomic value (Laikre *et al*. 1999).

We describe the successful implementation of our collaboration which may serve as an example for similar approaches to stakeholder collaboration that connects scientific knowledge with conservation action. From our experience, we suggest a shift in applied ecological science towards the development of collaborative research that merges scientific methods and management planning developed through lasting and dynamic stakeholder collaboration.

Background

Our collaborative research initiative was developed in the Haute-Savoie Department in the French Alps, covering an area of 4400 km^2 and encompassing around 2800 km of rivers, streams and mountain creeks. The recreational fishery in this large region is managed by the Departmental Federation of Fishing and Protection of Aquatic Ecosystems (FDPPMA). The region is subdivided into four

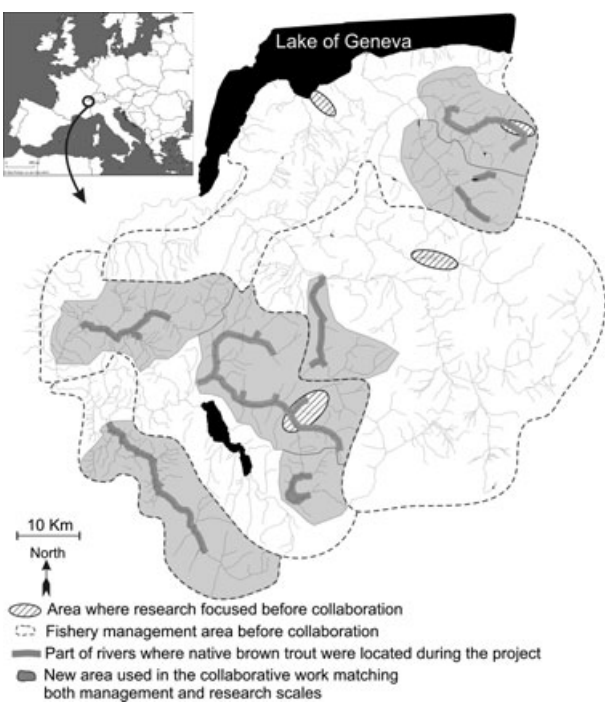

Fig. 1. Map showing the hydrographical network in the study area and the sizes of catchments before and after the collaborative work between managers and scientists.

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catchments where fisheries are locally managed by angler associations (Fig. 1). For over a century, and up until 2000, the main management action was to stock massively all the streams with non-native brown trout in order to increase the anglers' catches. Since 1980, the French National Institute of Agronomical Research (INRA) has undertaken research to derive biological and ecological information for management of brown trout populations, that is, age–maturity relationship, fecundity, growth and abundance. The key questions were derived by fishery scientists who developed their own research projects and communicated their results primarily in academic journals and congress proceedings. Direct interaction between scientists and managers was limited to presentations at meetings of fishery managers and articles in annual reports; requests for biological samples; and consultation to seek opportunities for co-funding. The involvement of managers in the science was usually limited to acknowledgements in the publications. This pattern is undoubtedly common in biodiversity research–stakeholder interactions.

In 2000, we sought to integrate research and management more closely for the benefit of both parties. Three essential ingredients were needed to increase the working relationship between stakeholders and to develop collaborative research. First, in 1999, FDPPMA recruited a fishery biologist who had worked with scientists at INRA. This person was able to identify appropriate representatives for a working group from local fishery managers and scientists who have already worked and published on brown trout populations. Secondly, both managers and scientists made a commitment to work together based on an understanding that such collaboration was essential for the sustainable management of the fishery. Thirdly, there was an opportunity to fund collaborative programmes through the European Union in 2000 (INTERREG III), which provided an opportunity to formalize the partnership. The result was a successful bid for funding to support a joint project that aimed to locate, identify and conserve the remaining native brown trout populations in the whole FDPPMA-managed area. This funding opportunity catalysed the first multidisciplinary meeting involving scientists from different disciplines (ecology, fishery biology and genetics) and fishery managers in 2000. This meeting represented the real beginning of the working relationship between stakeholders and provided the basis for future collaborative work.

Feedback on the approach implemented

The collaborative approach was a detailed and long-term process that included several pivotal tasks and objectives (Fig. 2). This formal structure enabled the development of closer working relationships between researchers and managers, the reciprocal exchange of information, delivery of scientific findings more closely applied to management and, finally, the implementation of more effective conservation measures. Our experience provides insights into what actions were successful and why. In particular, we

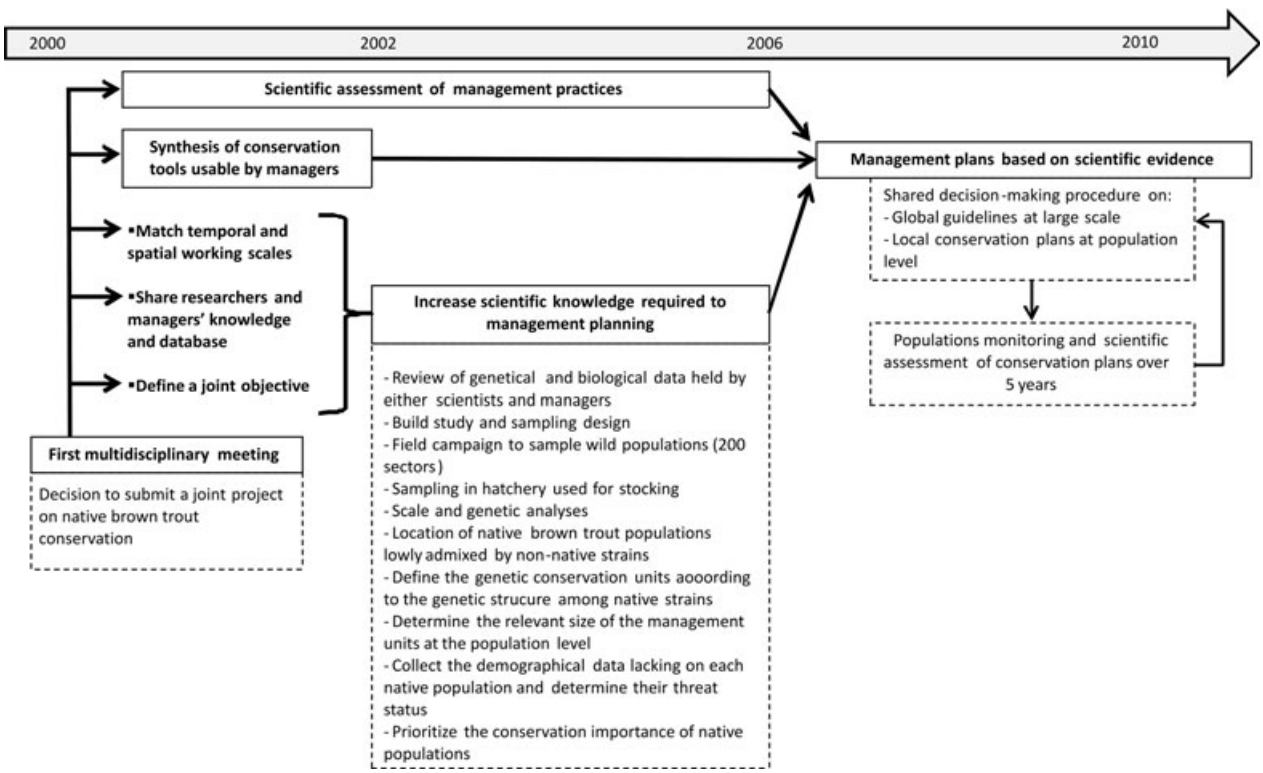

Fig. 2. Representation of the collaborative approach developed between fishery managers and scientists over 10 years of the research project to conserve native brown trout in Haute-Savoie Area, France.

identified eight major barriers to close collaboration between scientists and managers and the translation of scientific findings to management actions.

ABSENCE OF INFORMATION FROM MANAGERS IN RESEARCH PROGRAMMES

The opportunity to submit a joint bid for funding through the EU INTERREG III programme encouraged all stakeholders to become involved in the proposal. This included defining the aims and objectives, agreeing the study design and contributing to writing the proposal. Researchers were therefore able to learn from managers directly about their field of knowledge and management practices as well as their needs and concerns.

MISMATCH OF SCIENTIFIC AND MANAGEMENT GOALS

It was essential to identify a common objective shared by scientists and managers early in the project. Initially, the viewpoints of the scientists and managers diverged. The scientists' goal was to locate remnant native brown trout populations and set up effective management actions to conserve them. The fishery managers' goal was to maintain recreational fishing activity for anglers, which was best achieved through artificial stocking to sustain catches. Fishery managers were concerned that a significant decrease in the density of catchable brown trout in the rivers would occur if artificial stocking (that threatened the native populations) was stopped. Three important actions were included in the project to resolve these differing viewpoints: (i) an objective assessment of the real contribution of stocking to the standing populations of brown trout and in the anglers' catches; (ii) details of the precise hydrographical limits of the areas harbouring native brown trout populations, the demographic status and risk of extinction of each population; (iii) in the areas where native populations had been identified, fishery managers would commit to build conservation plans and implement new management actions that could be assessed by researchers for their effectiveness. These actions came within the overall objective that 'the local actions carried out by managers at the population level needs to take into account the scientific knowledge available in order to conserve the intraspecific diversity of the brown trout, to secure its evolutionary potential, and to ensure that recreational fishing of self-sustained native populations can be maintained'. The outcome would be that the role of stocking on native brown trout would be better understood, the catchments of conservation in priority could be identified and managers would know in which rivers stocking could be practiced without threatening the native brown trout.

LACK OF SHARED KNOWLEDGE BETWEEN MANAGERS AND SCIENTISTS

Different actions were carried out to increase the exchange of scientific and technical knowledge. In 2000, a fishery biologist working at FDPPMA was appointed as coordinator of the research project to develop permanent and lasting working relationship between managers and researchers. The flow of information was also improved by sharing the databases used by researcher and managers. Some of the results have been published in French peer-reviewed journals that, while incurring a cost to communicating with the international scientific audience and a lower journal impact factor, improved the dissemination of findings to fishery managers. Publications in international peer-reviewed journals in English were also popularized in simple technical documents accessible for managers, which were written together by stakeholders. This non-academic communication can help to link knowledge with effective action (Hart & Calhoun 2010). To improve communication further, an open meeting titled 'more knowledge for better management', was organized to present the collaborative research outcomes, their application for the management of the brown trout populations and the maintenance of the fishing activity. The meeting brought together several hundred people and will be repeated in future.

MANAGERS WERE UNAWARE OF APPROPRIATE CONSERVATION ACTIONS

In 2000, fishery managers used stocking as the sole management activity. Thus, the project aimed to improve the training of managers in different management strategies that can be applied in conservation plans. Scientists provided managers with a popularized synthesis of recent scientific findings and case studies published in the peer-reviewed literature addressing the conservation of salmonid species. Seven strategies (genetic refuges, non-native fish removal, deliberate isolation of threatened native individuals, reduction of river fragmentation, stocking with native breeding stock, transfer of wild fish and selective angling of non-native fish) were identified and described with emphasis on their advantages and disadvantages for management.

MISMATCH OF SPATIAL AND TEMPORAL SCALES

A major barrier was the difference in the spatial and temporal working scales between both research and management institutions (Fig. 1). The initial catchment size of the fisheries management plans were too big and included different river basins with several differentiated populations. The biological research focused on several small populations in a very limited area. To address this discrepancy, the two sides changed their habits and pooled their means to work jointly at the same scales. Initially, we worked at a large scale to locate the remaining native populations in the whole Haute-Savoie territory. As a second step, we used the results to determine the catchment of seven conservation units harbouring native brown trout populations (Fig. 1). These represent more relevant spatial scales upon which to build conservation plans including practical management measures. At the temporal scale, the timeline of the joint research fitted the administrative schedule of the management plans that are renewed every 5 years to provide scientific findings in sufficient time to promote their inclusion by the management board.

LACK OF SCIENTIFIC ASSESSMENT OF MANAGEMENT PLANS

According to Knight *et al.* (2011), documenting successful and unsuccessful experiences helps adaptive management to improve the conservation outcomes. Between 2000 and 2006, the different management strategies were scientifically assessed to identify their efficiency and impacts on brown trout populations. First, the assessment of the traditional stocking practiced by fishery managers revealed their minor contribution to the standing populations and in the anglers' catches. This result allowed scientists to reassure the managers regarding their initial concern that reducing stocking might be detrimental. Secondly, strategies used to restore threatened native populations such as temporary stocking with native fry and direct translocation of native fish were also evaluated, and the findings were used as a source of information to establish new conservation and restoration programmes.

LACK OF COMMON WORK IN THE TRADITIONAL RESEARCH PROGRAMME

At the beginning of the project, there was a severe shortage of genetic and biological information on the native brown trout populations in the Haute-Savoie area, and this hindered the ability of managers to plan efficient conservation actions. Thus, increased scientific knowledge in the large hydrographic network was the main goal of the research. Scientists and managers worked together throughout the research process in the field sampling, data analysis, interpretation of the results and in writing the peer-reviewed publications. Such an approach facilitated two-way information flow between scientists and managers, which not only provided practitioners with adequate training in essential disciplines used for biodiversity conservation (genetic, demographic analyses, population dynamics) but also improved the scientific quality of the research by integrating managers' knowledge in the data analysis. For example, our partnership allowed us to work at a large scale sampling 200 stretches of river, to discover eight new native brown trout populations, to define their spatial separation, to determine their level of threat and conservation prioritizing and to distinguish genetic strains within native brown trout that should be considered as distinct genetic units (Fig. 2).

MANAGEMENT DECISION MADE WITHOUT TAKING INTO ACCOUNT SCIENTIFIC EVIDENCE

Finally, operational findings need to be integrated in policy decisions to develop a decision-making procedure in management plans based on scientific evidence. Even with the availability of detailed information, without assistance it is always difficult for wildlife managers to select those conservation measures that are the most likely to preserve biodiversity. In our approach, scientists participated in this crucial step and also became decision-makers alongside managers to integrate the scientific findings into the conservation planning procedure. Scientific assessments and monitoring of the conservation measures were carried out to adapt the management strategies in a dynamic process.

Encouraging collaborative research in applied ecology

From the success of our experience, we believe that the implementation of collaborative research represents an efficient way to connect scientific knowledge with management action as well as to improve the match between social demand and scientific supply. This approach can be applied to other conservation issues, for example, collaborative research was effective in implementing science-based co-management of marine resources (Wendt & Starr 2009). We recommend five ways to encourage the development of collaborative research initiatives in both academic and management institutions.

(1) Funding institutions should call for joint proposals from scientists and practitioners to encourage the submission of collaborative research projects that merge scientific and management needs. This would support early connections between practitioners and scientists and would encourage stakeholders to work together.

(2) Collaborative projects need to establish joint scientist positions shared among different institutions to develop lasting and dynamic collaborations and close working relationships. Such positions ensure that there is collaboration between stakeholders throughout the research process from the study design to publication of the results, and they facilitate the integration of scientific findings into the decision-making procedures of conservation planning.

(3) The emphasis on scientific communication via peer-reviewed journals facilitates information exchange and collaboration within the scientific community, but not between different stakeholders. As highlighted by Pullin & Knight (2009) and Hulme (2011), academic journals in applied sciences and conservation sciences need to widen their audience to all the actors in applied ecology. Applied meetings involving researchers, wildlife managers and decision-makers are also needed to address both successful and unsuccessful outcomes of conservation actions.

(4) The current system used by academic institutions to assess research quality does not encourage scientists to implement applied research that delivers practical outcomes based on the long process of developing working relationship with different stakeholders. In reality, current measures of research quality do not indicate the efficiency of the research in terms of the implementation of effective actions for biodiversity conservation. In collaborative research, the role of the scientist does not stop once the results are published in peer-reviewed journals, since after publication findings should be used as a tool to improve the management actions. Scientific institutions need to use other indicators to measure the prestige of applied research such as the involvement of scientists in the management process (management and policy meeting, decision-making procedure), the production of non-academic articles popularizing scientific findings to practitioners and

their capacity to carry out successful projects with different stakeholders.

(5) Finally, the ultimate way of ensuring permanent and lasting approaches to science-based management should be the creation of Collaborative Research Units on local or specific conservation issues (i.e. threatened species or important conservation areas) merging different academic and management institutions and pooling their human, technical and financial means with the purpose of implementing applied research with practical outcomes.

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