

What can conservation strategies learn from the ecosystem services approach? Insights from ecosystem assessments in two Spanish Protected Areas

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Abstract

Biodiversity conservation strategies that overlook the interests of local people are prone to create conflicts. The ecosystem service approach holds potential for integrating the social dimension in and around protected areas, but its implementation in conservation policies is still in its infancy. This research assesses the extent to which ecosystem services are considered and have been implemented in conservation strategies in protected areas. The study was conducted in two Spanish protected areas, covering a wetland (Doñana Natural and National Parks) and a Mediterranean mountain (Sierra Nevada Natural and National Parks) ecosystem. Data were collected from deliberative workshops with managers and researchers, face-to-face questionnaires with users and a review of management plans. We found that, beyond intrinsic values of biodiversity, these areas provide multiple

ecosystem services that deserve further attention to ensure their sustained delivery. Our research shows that environmental managers and ecosystem service users have different perceptions and priorities regarding ecosystem services management. Environmental managers in both protected areas perceived that human-nature relationships and ecosystem service arguments are already widely included in management plans, if often not explicitly. We found that different ecosystem service categories receive uneven attention in management plans. These contained measures to manage provisioning and cultural services whereas measures for managing regulating services were perceived to be largely absent. We conclude by summarizing insights on how the ecosystem service approach may enhance management plans within protected areas.

Keywords

Deliberative workshop; document analysis; management plan; National Park; Natural Park; perception.

INTRODUCTION

Protected areas are considered one of the most successful instruments for conserving biodiversity (Juffe-Bignoli et al. 2014). However some scholars have pointed to some limitations of this conservation model, including their isolation, lack of support by local communities, and their inability to prevent land use change beyond their administrative boundaries (Rands et al. 2010; Palomo et al. 2014a; Venter et al. 2014). Some authors (e.g. Ban et al. 2013; Cumming et al. 2015) contend that, in the context of global change, conservation strategies need to integrate a wider social-ecological systems perspective and to respond to social demands on ecosystem services while preserving ecosystem integrity. To address this need, the ecosystem services approach has been proposed as a potentially useful argument to increase social support for conservation and avoid the isolation of the protected areas conservation model through analysis of the ecological processes sustaining ecosystem service flows both within and outside the protected area (Bertzky et al. 2012; Palomo et al. 2014b).

The ecosystem services approach extends conservation objectives beyond intrinsic values to cover social, economic and cultural values of nature (Cowling et al. 2008; López-Hoffman et al. 2010). It recognizes the wide range of benefits that protected areas provide (TEEB 2009), and the importance of recognising the multiple interests of society in their management (Palomo et al. 2013; García-Nieto et al. 2015). Because benefits from ecosystem services accrue at multiple scales, the ecosystem services approach allows managers and scientists to understand protected areas within the broader social-ecological systems in which they are embedded (Gómez-Baggethun et al. 2013; Palomo et al. 2014a; Cumming et al. 2015) overcoming the classical conservation vs. development model. It can also reflect the tension between users at different scales, such as local users and users outside the boundaries (i.e. tourist population) of protected areas (e.g. Iniesta-Arandia et al. 2014). It can also uncover existing and potential social conflicts, between management and use, especially when conservation policies are applied without due consideration of the interests and needs of the local communities (Kovacs et al. 2014). Finally, it might constitute a boundary concept (Hauck et al. 2015) that facilitates the engagement of different stakeholder groups in the management of the protected area (Bertzky et al. 2012; Palomo et al. 2014c).

As the ecosystem services concept has begun to gain momentum in science and policy agendas, the incorporation of ecosystem service arguments within conservation policies is increasingly supported by regulatory frameworks at international and national levels (Stolton and Dudley 2010; Dudley et al. 2011). One of the principal recommendations of the International Millennium Ecosystem Assessment for protected areas is to develop, through legal, policy, and other effective means, stronger societal support based on the benefits and values of the services the protected areas provide (MA 2005). In this context, International organisations are

beginning to consider ecosystem services in protected areas, for example, the International Union for the Conservation of Nature (IUCN) included the term ecosystem services in their definition of protected areas in 2008 (Dudley 2008). The importance of ecosystem services in the design and management of protected areas has been also recognised in the Strategic Plan for Biodiversity 2011-2020 and in the Aichi Biodiversity Target 11: *‘By 2020, at least 17 per cent of terrestrial and inland water areas and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascape’*. In Europe, the 2020 EU Biodiversity Strategy calls for protecting and restoring ecosystems and the services provided by protected areas (Target 2; European Commission 2011). The ecosystem services approach is also being implemented in national legislations. For example, Spain has passed a Biodiversity Law (Ley 42/2007) and a Sustainable Rural Development Law (Ley 45/2007) that aim to protect biodiversity and ecosystem services and to address rural abandonment affecting cultural landscapes. In spite of these policy developments, explicit use of the ecosystem services approach in international, regional and local conservation strategies is still rare (Thompson et al. 2011). This may reflect the need to address several scientific challenges before the approach can be operationalized in protected areas. These include improving understanding of the benefits and ecosystem services provided by protected areas and their biodiversity to human wellbeing, and clarifying the role that local communities and other stakeholders play in the management of ecosystem services in protected areas and their boundaries (Juffi-Bignoli et al. 2014; Bonet-García et al. 2015; Velasco et al. 2015). A recent publication demonstrated a positive relationship between the distribution of parks in Andalusia as a Mediterranean region and human wellbeing indicators, where protected areas act as attractors of policies promoting human wellbeing (Bonet-García et al. 2015). As noted by Mace et al. (2014), in the last 50 years conservation frames have evolved from the notion of “nature for itself” towards “nature for people” and “people and nature”. However, in the first case management indicators are well-established (e.g. number of species listed in threatened catalogues or the size of protected areas); metrics and management models under the new conservation frames are still at an early stage of development (García-Llorente et al. 2015).

In this research, we examine the extent to which ecosystem services are considered and have been implemented in conservation strategies in protected areas. In particular, we pursue the following specific objectives: (I) to analyze the importance of ecosystem services provided by protected areas for different stakeholders groups, including managers and researchers (as the groups responsible for implementation of ecosystem services in

conservation policies) and users, including local communities and tourist perspectives; (II) to assess trends in the condition of ecosystem services provided by protected areas in order to identify vulnerable ecosystem services (i.e. services considered as important by stakeholders but declining in condition) or contradictions between management and use (e.g. ecosystem services considered important by managers but not recognised by users or vice versa); (III) to examine the extent to which ecosystem services are implemented in current management plans; and (IV) to explore the opportunities and limitations perceived by managers and researchers for integrating ecosystem service arguments into conservation policy and practice. Our research draws on data collected in two of the most important but contrasted in terms of ecosystem types, protected areas of Andalusia region (southern Spain): Doñana (a coastal wetland) and Sierra Nevada (a Mediterranean mountain ecosystem; Fig 1). Both share important ecological and cultural values associated with unique ecosystems, endemic species, traditional management practices, expressed in unique cultural landscapes. Nevertheless, both areas experience environmental conflicts resulting from land use changes driven by conservation policy, intensive agriculture, urbanization or rural abandonment (Gómez-Baggethun et al. 2010; Martín-López et al. 2011; Iniesta-Arandia et al. 2014; Zorrilla et al. 2014). Whatever direction they take, these land-use changes always find supporters and opposers, with different interests in the ecosystem services delivered (Gómez-Baggethun et al. 2013).

METHODS

We used different methodologies to fulfil each of our specific objectives. Data on ecosystem service perceptions across stakeholder groups were collected from questionnaires and workshops (objective I, Table 1).

Questionnaires were conducted to assess preferences over ecosystem services by resource users and tourists (objective I). Tables showing a classification of ecosystem services within each of the study areas were provided to the respondents, who were asked to select the four services that they considered most important. The surveys were conducted during 2008-2011 ($N=1183$) (see Table 1). Our sample integrates data from previous research in the two study areas (García-Llorente et al. 2011; Iniesta-Arandia et al. 2014). Quantitative data collected from the survey were analysed using simple descriptive statistics and presented as radial diagrams to show differences in ecosystem services perception between both protected areas.

Participatory workshops were organized in Doñana (21 participants) and Sierra Nevada (20 participants) to assess the ecosystem service perceptions of managers and researchers. Workshop participants included park managers, staff from the National Park Agency and from the regional environmental agency, and social science

and environmental science researchers working in the study areas. Participants were split into five groups of four to five people, where managers and researchers worked together to identify the five ecosystem services they deemed the most important in each protected area (objective I). To do so, we used tables showing service classifications which were defined in previous research in the study areas (Gómez-Baggethun et al. 2011a; Palomo et al. 2013; Moreno et al. 2014). To assess ecosystem service condition in the protected areas (objective II), participants were asked to discuss the condition (declining, stable or improved) of selected services and to identify associated drivers and pressures. To provide a supplement with the data obtained from the workshops, we revised data from the Sustainable Development Plans (SDP) for both protected areas (SDP Sierra Nevada 2004; SDP Doñana 2010) about drivers and pressures affecting ecosystem services (Table 1).

Finally, the data collected in the workshops and in the surveys were combined in bubble diagrams in order to identify vulnerable ecosystem services (objective II). Here, vulnerable ecosystem services were defined as declining services considered important by the protected area managers and researchers (Iniesta-Arandia et al. 2014; Oteros-Rozas et al. 2014). These diagrams also allowed comparison of ecosystem service perceptions by managers and researchers with the perceptions of tourists and local resource users (objective I).

To explore opportunities and limitations for integrating the ecosystem services concepts into conservation policy and practice (objective III), we asked three open questions in the workshops about the type of information that is used in the design of conservation plans. These questions aimed to collect information on (1) whether protected area management plans includes information to address landscape planning; (2) the extent to which this information takes account of human-nature relationships; and (3) the extent to which the ecosystem service approach was adopted. These questions provide insight into how knowledge sources shape conservation plans.

Finally, to analyse the extent to which the ecosystem services approach is implemented in management plans (objective IV), we reviewed the Steering Plan for Use and Management (PRUG) in force for Sierra Nevada National and Natural Parks (Decree 238/2011), the PRUG in Doñana National Park (Decree 48/2004) and the PRUG in Doñana Natural Park (Decree 97/2005). In addition, we reviewed the Plan for the Regulation of Natural Resources (PORN), reports that both protected areas submit to the Senate every three years for the periods 2004-2007 and 2007-2010, as well as their annual reports for the period 2010-2015 (Table 1). We considered a service was contemplated when plans included guidelines to enhance and regulate it through sectoral or working plans, even if in most cases they did not use the concept in an explicit way.

RESULTS

Stakeholder perceptions on the importance of ecosystem services

In the workshops conducted with managers and researchers in both protected areas, six services were selected by at least one group. These included two provisioning services (food from agriculture and freshwater), one regulating service (habitat for species), and three cultural services (scientific knowledge, nature tourism, and aesthetic values). In Sierra Nevada, managers and researchers also remarked on the primary importance of other regulating services such as air quality, climate regulation, water regulation, and erosion control. In Doñana, participants also highlighted the importance of food from livestock, environmental education, and existence values (Table 2).

In the questionnaires, the ecosystem services deemed most important by respondents in both protected areas included food from agriculture and freshwater as provisioning services, air quality as a regulating service and nature tourism and tranquillity and relaxation as cultural services. We also found that the perception of ecosystem service importance varied significantly between users of the two protected areas. As expected, fishing and shell fishing, an important economic activity for locals in Doñana, were selected among the most important services, whereas clean energy from wind farms and solar panels, currently expanding in the Sierra Nevada mountains, were selected among the most important services in this protected area (Fig 2). Moreover, Doñana users placed greater emphasis on habitat for species, soil fertility and prevention of invasive alien species, while Sierra Nevada users highlighted the importance of regulating services as erosion control, and water and climate regulation (Fig 2). Finally, as shown in Figure 2, Doñana users gave more emphasis to cultural services than Sierra Nevada respondents. In particular, they expressed the importance of aesthetic values, environmental education, and scientific knowledge. Additional details on the results about user preferences are provided in Supplementary Material (Appendix A).

Our data shows that food from agriculture, freshwater, and nature tourism stand out as important ecosystem services from both the deliberative workshops with managers and researchers and from the users questionnaires. However, we found that managers and researchers considered regulating services to a higher degree. In addition, for managers and researchers the production of scientific knowledge was one of the most important services provided in the protected areas. This finding fits a key purpose of National Parks, which are expected to contribute to research and scientific knowledge. This service was not considered as important by the surveyed users (Fig 2).

Condition of ecosystem services provided in the protected areas

From the set of services identified as most important by managers and researchers in Doñana, only freshwater was classified as vulnerable (with a declining condition), mainly due to overharvesting of groundwater for irrigation of intensive agriculture in the surroundings of the protected area (Table 2). This condition is consistent with data provided in the SDP, which notes that freshwater provision is threatened by overexploitation and pollution from intensive agriculture and urbanisation. Three ecosystem services were evaluated as stable: food from livestock, habitat for species, and aesthetic value (Table 2). The SDP highlights how extensive livestock raising is integrated into the conservation strategies and the importance it holds for people in Doñana in terms of social recognition because of its emblematic species, singular landscapes, and links to local culture (see also Gómez-Baggethun et al. 2010). The trend in the condition of scientific knowledge was evaluated as stable-improving while the condition of four services, food from agriculture, existence values, environmental education, and nature tourism was evaluated as improving.

Among the services perceived as important by Sierra Nevada managers and researchers, the condition of two of them, food from agriculture and erosion control, was classified as declining and hence as vulnerable. The former is declining because of extensive agriculture low market competitiveness and the latter because of the consequences of land abandonment on soil conditions. Again, the assessed condition is consistent with information provided in the SDP, which notes a shift from traditional agriculture towards intensive agriculture with higher short-term market profitability since traditional and small scale agricultural activities have a lower capacity for innovation and competition in markets. Climate regulation, water regulation, and aesthetic values were in a stable-declining condition (Table 2) because of the impact of deforestation activities and the modernisation of irrigation channels. Aesthetic values were threatened by urban expansion, skiing infrastructure, and the abandonment of cultural landscapes, amongst other factors. Finally, the condition of freshwater, air quality and habitat for species was evaluated as stable. Trade-offs between ecosystem services were also identified. For example, increases in recreational ecosystem services associated with nature tourism (and mainly ski tourism) were reported to occur to the detriment of water-related services (e.g. through freshwater overexploitation; Table 2). Similarly, agricultural intensification and overgrazing was reported to have negative consequences on soil quality and traditional agriculture (Table 2).

Finally, when comparing the assessed level of vulnerability of a given service with its social importance (Fig 3), we found that food from agriculture and erosion control in Sierra Nevada and freshwater in Doñana need urgent protection measures, because in spite of their importance, they are in a vulnerable condition. It is also interesting

to remark that food from agriculture had an improved condition in Doñana but a vulnerable condition in Sierra Nevada. In Doñana this improvement has been related with the inclusion of technology on agricultural activities, while in Sierra Nevada its declining was expressed in terms of the abandon of traditional practices.

Opportunities and limitations for implementing ecosystem services in management plans

In response to the questions about the information used to design management plans within protected areas, Doñana managers and researchers reported that they suffer from significant limitations in information availability (Table 3). However, according to workshop participants, information problems stemmed from: (i) lack of communication between researchers and managers, (ii) lack of coordination among governance sectors (e.g. conservation with agriculture), (iii) lack of public participation, and (iv) interest bias in some research and conservation priorities. In Sierra Nevada, reported limitations included: (i) lack of communication between researchers and managers and (ii) growing complexity and uncertainty from environmental global change.

Workshop participants in both protected areas believed that human-nature relationships were widely included in management plans, although this perception was slightly higher in Sierra Nevada (Table 3). Some of the explanations given regarding remaining challenges for management based on a social-ecological systems perspective in both areas include: the perception of humans as external to nature, the adoption of strict conservation criteria without the consideration of social dimensions, lack of a historical perspective, low public participation, and disagreement regarding the role of traditional management practices in the protected areas. Finally, about half of the workshop participants considered that the ecosystem service approach is already integrated in the management of the protected areas to some extent through the management plans and systemic approaches (if not always explicitly, at least in an implicit and/or intuitive way).

Ecosystem service implementation in current management plans

Our results suggest that the ecosystem service approach is similarly included in the management plans of both protected areas (Table 4). Regulation of the use of provisioning services has been an important issue, in particular for livestock activities, as ensuring the compatibility of traditional activities with conservation is one of the key aims of both protected areas. However, regulating services are included to a lesser extent in management plans. Both areas have made the effort to include crucial regulating services such as the design of prevention of invasive alien species programmes in Doñana, and climate change adaptation plans in Sierra Nevada, as expressed by managers' during the workshops. Nevertheless, vulnerable services, such as erosion control and water regulation, are not included in management plans (Table 4). We can also see a higher interest

in the management of cultural ecosystem services, motivated by the growing social interest in protected areas as nodes of nature tourism.

DISCUSSION

Multi-targeted protected areas: managing multiple ecosystem services

Results from the workshops with managers in both protected areas indicate that habitat provision for species was perceived as one of the most important ecosystem services delivered, which is not surprising given that one of the ultimate aims of protected areas is biodiversity conservation creating areas for its preservation. The main general objectives of the Plan for the Regulation of Natural Resources (PORN) for both areas (PORN Doñana Natural Park 2005; PORN Sierra Nevada Natural and National Parks 2011) are concerned with: maintaining the ecological integrity of the ecosystems protected, conserving biodiversity, promoting the socio-economic development of local populations, maintaining tourism, conducting environmental education, and contributing to scientific knowledge with applied results for management, amongst others. National parks objectives are complex and multi-targeted, integrating ecological, research, cultural, and socio-economic priorities related to different ecosystem services, as well as users at different scales (local, regional, and national). However, different ecosystem service categories received uneven emphasis in the two studied areas during the workshops.

Emphasis in Doñana was mainly on cultural ecosystem services, and specifically on those that are growing in demand by beneficiaries from urban areas and the regional and national scales (such as nature-based tourism and environmental education), which currently gain prominence above locally experienced cultural services (such as sense of identity) (see Gómez-Baggethun et al. 2011a). In contrast, workshop participants in Sierra Nevada put greater emphasis on regulating services. This divergent pattern may be explained by the different mind-set that motivated their conservation strategies. Doñana natural protected area PRUG has the aim of protecting emblematic vertebrates and the habitat for these species (Decree 48/2004; Decree 97/2005), while Sierra Nevada natural protected area is more linked to the protection of vegetation (based on the interaction of freshwater-soil-vegetation) and the distinctiveness/uniqueness of its cultural landscapes ((Decree 238/2011; Palomo et al. 2014b).

In Doñana, as in Spain more broadly, conservation efforts target mainly emblematic species, such as the Iberian lynx (*Lynx pardinus*), the Iberian Imperial eagle (*Aquila adalberti*), or particular aquatic birds, such as Greylag goose (*Anser anser*), red-knobbed coot (*Fulica cristata*), white-headed duck (*Oxyura leucocephala*), and

Eurasian Spoonbill (*Platalea leucorodia*) (Martín-López et al. 2009), which attract a high number of birdwatchers (Múgica and De Lucio 1996; Gómez-Baggethun et al. 2011b). In fact, Doñana has been identified as one of the areas of high-value vertebrate diversity (Rey Benayas and de la Montaña 2003). Sierra Nevada, however, is one of the hotspots of vascular plants diversity and degree of endemism (Lobo et al. 2001). Here, conservation efforts target endemic mountain vegetation species (e.g. wet grassland communities locally known as borreguiles) and the preservation of traditional land use practices (e.g. traditional irrigation ditches) related to the maintenance of regulating services, such as hydrological regulation and water purification (Aspizua et al. 2010).

Managers and users priorities for conservation practices

We found divergences between the priorities of workshop participants and ecosystem service users, with scientific knowledge being the most notable case.

Scientific knowledge was acknowledged by workshop participants as standing out amongst the main aims of the protected areas, as contributions to research and scientific knowledge are a key stated purpose of National Parks (Decree 97/2005, Decree 238/2011). However, our results suggest that the priorities of managers and users towards ecosystem services diverged from those expressed by surveyed ecosystem service users, most of whom did not identify scientific knowledge production as amongst the most important services (Fig 2). Not surprisingly, scientific knowledge is mainly related to managers' and researchers' interests. In fact, previous studies indicate that scientific knowledge in Doñana is not sufficiently transferred to decision-makers and the broader society (Moreno et al. 2014). These findings suggest that more efforts should be made to communicate scientific knowledge in a format that is more useful for decision-making and society.

For example, in Sierra Nevada traditional and small scale farms are vulnerable through limited access to technical information and knowledge derived from scientific research; as they have a limited capacity to generate their own knowledge and to innovate (Labarthe and Laurent 2013). In this case, it is essential to generate useful scientific research for small scale farmers. In those cases, collaborative research between scientists, managers, and local users (e.g. farmers and livestock keepers) under an adaptive co-management approach could be an effective way to connect scientific priorities with conservation and socio-economic needs (Caudron et al. 2012). In addition, in Sierra Nevada there is now a lot of research is being conducted on climate change, which is an important issue for the Mediterranean mountains. Disseminating this knowledge among users and integrating it to research and management processes could help to establish collaborative research processes, as has been

promoted since 2007 with the creation of the Global Change Observatory in Mountain Regions (GLOCHAMORE; Aspizua et al. 2010). Equally important is to promote further engagement of ecosystem service users (e.g. farmers) in the management of protected areas, as they influence conservation decisions and are influenced by them, but also to achieve more inclusive, supported, realistic, and transparent plans (Ban et al. 2013). Finally, collaborative work between scientists and protected area managers and users, as the one presented here, can help to identify research priorities for conservation practice. In that case, our analysis demonstrated that only some ecosystem services considered as vulnerable and important by stakeholders are part of the management plans of both protected areas, while vulnerable services still need management plans to be developed.

Ecosystem services interactions and trade-offs

One of the main risks to protected areas derives from a system of polarized territorial planning, where natural areas, often protected through ‘fortress conservation policies’ are embedded in an ecologically degraded territorial matrix devoted to economic development (de Fries et al. 2007; Joppa et al. 2008; Radeloff et al. 2009). Land use change and intensification outside protected areas create border effects that impinge upon the ecosystem services delivered within the protected area (Martín-López et al. 2011; Palomo et al. 2014c).

In Sierra Nevada, ski tourism has a negative impact on erosion, hill stability and landscape quality (Moreno et al. 2014). In addition, since the 1950s, the upper mountainous areas of Sierra Nevada have experienced strong depopulation with the abandonment of traditional agriculture. In contrast, the lower areas with milder climates (near the coast) have developed competitive, intensive greenhouse horticulture (Aznár-Sánchez et al. 2011), which also has led to decreasing aquifer levels and soil contamination (Sánchez-Picón et al. 2011).

In the surroundings of Doñana, the growth of intensive agriculture (Gómez-Baggethun et al. 2011a; Martín-López et al. 2011) and land use change (Zorrilla et al. 2014) are affecting regulating services such as water regulation, habitat for species, and erosion control, due to high levels of pesticides, nitrogen and phosphorus compounds (Olías et al. 2007; Tortosa et al. 2010). Similarly, beach tourism has had negative impacts on water quality and quantity. For example, increased water demand from the growth of coastal tourist resorts has been associated with a drop in the phreatic level of Doñana’s main aquifer (Custodio et al. 2009; Moreno et al. 2014). In both areas, a few provisioning and cultural services with high market value are being promoted at the expense of other ecosystem services, especially regulating services and non-commodified cultural services (Gómez-Baggethun et al. 2011a). Additional conservation efforts are required to protect vulnerable, but essential

ecosystem services in both protected areas, including freshwater supply and erosion control in Doñana and food from agriculture, erosion control, climate regulation, water regulation, and aesthetic values in Sierra Nevada.

Opportunities and limitations for implementing ecosystem services in conservation policies

Our results show that most workshop participants (managers and researchers) demand more and better information to make accurate management decisions. Specifically in Doñana, they felt that they suffer from a lack of information availability. This result is paradoxical; however, as Doñana is one of the most studied and documented protected areas in Spain (Voth 2007). As noted by Cook et al. (2012), protected area managers have to take complex conservation decisions, taking into consideration diverse and multifaceted factors such as biodiversity threats, conservation effectiveness, financial cuts, species distribution, etc (Young et al. 2012). They never have full information for taking management decisions, which always are taken under some degrees of uncertainty. Even decisions that could seem simple in ecological terms need to take into account complex socio-economic and political aspects (Cook et al. 2012).

In both protected areas, the importance of including social dimensions in conservation (e.g. demands of local users) was recognized, and the ecosystem service perspective is already included to some extent in management plans. The management plans of Doñana and Sierra Nevada protected areas (particularly in Doñana), focus on provisioning and cultural services (without explicitly using the ecosystem services term), whereas regulating services are included to a lesser extent (Palomo et al. 2014b). Paradoxically, regulating services generally have a higher dependence on core ecosystem processes and hence play a major role in the long-term capacity of protected areas to sustain biodiversity and ecosystem functions, so a stronger focus on ecological regulating processes might be needed. At the same time, their inclusion in conservation plans is complex and further studies are needed to better understand their interaction with ecological components (Harrison et al. 2014), as well as for delimiting indicators and measures of performance for conservation strategies. As mentioned before, in contrast with Doñana, Sierra Nevada protected area is taken steps in that direction, holding a Global Change Observatory for Mountain Regions (<http://wiki.obsnev.es/index.php/Objetivos>) which is incorporating and making accessible biophysical, social and ecosystem service information and indicators.

The analysis of which ecosystem services are included in protected area management plans reveals which ecosystem aspects are addressed and which ones are omitted from conservation strategies (Wilkinson et al. 2013). In the pitfall trap described for biodiversity conservation, a connection exists between conservation policies, research priorities and public concern (Martín-López et al. 2009). We consider that a similar situation occurs in the case of ecosystem services provided by protected areas. The aims for which a protected area is

declared, predetermine the development of management and conservation strategies (i.e. PRUG), that consider and include specific ecosystem services associated with their creation purpose, which could be later translated to users that depend upon protected-area management (Bonet-García et al. 2015).

CONCLUSIONS

Our research suggests that the frame of “nature and people” (sensu Mace 2014) and an understanding of protected areas as social-ecological systems (Palomo et al. 2014a, Cumming et al. 2015), can tackle some of the limitations of the protected areas conservation model, such as their narrow capacity to prevent border effects and their propensity to create environmental conflicts with local resource users. In order to strengthen a social-ecological approach to protected areas several challenges need to be met, including: (i) to identify the main ecosystem services provided by protected areas under a given management regime, and who are the beneficiaries and losers from this management, (ii) to advance the recognition that socio-economic context affects conservation plans and vice versa; (iii) to assess how ecosystem services are included in conservation strategies and what are the main difficulties that are encountered in so doing; (iv) to assess how pressures originating from beyond the boundaries of protected areas impinge upon their capacity to sustain biodiversity and ecosystem services. This should help to delineate the relationships between different ecosystem services and establish priorities in conservation. In line with Iniesta-Arandia et al. (2014), we consider that these priorities could be established by combining information on the importance of different ecosystem services for people and their vulnerability. In this study, ecosystem services identified as both vulnerable and socially important (and hence as priority conservation targets) include freshwater supply and erosion control in Doñana, and water regulation, climate regulation, aesthetic values, and food from agriculture in Sierra Nevada. While we believe that biodiversity conservation should remain at the core of conservation strategies, we contend that, besides the criteria of managers and researchers, protected areas should take broader consideration of the demands of ecosystem services by their immediate users (e.g. local people that depend on access to resources for their livelihoods). However, our analysis demonstrated that only some ecosystem services considered as vulnerable and important by stakeholders are part of the management plans of both protected areas. Conservation plans should take into account the ecosystem services considered as relevant by different users, as well as the diversity of conflicting perceptions. Proper consideration of multiple ecosystem service perceptions (i.e. ecosystem service needs by local populations and their expectations) can be an important step towards the co-management

of protected areas. This can help to prevent environmental conflicts in protected areas, strengthen social support for their management and increase the human well-being of local populations.

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