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Limited resources mean that conservation investments must be chosen carefully and their performance evaluated critically. These approaches highlight areas in need of conservation action, but provide limited information as to how resources might best be allocated among regions over time. An alternative approach is to use information on biodiversity values, threats, and costs to determine a conservation investment schedule that maximizes our expected biodiversity returns for a fixed budget (Costello & Polasky 2004; Wilson et al. 2006).

This approach, however, does not address sources of uncertainty that have the potential to compromise conservation outcomes. Such sources include political instability and corruption; the impact of natural catastrophes; lack of budget continuity; weak governance; project failure; absence of stakeholder willingness to be involved; failure to effectively empower stakeholders or mainstream conservation priorities; and implementer “burnout” (Barrett et al. 2001; Byron et al. 2001; Smith et al. 2003; Laurance 2004;Winter et al. 2005; Knight et al. 2006).

Broadly, the impact of these socioeconomic uncertainties on conservation investments can be distilled into two types: (1) the ability to invest and the level of investment in a region are not constant over time (i.e., transaction uncertainty) and (2) investment in a region does not guarantee the long-term persistence of biodiversity (i.e., performance uncertainty). Investment uncertainty may result not only from country-level issues, such as weak governance, domestic conflicts, and corruption, but also from shifting priorities among donors and budget shortfalls.

We used stochastic dynamic programming (SDP) to determine an optimal resource allocation schedule, which is a statebased backwards-iteration algorithm. For each possible system state, the algorithm determines the optimal solution based on the current state and the expected return, given the likely transition probabilities (Bellman & Kalaba 1965; Clark & Mangel 2000).

There is however, a dearth of publicly available, quantitative, and empirical data that describes the relative successes of past conservation investments (Ervin 2003; Stem et al. 2005).

We explored two alternative expressions of transaction uncertainty to assess the effects of the possibility that resource allocation will either cease or increase. First, we introduced an annual probability that the ability to acquire more parcels might be lost and that all currently available parcels might become unavailable. Likewise, to examine the effects of potential increases in funding or capacity to mitigate parcel loss, we incorporated a probability that each year enough funding might become available to acquire all remaining available parcels. Second, we considered the effects of incorporating a less extreme expression of transaction uncertainty by relaxing the assumption that once funding ceased, it could never be reinstated. Instead we allowed for the possibility of variable lengths of funding unavailability, following which conservation investment in a region could recommence.

To assess the effects of performance uncertainty, we introduced a region-specific probability that each year any currently reserved parcel within a region had a fixed probability of failing.

Relative differences of between 1 and 10 were used for the predicted rates of habitat loss, which were obtained by predicting changes in human-footprint values on the basis of predicted rates of human population growth. The lowest predicted rate of population growth was 0.002 in the forest ecoregions of northeastern Spain and southern France, and the highest predicted rate of population growthwas 0.02 in the eastern Mediterranean conifer-sclerophyllous-broadleaf forests (E. Underwood et al., unpublished data).

Nevertheless, when differences in transaction uncertainty were less extreme, the relative vulnerability or the biodiversity value of each region remained more influential on the optimal approach. The minimize-loss heuristic again underperformed relative to the maximize-gain heuristic, delivering final outcomes that differed from the optimal solution by up to 20% (Fig. 2c). The impacts of transaction uncertainty on the performance of the heuristics were reduced significantly when the loss of funding was not final, and there was a chance that funding would resume at some time in the future (Fig. 2d).

When performance uncertainty was incorporated, the optimal solution became a complex trade-off between the immediate biodiversity benefits of acting in a region and the perceived longevity of the investment. In general, variation in the probability of reserve failure was more influential in determining the optimal solution than either the regional rate of habitat loss or biodiversity value, and the optimal SDP solution almost always favored the region with the greatest performance certainty, even if the alternative region was highly threatened or had higher biodiversity value (Fig. 3)

In societies that too often value short-term profits over long-term gains, it is important to look beyond the quick fix and focus conservation efforts on achieving lasting benefits for biodiversity. Current priority-setting approaches typically neglect the range of economic, political, and social factors that affect the likelihood of investment success.

Losing the ability to acquire new land in a region (i.e., cessation of funding) had considerable impact on the optimal resource allocation strategy. The optimal strategy changed if there was even a small chance that funding would cease. Under such uncertainty, strategies that maximize short-term gains are the most robust in the long term. In comparison there was little variation in the performance of the heuristics when there was a possibility that future funding levels would increase. These results, although intuitive, highlight the importance of considering the sensitivity of funding strategies over time to system dynamics and uncertainties. Regardless, our results highlight the pragmatic importance of a precautionary and opportunistic approach (i.e., Noss et al. 2002; Knight & Cowling 2007), which would likely be further emphasized under both sources of uncertainty.

When we included a measure of performance uncertainty— a possibility that investments fail to protect biodiversity assets—our resource-allocation strategies changed drastically. Resources were directed away from regions with high levels of performance uncertainty, particularly during the early years of an investment term. Because it affected the length of time reserves were able to contribute to biodiversity conservation, the level of performance uncertainty was the regional characteristic that had the greatest influence in determining where and when resources were allocated.

The underperformance of the myopic SDP algorithm further highlighted the importance of making decisions based on long-term expected outcomes, as opposed to decisions that optimize only in the short term.

Our results demonstrated the importance of accounting for the likely success and longevity of conservation investments when prioritizing the allocation of conservation resources at the interregional scale. Our results confirmed commonly held beliefs that, in systems such as the Mediterranean Basin, the exclusion of social and political factors may preclude the efficient allocation of conservation funds. These factors (and their potential influences on conservation outcomes) remain largely neglected within the field of systematic conservation assessment.

Lack of research into the effects of sociopolitical uncertainties on conservation priorities is likely to be driven by the paucity of empirical data on the relationships between the characteristics of conservation investments and their performance outcomes.

Our results show that the ability to invest and the performance of investments should significantly alter investment strategies and long-term conservation outcomes. It is clear from these results that the impact of investment uncertainty must be accounted for explicitly when prioritizing the allocation of conservation resources. By shifting the focus to achieving longer-term outcomes and by accounting for investment uncertainty when prioritizing the allocation of conservation funds, the ability to maximize conservation returns from every dollar invested improve substantially.