The promise and pitfalls of systematic conservation planning

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Systematic conservation planning continues to grow as a discipline, revealing both promise and pitfalls for conservation. The article by Kark et al. (1) in this issue of PNAS illustrates this promise, making a clear case for international coordination during conservation. However, it remains unclear how much faith conservationists should have in the utility of large-scale centralized planning exercises or the protected area strategy on which they are based.

Kark et al.'s (1) analysis stands at the forefront of a large body of literature on systematic conservation planning (2). In this corpus, the first focus historically was simply on identifying where different elements of biodiversity are located (3), a task that is still far from complete in many developing countries. Once that basic knowledge is obtained, it was natural for conservationists to try to find a portfolio of sites that protected all, or at least most, of the elements of biodiversity (Fig. 1*A*). Various optimization procedures (4) began to be used to find a portfolio of sites that met some objective criteria while minimizing the cost of site acquisition or protection (5), building on established algorithms in mathematics. Most recently, explicit consideration and mapping of the threats to the persistence of biodiversity have sharpened the focus of systematic conservation planning exercises on what really matters, the utility of conservation action versus the baseline status quo (6). By including information of biodiversity value, cost, and threat, papers such as that by Kark et al. (1) approach a full calculation of the return on conservation investment, the amount of biodiversity bang for the buck relative to what would have happened if humanity had not made that investment (7).

What makes the article by Kark et al. (1) striking is its political relevance. Cross-border collaboration by Mediterranean Basin countries could save $67 billion compared with the cost of country-by-country conservation, a 45% reduction in cost. Mathematically, it may not be surprising that an unconstrained optimization algorithm finds a more optimal solution than a constrained optimization. Politically, however, Kark et al.'s results could be a call to action for the European Union,
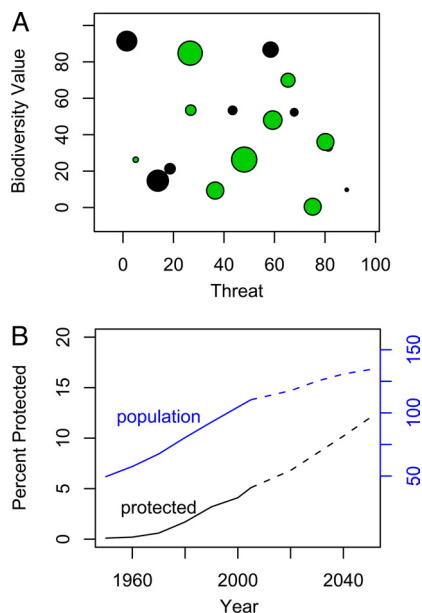

Fig. 1. Systematic conservation planning. (*A*) Conceptual diagram showing the relative threat and biodiversity value for a set of hypothetical sites in two different regions, marked green and black. The size of the circle is proportional to site cost. The fundamental goal of systematic conservation planning is to pick a subset of sites for protection that have high biodiversity value, are threatened, and are cheap. Unconstrained selection (devising a conservation plan jointly for both regions) will generally be more efficient than constrained selection (devising conservation plans separately for each region). (*B*) Trends in population density (blue line, people/km^2) and land protection (black line, percentage of landscape) in the Mediterranean. Historical population (17) and protection (19) data are indicated by solid lines. Future trends for population, based on Intergovernmental Panel of Climate Change Scenario B2 (20), and land protection, based on full protection of the selected set in ref. 1, are indicated by dashed lines.

which is considering new conservation actions in the Mediterranean region at a given scale.

This level of benefit from cross-border collaboration is particularly striking because currently most conservation decisions are made at a national or local level. Environmental nongovernmental organizations similarly do not collaborate during the development of their strategic conservation plans. In the United States, for example, >1,600 private land trusts have put conservation easements restricting land development on ≈15 million ha (8), and yet no one

has an integrated map of who has protected what, let alone an integrated plan. Kark et al.'s (1) analysis suggests that there may be significant financial benefit from collaboration, getting the same amount of conservation for fewer bucks.

One important limitation of Kark et al.'s article (1) is that it can quantify only the economic benefits to collaboration. However, as they acknowledge, there are significant costs to broad-scale collaboration. When there are more actors involved in the development of a systematic conservation plan, it takes more time, more money, and more political battles, and sometimes coming to any agreement may prove impossible. Without considering these very real costs, increased large-scale conservation planning will always seem more efficient and rational. By analogy, the failure of the Soviet Union's model of centralized economic planning can be seen to demonstrate that at least occasionally the costs and complexity of increased coordination and planning can outweigh any efficiency gains. It may be that a plethora of local land trusts, each independently pursuing conservation opportunities in their local region, is overall an efficient system.

Another important point to consider is that systematic conservation planning generally focuses on finding the most cost-effective way to protect elements of biodiversity, yet other factors are often far more important in driving conservation (9). Often another ecosystem service, such as recreational opportunity or aesthetic beauty, is more valuable to those making conservation decisions than the biodiversity itself (9, 10). In Europe, sites are often protected as part of a cultural landscape, ensuring that historical land-use practices persist but not necessarily optimizing the biodiversity value of the land protected (11). Moreover, often interest groups demand local conservation close to where they live, regardless of whether that is the globally optimal place for a protected area. These sorts of real-world complex-

ities mean that systematic conservation planning algorithms will never be more than a useful tool consulted during the political process of negotiation among stakeholders over what is protected and why.

Kark et al.'s article (1) does an excellent job mapping the priority places where on-the-ground conservation action is warranted and many readers may assume that the conservation action will be the creation of traditional protected areas. However, a case can be made that in several biomes, including the Mediterranean Basin, humanity is approaching the limits of the protected area strategy. Protected areas historically were first created on economically worthless land that was too cold or steep for cultivation or habitation (12, 13). As the conservation movement has grown, protection has occurred in a broader array of sites, but is still generally limited on landscapes with a high population density or a high degree of agriculture utilization (14). Simultaneously, the growth of human population and the expansion of agriculture and cities (15, 16) to meet that population's needs have meant that more of the globe has become a difficult place to create a protected area.

The Mediterranean Basin has always had relatively high population density (Fig. 1*B*), with 110.4 people/km^2 in 2005, relative to a global average of 51.2 people/km^2 (17). Similarly, only 56.4%

Kark et al. approach a full calculation of the return on conservation investment.

of the region remains in a seminatural land-cover state and has not been converted to an agricultural or urban land use (18), although it should be acknowledged that in Europe some rare species depend on human-controlled agricultural systems (11). Perhaps because of this landscape context, the Mediterranean Basin has never had much protection, with only 5.1% of the region protected relative to the global average of 13.1% (19). Data on likely future population growth (20) suggest that, if anything, the future the Mediterranean Basin will become a harder place to create protected areas. Given the reality, the European Union's goals for the region are truly optimistic and seem unlikely to succeed by using traditional land protection. As Kark et al. (1) acknowledge, success in the Mediterranean will require conservation actions other than the creation of traditional protected areas.

Kark et al.'s article (1) is thus a call to action for conservationists and a warning about the difficult work ahead. Cross-border collaboration can dramatically increase the efficiency of conservation planning efforts, but it is likely to pose significant transaction costs as well. Moreover, while Kark et al. (1) have identified priority areas to work in, the Mediterranean Basin will not be an easy place for broad-scale conservation and innovative conservation strategies will be needed.

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