Preface

Conservation biology: The new consensus

When conservation biology emerged as an identifiable organized discipline in the late 1980s [for histories, see Sarkar (1998, 2002)], it was already apparent that it would have to draw its principles and practices from many different biological specialties including genetics, evolution and, especially, ecology (Soulé 1985). However, besides this single point of agreement, the practice of conservation biology diverged radically in different cultural and political contexts.

In the North, particularly in the United States, humans were perceived as being essentially separated from nature, and their presence was taken to be the main reason for biodiversity depletion; human exclusion and wilderness preservation became major tenets of the new discipline. For many of these conservation biologists, the discipline's normative foundations were provided by "deep ecology" (Sessions 1995), a doctrine of questionable intellectual cogency and considerable ethical dubiety [for critiques see, for example, Salleh (1984) and Guha (1989)]. In sharp contrast, in the South, particularly in India and Latin America, biological conservation was viewed to be so closely integrated to cultural traditions in which the conservation of biodiversity was seen as part of the biocultural restoration of degraded habitats and the preservation of cultural practices that co-evolved in harmony with biodiversity (Gadgil and Berkes 1991; Diegues 1998; Guha and Martinez-Alier 1998). Over the years this view has been called human, liberation, or social ecology (Guha 1994; Peet and Watts 1996).

If in the North, in the United States, for instance, the pursuit of a science of biodiversity conservation was largely seen in continuity with basic rather than applied biological science, in the South, it was usually perceived to be in continuity with the social sciences. At the theoretical level, practices even diverged between different Northern contexts. Spurred by the requirements of the (US) Endangered Species Act, the most effective tool for biological conservation in the US, conservation biologists in the US pioneered the population viability analysis of small populations at risk of stochastic extinction. Meanwhile, from the radically different Australian context, in which a background in the control of introduced pests probably formed a central component, Caughley (1994) and others argued for viability analysis based on large declining populations.

Importantly, Australian conservation biologists pioneered many of the techniques for conservation evaluation that have since become the staples of the discipline (Margules 1989). These include procedures for the prioritization of places for biodiversity content and the incorporation of trade-offs between biodiversity and other societal values such as economic cost. Undoubtedly, Australia and the US have probably contributed most to the development of conservation biology as a science, though important work has also been done in India and the United Kingdom, among other places. Indian conservation biologists have been instrumental in promoting the idea that much can be learnt about biodiversity conservation from traditional ecological practices (Gadgil and Berkes 1991). There is also an important difference between Australian and US conservation biologists with respect to professional backgrounds: a much higher percentage of the former have come from forestry, wildlife management, and other applied backgrounds rather than academic biology, as in the United States.

During the last five years, a synthetic consensus framework of conservation planning has emerged from these rather disparate developments (Sarkar 2002). Insights from each of the different traditions have been integrated during the formulation of this framework. Some fruitless disputes, especially about the normative foundations of the discipline (which are now discussed under the rubric of environmental ethics), have been relegated to the background because they have little relevance to the everyday practice of conservation. On some of these issues, the new framework implements insights gained from experience in the field during the last few decades. For instance, it is now uncontroversial to suggest that, no matter where one draws an ethical basis for concern for biodiversity (biocentrism, animal rights, tempered anthropomorphism, etc.), leaving human interests out of conservation planning is a mistake purely because of pragmatic reasons. It does not work in practice. Viewed practically, a conservation measure is almost never likely to succeed without local support and, preferably, enthusiasm. Perhaps even more importantly, there has been a realization that conservation policies must be tailored to local contexts, both ecological and sociopolitical. Conservation in an African park cannot be effectively planned entirely from the offices of some international conservation organization in Washington.

The new framework of conservation planning is sometimes said to embody "adaptive management", with "adaptive" signifying that the process of planning is iterative and continuous, having to be periodically repeated to take into account changing ecological and political contexts (Margules and Pressey 2000). Rational conservation planning begins with an explicit delineation of specific biodiversity conservation goals and constraints. For instance, it takes into account which species deserve attention and to what level, the area that will be put under a conservation plan, the amount of resources that may be used, and so on. Central to adaptive management is a four-stage process:

(i) Selecting "surrogates" as representatives of biodiversity. These must be features that are capable of efficient and accurate quantitative assessment in the field, and are to be used to assess the biodiversity content of a place;
(ii) Prioritizing places for conservation action on the basis of their biodiversity content. Prioritization is necessary since sociopolitical constraints preclude the conservation of all places of any biological interest;
(iii) Viability analysis, to determine the long-term prognosis for biodiversity in a given place. This determines the biodiversity value (as opposed to mere content) of a place. Ecological methods to assess viability include those based on population trends and the resources available in landscapes; "social" methods include attempts to estimate vulnerability on the basis of threat from economic and other interests;
(iv) Multiple criteria synchronization, to devise conservation plans that attempt to optimize the conservation of biodiversity and other sociopolitical goals (such as the minimization of economic and social costs) simultaneously. This is perhaps the most difficult part of conservation planning and, while it is finally beginning to receive the systematic attention that it deserves, much remains to be done.

These stages should not be thought of as independent of each other; the results of one can percolate into another. For instance, the results of attempts to synchronize a need for timber with biodiversity conservation may well affect the long-term prognosis (or viability) for a forested area. While the consensus framework, as sketched above emphasizes the management process, the biological features of places must be known for management considerations even to begin. The framework thus presupposes adequate biogeographical data, preferably collected through properly designed surveys (Haila and Margules 1996), which is an integral part of conservation biology. However, in many circumstances, for rapid assessment non-biological surrogates such as climatic and soil parameters may have to be used for rapid assessment. (Finding such surrogates was the first of the four stages outlined above.)

The formulation of a consensus framework of conservation biology marks an important stage in the establishment of this branch as a discipline. The shared consensus reflects how conservation biologists view themselves and sets the framework for future research and action. In particular, the consensus framework shows the sense in which conservation biology is a hybrid discipline that cuts across the boundary of the natural and the social sciences: the multiple criteria that have to be synchronized are generically socioeconomic. (The social sciences may also enter into viability analysis if the risk to a place, because of socioeconomic factors, must be brought into the assessment of the prognosis for the persistence of biodiversity at that place.) This consideration of socioeconomic factors indicates the extent to which a quest for normative reasons for conserving biodiversity remains part of the discipline. However, theoretical debates about norms, such as the one between deep and social ecology, have largely been replaced by the pragmatic concern for accommodating as many diverse norms as are possible. Finally, the consensus framework also underscores the extent to which conservation biology deviates from traditional ecology. Only viability analysis, when performed through the analysis of population or landscape trends (rather than through external socioeconomic risk assessment), falls squarely within traditional ecology. The rather "applied" nature of the consensus framework may also partly reflect a sociological fact already noted: the Australian conservation biologists, who have contributed most to the parts of the consensus framework other than viability analysis, have tended to come from applied rather than academic backgrounds.

The papers collected in this issue reflect the new consensus framework of conservation biology and illustrate each of its aspects from different points of view. An effort has been made to include exemplars of all the major research programmes in conservation biology. In the next paper, Sarkar and Margules argue that the concept of biodiversity, which is notoriously difficult to define, should be operationalized using a place prioritization procedure: biodiversity is what such procedures maximize. Moreover, whether or not some biodiversity feature is an adequate surrogate for biodiversity is to be determined by how well it performs during the operation of such prioritization procedures. Margules, Pressey and Williams discuss the problem of measuring biodiversity using such surrogates. A critical part of some of the most efficient heuristic place prioritization procedures is the use of the principle of complementarity: roughly, a place has higher biodiversity content than another if it adds more biodiversity surrogates (which are not already adequately protected) than the other. Margules, Pressey and Williams show how complementarity can be used to put measures on biodiversity. (Margules and Sarkar also emphasize complementarity.)

Next, Williams, Margules and Hilbert discuss the desirable qualities for data sets that are used for place prioritization to have. They emphasize that the various data points and sets that are used should be of comparable quality and quantity if the place prioritization process is to be reliable. Sarkar *et al* describe an explicit place prioritization algorithm, based on rarity and complementarity, which is implemented in the ResNet software package (available freely in the public domain). They then illustrate the use of this algorithm for data sets from Namibia and the Islas Malvinas/Falkland Islands. Garson, Aggarwal and Sarkar use the same algorithm to explore whether the distribution of bird species can be a good surrogate for biodiversity using a data set from southern Québec. In what may be the first explicit spatial analysis of the surrogacy problem, they explore the influence of spatial scale on the choice of adequate surrogates.

Turning to the viability problem, Gaston, Pressey and Margules review formal and non-formal procedures for estimating the probability of persistence of biodiversity and for measuring degrees of vulnerability at different spatial and temporal scales. Boyce, Kirsch and Servheen use the principle of bet hedging to analyse and support the plausible claim that maintaining multiple populations of a species enhances the chance of its long-term survival. They suggest ways of using this tactic for the conservation of grizzly bears (*Ursula arctos horribilis*) in the northern rocky mountains in the United States and least terns (*Sterna antillarum*) in Nebraska.

Faith and Walker contribute to the difficult study of multiple constraint synchronization by exploring the role of trade-offs in biodiversity conservation planning. They use a method in which biodiversity is parameterized with a value that can be adjusted by a planner. This makes it commensurable with other values such as cost. They also explore the problem of developing links between conservation planning at local management, regional planning, and global policy levels. Callicott discusses the problem of choosing appropriate temporal and spatial scales in the context of ecological restoration. He argues for the use of entire landscapes and bioregions for spatial resolution and the period between significant ecological disturbances for temporal resolution.

Finally, Justus and Sarkar construct a preliminary history of the design of biodiversity reserve networks, focusing on the use of the principle of complementarity. They explore the history of the formulation of that principle, and discuss in detail cases in which methods based on complementarity have been used to suggest practical policy decisions (rather for only academic purposes) in Australia, Canada, Guyana, Papua New Guinea, South Africa, and the United States. This paper is intended to encourage further work by professional historians and philosophers of science on the history of conservation biology which has so far been unfortunately neglected.

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