The Cost of Postponing Conservation Planning and Implementation

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Even when social institutions agree on conservation goals, for instance, the protection of endemic, rare, or at-risk species in regional conservation area networks, there is typically a long waiting period between setting goals and the formulation of an explicit action plan to achieve those goals, and an even longer period before the plan is funded and implemented on the ground. Meanwhile habitats continue to be transformed through human habitation, resource extraction, agricultural and industrial development, etc. There is plenty of evidence showing that such habitat transformation disproportionately affects regions of high species richness and endemism, particularly in the tropics. This raises the possibility that ongoing habitat transformation also disproportionately affects areas with high "complementarity" value, that is, those areas that have unique biological features not represented in other potential conservation areas. Areas with high complementarity value have the highest priority for conservation management if the goal is to conserve biodiversity in as little total area as possible, that is, the goal is to minimize the economic and social cost of a conservation plan.

Until recently, the hypothesis that ongoing anthropogenic habitat transformation disproportionately affects high priority areas for conservation, though widely regarded as plausible, had not been seriously tested against data. However, during the last two years, methods of systematic conservation planning have been used to subject this hypothesis to a stringent test in México, a megadiverse country with severe levels of deforestation, especially of tropical humid forests. This work was a collaboration between the Laboratorio de Sistemas de Información Geográfica at the Universidad Autónoma de México and the Biodiversity and Biocultural Conservation Laboratory at the University of Texas at Austin.

Because México has an elevated degree of endemism, especially among mammals, the biodiversity surrogates that were tracked in the study were all 86 non-volant endemic mammal species of México. These must be adequately protected in any reasonable conservation plan for the country. The geographical distributions of these species were modeled using a genetic algorithm on the basis of extensive field records and the predictions were verified for a representative subset of the regions. These "niche" models produce the "fundamental niche" or hypothetical distribution of a species purely on the basis of climatic, topographic, soil, and other similar ecological factors. The predicted range or "realized niche" of the species must then be identified using other exigencies such as historically contingent patterns of presence, barriers to dispersal, etc. In this study, for each of four time slices (1970, 1976, 1993, and 2000), the predicted range of the species was restricted to regions of the potential distribution which maintained either primary or secondary vegetation cover. This choice was dictated by previous work that indicated that most species only managed to maintain self-sustaining viable population within such forests. As elsewhere in the tropics, between 1970 and 2000, large areas of México were progressively deforested, with the rate of deforestation increasing rapidly after 1980. Concomitantly, the habitat of almost all of the modeled species progressively shrank during this period.

Next, area prioritization algorithms were used to find optimal sets of nominal conservation areas which would represent all these species in as little area as possible. The particular algorithm used was an optimal branch-and-bound algorithm implemented in the CPLEX software package. Heuristic algorithms, such as the rarity-complementarity algorithm implemented in the ResNet software package, gave similar results but an optimal algorithm was preferred to ensure that no potential inaccuracy, however slight, was introduced through the use of heuristics.

For different runs of the algorithm, the targeted representation for each species was set at 10 %, 12 %, 15 % and 20 % of its original (pre-1970) habitat. In these optimal solutions it was uniformly found that, as time went on and deforestation took its toll, progressively more area was needed to protect the same fraction of the original habitat of the species (see Figure 1). In other words, assuming that the area of land that must be protected is positively correlated with the social and economic cost of a conservation plan, these results indicate that achieving the same level of conservation has progressively become significantly more expensive in México. In particular, the cost rises sharply in the 1980s and 1990s, after only rising slightly in the 1970s. Presumably, this behavior reflects the increased rate of deforestation in the later decades. Such is the cost of postponing conservation action. While these results are limited to non-volant mammals, analyzing the performance of other taxa is unlikely to change their basic import because patterns of endemism and complementarity in México are similar for the other taxa for which data can be obtained.

As yet, similar analyses have not been performed for any other region of the world. However, because México encompasses a wide diversity of habitats, especially in its tropics, these results are likely to be replicated in other tropical regions with similar deforestation pressures and other land use—land cover (LULC) change patterns. It is almost certainly generally true that optimal cost-effective conservation action requires immediate formulation of explicit plans to achieve goals, followed by timely implementation of those plans. The cost of achieving conservation goals progressively increases with the time lag between setting goals and formulating and implementing explicit plans to achieve them. The salience of this problem is underscored by the fact that all signatories of the 1992 Rio Convention on Biodiversity have in principle committed themselves to the goal of protecting representative samples of their biota in conservation area networks. Yet very few have translated those goals into explicit conservation plans during the last fifteen years and even fewer have begun implementing such plans.

These considerations strongly suggest that serious analyses of the impediments to conservation action should be part of the process of identifying conservation goals for every region right from the very beginning. Typically, these impediments arise from: (i) the various (forgone) costs associated with excluding an area from potential LULC change (through development, intrusive agriculture, resource extraction, etc.); and (ii) the traditional presence of communities within nominal conservation areas. Negotiating these impediments requires that economic and community stakeholders should be meaningfully included in the process of identifying conservation goals even before the stage at which explicit plans are formulated to achieve those goals (let alone the implementation stage of those plans). Unfortunately, this is a lesson that conservation biologists are yet to learn sufficiently well.

This article summarizes the results of:

Fuller, T., V. Sánchez-Cordero, P. Illoldi-Rangel, M. Linaje, and S. Sarkar, 2007. "The Cost of Postponing Biodiversity Conservation in Mexico." *Biological Conservation* 134: 593 - 600.

Sánchez-Cordero, V., P. Illoldi-Rangel, M. Linaje, T. Fuller, and S. Sarkar, 2008. "Por qué hay un costo en posponer la conservación de la diversidad biologica en México." *Biodiversitas* 76: 7 - 12.

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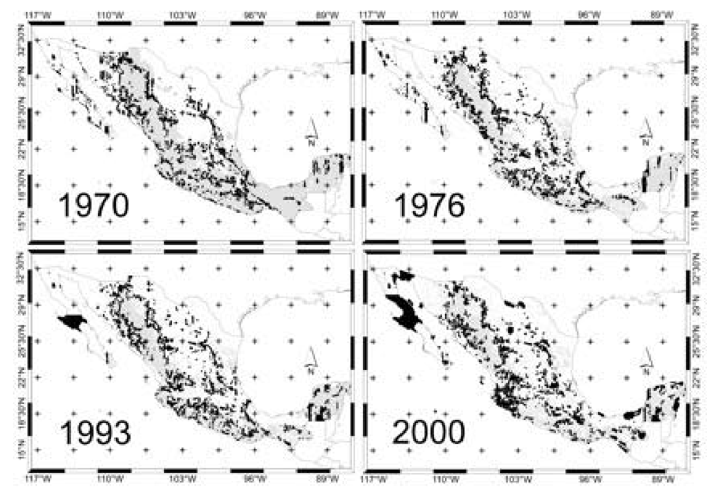

Increasing Diseconomy of Nominal Conservation Area Networks in Mexico

This figure shows the increased area needed (regions in black) to achieve the adequate representation of 86 non-volant endemic mammal species in protected areas. The target of representation for this set of maps was 10 % of the predicted original (pre-1970) habitat of each species which falls within areas that retain primary or secondary vegetation (shown in grey). The amount of land required was less than 0.45 % or the total area of Mexico in 1970, 0.6 % in 1976, but 4.69 % in 1993, and 71.25 % in 2000. That the grey region decreases over time shows the toll of continued deforestation.