POLICY FORUM: CONSERVATION

Sustaining Natural and Human Capital: Villagers and Scientists

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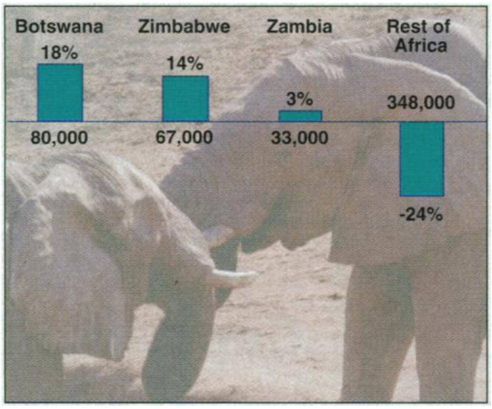
Biodiversity is being irretrievably lost around the world at an alarming rate. Attempts to identify "win-win" scenarios in which "communities are able to generate social benefit flows from wildlife" (*1*), referred to as community-based natural resource management (CBNRM), have received attention in several wildlife-rich African nations. The focus has been on the large mammals most threatened with extirpation outside protected areas (*2*).

Communities and Management

CBNRM combines conservation and rural development, meeting the needs of both wildlife populations and human communities. Use of natural resources and maintenance of biodiversity can be complementary, especially when viewed against the larger losses to biodiversity caused by transforming natural habitats into cultivated lands. But maintenance of biodiversity can have costs for human communities. Local people often view wild animals as pests who destroy crops, raid granaries, and sometimes cause loss of life. This is especially problematic in areas surrounding national parks in which wildlife populations are increasing. For example, in Zimbabwe elephant populations have increased an estimated 14% from 1989 to 1995, and in Botswana the rate of increase appears to be even higher (see the figure) (*3*). Growth of wildlife populations can either create major pest problems or provide resources for sustainable use, but the latter is hard to realize without effective CBNRM.

Central to the success of CBNRM in southern Africa are (i) the devolution of authority to local communities to manage their wildlife and (ii) the ability to realize significant value from that wildlife through consumptive or nonconsumptive use. CBNRM recognizes that villagers have sophisticated knowledge of local ecological and social conditions that can be effectively used to manage natural resources (*4*), although in some areas indigenous knowledge has been diminished through migrations caused by colonialism, land hunger, drought, and war (*5*).



More or fewer elephants. Percent change in elephant populations between 1989 and 1995 and 1995 elephant population estimates (to the nearest thousand) (*3*).

The 17-year-old Communal Area Management Programme for Indigenous Resources (CAMPFIRE) in Zimbabwe (*6*), although not without problems (*7*), provides concrete examples of CBNRM success in raising the income levels of poor rural communities and simultaneously increasing wildlife populations. Under CAMPFIRE, proprietary rights over wildlife have been devolved to communal area authorities where villagers manage local resources, including making contractual arrangements with safari operators for the lease of hunting and nonhunting tourism concessions. Key species such as elephant, buffalo, lion, and leopard provide the bulk of income from sport hunting. Because of their high value, they are tolerated and, consequently, conserved. Between 1987 and 1992, the number of problem elephants shot in CAMPFIRE areas declined from 156 to 54, and even the number of elephants killed for trophies declined slightly from 203 to 187 (*8*). As total animal deaths declined, income earned by villagers from wildlife rose from zero before 1989 to a cumulative total of $4.9 million by 1996 (*9*).

CBNRM programs currently operate in several African states (*10*). Though not all focus on generating income from controlled hunting, each makes out-of-park habitat available to wildlife, uses local knowledge, and addresses human well-being. The outcome of CBNRM varies widely and its success depends, among other things, on the value and reliability of the resources, the cultural legitimacy of management structures (*11*), possibly inverse effects of donor aid (*12*), and whether sufficient authority has been given to local communities (*13*).

Areas where CBNRM has the greatest opportunity for success are those rich in wildlife where agricultural alternatives are problematic (*14*). When considering CBNRM for a particular region, the first issue that villagers address is whether CBNRM can compete with other land uses that would convert a natural ecosystem into a cultivated one. The answer depends on many factors: the quality of soils, the extent to which communities trust government, subsidies to agriculture and cattle farming, and local culture. Finding a good answer may also depend on indigenous knowledge, with analyses being substantially enhanced by the use of scientific methods. Science can help in assessing the likely economic and ecological outcomes of different options, especially if relevant data exist on the application of these options in other areas.

Communities and Science

Computer technology and quantitative modeling help provide solutions to natural resource and ecosystem management problems. However, Western-trained scientists often do not appreciate the extent to which solutions depend on the expertise and power of local people (*15*). Indigenous knowledge provides direction for data collection, villagers' priorities guide the formulation of management questions, and village institutions implement policies. Science provides tools for storing, visualizing, and analyzing information, as well as projecting long-term trends so that nonmyopic efficient solutions to complex problems can be obtained. In Zambia, geographic informa-

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tion systems (GIS) are used by local people to consolidate, store, and analyze their data to make resource management decisions. In the Sandwe area, for example, after extensive discussion of GIS analyses, the community decided to relocate 58 families that had recently settled in the richest wildlife areas of their community land (*16*). Equally important to CBNRM is the fact that science can help integrate analyses and policy formulation across ecological and sociopolitical scales. In Madagascar, for example, scientists and villagers developed social and biological monitoring programs for an area that had complex overlapping ecological and social units (*17*).

Partnerships between academic scientists and villagers require that scientists solicit and heed the knowledge and opinions of local women and men. The role of the scientist is to provide knowledge and political leverage to enable communities to implement their own decisions and affect decision-making at higher levels (*18*). The goal is policies and institutions that enable local people to have sustainable livelihoods where they live and an effective voice at higher sociopolitical levels.

Scientific methods can also evaluate the potential for reestablishing native species that have disappeared and maximizing long-term sustainable use rates for existing species (*19*). Such evaluations involve estimates of carrying capacities under different environmental conditions (wet years versus drought years, for example) and projected average long-term offtake rates and income flows. Such estimates are important in providing benchmarks for community leaders to judge the benefits of sustainable wildlife utilization against alternative competing land use options, typically dryland cropping.

Wherever villagers are willing participants, collaboration should result in a bridge across the technology gap that presently inhibits local communities from using low-end technologies. This bridge could be provided by local individuals with the skills and training to maintain equipment for monitoring environmental and biological population variables, use hardware and software for data management, and use and interpret output from decision analysis algorithms for assessing the effects of different policies on animal populations and the ecosystem. To be effective, collaboration between villagers and scientists must involve locally controlled experimentation and adaptation, rather than be a blueprint for the transfer of technology (*20*).

Conservation and the sustainable use of natural resources are two sides of the same coin. CBNRM accepts that much of the state of ecosystems rests with local people and, therefore, the technology that can contribute to the sustainable use of natural resources is best used by local people. This will require partnerships between professional scientists and their "civil scientist" counterparts at the village level (*21*). Scientists who wish to be effective in conserving biodiversity for further generations will have to learn how to operate in this new arena.

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POLICY FORUM: CONSERVATION

Capitalizing on Nature: Protected Area Management

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Recent debate in *Science* (*1*) and elsewhere reveals the financial difficulties of government agencies responsible for biodiversity conservation in the developing world. It reflects a growing paradox. On the one hand, such agencies hold embarrassingly large land assets (often in excess of 5% of the total area of a country), which are expensive to maintain but can in some cases create the majority of their earned revenues through tourism. On the other hand, many protected areas (PAs) are by definition socially exclusive, a point receiving growing criticism from an increasingly democratized populace at home and from the international community. Many agencies have responded through new initiatives, such as outreach, rural development, and Community-Based Conservation (CBC). But these activities are expensive, their conservation benefits are ambiguous, and they have little prospect of generating income to cover their costs. The result has been more or less uniform: Biodiversity agencies throughout the developing world remain financially strained.

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Costs of the PA Estate

International conservation organizations such as the World Conservation Union (IUCN) propose that 10 to 12% of the total land area of each nation or each ecosystem should be set aside for conservation (*2*). With apparent sincerity, Soule and Sanjayan (*3*) suggest that closer to 50% of the total land area is necessary "to represent and protect most elements of biodiversity." Neither of these estimates enlightens us about the cost implications of PAs to people in the developing world.

One country that has achieved the IUCN target is Kenya, where 10% of the land area, about 60,000 km^2, is under PA status. To illustrate the costs of putting the land under protection, a recent study calculated that this estate could support 4.2 million people and agricultural and livestock production with a net return of \$203 million, or 2.8% of gross domestic product (*4*). In contrast, the net revenues from