Ecological Limits and Opportunities for Community Based Conservation

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Introduction

A Lack of Ecology in Integrated Conservation and Development Projects

There is a fundamental tension between biodiversity conservation and human development (Robinson 1993). The strict preservation of natural ecosystems, as traditionally practiced, essentially requires that humans be excluded from the system. In contrast, the process of development basically demands that natural resources be used to improve human welfare.

Despite the inherent contradictions, the spatial, ethical, and organizational overlap of conservation and development concerns inevitably meant that these two fields would be linked together. Unfortunately, the missionary zeal with which this linkage was promoted often did not have grounding in proven results. As David Western states, the intellectual appeal of the Integrated Conservation and Development (ICDP) paradigm "ran far ahead of its realization, as if the inherent rightness of the principle was synonymous with efficacy" (Case Study (CS) 1, p. 35).

Perhaps the greatest casualties of this new paradigm were the ecological concepts that were trampled on or co-opted in the stampede to produce rhetorically correct project proposals. One example is the term "biodiversity," which had long been used by ecologists to refer strictly to "the variety and variability among living organisms and the ecological complexes in which they occur" (Office of Technology Assessment 1987). This term has expanded into a buzzword used to describe biological resources in general (van Schaik et al. 1992). As a result, any type of "green" development effort, such as planting monocultures of fast-growing, exotic, tree species for fuelwood, was billed as a biodiversity conserving project. Not to be outdone, however, conservationists began applying the phrase "sustainable development," which had been used primarily to describe the maintenance of ecological processes and life-support systems (IUCN/UNEP/WWF 1980), to describe their preservation efforts (Robinson 1993). Thus, even strict conservation projects, such as the gazetting of a remote nature reserve, was promoted as having sustainable development benefits, like watershed protection. Meanwhile, both sides seemed to ignore the underlying threat of ecological collapse latent in human population growth and expanding consumerism (Meffe et al. 1993).

Despite these contradictions, the concept of Community-Based Conservation (CBC) is the only possible means of finding common ground between humans and the natural world but ICDPs can only be successfully developed with knowledge of ecological limits and opportunities.

The case studies written for this Workshop present an opportunity to consider the CBC concept within the context of ecological theory and practice. In this theme paper, I would thus like to use these case studies to examine three critical questions: Can CBC projects stop our slide towards ecological collapse? Can CBC projects accomplish meaningful biodiversity conservation? And can CBC projects develop ecologically sustainable land-use systems? In the process of examining potential answers to these questions, I also hope to demonstrate the relevance of ecology to community-based conservation.

A Graphical Model for Addressing these Questions

As a device for discussing the role of CBC in addressing these questions, I would like to propose a simple graphical model. Like any model, it is an abstraction of complex problems and is not intended to be a perfect analogue of the real world, but rather a framework for discussion and debate. The model begins by plotting the welfare of the natural world as a function of human induced ecosystem alteration (Fig. 1). The X-axis is scaled so that movement to the right indicates increasing human impact on the environment, be it at a local, regional, or global level. The Y-axis, by contrast, is a unitless measurement of welfare that, like the analogous concept of utility in microeconomics, is ordinal rather than cardinal. In other words, we cannot measure how much welfare is represented by any single point along the Y-axis, but only state that a point higher up on the axis represents relatively greater welfare than one lower down.

In general, I think almost all ecologists would agree that the welfare curve for the natural world would look something like the solid line in Figure 1. Depending on the scale being considered, at the left hand side of the curve there might be an initial dip (dotted line A) as a result of extirpation of species that are extremely sensitive to disturbance and a subsequent rise (dotted line B) as a result of increased diversity of habitats and ecotones (habitat borders that in general seem to be preferred by many species). In addition, at the right hand side of the curve there might be an extended tail (dotted line C) resulting from the survival of human-adapted species such as cockroaches, rats, and kudzu. Nonetheless, particularly at a global scale, the solid line is probably a reasonable approximation of the welfare of the natural world.

As shown in Figure 2, the human welfare curve starts at the origin by definition of the X-axis. After that, however, there is a great deal of debate as to the shape of this curve. On one side of the spectrum is the "Simons Curve" (named after the economist Julian Simon) in which human welfare increases without limit owing to the use of ever improving technology to shift from one natural resource to another. On the other side of the spectrum is the "Club of Rome Curve" (after the authors of the Limits to Growth study) in which human welfare gradually increases and then dramatically crashes as non-renewable resources are ultimately used up. A middle ground position between these two extremes is the "General Human Curve" in which there is an initial increase in welfare, a steady-state period, and then a subsequent decline as habitat conversion and resultant pollution

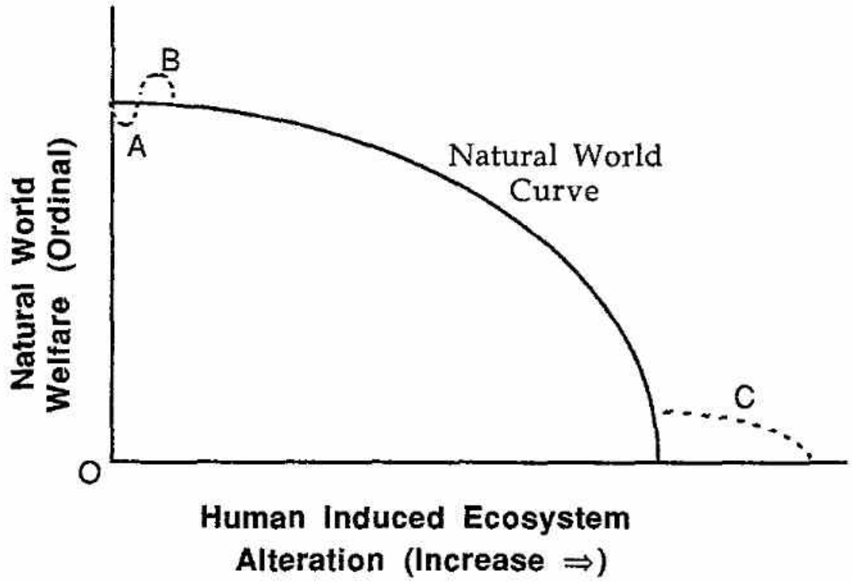

Figure 1. The Welfare Curve for the Natural World

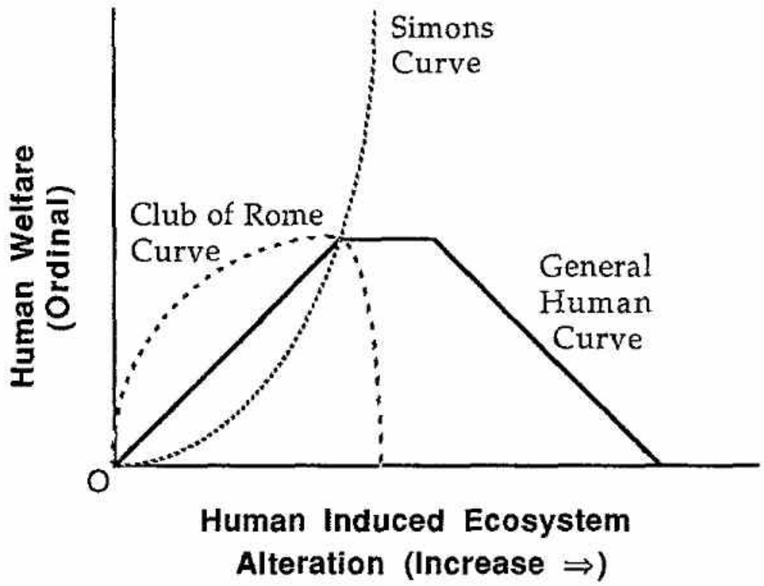

Figure 2. Potential Welfare Curves for Humans

accumulation erode the quality of life. Although in reality this curve is probably non-linear, and may have several local maxima. Furthermore, the question of whether a society can organize itself to avoid the inevitable decline brought on by deterioration of the natural world is subject to considerable debate especially between ecologists and economists. Nonetheless, for the purposes of my argument the simple linear function shown in the figure is a sufficient representation.

In Figure 3, the generalized human welfare curve is superimposed on the natural world's welfare curve. Although in the figure the natural world curve is drawn to be "greater" than that of the human curve, the fact that two ordinal Y-axes are being used means that differences in vertical position between the two curves are meaningless. What is important, however, is the relative shape of the two curves at different points along the common X-axis and the fact that there is a relationship between the curves themselves, particularly as society is dependent upon the natural world for production of goods and services and absorption of its wastes. In particular, there are three regions that need to be considered: Region I in which the human welfare curve is ascending, Region II which the human welfare curve is relatively flat, and Region III in which the human welfare curve is descending.

In the next three sections of this paper, I explore the ecological implications of this model, focusing in particular on the role that CBC projects can play in finding solutions to the three questions posed earlier. For each question, I provide a brief theoretical background to the ecological concepts involved in relation to the model presented in Figure 3, examine how these concepts are treated in the case studies, and then summarize the major issues that need to be considered by the participants in the CBC workshop.

Can We Avoid
Ecological Collapse?

In looking at the model presented in Figure 3, one of the first questions that comes to mind is where along the X-axis are we located today? Many, if not most ecologists would argue that the world as a whole is at least in Region II, and more likely in the initial stages of Region III, on the precipice of the drop towards the depths of ecological collapse (Meffe et al. 1993). Although living standards have dramatically improved for much of the world over the past few centuries, this economic expansion has only been possible through the unsustainable exploitation of rapidly diminishing stocks of fossil fuels, forests, fish, and farmland. The harbinger of the future seems all too apparent in the poorest parts of the world such as Haiti, Bangladesh, the Sahel, and even rural Mississippi where natural ecosystems are being completely expended in the desperate quest for survival.

The Open Access Resources Problem
If we are indeed in Region III, the next question is why are we here when it is clearly a non-optimal position for society as a whole? The answer to this question seems to be rooted in the different incentives for individuals as opposed to society, or as an economist would put it, an externality problem owing to an incomplete allocation of the costs and benefits of resource extraction. In other words, there is what is referred to as a "tragedy of the commons"[1] effect in which individuals and nations face perverse incentives to convert habitat and exploit natural resources at a faster than optimal rate since they receive all the benefits, while the costs are spread over society as a whole.

The fifteen CBC case studies present a number of potential solutions to this open access resource problem, such as the Community Forest Management system in India (CS 5) or the Sasi system in the Maluku Islands (CS 6). These solutions generally seem, however, to be more socioeconomic than ecological, and hence beyond the scope of this paper.

<u>Summary of Issues that Need to be Addressed in the Workshop</u>

Perverse incentives for individuals mean that habitat is being converted at a greater rate than is socially desirable. Specific questions that need to be addressed include:

* How can CBC projects help society to overcome individual incentives to convert natural habitat at faster than optimal rates?

1. Although often misunderstood as a "common property" problem, this issue is rather one of "open access" where there are no property rights or rules limiting access.

The Population Problem

I would be remiss in my role as an ecologist, however, if I did not emphasize the ultimate open access resource problem, explosive growth in human populations (Meffe et al. 1993). The idea that population growth is an open access resource problem is not new. Indeed, Garrett Hardin (1968) developed his famous model of common pasture land as a means of illustrating the overpopulation that might be expected if society subsidizes the education and upbringing of children so that there is an incentive for each family to have more kids than it can afford.

Exponential growth in human population is hardly surprising to ecologists. A fundamental tenant of ecology is the concept of carrying capacity, which is defined as the maximum population that a given environment can sustain (Daily & Ehrlich 1992). As countless experiments with paramecia in jars, rats in boxes, and deer on islands have shown, a population in a closed system with no predators will expand exponentially until the carrying capacity is reached and then crash. Humans are different from other species in that continual advances in technology have enabled us to keep the system open and thus maintain higher and higher populations. But as Hardin (1968) pointed out, these technological "fixes" merely ratchet the population one notch higher without addressing the underlying social problem. Ultimately, although believers in the "Simons Curve" to the contrary, simple mathematics appears to dictate that true sustainability will not be achieved unless society actively provides a system of incentives and constraints to ensure that the average number of children per woman is two or less.

Most of the fifteen case studies explicitly mention human population pressure as one of the critical factors motivating and affecting their CBC program. Several of the case studies also report specific population growth rates, including 3.1% per year in Madagascar as a whole (CS 4, p. 3), 4% per year at Amboseli, Kenya (CS 1, p. 4), 4.7% at the Crater Mountain site in Papua New Guinea (calculated from population figures in CS 8, p. 20) and an astounding 10% per year in the Greater Yellowstone Region in the United States (CS 15, p. 6). A few of the case studies also address human carrying capacity issues, for example, the CAMPFIRE study in Zimbabwe states that the country's "population will exceed its total production capacity by the year 2030" and tries to differentiate between ecological and economic carrying capacity (CS 3, p. 22). The Extractive Reserve case study examines human population density in the various reserves and suggests that high densities mean that subsistence hunting may not be sustainable (CS 9, p. 12 & Table 4). Finally, the Wildlife Resources in Latin America study discusses the carrying capacity of the local environment in the context of both animal and human populations. The authors conclude that based on their findings, "catchment areas of about 2,500 sq km seem to be necessary to provide the subsistence needs for human communities of a few hundred people in neotropical forests" (CS 12a, p. 19).

Unfortunately, however, none of the other case studies even mention the concept of carrying capacity, let alone attempt to estimate what the capacity of the local environment might be. Furthermore, none of the CBC studies discusses including family planning efforts in their project, save the Ranomafana, Madagascar report in which it is stated that although "most people surrounding the park have more children than they actually want...we have not been able to address family planning issues because there is no birth control available" (CS 4, p. 20) and the Crater Mountain project in New Guinea in which it is stated that "local people have, up until recently, rejected any notion of population control, citing the need for sons as warriors, as protection against sorcerers, or as gardeners" (CS 8, p. 20).

Finally, none of the case studies mention developing strategies to deal with the influx of poor migrants that might be expected if the project does indeed succeed in raising the standard of living relative to surrounding areas. These situations have already occurred at the Ranomafana site where the population has swelled by 2,000 people in the past two years (CS 4, p. 20), in the village of Chandana in India whose forests are under constant attack from neighboring villages (CS 5, p. 6), and (with an ironic twist) in the Greater Yellowstone Region in the US where the problem is an influx of wealthy migrant yuppies (CS 15, p. 7).

<u>Summary of Issues That Need to be Addressed in the Workshop</u>
The bottom line is that ultimately no project will succeed if human population numbers perpetually increase. Specific questions that need to be considered include:

* How can CBC projects assess the carrying capacity of the local environment?

* How can family planning be incorporated into CBC projects?

* How will locally successful CBC projects deal with influxes of migrants from surrounding lands?

Can We Enhance Biodiversity Conservation In Modified Landscapes?

For a society in Region III of the model in Figure 3 where the natural and human welfare are both in decline, the optimal actions would be those that reduce habitat alteration so as to move the society back to point N on the graph. From a self-centered and anthropocentric perspective, a society in Region II should be largely indifferent to being anywhere between Point N and Point M, where human welfare is stable. If, however, even the smallest amount of biocentric perspective, concern for nature, enters into the equation, then the optimal amount of habitat conversion maximizes the welfare of the natural world without cost to humans (Point M). The question becomes how can society preserve natural habitat in the face of incentives for individuals to overexploit resources? In the following sections I discuss two approaches to solving this problem.

Biodiversity Conservation in Buffer Zones around Parks and Reserves
The traditional answer to this question has been to set aside land in parks and reserves dedicated to conservation. Without a doubt, parks and reserves are important—I think almost all ecologists would agree that from a conservation perspective, the more parks and reserves there are, the better. Nonetheless, parks and reserves have a number of limitations.

Foremost among these limitations is the size of parks. Conservation biology theory holds that small isolated parks will generally not provide sufficient habitat to maintain viable populations (a minimum number of individuals) of species necessary to avoid deleterious inbreeding effects and allow for random fluctuations in population size (Shaffer 1981; Thomas 1990). This need for extensive areas is particularly true in the case of large predators at the top of the food chain that need hundreds and even thousands of square kilometers of habitat to survive (Noss 1993). Large parks are also less susceptible to edge effects (Lovejoy et al. 1986) and to invasions of exotic and parasitic species (Wilcove 1985). Finally, and perhaps most importantly, very large parks are needed to allow for the maintenance of ecological and evolutionary processes and the movement of ecosystems in response to normal long-term and/or human-induced climatic change (Noss 1993).

Few, if any, existing parks and reserves are sufficiently large given the above criteria. Accordingly in the mid-1970s, the biosphere reserve concept was developed in which the core conservation area of a park was to be surrounded by a ring of buffer zones (UNESCO 1974). These buffer zones were seen as fulfilling two basic functions: extension buffering which extends the core habitat of plants and especially animals, and socio-buffering which provides goods and services for people (MacKinnon et al. 1986). Over time, the biosphere concept was expanded from the initial simple ring design to encompass complex mosaics of multiple use areas connected to one another via corridors or linkages along rivers and uplands (Harris 1984; Schelhas In press). At its extreme, proponents have developed maps in which entire continental regions would be placed into interlinked networks of core preserves and buffer zones (Noss 1993).

A number of the fifteen case studies have as elements the augmentation of conservation in traditional parks and reserves through the development of buffer zones and multiple use areas. For example, the Baban Rafi case study from Niger describes efforts to develop a 40,000 ha zone of intervention and an additional extensive buffer zone of peripheral villages and farmlands around the 70,000 ha core protected forest (CS 2, pp. 17-18). The Ranomafana project in Madagascar involves establishing a buffer zone of secondary forest or agricultural land around a national park established to protect lemurs and other endemic, endangered species (CS 4, p. 13). Likewise, the BOSCOSA Project in Costa Rica has centered its efforts on communities located on the fringe or buffer area of an existing national park or reserve (CS 10, p. 12). Finally, at the heart of the Greater Yellowstone project is a vision of "whole ecosystem management that minimizes habitat fragmentation, maintains or restores habitat corridors and linkages, reintroduces extirpated species, protects those that exist and allows for natural disturbances" (CS 15, p. 5).

A number of other projects, although not linked to explicit "hard–edged" conservation areas, also promote the development of a holistic mosaic or spectrum of land-uses. For example, the CAMPFIRE Project in Zimbabwe describes zonation of land into "a regional landscape plan which integrates the primary conservation ethic of protected areas with the ascendent development ethos of the communal lands" (CS 3, p. 21 and Map 1). The Annapurna Conservation Area in Nepal is divided into a series of regions that include fully protected wilderness zones as well as protected forest, intensive use, and special management zones (CS 7, p. 10). And finally, the North York Moors National Park in the UK is described as containing a mosaic of habitats including heather moorland, farmland valleys, and broadleaved woodlands (CS 14, pp. 4 & 6).

Although a number of the CBC case studies have as their goal the creation of buffer zones, only a few explicitly describe efforts to determine what types of land-use patterns would be suitable in these areas. For example, the report from the Ranomafana National Park Project in Madagascar discusses how project members tested different tree species for inclusion in plantations and aquatic species for use in ponds (CS 4, p. 9). Likewise, the BOSCOSA project in Costa Rica discusses testing tree species for inclusion in buffer zone agroforestry systems that could potentially provide products for both household consumption and market sale (CS 10, p. 18).

Furthermore, these few studies that report testing potential land-use systems have done so exclusively from the standpoint of socio-buffering functions. None of the studies report efforts to examine the suitability of these buffer zone land-use systems for extending animal habitat. The need for this type of study is of greatest importance in the humid tropics where only a few studies have been made of animal use of agroforestry systems, plantations, and other typical buffer zone habitats (e.g., Terborgh & Weske 1969; Duff et al. 1984; Steubing & Gasis 1989; Salafsky, In press).

Overall, I think that community-based conservation projects have an important role to play in developing buffer zone land-use systems that can both provide goods and services to people and habitat for wildlife. I would argue that the best conservation strategy for developing such buffer zones is not to try to import or invent completely new land-use systems. Instead, wherever possible, the range of existing local land-use systems should be evaluated in terms of their economic return and suitability to provide key resources to animals and plants. The most promising should then be tested and evaluated in trial plots in conjunction with local residents to learn how to improve them still further. Finally, the system needs to implemented. Since it is unlikely that it will be completely in local peoples' interest to plant systems in an optimal conservation pattern (see below), it may also be necessary to develop an incentive system to induce residents to adopt the system.

<u>Summary of Issues That Need to be Addressed in the Workshop</u>
The augmentation of biodiversity conservation in parks and reserves through the creation of buffer zones and multiple use areas is an important role for CBC projects. Specific questions that need to be addressed include:

* How can CBC projects work with local peoples to evaluate existing land-use systems, select those that are most promising at providing extension and socio-buffering functions, and then improve them?

* How can CBC projects create an incentive system to induce local peoples to establish these land-use systems in a pattern that enhances their conservation value?

Biodiversity Conservation in Managed Habitats

In addition to size, the other major limitation of parks and reserves is that historically they tend to be established where there is little or no opportunity cost to humans (Fig. 3). The low opportunity cost criterion means that most parks are located in marginal lands that have little or no alternative value. One only needs to look at an ecological map of the United States to see that while there are numerous parks in deserts and mountain ranges, there are none on fertile prairie lands. Similarly, in Zimbabwe "the communal areas and protected lands occur predominantly in the [marginal lands of] Natural Region Areas IV and V" (CS 3, p. 18 and Maps 4 & 5). In the Annapurna Conservation Area in Nepal, the wilderness zones are located "above the upper elevation limits for season grazing (about 15,000 feet)" (CS 7, p. 10). And in Australia, the entire Kakadu National Park is located on soils that are described as being "acidic, shallow, and infertile" (CS 13, p. 9). Furthermore, the low opportunity cost criterion means that if parks do include valuable lands, they are subject to intense conversion pressure from both local peoples (gold miners and farmers in the Osa Peninsula in Costa Rica in CS 10) and established interests (loggers and ranchers in National Forests in Greater Yellowstone in the United States in CS 15).

Given these limitations of parks and reserves, it is clear that they are not the sole answer for biodiversity conservation. At the core of the CBC concept is the idea of promoting conservation in lands beyond parks and beyond buffer zones that make up the vast majority of the world's land surface. The downward slope of the natural world's welfare curve in Figure 3 means that it will never be possible to conserve a complete natural ecosystem in a modified landscape. Instead, CBC projects need to focus explicitly on certain achievable goals which explicitly address the trade offs between improvements in human welfare and the depletion of the natural world. The challenge for CBC project members is thus to determine

1) How to define these conservation goals,

2) How to design and implement conservation practices necessary to reach these goals, and

3) How to monitor progress and measure success toward achieving these goals.

1. Definition of Conservation Goals.

The first step in establishing a biodiversity conservation program in modified lands is to define the goals of the program. As discussed above, the term 'biodiversity' refers to the "variety and variability among living organisms and the ecological complexes in which they occur" (Office of Technology Assessment 1987). With regards to conservation, this definition has traditionally focused on preserving individual species (groups of interbreeding individuals). The definition can be extended, however, both downwards to cover genetic variability within a population (differences between individual organisms) and upwards to include habitat and ecosystem diversity (different types of communities).

One potential goal for a CBC project would be to preserve viable populations of all native species found in the area of the project. If this goal were to be adopted, it would not be necessary to work with every last species. Instead, conservation efforts should focus on those species that are rare and/or adversely impacted by human activities. A good model for the process of selecting critical species can be found in the ranking system developed by The Nature Conservancy in conjunction with State Heritage Programs in which all species are assigned to a five-point scale based on their relative global and statewide rarity (Noss 1993).

Although desirable in principle, the goal of preserving all species may be extremely difficult or impossible to attain in a modified landscape. A more pragmatic goal would thus be to select certain target species for conservation efforts. Criteria for this selection process might include degree of endemism (is the species found elsewhere in world or only in this one site?), function as a keystone resource (how many other species depend on this species for food or other resources?), role in the ecosystem (is the species an important and/or unique pollinator?), cost of protection (would conservation require extensive modification of existing land-use practices or only minimal changes; is the species a local pest?), and probability of success (will the species respond to conservation efforts, or is it likely to go extinct anyway?). One can factor in community issues where value to humans may make protection a high local priority but also increase pressure for utilization. There are a number of moral and ethical criticisms that can be applied to this process of targeting only certain species for conservation actions. Nonetheless, if a project's conservation resources are limited, it seems sensible to make decisions based on rational and informed deliberation rather than by default.

Finally, an alternative (but not necessarily exclusive) goal for CBC projects would be to focus less on individual species, and more on ecosystems and ecosystem functioning. Under this goal, a project would try to preserve ecosystem functioning such as hydrological and nutrient cycles, topsoil accumulation, and food chains or webs, by using a combination of native species and management efforts.

A few of the case studies do explicitly define how they might measure success from a species perspective or list a species-based indicator in their list of successes. For instance, the Amboseli case study in Kenya concludes that "ecologically, the overall success of the project can be judged by the data...that show that the ecosystem has remained open, migrations viable, and populations healthy" (CS 1, p. 29 and Figs. 2, 5, 6). Similarly, the Crater Mountain case study in New Guinea lists as one success "the restoration of populations of rare birds whose number had declined in the previous decade" (CS 8, p. 22). Other case studies implicitly set goals that are oriented towards maintaining viable species populations. For example, the Wildlife Resources project in Latin America has the goal of obtaining an ecologically sustainable resource harvest (CS 12, p.27). Finally, several of the projects set an ecosystem-based conservation goal. For example, in the Greater Yellowstone case study, The Nature Conservancy states that its "central goal in the Yellowstone area is to preserve both ecosystem integrity, as expressed in the maintenance of viable populations of native species and communities, and the natural processes to which they are adapted and under which they evolved" (CS 15, p. 24).

Most of the case studies do not define what they are trying to attain with regard to biodiversity conservation. In other case studies, however, an implicit or explicit decision was made not to focus directly on biodiversity. For instance, the report from the Annapurna Conservation Area Project in Nepal states that "biodiversity conservation efforts were not among ACAP's original objectives" because at the time the project began, the term biodiversity was poorly understood (CS 7, p. 23). Likewise, the report from the Extractive Reserve case study in Brazil states that while some reserves do seem to cover areas of significant biodiversity, others do not and it is "left to chance to explain the favorable situations regarding biodiversity that can be found" (CS 9, p. 11 and Table 1). Finally, and perhaps most tellingly, the report from the BOSCOSA project in Costa Rica explicitly states that "BOSCOSA was not designed or envisioned as a biological conservation project." Instead, it was "to complement the protection program by fomenting grassroots level sustainable economic alternatives for people in Corcovado's buffer zone" (CS 10, pp. 9-10). The case study goes on to conclude, however, that this approach did not work and that "unless a program explicitly incorporates biological conservation (i.e. forest or species conservation) as a criteria for evaluating project activities, it is likely that the rate of deforestation will continue" (CS 10, p. 41).

In addition to the question of <u>what</u> is the conservation goal, a major issue in any CBC project will be <u>who</u> sets that goal, particularly when both communities and external institutions are involved.

2. *Implementation of Conservation Practices.*
   The second step in establishing a biodiversity conservation program in modified lands involves determining which conservation practices will be tested and implemented. The actions that any CBC project can take are, of course, completely dependent on the site-specific ecological, socioeconomic, and cultural environments and on the goals and resources of the project. Thus, steps that would be required to promote conservation of marine animals in the Maluku Islands are very different from those that would be required to promote conservation of rare plants in the North York Moors. Nonetheless, a few general principles can be elucidated from the case studies.

   The first and perhaps most important of these principles is to *focus primary attention on conservation actions that minimize the trade-off between human and natural world welfare.* Although from the global perspective of Figure 3 these welfare curves have a smooth appearance, at a local level it is much more likely that these curves have all sorts of vertical variations as shown in Figure 4. Local variability may offer effective but relatively costless opportunities for biodiversity conservation. The most desirable conservation practices to implement are those that improve the welfare of the natural world while simultaneously either benefiting (Step A) or, at least, coming at little or no cost (Step B) to humans. Conversely, from the conservation perspective, the practices that should be avoided are those that neutrally (Step D) or negatively (Step E) impact the natural world, while benefiting humans. In between are those steps that benefit the natural world, but come at a cost to humans and thus set up a trade off situation (Step C). In theory then an efficient conservation plan would call for first taking all Type A and Type B steps and then ranking the Type C steps on the basis of anticipated effectiveness and cost and choosing those that are feasible within existing project constraints.

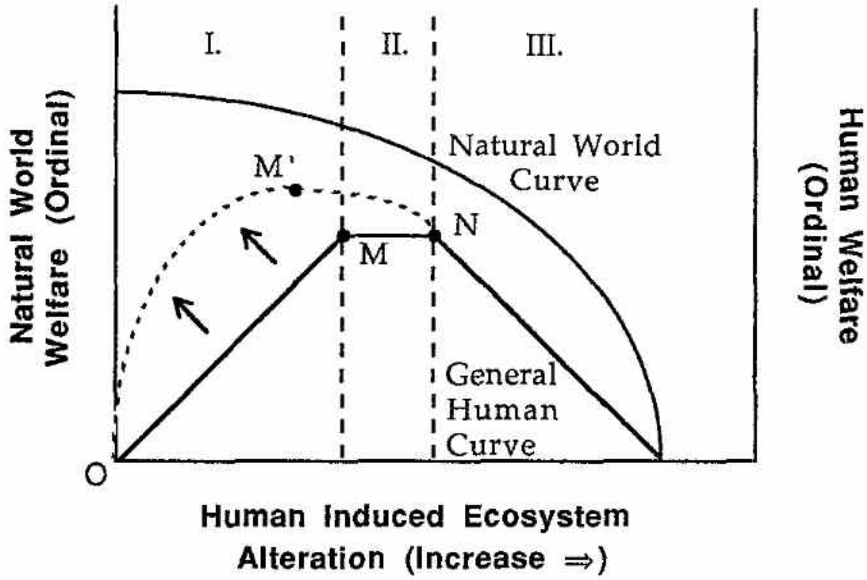

Figure 3. Important Regions of the Model
Region II in which the human welfare curve is relatively flat
Region III in which the human welfare curve is descendin.

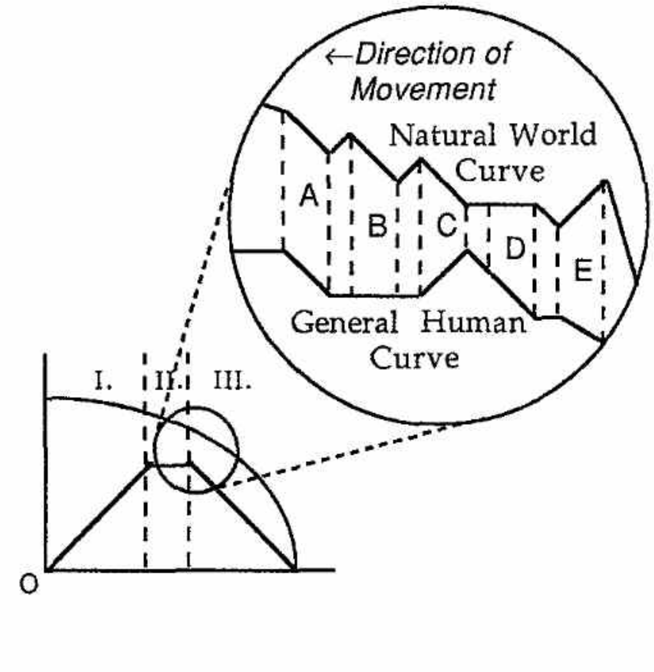

Figure 4. Different Types of Relationships Between Welfare Curves at the Local Level

The real world decisions that CBC projects make will, of course, not be as simple as the theoretical steps discussed above, especially given that costs and benefits can be difficult to quantify and community perception of benefits may differ in ranking benefits. Nonetheless, as the following examples illustrate, most project actions can be so categorized. Modifying traditional Sasi techniques to allow populations of marine organisms to remain unmolested during critical breeding times is an example of a Type A "win-win" situation (over the long term) since it both allows for growth in the population levels and enhances future harvests (CS 6) although there remains an immediate "lose" from deferred harvest. Implementing a control program for tse-tse flies, on the other hand, is an example of a Type E "lose-win" situation because it is beneficial to livestock and their human owners, but reduces the habitat available for wildlife (CS 3). Finally, while instituting a marginal fee increase on tourists to fund the installation of fuelwood-saving kerosene stoves in lodges in the Annapurna Region of Nepal (CS 7, p. 13) is an example of a Type C "trade off" situation in which the benefits are great in relation to the costs, spending vast sums of money on ex-situ efforts to conserve highly endangered species (like the California Condor) is a trade off in which (from a global perspective) the cost is high in proportion to the benefit. Of course, one must also consider that there can be winners and losers within or between communities a result of particular conservation actions.

The second principle is, wherever possible, to promote land-use practices that maintain the structure and function of the natural ecosystem(s) in the region and employ native species. Use of ecologically appropriate land-use systems and native species has a number of potential benefits for humans (see the discussion of ecosystem agriculture in the next section). As a rule, one would also expect that these systems would be better suited to provide habitat requirements for indigenous wildlife.

For example, in the humid tropical regions, multi-species agroforestry systems or the circular garden techniques employed by the HIFCO project in Peru (CS 11, p. 25) are more likely to provide habitat for forest wildlife than monocrops of exotic grains. In arid savannah regions such as in Kenya or Zimbabwe, by contrast, open range cattle herding is more compatible with the conservation of migrant ungulate herds than the division of the range into small agricultural plots. And a still better system would be the direct use of these wild herds as "second cattle" (CS 1, p. 8 and CS 3, p. 13), or even "primary cattle" assuming that controlled harvests could prove to be economically and culturally feasible.

The third principle is to pay attention to the biological needs of target species and to conservation biology theory discussed above in the context of buffer zones. Adherence to this principle means asking, for each proposed action, questions such as: Does the action provide foraging or breeding habitat or other critical resources for target species? Does it take into account time periods when populations are more sensitive, such as breeding seasons? Does it minimize the impact on a population's reproductive capability? Does it protect key migration routes or provide corridors linking natural areas? Does it allow for the movement of populations over time? Does it promote the formation of large holistic land-use complexes?

Examples of conservation actions that provide key resources include the efforts to protect dry-season water sources in Amboseli in Kenya (CS 1, p. 7) and the establishment of hedges in the North York Moors in the UK that "are excellent nesting habitat for small birds," "provide an abundance of winter food for birds and mammals," and "are regarded as valuable wildlife 'corridors' " (p. 6). An example of an action that makes use of biological knowledge about population dynamics is the institution of regulations that promote male-directed hunting of deer, peccaries, and large rodents in the Tamshiyacu-Tahuayo Communal Reserve in Peru (CS 12b, pp. 12-13). Finally, examples of holistic landscape design can be found in North York Moors in which park policy promotes the maintenance of "native broadleaved woodlands in deeply incised water courses running up the valley sides....[that] form a link between the moorland and the river in the valley bottom" (CS 14, p. 6).

The fourth principle involves the need to anticipate and minimize conflicts between humans and the natural world. These conflicts can include competition for scarce resources such as grass or water, dispersal of weed plants from non-agricultural areas, crop or livestock damage by marauding animals from nearby wild lands, and even (in very rare instances) attacks on human populations by large predators, such as tigers in India. CBC projects thus need to anticipate what types of conflicts will occur and how they can be minimized at least cost to both sides.

One example of the complexities inherent in trying to resolve this type of conflict can be seen in Amboseli in Kenya where crops planted by local agriculturalists suffer from wildlife depredations. The Kenya Wildlife Service proposed as a solution fencing off all park lands to protect people from animals and vice versa. This fencing, while perhaps solving the immediate problem, would have stopped animal migrations and led to "gradual biological impoverishment of the national parks due to insularization effects" (CS 1, p. 27). Another approach to the crop raiding problem was tried in the CAMPFIRE program in Zimbabwe in which a compensation program was established to repay farmers for damage caused by wildlife. Problems with this system developed, however, in that "the compensation claims against the Trust lacked any built-in mechanism for balancing individual costs against group benefits" (CS 3, p. 11).

The fifth and final principle is to understand that there are limitations to what Community-Based Conservation can achieve. It is inevitable that some species will not survive in a modified landscape. For instance, populations of disturbance-sensitive animal species will be difficult to maintain in any system regularly frequented by humans. Furthermore, most wild tree species and other large plants are likely to be excluded from agriculturally based land-use systems. And finally, there are entire ecosystems that generally do not seem to be compatible with human activities and the human psyche.

An example of a disturbance-sensitive animal species is the black and white ruffed lemur in Ranomafana National Park in Madagascar that cannot live in even selectively logged forest (CS 4, p. 8). An example of the problem faced by plants is that even ecologically sensitive agroforestry projects, such as those being implemented in the Osa Peninsula of Costa Rica, involve replacing native forest with domesticated species (CS 10, p. 18). And finally, an example of the incompatibility of ecosystems with the human psyche can be found in my own experience living and working for over a year in a pristine tropical rain forest in Kalimantan (Indonesian Borneo). Although on many levels the forest was the most beautiful place I have ever been, it was also very clearly not a human environment. Inevitably, there was a sense of relief in coming out from under the canopy into the small clearing of the research station. While there may be a few indigenous forest tribes such as the Guaymi in the Osa Region of Costa Rica who prefer to live in the deep forest (CS 10, p. 1), most peoples probably prefer to live in cleared areas. Thus, it seems likely that large tracts of unbroken forest will only be maintained in parks and reserves or in dedicated timber and non-timber forest product extraction areas in which people work, but do not live.

3. *Monitoring of Results.*

The final step in establishing a biodiversity conservation program in modified lands is to establish a mechanism for monitoring the results of the program, so that corrective actions can be taken if the target goals are not achieved. If a species-based criterion for conservation has been adopted, then biodiversity can be measured in one of several ways. As usual, the choice of a given technique depends on a trade-off between accuracy of the results and the cost. Project staff thus need to decide what type of monitoring best fits their needs.

The most rigorous technique for monitoring conservation results involves systematic censuses of target populations. In a forest ecosystem, for example, trained observers can walk established census routes and record all animal encounters, either as a linear distance from the trail (Burnham et al. 1980) or as a radius around fixed observation points (Reynolds et al. 1980). These observations can then be analyzed using simple statistical techniques or with a Geographical Information Systems (GIS) program to estimate the density (number of individuals per unit area) or biomass (total weight per unit area) of target species in the habitat. For territorial species, it is also possible to map territories to get similar estimates of density or biomass (Brockelman & Ali 1987).

Since the census-based methods must be rigorously conducted to have meaning and thus require the presence of trained observers, they tend to be relatively expensive (in the greater scheme of things, professional ecologists generally come pretty cheap). A less labor -ntensive approach is not to census all species, but merely target select indicator species (species known to be sensitive to certain types of habitat disturbance) (Noss 1990). Finally, a "quick and dirty" approach is to rely on ad-lib observations of species or reports from knowledgeable local peoples (Salafsky, In press). Monitoring of ecosystem-based approaches to biodiversity conservation require different techniques to ensure that important parameters (e.g., water quality or soil nutrient levels) are being maintained. These types of monitoring efforts can also suffer from logistical problems, such as were experienced in the Guesselbodi site in Niger where vandals stole fencing and other items that demarcated test plots (CS 2, p. 15).

A number of the case studies explicitly describe efforts to monitor population levels of critical species, including primarily large vertebrates. For example, the Amboseli Project in Kenya tracks the populations of rhinos, elephants, and general ecosystem biomass (CS 1, p. 29 and Figs. 2, 5, and 6). Although numbers are not presented, the Ranomafana Project describes extensive surveys by a range of biological specialists to survey plants, invertebrates, and vertebrates (CS 4, p. 7), efforts to develop indicator species for habitat disturbance (p. 8), and long-term assessments of changes in various habitats (p. 12). Similarly, the Crater Mountain Project Report in Papua New Guinea describes initiating surveys of plant and animal species (CS 8, p. 5). The BOSCOSA project in Costa Rica describes the results of botanical and faunal inventory efforts and the establishment of a Conservation Data Center for the Osa region (CS 10, p. 2). The North York Moors project describes how they will select a subset of areas on which to perform detailed monitoring of plant communities (CS 14, pp. 29-30). Perhaps the most ambitious effort is the creation of the Conservation Data Center in the Greater Yellowstone Project in the US that will "gather and organize all known biological information regarding a selected number of species of concern in the Yellowstone Ecosystem, display those data in geographic format, and ultimately serve as a central repository for all biological information related to the Ecosystem" (CS 15, p. 26).

Other case studies, however, include little or no mention of monitoring efforts. At best, there is a hope expressed that since "natural areas" exist, there must be conservation occurring. For example the Natural Forest Management Project in Niger describes what seems to be highly disturbed secondary forest with little or no reference to species compositions (CS 2, pp. 14-18). While the Community Forest Management study from India mentions that in the village of Chandana there are over 214 species of flora and fauna present in the forests (CS 5, p. 9), the study of Mahapada Village has no mention of species present save one anecdotal tale of a bear emerging from the forest (CS 5, p. 14). The study of the Marine Resource Management Institutions in Indonesia has no mention of monitoring of the species in the marine areas (CS 6). Finally, the report on the Kakadu National Park in Australia claims that "the fact that Kakadu exists is a major contribution to the nature conservation estate not only nationally, but internationally" but does not say more (CS 13, p. 20).

Summary of Issues That Need to be Addressed in the Workshop

Biodiversity conservation in the vast areas located outside of parks and reserves is perhaps the most important role for CBC projects. Specific questions that need to be addressed include:

* What goals should CBC projects adopt regarding conservation? Preservation of all species? Of populations? Of ecosystems? Of species that maintain

ecosystem functioning? Of species that can be saved within certain cost criteria? Who establishes the goals?

* What steps can CBC projects take to ensure biodiversity conservation? What trade offs can be made between human and natural world welfare? Can land-use systems be developed that maintain or mimic the structure and functions of natural ecosystems? Can ecological and conservation biology principles be incorporated into CBC projects? How can projects deal with the conflicts between humans and wildlife? What are the limitations to CBC projects?

* How should CBC biodiversity conservation projects be assessed? Should elaborate census techniques be used, or is it possible to rely on "quick and dirty" alternatives such as indicator species or local knowledge?

Can We Sustainably Increase Production?

To this point in the paper, and indeed throughout most of human history, it has largely been assumed that the human welfare curve in Figure 3 is fixed in place. In other words, human welfare can only be increased by moving along the curve towards an optimal position in Region II. A more intriguing approach to this problem, however, is to see if it is possible to increase production while maintaining a given level of habitat disturbance (shift the curve upwards), or even better, increase production while reducing habitat disturbance (shift the curve upwards and to the left as illustrated by the dashed line in Figure 3). Ideally, this shift could result in the establishment of a new optimum point (Point M') that is better for both humans and the natural world. In the following sections, I discuss two ways in which such a shift could occur.

Shifting the Curve I: Developing Sustainable Land-Use Systems
The first way in which the curve can potentially be shifted upwards is to develop land-use systems that provide increased returns to humans with minimal ecosystem disturbance. This research is covered in the fields of agroecology and ecosystem agriculture and the concepts of extractive reserves and ecosystem management.

The basic tenant of agroecology is that human derived agricultural systems are also ecosystems. Accordingly, they must be understood and studied from an ecological perspective (Marten & Saltman 1986; Hecht 1987; Gliessman 1990). The concept of ecosystem agriculture goes a step further and holds that the ideal agricultural systems from an ecological point of view are those that mimic the naturally occurring ecosystem(s) of the region (Jackson 1980). For example, in the humid tropics, a diverse agricultural system based on multi-strata tree crops would be the most appropriate farming method. At the broadest levels, both agroecology and ecosystem agriculture are not merely a set of scientific or farming methods, but a complete philosophical outlook on life based upon farmers working in partnership with nature rather than in opposition (Hecht 1987).

Extractive reserves and ecosystem management involve maintaining a steady return of products for household consumption and/or market sale from a relatively intact natural ecosystem. These management systems are most often thought of in the context of harvesting timber and non-timber products from forests, but similar principles apply to the harvest of marine resources from coral reefs or game from savannahs. Although the extractive reserve concept generated considerable excitement when it was first developed (Peters et al. 1989; Allegretti 1990), a growing body of research indicates that it is not a universal panacea for sustainable development, but rather one component of an overall land-use strategy (Browder 1992; Salafsky et al. 1993).

The fifteen CBC case studies present a number of examples of potentially sustainable land-use systems. Examples of ecosystem agriculture include the cattle herding and game ranching efforts in Amboseli, Kenya (CS 1) and Zimbabwe (CS 3), the agroforestry systems being developed in the Osa Peninsula in Costa Rica (CS 10, p. 18), and especially the "raised beds" and "circular garden" farming systems being developed in the rain forests of Peru (CS 11, pp. 25-27). Examples of extractive systems and ecosystem management include the forest management projects in Niger (CS 2) and India (CS 5), the marine harvesting system in the Maluku Islands, Indonesia (CS 6), extractive reserves in Brazil (CS 9), subsistence hunting efforts in Latin America (CS 12a & b) and the National Forests in the Greater Yellowstone Region in the US (CS 15). In looking at these various systems, several important ecological issues arise that need to be considered in project design.

The first of these issues involves how to define 'sustainable use' in theoretical and practical terms. The basic definition of this term involves employing resources "at rates within their capacity for renewal" (IUCN/UNEP/WWF 1991), or in economic parlance, spending the interest and not the principal (Robinson 1993). Although translating this simple theoretical definition into practical terms can be difficult, a few of the case studies do deal with this issue. For example, the Natural Forest Management project in Niger monitored forest regeneration rates to try to determine if rotational cycles were sufficiently long enough to allow for maintenance of forest stocks. The case study authors concluded that initial harvest projections were overly optimistic, perhaps in part due to the fact that the initial harvesting efforts did not take into account the "one-time bonanza of fuel wood" that comes from "the initial harvest of mature forests" (CS 2, pp. 25-26). A similar one-time bonanza occurred in the Maluku Islands in Indonesia where initial harvests of trochus shells after a lull during World War II turned out to be much greater than harvests in subsequent years (CS 6, p. 17). Perhaps the best treatment of sustainability, however, is the Wildlife Resources Project in Latin America which explicitly discusses a number of ways in which population growth rates and observed hunting yields can be used to estimate the sustainable yield from populations of neotropical mammals (CS 12a, pp. 27-33).

The second issue involves understanding the ecological constraints on the system. In the case of agricultural systems, important considerations include choice of species (what plants and animals will be used in the system?), interactions between species (are plants stratified or do they compete for space and light?), and nutrient cycling (are nutrient budgets balanced or will inputs be required?). A few of the studies such as the Ranomafana Project in Madagascar and the BOSCOSA Project in Costa Rica do discuss testing various species for inclusion in agroforestry systems. Furthermore, the HIFCO project discusses how the integration of trees into the raised bed system optimizes use of vertical and horizontal space and how the use of leaf litter maintains the nutrient balance in the circular gardens (CS 11, pp. 25-26). Overall, however, it seems as if there is room for much more on-farm research into ways of further improving these systems.

In the case of extractive systems, important considerations include the density of the exploited species (how long does it take to locate, harvest, and transport the product to the point of sale?), the phenology or temporal availability of product (is the product available year round or only at certain times?) and the sustainability of the extraction system (does harvesting the product interfere with reproduction or kill the species?) (Salafsky et al. 1993). Here again, some work has been done in the case studies on ways of improving these systems along these lines. For example, as mentioned above, the Wildlife Management project in Peru discusses how promoting harvesting of males can enhance the sustainable yield of deer and large rodents (CS 12b, pp. 12-13). Overall, however, again there seems to be a need for considerably more research on these topics.

The third issue involves the fact that most potential sustainable land-use systems currently only seem to support low human population densities. In general, low population density seems to be characteristic of most of the land-use systems described in the various case studies, especially the resource extraction oriented ones. For example, the Extractive Reserves in Brazil support only between 0.8 and 21.5 inhabitants/km^2 (CS 9, Table 4) and the huge Kakadu Region in Australia only supported an aboriginal population of around 2,000 individuals (CS 13, p. 10). By contrast, the HIFCO circular farms in Peru support a density of around 100 inhabitants/km^2 (calculated by dividing an estimated 6 individuals per household by the reported .06 km^2 plot size from CS 11, p. 26). Unfortunately, however, population densities in many parts of the world are already much higher. Although in theory it may be correct to argue that many large populations supported by modern high-input agricultural systems are inherently unsustainable, in practice, this argument is moot unless radical population reduction measures are enacted. Sustainable systems will thus have to become even more productive.

The final and critical issue for any CBC project is that a sustainable system is not necessarily a biodiversity conserving system. As Robinson (1993) writes, hunting efforts can produce a short-term sustainable yield while still holding a species at a relatively small population level at which it cannot perform its traditional ecological services such as seed dispersal. Similarly, a tree plantation can be managed to provide a sustainable yield of fuelwood, but it may not provide habitat for many animals compared to a natural forest. This argument is apparent in the Natural Forest Management case study from Niger in which the forests are described "from the perspective of productivity" as being "over-mature due to protective policies [so that] conservative cutting would help to remove older growth and promote regeneration of coppice and natural seeding" (CS 2, p. 10). Although from a economic viewpoint it may indeed make sense to cut the old growth, from an ecological viewpoint this is likely to be damaging to biodiversity conservation. A similar distinction between ecological and economic sustainability is also made with regard to the carrying capacity of the rangeland in Zimbabwe (CS 3, p. 22).

<u>Summary of Issues That Need to be Addressed in the Workshop</u>
Developing land-use systems that increase production while maintaining or reducing ecosystem degradation should be one of the major goals of CBC. Specific questions that need to be addressed include:

* How should sustainability be defined?

* What are the ecological constraints on these systems?

* Can these systems support high human population densities?

* To what degree is sustainability compatible with biodiversity conservation?

Shifting the Curve II: Making Natural Systems a Part of Human Welfare
The second way in which the human welfare curve can be shifted as shown in Figure 3 is to incorporate the natural world's curve into the human curve. In other words, if the largely artificial dichotomy between these two curves is dissolved, then the value that humans place on the survival of the natural world should influence the extent of habitat conversion that we choose. This value of the natural world has been termed biophilia by E. O. Wilson (1984) and is closely related to the economic concept of existence value which states that people value knowing that wildlife and wild habitats exist in the world, even though they may never see or experience it themselves. Empirical evidence for the presence of positive existence values can be found in the substantial sums of money donated to

conservation groups around the world and through use of various economic techniques used to estimate people's valuation of biodiversity (Loomis & Walsh 1986).

An important consideration in trying to develop biophilia in a CBC project is that a non-consumptive use of biodiversity tends to be a luxury good (an item for which demand increases as income rises). A poor farmer may enjoy the variety of animals around the forest in her village, but if given the choice between clearing the land to feed her family and preserving the habitat for the animals, her decision is very clear-cut (so to speak). Her wealthy neighbor, on the other hand, having a wider array of options for survival might choose to maintain the forest (van Schaik et al. 1992). Although a number of indigenous societies may have a deep reverence for wildlife, such as the Gimi speaking peoples in the Crater Mountain Region of New Guinea who pattern their initiation rituals on hornbill behavior (CS 8, p. 6), the majority of people in the world seem more like the Maasai in Amboseli, Kenya whose "attitudes to wildlife have ranged from indifference to antagonism" (CS 1, p. 8). Effective CBC projects will thus need to help create systems in which people have a vested interest in wildlife such as in Amboseli, Kenya and in Zimbabwe where local peoples share in the return from wildlife earnings in the form of infrastructure and cash dividends (CS 1, p. 21 and CS 3, pp. 14-15). Furthermore, these projects will need to include conservation education such as the " 'farmer-to-farmer' horizontal exchanges of local knowledge" promoted by the HIFCO project in Peru that helps to"encompass and articulate the particular group's understanding and cosmological vision of the surrounding natural environment and its management of various goods and services" (CS 11, p. 10).

Summary of Issues That Need to be Addressed in the Workshop

CBC projects can also play a role in enhancing and developing people's appreciation of the natural world. Specific questions that need to be addressed include:

- How can CBC projects promote biophilia given that it tends to be a luxury good?

- How can people derive economic returns from wildlands and wildlife?

Conclusions

The basic premise of the graphical model presented in Figure 3 and discussed throughout this paper is that human-induced ecosystem alteration is an independent variable that directly affects both human and natural world welfare. We humans can control this variable. It is within our power to control the forces of expanding consumerism and population growth and reverse our slide towards ecological collapse. It is within our power to create holistic land-use complexes that expand parks and reserves to encompass entire ecosystems and to actively promote biodiversity conservation in modified landscapes. And it is within our power to develop sustainable land-use systems that enable us to improve both our welfare and that of the natural world.

Taken as a whole, the fifteen case studies prepared for this Workshop demonstrate that Community-Based Conservation projects are an important means by which we can address these issues. To be sure, there are a great number of questions and challenges that need to be resolved. In particular, biological conservation is often in conflict with human development. But ultimately, there is truth in the platitude that conservation will never be successful without human development and vice versa Hopefully CBC projects can accomplish both if they are grounded in the knowledge of ecological limits and opportunities.

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