SELECTION, CATEGORIZATION, SIZE, AND ZONING IN THE WORLD'S PROTECTED AREAS

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Summary

The mechanisms underlying the selection, categorization, size extension, and zoning of the protected areas in the world are shortly presented and discussed. After a screening of literature cases, this chapter is primarily based upon a series of procedures and methods, from the biodiversity estimation to iterative and information-based systems. The

categorization that is currently utilized follows the most recent classification given by the IUCN and includes internationally recognized categories that range from strictly protected areas destined only for scientific uses to managed areas. The size of the protected areas is variable: from one side it depends on the area's original designation, especially in the case of long-existing reserves; alternatively, it depends on the process used to define the area itself. In general, it should be taken into account which taxa or ecosystems must be protected inside the area, taking also into consideration that an area of limited size is often characterized by a drastic loss in biodiversity, with a consequent extinction of animals with large home range extensions. The zoning is then an instrument to calibrate the intervention within the protected area, and it is rather flexible in the recently constituted reserves. A case study for a biodiversity "hot spot," Madagascar, is also provided. On this large island, the habitat alteration and deforestation rate are extremely severe, and the protected area network is among the few means (together with education and development) to preserve and possibly reverse this trend.

1. Introduction

Protected areas—legally established sites managed for conservation—are evident means for protecting biodiversity. Worldwide, something more than 8000 protected areas cover over 750 million hectares of marine and terrestrial ecosystems, amounting to 1.5% of Earth's surface or 5.1% of national land area.

The protected areas have long been considered as territories where the nature is to be protected and where "normal" use of the land is to be suspended. This is the philosophy that underpins every protected area, due to the historical perspective upon which the first parks and national reserves were based between the end of nineteenth and beginning of the twentieth centuries.

The basis for the definition of the national parks and their management was finalized on the occasions of the London (1933) and Washington (1940) international conventions. According to the final resolutions, the term "national park" designated an area (a) placed under the public control, and whose borders must not be changed; (b) specifically designated for the propagation and conservation of wildlife and for safeguarding elements of aesthetic, geological, prehistoric, historical, archaeological, and scientific interests, and for public recreation; (c) where hunting activities (i.e., the killing or capture of the wild fauna) as well as the destruction and collection of flora are forbidden, excepting for the initiative or under the direction and control of the park's authorities.

In this chapter, the most important aspects regarding the processes of selection, categorization, size, and zoning in the protected areas are sketched. This exposition is necessarily synthetic, drawing largely from exhaustive arguments developed in specialized treatises as well as in dedicated papers published in journals of conservation, habitat management, and ecology.

2. Selection Process

2.1. Methods to Select a Protected Area

Historically, most national parks and other areas that implicitly are thought to protect biodiversity are selected for reasons other than those that are biological. Although a variety of methods for evaluating the conservation worth of areas has been suggested, few have attempted to provide a cost-effective means for evaluating biodiversity at the scale of the ecoregion. The first reserves to be created were designated on ad hoc basis in an effort to conserve some species. This is still an important objective (sometimes still adopted to address area conservation), but it is evident that it is suboptimal for protecting biodiversity. Several criteria are used to identify such areas; these include biodiversity parameters, rarity, population abundance, and site area. In the case that data are accurate, it is possible to identify areas of high specific diversity ("hot spots") for certain taxa, focusing on threat level or biogeographical status.

Although biodiversity is often claimed to be a powerful tool for identifying and selecting areas for protection, aside from easily surveyed taxa (such as birds, large mammals, and butterflies) it is evident that for many groups a diversity estimate is often difficult. In general it should be stressed that the most suitable groups are those that can be rapidly censused. This is the main aim of several surveys carried out since the 1980s. It is not unlikely that the diversity for certain groups of species (or higher taxa) may not be coincident with that of others. Regardless, there is the tendency to utilize some "indicator taxa," which, for their facility in being surveyed, are taken into consideration in a general sense. This occurs for some vertebrate and invertebrate groups. However, the correlations between the indicator and the indicated taxa are quite variable and, in a general sense, questionable

Where knowledge of existing species distributions is inadequate for reserve planning, other approaches might be attempted. It is worth noting the application to the protected areas' management of MacArthur and Wilson's (1967) island biogeography theory. In this case, the reserve is selected on the assumption that a larger reserve hosts a higher number of species, and, consequently, a higher biodiversity. However, no satisfactory resolution has come from the well-known debate over the relative benefits of a single large reserve versus several small reserves.

A comprehensive biodiversity plan needs to evaluate the sufficiency of these and other protected areas for conserving biodiversity. Gap analysis appears to be a useful instrument toward this goal. Gap analysis uses geographic information systems (GIS) to identify "gaps" in biodiversity protection that might be filled by the establishment of new preserves or changes in land use practices. Gap analysis consists of three primary data layers. These are (a) the distribution of actual vegetation types delineated from satellite imagery, (b) land ownership, and (c) distributions of terrestrial vertebrates as predicted from the distribution of vegetation. Within the GIS, overlays of animal distribution and ownership can be used to estimate the relative amount of protection afforded vertebrate animals. Gap analysis functions as a first-pass approach for organizing biological information. Depending on the database, the database can be used to springboard into other, more detailed studies and is meant as a proactive rather than reactive management tool. Gap analysis is a method of identifying gaps in the protection of biodiversity at state, regional, and national scales. Although designed to identify

"gaps" in the protective network, the data collected for gap analysis can serve numerous other purposes. In one sense, the data represent the first systematic biodiversity compilation that transcends political boundaries. As such, the data are a useful starting point for other efforts designed to protect biodiversity. Some important applications include the ability to note temporal and spatial change in the extent and distribution of vegetation types.

2.2. Case Studies of Ugandan Reserves and South African Coastal Fishes

In the late 1980s the Ugandan Government decided to dedicate one-fifth (~3000 km^2) of the country's 15 000 km^2 forest estate to management as "strict nature reserves" for biodiversity protection. A program of biological inventory work was undertaken between 1991 and 1995. It was decided to survey those areas most likely to support viable populations of most species in the long term (namely the larger reserves exceeding 50 km^2), and any smaller reserve in which a particular vegetation type was uniquely represented.

Sixty-five of the country's principal forests were evaluated for biodiversity, focusing on five "indicator" taxa: woody plants, small mammals (of the families Cricetidae, Gerbillidae, Muridae, Mioxidae, and Soricidae), birds, butterflies, and large moths. Conservation priorities were established by comparing sites on the basis of species diversity and rarity, using directly comparable data sets. The first stage of the analysis was aimed at identifying areas with an unusually large number of species or high concentrations of rare species. Each site was scored for biological importance based on a measure of species diversity and the "rarity value" of the species (based on frequency of occurrence in Uganda's forests and known Africa-wide distributions) represented within the five indicator taxa at each site. Each site was then evaluated for various alternative land uses (e.g., timber production, local community use, recreational production, and local community use). In this way, scores were derived as objectively as possible using data on standing timber volumes, population, census statistics and so on, but more subjective assessments were also necessary to establish scores for certain criteria such as recreational potential. These scores were then combined in a single statistic used as a measure of each forest's overall suitability for designation as a reserve.

Usually prioritization for biodiversity conservation is based upon data occurring for the terrestrial habitats. A recent study analyzed available data sets of coastal fishes in South Africa. The 57 marine protected areas in that study have largely been designated by an opportunistic process, and currently only three of these are considered to offer substantial protection to coastal biota including fishes. The authors collated existing fish distribution data and applied and compared hot spot, biogeographical, and "complementarity" approaches to the selection of marine protected areas for the conservation of coastal fish diversity. First they examined the patterns of species and endemic species richness around the coast in order to understand whether any hot spot could be identified by the presence of fish. Then, they carried out a biogeographical analysis, based on zonation. They used a cluster analysis and multidimensional scaling that allowed the identification of major biogeographical zones. The final approach used complementarity analysis, which is a selective technique identifying how the target set

of species can be conserved at the minimum number of sites. The study used a "rarity algorithm" that identifies sites scoring high on a scale of species rareness. This kind of selection produces high efficiency by leading to the selection of a minimum, or near-minimum, set of reserves that conserve all target species at least once.

3. Categorization and Denomination of Protected Areas

3.1. IUCN Categories

The main accepted purposes for managing protected areas are (a) scientific research, (b) wilderness protection, (c) preservation of species and genetic diversity, (d) maintenance of environmental services, (e) protection of specific natural and cultural features, (f) tourism and recreation, (g) education, (h) sustainable use of resources from natural ecosystems, and (i) maintenance of cultural and traditional attributes.

In 1978, the IUCN Commission on National Parks and Protected Areas (CNPPA) published a document regarding the new classifications of the protected areas, subdivided into 10 categories within three groups, as follows:

Group A. These categories are those for which the CNPPA and the World Conservation and Monitoring Center (WCMC) take responsibility to check the status of each area destined for conservation. They are (I) scientific reserve or strict nature reserve; (II) national park; (III) natural monument or natural landmark; (IV) natural conservation reserve, managed nature reserve, or wildlife sanctuary; and (V) protected landscape.

Group B. These categories are of particular importance to the IUCN, but not considered as essential within the formal structure of the CNPPA. Nevertheless, CNPPA and WCMC can check their conservation status and provide suggestions and experts. They are as follows (continuing the listing from Group A): (VI) resource reserve; (VII) natural biotic area or anthropological reserve; and (VIII) multiple-use management area or managed resource area.

Group C. The following categories are relative to areas that are already included in international programs and have a specific relevance for the nature conservation, although in some cases they are coincident with some of the former categories. The CNPPA and WCMC can provide their experience in cooperating with other institutions. These include (IX) biosphere reserve, and (X) world heritage site. Nonetheless, it was evident that this categorical system needed updating. In fact, the differences between some of these certain categories were not always clear, and the treatment of marine conservation needed strengthening. Categories (IX) and (X) were not discrete management categories, and often the international designations are overlaid on other categories.

On the occasion of the IUCN meeting in Madrid (1984), only the first five categories were maintained, while categories VI–X were abandoned (with the exception of the international designations, like Ramsar Site, Biosphere Reserve, and World Heritage, which were maintained). In 1994, the IUCN published the "Guidelines for Protected Area Management Categories," which were updated in 2000, with the proposition of six

categories as follows:

Category Ia: Strict Nature Reserve. A protected area (of land and/or sea) managed mainly for scientific purposes, possessing some representative ecosystems that are available mainly for scientific research. It is usually not open to tourist access. The main objectives are (a) to preserve habitats, ecosystems, and species in an undisturbed state; (b) to preserve genetic resources; (c) to maintain and preserve ecological processes; (d) to safeguard structural landscape features or rock exposures; (e) to secure examples of the natural environment for scientific research, environmental monitoring, and education, including baseline areas from which all avoidable access is excluded; (f) to minimize disturbance by careful planning and execution of research and other activities; (g) to limit public access. The selection of these reserves is based upon the verification that the area is large enough to ensure the integrity of its ecosystems, is significantly free of human disturbance and intervention (and capable of remaining so), and the conservation of the area's biodiversity is achievable through protection and does not require substantial active management or habitat manipulation.

Category Ib: Wilderness Area. A large protected area managed mainly for wilderness protection, with unmodified (or slightly modified) land and/or sea, retaining its natural character and influence without permanent or significant habitation, and that is protected and managed so as to preserve its natural condition. The objectives are (a) to ensure that future generations will have the opportunity to experience understanding and enjoyment of areas that have been largely undisturbed by human action over a long period of time; (b) to maintain the primary attributes and qualities of the environment over the long period; (c) to provide public access at levels and of types that will best serve the physical and spiritual well-being of visitors and maintain the wilderness qualities of the area for present and future generations; and (d) to enable indigenous human communities living at low density and in balance with the available resources to maintain their lifestyle. The selection is based upon the verification that the area possesses high natural qualities, and a substantially absent human disturbance. Furthermore, the area should have outstanding ecological, geological, or other aspects of scientific, educational, scenic, or historic relevance. "Wilderness" is basically a human concept, not having an ecological implication; wilderness areas may include areas that were formerly exploited but have been abandoned and subsequently returned to natural succession. This subcategory was not yet reported in the 1978 system, but has been introduced following the IUCN General Assembly Resolution on Protection of Wilderness Resources and Values, adopted at the 1984 General Assembly in Madrid (Spain).

Category II: National Park. A protected area managed mainly for ecosystem protection and recreation, protecting the integrity of one or more ecosystems, excluding exploitation or occupation contrary to the purpose of designation of the area, and providing a foundation for spiritual, scientific, educational, and recreational opportunities, all of which must be environmentally and culturally compatible. The main objectives are (a) the protection of natural areas of national and international significance for a series of purposes (e.g., spiritual, scientific, educational, recreational, or tourist); (b) the perpetuation of representative examples of biotic communities, genetic resource, and species, meanwhile providing ecological stability and diversity;

and (c) the elimination and prevention of exploitation. The area should contain a representative sample of major natural regions, features, or scenery where plant and animals species, habitats, and geomorphologic sites are of special significance.

Category III: Natural Monument. A protected area managed mainly for conservation of specific natural features, containing one or more specific natural or natural/cultural features of outstanding or unique value because of rarity, representative or aesthetic qualities, or cultural significance. Among the objectives are (a) to protect specific outstanding natural features because of their natural significance, unique or representational quality, and/or spiritual connotations; (b) to provide opportunities for research, education, and public satisfaction if in accord with the foregoing objectives; (c) to eliminate disturbing factors; and (d) to deliver to any resident population benefits as are consistent with the other objectives of management. In a general sense, the area should contain one or more features of outstanding significance (e.g., spectacular waterfalls, craters, caves, fossil beds, or sand dunes) and also should be large enough to protect the integrity of the feature and its immediate surroundings. In the 1978 system this category corresponded to the natural monument–natural landmark.

Category IV: Habitat/Species Management Area. A protected area managed mainly for conservation through management intervention, subject to active intervention for management purposes to ensure the maintenance of habitats and/or to meet the requirements of specific species. The main objectives are (a) to maintain the habitat conditions needed to protect significant species, groups of species, biotic communities, or physical features of the environment where these require specific human manipulation for optimum management; (b) to facilitate scientific research and monitoring as primary activities associated with sustainable resource management; (c) to develop limited areas for public education and appreciation of the characteristics of the habitats concerned and of the work of wildlife management; (d) to eliminate and prevent exploitation or occupation inimical to the purposes of designation; and (e) to deliver such benefits to people living within the designated area as are consistent with the objectives of management. The areas should be important in the protection of nature and survival of species (including breeding areas, wetlands, coral reefs, estuaries, grasslands, forests, or spawning areas). They should also be those where habitat conservation is essential for locally important flora and fauna. The conservation of these habitats should depend upon active intervention and, when necessary, of habitat manipulation. In the 1978 system this category corresponded to the nature conservation reserve–managed nature reserve–wildlife sanctuary.

Category V: Protected Landscape/Seascape. A protected area managed mainly for landscape/seascape conservation and recreation, and where the interaction between people and nature has produced an area of distinct character with significant aesthetic, ecological, and/or cultural value, and often with high biological diversity. The preservation of the integrity of this traditional interaction is vital to the protection, maintenance, and evolution of such an area. Objectives are (a) to maintain the harmonious interaction between nature and culture, by means of the protection and the continuation of traditional land uses, building practices, and social and cultural manifestations; (b) to support lifestyles and activities that are in harmony with nature and the preservation of the social and cultural fabric of the communities concerned; (c)

to maintain the diversity of landscape and habitat, and associated species and ecosystems; (d) to eliminate where necessary, and thereafter prevent, land uses and activities that are inappropriate in scale and/or character; (e) to provide opportunities for public enjoyment through recreation and tourism appropriate in type and scale to the essential qualities of the areas; (f) to encourage scientific and educational activities that contribute to the long-term well-being of resident populations and to the development of public support for the environmental protection of such areas; and (g) to bring benefits to, and to contribute to the welfare of, the local community through the provision of natural products and services. The areas should therefore possess a landscape/seascape of high scenic quality and diverse associated habitats, together with peculiar fauna and flora, and unique or traditional land use patterns. The area should provide opportunities for public enjoyment through recreation and tourism within its normal lifestyle and economic activities. In terms of organizational responsibilities, this kind of area may be owned by a public authority, but it is more likely to include a mosaic of private and public ownership. In the 1978 system this category corresponded to the protected landscape.

Category VI: Managed Resource Protected Area. A protected area managed mainly for the sustainable use of natural ecosystems, containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, providing a sustainable flow of natural products and services. Objectives for management include (a) the protection of biodiversity and other natural values; (b) the promotion of sound management practices for sustainable production; (c) the protection of the natural resource base from being alienated for other land use purposes that would be detrimental to the area's biological diversity; (d) the contribution to regional and national development. The area should be at least two-thirds in a natural condition, although it may contain limited areas of modified ecosystems. Management should be undertaken by public bodies, in partnership with local communities. This category does not correspond directly with any of those reported in the 1978 system, although it is likely to include some areas formerly classified as resource reserves, natural biotic areas–anthropological reserves, and multiple-use management areas–managed resource areas.

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Biographical Sketch

Franco Andreone is PhD and Zoological Curator at Museo Regionale di Scienze Naturali in Torino (Italy). He carries out research on many zoological aspects, mainly related with herpetology. He is currently a member of the Conservation Committee of the Societas Herpetologica Italica, of the IUCN SSC (Species Survival Commission), "Amphibians and Reptiles of Madagascar and Mascarenes" and Country Liaison Representative for Italy and Madagascar of the journal *Amphibian and Reptile Conservation*. He has published approximately one hundred scientific papers, served as a referee for several international zoological journals, and is currently a member of the editorial board of the international batrachological journal *Alytes.* His main interests include the conservation, ecology, and taxonomy of amphibians and reptiles of Madagascar, where he conducts regular field survey activities. Furthermore, he collaborates with several nongovernmental organizations to carry out studies to be applied to habitat management and protected areas valorization, both in Italy and in Madagascar.