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Time for a Resurrection of Biosphere Reserves?

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Although my first professional training was in a traditional forestry curriculum in the 1940s (designed mainly to produce what we called "stumpies"), fairly early on I began to appreciate what was meant by biodiversity and the need for conserving it, and gradually segued into conservation. Then the work of MacArthur and Wilson in 1967 on island biogeography captured my attention. It showed that large islands had a richer biodiversity than the smaller islands, and that the rate of species extinction was lower on the larger islands (other things being equal; MacArthur and Wilson 1967). One thing that did make a difference was the rate of replenishment through in-migration, and this depended usually on the proximity to a source—usually a large land mass. Hence, it is easier to conserve biodiversity on continental islands than on oceanic islands. This seems like common sense and pretty intuitive, but their pivotal work initiated a series of new guidelines for natural reserve design.

It soon led to one of my favorite diagrams which is derived from work by Jared Diamond (1975; see Figure 1). In summary, it suggests that big is better than small; one large park or reserve is better than several that aggregate the same area; reserves close together are better than equivalent ones widely spaced; reserves clustered are better than spread out in linear fashion; reserves connected to each other are better than separated; and in shape, the ratio of interior to perimeter is better the higher it is. To this list we must add one more: buffered from conflicting use is better than unbuffered (see Janzen 1983).

Fine studies followed on the topic of minimum viable protected area to sustain various species and their genetic integrity. An emphasis was often placed on keystone, flagship, or umbrella species, usually large carnivores, with the rationale that an area large enough for these would also conserve also most of the other biodiversity. Such studies revealed that very large areas were needed, for example, Newmark (1985) showed a loss of nearly all wide-ranging animal species in all but the largest North American park complexes. Subsequently, in East Africa he estimated that a minimum viable population of African wild dog (500 individuals) would require 100,000 km^2, a size not achieved by any East African park (Newmark 1992).

This is not to say that small reserves are without value for maintaining some species, particularly plants. A reserve that is too small for rhinoceros can be large enough for rhinoceros beetles.

Citation: Weber, Samantha, ed. 2014. *Protected Areas in a Changing World: Proceedings of the 2013 George Wright Society Conference on Parks, Protected Areas, and Cultural Sites*. Hancock, Michigan: George Wright Society.

Though a reserve too small for elephants is also too small for elephant-dung beetles which need elephant dung to reproduce (Burkey 1997). And remember that an area too small to maintain large predators usually means a higher population of meso-predators that can seriously impact their smaller prey species (e.g., raccoons or possums preying upon ground-nesting birds). Therefore we generally buy into the guidelines (Figure 1) with regard to size, distribution on the land, shape, and connectivity. But what can the protected area manager or agency do about implementing these guidelines?

Figure 1. Some reserve design principles simplified (after Diamond 1975).

Enlarging the size of an existing park or reserve is difficult, with limited acquisition budgets, and complicated by landscapes occupied by humans. Likewise for shape and clustering alteration. Legal boundary changes are usually political non-starters in the USA, and extremely difficult in most other countries. A more feasible alternative would be to enlarge the *effective* area of conservation through managing the surrounding land. Promoting nature-friendly land and water management on surrounding private lands is difficult, but absolutely necessary. In surrounding lands, much native biodiversity can thrive, reserve threats can be reduced, and migration pathways can be maintained or established. This might include the following measures:

- Promoting a reduction in pesticide use, by encouraging organic farming, such as was done in the Entlebuch Biosphere Reserve (Switzerland)
- Working through education and changed laws to prohibit hunting (fishing, trapping) of rare species, e.g., viable wolf populations cannot exist within the confines of Mercantour National Park (France) if wolves are shot when they set foot beyond park boundaries
- Cooperating in fire-fighting on surrounding lands, as is done by many parks, such as Glacier National Park, U.S. National Park Service (USNPS)
- Promoting eradication of alien invasive species that threaten park ecosystems, as practiced in Hawai`i Volcanoes National Park (USNPS)
- Promoting restoration with native plants of cleared, degraded, or abandoned areas, particularly using plant species that are stressed or rare within the park (Mount Kenya World Heritage Site in Kenya, and some other Biosphere Reserves in Africa)
- Breeding and providing sheep-guarding dogs to surrounding graziers, who are experiencing problems with the large predators that are being restored within the reserve, as was done by Abruzzo National Park, Italy
- Promoting social and economic vitality, and environmental health, by "branding" an association with the reserve that has quality standards, for instance with surrounding restaurants that use locally-produced supplies (especially organic) that keep money in the community, e.g., Alpi Marittime Regional Nature Park in Italy
- Participating in the local community's planning process, for example, in Cuyahoga Valley Communities Council, participation by Cuyahoga Valley National Park (USNPS) is helping to promote a sustainable rural landscape, and the park launched a Countryside Initiative to work with farmers to maintaining agro-biodiversity and the agricultural heritage of the valley (Brown, Mitchell, and Tuxill 2003)
- Other actions which many have already instituted or planned for, such as joint celebrations, extending nature tours into park-surrounding ecosystems that are not represented in the park, etc.

The recent report of the National Park System Advisory Board Science Committee (NPSAB 2012, 14) states that, "National Park Service management strategies must be expanded to encompass a geographic scope *beyond park boundaries* to larger landscapes and to consider longer time horizons." It would certainly seem like an appropriate expenditure of park or reserve funds, or use of park volunteers, to conduct an assessment beyond park boundaries of threats to, or of the barriers or impediments that inhibit, species (and gene) movement into and out of a park. The biopermeability of the landscape surrounding the reserve should be a major concern of the management policy. This could be demonstrated by identifying crossings or underpasses for significant roads and railways, or documenting location and size of culverts and dams in waterways. Some work in this arena has been done, or is underway, for road crossings in the Crown of the Continent and in the E-CONNECT project of the Alpine Protected Areas Network in Europe. A study by the Center for the State of the Parks reported that of 54 USNPS park units, 72 percent had significant

barriers to migration in their surrounding environments (Dethloff 2010). This, of course, is aimed at the last row of "This is better than that" in Figure 1, connectivity to the nearest area that is conserved and managed for biodiversity and maintenance of ecosystem and evolutionary processes.

Gateway communities might be worthy of some special attention. These areas can be are sources of light, sound, and even air pollution that may affect the reserve, and these places may also host a concentration of park visitor accommodations. Gateway communities are portals to our most cherished public lands and a target for the increasingly popular search for rich rural living. Intervention here might take the form of not just educational outreach, but also active participation in local planning processes to reduce potential harm to park natural and cultural heritage from a gateway community's uncontrolled growth. Park staff participation in the Gateway Institute in Gatlinburg at Great Smoky Mountain National Park and Biosphere Reserve is an example.

If park and reserve biological and cultural resources are to be maintained, in the face of climate change, we must make the leap over the boundary to work at a landscape scale. The protected area must be within a matrix of nature-friendly, sustainably-managed landscape. These are just some of the questions that need to be answered:

- Does authorization now exist in the administering agency to spend official work time on issues that lie outside the limits of the protected area?
- What are the geographic limits of such activities (e.g., Can Grand Teton National Park staff extend their work to the Greater Yellowstone Ecosystem?), where does the geographic extent of park intervention stop?
- Which are the most effective measures to reduce the effects of ecological isolation and habitat fragmentation?

It would surely help provide answers to these and to other questions if we took another look at the biosphere reserve concept and program as instituted by United Nations Educational Scientific and Cultural Organization (UNESCO 1995). This provides for a designated *core zone* of protection, surrounded by a *buffer zone* where land uses and other activities are sustainable, and help protect the core area. The outermost part of a biosphere reserve is a loosely delineated *transition area*, a zone of cooperation where agriculture, forestry, recreation, and other land uses characteristic of the region are carried out in a sustainable fashion, including degraded areas for rehabilitation (see Figure 2).

In its original concept, biosphere reserves also served a research function, where the core area was considered a natural baseline, and was compared against the managed land in the buffer zone. The buffer zone "formalized" the area of positive intervention for reserve projects or program. It is also now suggested that there be new "linkage" corridors of buffer zone established to connect to any nearby biosphere reserve or other protected area.

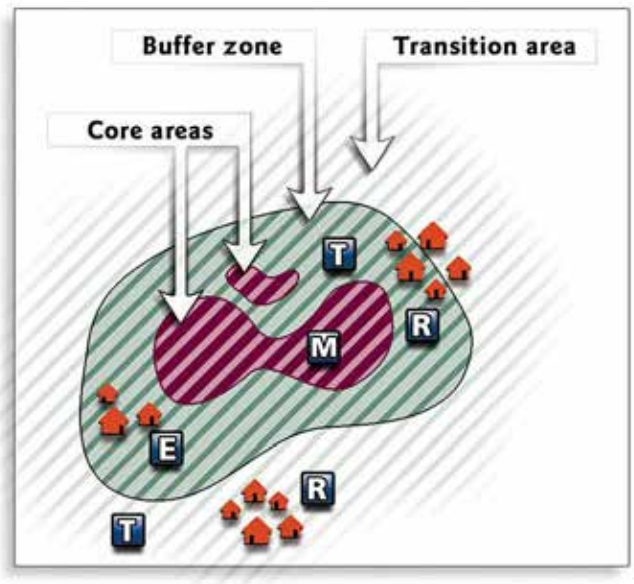
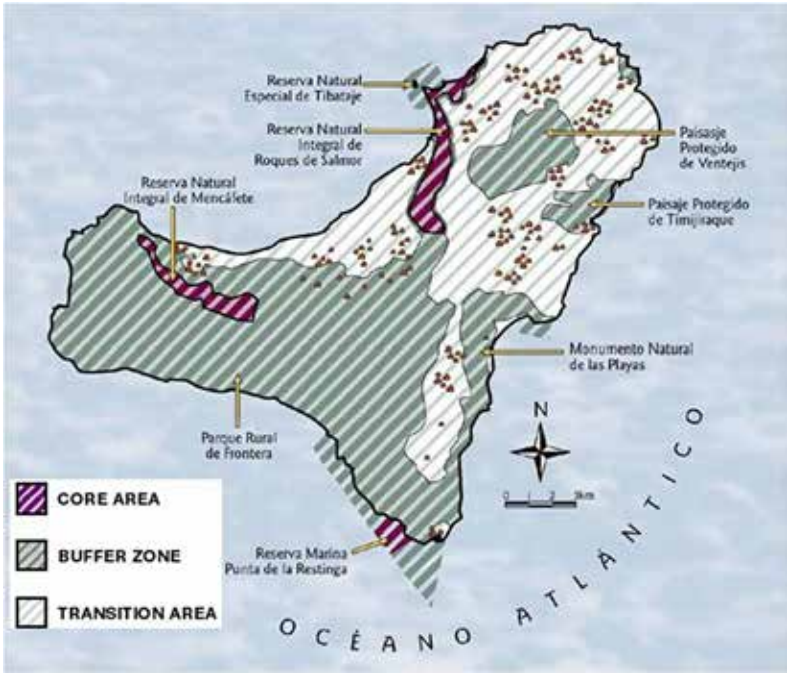


Figure 2. Model of a biosphere reserve (UNESCO).

Globally, there are now 610 biosphere reserves in 117 countries, with varying levels of performance. There exists a formal World Network of Biosphere Reserves, fostered by UNESCO/Man and Biosphere Programme. One of them, in the Canary Islands, gives a more realistic picture of an actual biosphere reserve (Figure 3).

The United States has listed 47 Biosphere Reserves, but since 1996 has not fulfilled its original commitment to have a

Figure 3. A biosphere reserve "on the ground" in Canary Islands (UNESCO).



dynamic program or to report periodically on the state of the biosphere reserves (which is called for every 10 years). Canada and Mexico both have viable programs. This contrast is surprising, since the concept of biosphere reserves had much of its origins in the USA, and Great Smoky Mountain National Park was the original "Biosphere Reserve poster child." Tom Gilbert, of the International Biosphere Trust, had much to do with the initiation of the this whole program in 1973–74. In his paper (Gilbert 2014) he briefly alludes to the politics and false information circulated about loss of US sovereignty (and even patrols by black helicopters) that effectively undermined the US Biosphere Reserve program.

In an editorial brief in *The George Wright Forum*, Diamant states: "It is easy to lose sight of the enormity of the challenge facing National Park Service in working and partnering effectively outside park boundaries" (Diamant 2012, 301). This statement applies equally to other protected areas managed by other agencies, and to other countries as well.

I, now, together with Gilbert and others, raise the question: "Is it not time to reconsider the relevance of the Biosphere Reserve in the United States as a useful way to meet the challenges faced by today's protected area managers?" If the label "buffer zone" has too much negative baggage for politicians or others, we can coin a new descriptor which delineates a zone of positive, proactive interaction with the surrounding communities to achieve a nature-friendly cultural landscape. At a minimum, we might re-activate some or all of the existing 47 Biosphere Reserves. More details about the program are available at www.unesco.org/mab.

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