

To the Editor:

Quinn et al. (*Park Science*, Fall, 1985) are gathering interesting data relating habitat island size to number of species. Subsequent discussion by Bratton (*Park Science*, Winter, 1986), White (*Park Science*, Spring, 1986), and Quinn and van Riper (*Park Science*, Summer, 1986) has emphasized factors in addition to reserve size that are important to design of nature reserve systems. We raise a question about the appropriateness of some of Quinn et al.'s data to their hypothetical choices of reserve system designs, and suggest reserve systems should be designed within a landscape context.

One goal of Quinn et al.'s paper is to provide data bearing on the question of whether "a few large areas . . . (or) a number of smaller tracts, equal in area to the larger ones" (p. 6) (note the narrow range of reserve sizes) will conserve more biological diversity. Yet the natural island, experimental grassland, and marine systems they describe have a wide range of reserve sizes, an important structural difference. Their grassland experiment compares reserves that differ 16-fold in size in *one* reserve system. In this system the large islands (and probably the surrounding landscape – a very large source of organisms) help maintain diversity on small islands since animals and probably plants can move among islands. For example, the larger population sizes on large islands may make them the source for a large proportion of the recent colonists on small islands. Thus the structure (range of island sizes in this case) of the reserve system is probably important to the number of species on islands in each size class.

There is a similar difference in the structure of natural island systems they describe and alternative man-made reserve designs. The authors compare numbers of species on the largest islands (at least in the Galapagos and Hawaiian archipelagos) with those on the other smaller islands. But the species diversity

on the islands in each size class results in part from species interchange in archipelago ecosystems that include a wide range of island sizes. Interchange will be less important in the Hawaiian archipelago since islands are farther apart.

The marine system comprised of "reserves" of hard substrate on a sandy flat also contains a wide range of reserve sizes. The constant influx of propagules of all species from the ocean is another important difference between this system and Quinn et al.'s hypothetical choices of reserve systems.

The data discussed by Quinn et al. contribute to this scientific field, but are not directly applicable as a guide to choosing among reserve systems comprised of similar-sized reserves when the goal is to conserve maximum biological diversity. Though data from natural islands suitable for addressing this question are probably quite rare, experiments can be designed that directly address this point.

Our second point is each reserve system is part of an encompassing landscape-level ecosystem with which it has many interactions – no reserve is an isolated island. The previous discussion and a short list of interactions illustrate the point. Some species will use resources outside reserves, transversing boundaries frequently, and some would maintain healthy populations even without reserves. While certain species prefer edges, interior species may need large buffers in order to avoid the modified edge environment (scale of meters to hundreds of meters) or the influx of predators or competitors from the non-reserve landscape. Interchange among reserves can occur if distances and adequate travel corridors (when needed) allow species movement. These interactions will depend on the composition, sizes, and shapes of different units in the landscape pattern, and importantly, will change as the landscape mosaic changes. Reserve systems therefore should be designed to *function* as part of the encompassing landscape ecosystem and to anticipate temporal changes in this landscape.

In the United States many National Parks abut other extensive federal lands. USDA Forest Service managers, for example, typically manipulate relatively large landscapes (relative to National Parks) and control a contiguous pattern of habitat patches and corridors in a dynamic state. They must manage for a wide range of values, including timber, recreation, water, wildlife, range. National Park Service managers on the other hand have different perspectives and options, managing one or two reserves within a landscape over which they have little or no control. Their objectives are admittedly different. Design (and management) of reserve systems and single reserves and management of adjacent lands would benefit from close coordination and long-term commitment among all managers of the landscape.

Studies of population biology and island biogeography to be applied to reserve systems must be put in a landscape context. From this perspective differences in structure (see discussion of grassland and natural island systems above) and context (see discussion of marine system above) become apparent. The emerging field of landscape ecology (see for example *Landscape Ecology* by R. Forman and M. Godron, 1986, Wiley) and tools for analyzing information in a spatial context (such as geographic information systems) promise to be of increasing value in this effort.

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