Biodiversity Hotspots Revisited

NORMAN MYERS

The biodiversity hotspots thesis was first published a long while ago (Myers 1988, 1990), and greatly revised and expanded recently (Mittermeier et al. 2000, Myers et al. 2000). Along the way it has generated an unusual amount of interest among conservation biologists, with several hundred journal articles published on one aspect or another. It has satisfied the scrutiny of the MacArthur and Moore Foundations, the World Bank, the Global Environment Facility, and Conservation International, among other organizations, which together have viewed the science as rigorous enough to warrant funding of over $750 million—the largest sum ever assigned to a single conservation strategy.

The thesis is based on the fact that conservationists cannot support all species under threat forthwith, if only because present funding is far from sufficient. Short of a monumental increase in funding, this problem is set to grow worse, fast. Much conservation activity has sought to do many things for many species, but because of a sheer shortage of funds has ended up doing relatively few things for relatively few species. Hence conservationists must determine planning priorities: how to get the biggest return per scarce dollar available, especially as concerns the super-imperative of stemming the mass extinction under way.

Various biological criteria can be invoked for priority-setting purposes (e.g., endemism, species richness, rarity, and taxonomically unusual species), as an article I wrote for *Nature* specifies up front (Myers et al. 2000). I selected *endemism,* but the hotspots approach explicitly does not rule out other criteria. It focuses on large terrestrial concentrations of endemic species, because these are, by virtue of their limited ranges, unusually vulnerable to extinction—and because a topmost priority for conservationists should surely be to prevent as many extinctions as possible. The hotspots analysis reveals that two-fifths of all species, roughly reckoned, are under extreme threat in 25 localities that make up just 1.4 percent of Earth's land surface; if we protect these areas, we would do more to stem the current mass extinction than we could through any other single measure. As a bonus, the hotspots also feature well over half of all species and of all known threatened species.

The hotspots thesis does *not* mean that if we save the 1.4 percent of Earth where so many species are endangered, then the rest of the planet can be paved over. Rather, the thesis asserts that by saving the most species at the least cost, the hotspots approach offers one good way to set conservation priorities. By extension, it implies that other species and other areas should receive lesser priority, which is altogether different from no priority. Moreover, the article in *Nature* expressly refers, in addition to the 25 hotspots, to several species-rich wilderness areas that face little threat so far and offer scope for us to "do things right from the start." They cover 6 million to 7 million square kilometers, an expanse as large as the continental United States.

The hotspots strategy does not exclude other areas from urgent conservation in accord with alternative criteria. "Biodiversity" writ large includes ecosystem processes, and thus it embraces the whole Earth. The British Isles harbor only a handful of endemic species, whereas many more are surely being pushed closer to extinction in the hotspots with every passing week. Hence, insofar as one of our prime conservation aims is to prevent mass extinctions, we should give more—but not exclusive—priority to the hotspots. This is not to say that the British Isles should be denied conservation efforts. Indeed, quite the opposite is true, bearing in mind the Isles' many biotas with their ecological functions and services. Biotic impoverishment assumes many guises, and the hotspots thesis should not be misconstrued to suggest anything else. At the same time, let us bear in mind that whereas certain ecological functions can be regenerated through restoration ecology, there is no restoration biology to regenerate extinct species.

There are other criteria that could be evaluated for priority-setting purposes. For instance, the hotspots approach reflects patterns of species distribution today, whereas we should also consider processes of speciation in the future in light of evolution's scope to make good the extinction losses under way. Some hotspots take care of this need, some do not. This issue has been addressed in detail elsewhere (Myers and Knoll 2001).

The hotspots thesis reflects the fact that we can never do only one thing. When we assign funds to one purpose, we implicitly deny those funds to some other purpose(s). We do not do it deliberately, but we do it, however little we may intend it. As long as conservation funds fall severely short of meeting all needs, we automatically make choices between this and that, and our spending patterns willy-nilly reveal our presumed priorities. Since choice is a built-in factor of the situation, let us make our choices by design rather than by default, and by a silver bullet strategy rather than a scattershot approach.

In point of fact, there could be sufficient funds available to safeguard the 25

hotspots, if we were to reorder some of our present conservation spending. The amount assigned to biodiversity in all forms worldwide—by governments, international agencies, and nongovernmental organizations—totals around $10 billion per year. An exploratory estimate (Myers et al. 2000) proposes that all the hotspots could be protected for one-twentieth of that annual total per year over five years; a later estimate (Pimm et al. 2001) proposes a one-time cost of $25 billion, which, spread over five years, amounts to $5 billion per year. Even the higher estimate could be accommodated by the $10 billion already being spent, as long as we choose to choose. At the same time, there would still be plenty of funds left over for other purposes.

The empirical evidence for hotspots—namely, that a great number of endemic species are found in relatively few areas—accords with findings from other priority-setting exercises. There is a 68 percent overlap with Birdlife International's Endemic Bird Areas, an 82 percent overlap with IUCN/WWF International's Centres of Plant Diversity and Endemism, and a 92 percent overlap with the most crucial and endangered ecoregions of WWF/US's Global 200 List. The hotspots analysis looks beyond the first two efforts, with their focus on birds and plants, to include mammals, reptiles, and amphibians, and it is more tightly targeted than the third.

It has been suggested that the hotspots approach, with its emphasis on species, does not highlight higher taxonomic groups. Yet the *Nature* article specifically includes a section on this topic. Another criticism that has been sounded is that the hotspots approach overlooks crucial biotas such as wetlands, notably tidal marshes. But the extensive coastal zones of Mesoamerica, Brazil's Atlantic Forest, West African forests, Sundaland, and another 10 of the 25 hotspots do include such crucial biotas. It has even been argued that hotspots do not provide for large carnivores, such as polar bears; but tigers, leopards, jaguars, cheetahs, cougars, and many other large mammals, as well as crocodiles and alligators, are protected in hotspots.

Where do we go from here? Conservation International has already sponsored research identifying 10 coral-reef hotspots (Roberts et al. 2002), and it plans to define another 10 terrestrial hotspots now that basic data have become available. In addition, there is an urgent need to document freshwater ecosystems—a composite of lakes, rivers, and other freshwaters—which could prove to be one of the most species-rich hotspots, certainly in terms of fish (the vertebrate category omitted from the *Nature* analysis), and one of the most severely threatened of all hotspots. Certain of the 25 already-identified terrestrial hotspots have been assessed as the hottest, and they are receiving beefed-up conservation efforts. There is also a need to address the extinction of populations, which are the main providers of ecosystem functions and services and whose extinction rate is far higher proportionately than that for species.

It is puzzling that the basic concept of hotspots has been challenged only in the last few years. Some have even charged that the originators should have compared notes with skeptical scientists to verify the underlying science, even though the empirical evidence reflects the findings of almost 100 field researchers. The concept was first published 15 years ago,. surely enough time for dissidents to have had their say. After all, we are dealing with a matter of exceptional importance and unique urgency. So perhaps the number one "what to do next" item should be for conservationists to make common cause on hotspots, as well as on whatever other priority-ranking systems are deemed worthwhile, and where there is no agreement, to pursue their own preferences rather than devising late-in-the-day arguments about hotspots—a case of horses for courses.

Clincher factor: The hotspots thesis has the potential to reduce the mass extinction under way by a whopping one-third. Edward O. Wilson, one of the leading authorities on conservation, described it as "the most important contribution to conservation biology of the last century."

Norman Myers (e-mail: Myers1N@aol.com), author of numerous books and hundreds of scholarly articles, is Honorary Visiting Fellow at Green College, Oxford University.

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