

Chapter 1

Global Biodiversity Conservation: The Critical Role of Hotspots

Russell A. Mittermeier, Will R. Turner, Frank W. Larsen,
Thomas M. Brooks, and Claude Gascon

Abstract Global changes, from habitat loss and invasive species to anthropogenic climate change, have initiated the sixth great mass extinction event in Earth's history. As species become threatened and vanish, so too do the broader ecosystems and myriad benefits to human well-being that depend upon biodiversity. Bringing an end to global biodiversity loss requires that limited available resources be guided to those regions that need it most. The biodiversity hotspots do this based on the conservation planning principles of irreplaceability and vulnerability. Here, we review the development of the hotspots over the past two decades and present an analysis of their biodiversity, updated to the current set of 35 regions. We then discuss past and future efforts needed to conserve them, sustaining their fundamental role both as the home of a substantial fraction of global biodiversity and as the ultimate source of many ecosystem services upon which humanity depends.

1.1 Introduction

Earth's biodiversity is in trouble. The combination of unsustainable consumption in developed countries and persistent poverty in developing nations is destroying the natural world. Wild lands continue to suffer widespread incursions from

R.A. Mittermeier (✉) • W.R. Turner • F.W. Larsen
Conservation International, 2011 Crystal Dr. Ste 500, Arlington, VA 22202, USA
e-mail: r.mittermeier@conservation.org; ramittermeier@aol.com

T.M. Brooks
NatureServe, Arlington, VA 22209, USA

World Agroforestry Center (ICRAF), University of the Philippines Los Baños, Laguna 4031, Philippines

School of Geography and Environmental Studies, University of Tasmania, Hobart, TAS 7001, Australia

C. Gascon
National Fish and Wildlife Foundation, Washington, DC 20005, USA

agricultural expansion, urbanization, and industrial development, overexploitation threatens the viability of wild populations, invasive species wreak havoc on ecosystems, chemical pollution alters biochemical processes in the soil, air, and water, and rapidly spreading diseases jeopardize entire branches of the tree of life (Millennium Ecosystem Assessment 2005; Vitousek et al. 1997; Wake and Vredenburg 2008). As these threats continue unabated, the impacts of climate change multiply. Changing precipitation and temperature, rising and acidifying oceans, and climate-driven habitat loss will disrupt ecological processes, test species' physiological tolerances, turn forests to deserts, and drive desperate human populations toward further environmental degradation (Turner et al. 2010).

Extinction is the gravest consequence of the biodiversity crisis, since it is irreversible. Human activities have elevated the rate of species extinctions to a thousand or more times the natural background rate (Pimm et al. 1995). What are the consequences of this loss? Most obvious among them may be the lost opportunity for future resource use. Scientists have discovered a mere fraction of Earth's species (perhaps fewer than 10%, or even 1%) and understood the biology of even fewer (Novotny et al. 2002). As species vanish, so too does the health security of every human. Earth's species are a vast genetic storehouse that may harbor a cure for cancer, malaria, or the next new pathogen – cures waiting to be discovered. Compounds initially derived from wild species account for more than half of all commercial medicines – even more in developing nations (Chivian and Bernstein 2008). Natural forms, processes, and ecosystems provide blueprints and inspiration for a growing array of new materials, energy sources, hi-tech devices, and other innovations (Benyus 2009). The current loss of species has been compared to burning down the world's libraries without knowing the content of 90% or more of the books. With loss of species, we lose the ultimate source of our crops and the genes we use to improve agricultural resilience, the inspiration for manufactured products, and the basis of the structure and function of the ecosystems that support humans and all life on Earth (McNeely et al. 2009). Above and beyond material welfare and livelihoods, biodiversity contributes to security, resiliency, and freedom of choices and actions (Millennium Ecosystem Assessment 2005). Less tangible, but no less important, are the cultural, spiritual, and moral costs inflicted by species extinctions. All societies value species for their own sake, and wild plants and animals are integral to the fabric of all the world's cultures (Wilson 1984).

The road to extinction is made even more perilous to people by the loss of the broader ecosystems that underpin our livelihoods, communities, and economies (McNeely et al. 2009). The loss of coastal wetlands and mangrove forests, for example, greatly exacerbates both human mortality and economic damage from tropical cyclones (Costanza et al. 2008; Das and Vincent 2009), while disease outbreaks such as the 2003 emergence of Severe Acute Respiratory Syndrome in East Asia have been directly connected to trade in wildlife for human consumption (Guan et al. 2003). Other consequences of biodiversity loss, more subtle but equally damaging, include the deterioration of Earth's natural capital. Loss of biodiversity on land in the past decade alone is estimated to be costing the global economy

\$500 billion annually (TEEB 2009). Reduced diversity may also reduce resilience of ecosystems and the human communities that depend on them. For example, more diverse coral reef communities have been found to suffer less from the diseases that plague degraded reefs elsewhere (Raymundo et al. 2009). As Earth's climate changes, the roles of species and ecosystems will only increase in their importance to humanity (Turner et al. 2009).

In many respects, conservation is local. People generally care more about the biodiversity in the place in which they live. They also depend upon these ecosystems the most – and, broadly speaking, it is these areas over which they have the most control. Furthermore, we believe that all biodiversity is important and that every nation, every region, and every community should do everything possible to conserve their living resources. So, what is the importance of setting global priorities? Extinction is a global phenomenon, with impacts far beyond nearby administrative borders. More practically, biodiversity, the threats to it, and the ability of countries to pay for its conservation vary around the world. The vast majority of the global conservation budget – perhaps 90% – originates in and is spent in economically wealthy countries (James et al. 1999). It is thus critical that those globally flexible funds available – in the hundreds of millions annually – be guided by systematic priorities if we are to move deliberately toward a global goal of reducing biodiversity loss.

The establishment of priorities for biodiversity conservation is complex, but can be framed as a single question. Given the choice, where should action toward reducing the loss of biodiversity be implemented first? The field of conservation planning addresses this question and revolves around a framework of vulnerability and irreplaceability (Margules and Pressey 2000). Vulnerability measures the risk to the species present in a region – if the species and ecosystems that are highly threatened are not protected now, we will not get another chance in the future. Irreplaceability measures the extent to which spatial substitutes exist for securing biodiversity. The number of species alone is an inadequate indication of conservation priority because several areas can share the same species. In contrast, areas with high levels of endemism are irreplaceable. We must conserve these places because the unique species they contain cannot be saved elsewhere. Put another way, biodiversity is not evenly distributed on our planet. It is heavily concentrated in certain areas, these areas have exceptionally high concentrations of endemic species found nowhere else, and many (but not all) of these areas are the areas at greatest risk of disappearing because of heavy human impact.

1.2 History of Hotspots

Myers' seminal paper (Myers 1988) was the first application of the principles of irreplaceability and vulnerability to guide conservation planning on a global scale. Myers described ten tropical forest "hotspots" on the basis of extraordinary plant endemism and high levels of habitat loss, albeit without quantitative criteria for the

designation of “hotspot” status. A subsequent analysis added eight additional hotspots, including four from Mediterranean-type ecosystems (Myers 1990). After adopting hotspots as an institutional blueprint in 1989, Conservation International worked with Myers in a first systematic update of the hotspots. It introduced two strict quantitative criteria: to qualify as a hotspot, a region had to contain at least 1,500 vascular plants as endemics ($>0.5\%$ of the world’s total), and it had to have 30% or less of its original vegetation (extent of historical habitat cover) remaining. These efforts culminated in an extensive global review (Mittermeier et al. 1999) and scientific publication (Myers et al. 2000) that introduced seven new hotspots on the basis of both the better-defined criteria and new data. A second systematic update (Mittermeier et al. 2004) did not change the criteria, but revisited the set of hotspots based on new data on the distribution of species and threats, as well as genuine changes in the threat status of these regions. That update redefined several hotspots, such as the Eastern Afromontane region, and added several others that were suspected hotspots but for which sufficient data either did not exist or were not accessible to conservation scientists outside of those regions. Sadly, it uncovered another region – the East Melanesian Islands – which rapid habitat destruction had in a short period of time transformed from a biodiverse region that failed to meet the “less than 30% of original vegetation remaining” criterion to a genuine hotspot.

Analyses up to now have revealed a set of 34 biodiversity hotspots. These regions collectively hold no fewer than 50% of vascular plants and 42% of terrestrial vertebrates (amphibians, mammals, birds, and reptiles) as endemics (Mittermeier et al. 2004). Because of the extreme habitat loss in these regions, this irreplaceable wealth of biodiversity is concentrated in remaining habitat totaling just 2.3% of the world’s land area (3.4 million km²; the original extent of habitat in these regions was 23.5 million km², or 15.7%).

In contrast with the terrestrial realm, data on the distribution and status of aquatic species are just beginning to be synthesized at a global scale. The publication of a first comprehensive global assessment of conservation priorities for an aquatic system – the coral reef study by Roberts et al. (2002) – has led to much-needed attention on marine hotspots. Our data on marine regions remain sparse compared with information on terrestrial systems (Sala and Knowlton 2006), and our lack of knowledge about freshwater systems is even more pronounced. However, significant strides are being made on aquatic biodiversity, for example, with efforts such as the Global Freshwater Biodiversity Assessment (Darwall et al. 2005) and the Global Marine Species Assessment, which includes comprehensive status assessments completed for reef-forming corals (Carpenter et al. 2008), and similar work under way for many thousands of other species.

The impacts of the biodiversity hotspots on conservation have been diverse and profound. Perhaps the most easily tracked metric is scientific impact. This metric indicates that the hotspots benchmark paper, Myers et al. (2000), has been cited by thousands of peer-reviewed articles, becoming the single most cited paper in the ISI Essential Science Indicators category “Environment/Ecology” for the decade

ending 2005. Yet the far more substantive impact has been in resource allocation. Myers (2003) estimated that the hotspots concept focused US\$750 million in globally flexible funding over the preceding 15 years. Entire funding mechanisms have been established to reflect global prioritization, among them are the US\$235 million Critical Ecosystem Partnership Fund (cepf.net/) and the US\$100 million Global Conservation Fund (conservation.org/gcf/; GCF additionally targets high-biodiversity wilderness areas). The ideas have also been incorporated into the Resource Allocation Framework of the Global Environment Facility (gefweb.org/), the largest conservation donor. All told, it is likely that the concept has focused well in excess of US\$1 billion on these globally important regions.

The last major hotspots update (Mittermeier et al. 2004) gave “honorable mention” to two other areas, the island of Taiwan and the Queensland Wet Tropics of northeast Australia, which just missed making the hotspots cutoff criteria. However, it was noted that *all* the rain forests of east Australia, and not just the very circumscribed Wet Tropics, should be included as a hotspot, but that data gathering to support this had not yet been completed. That investigation has now been concluded, showing that the region does in fact merit hotspot status, harboring at least 2,144 vascular plant species as endemics in an area with just 23% of its original vegetative cover remaining. This new addition to the hotspots list is detailed in Williams et al. (2011), bringing the total number of hotspots to 35 (Fig. 1.1). Table 1.1 tracks the regions considered biodiversity hotspots from the inception of the concept in 1988 through the various revisions to the present version, which includes the Forests of East Australia Hotspot.

1.3 Hotspots and Biodiversity

As new data enable us to periodically update the hotspots, they also grant us an increasingly complete picture of the natural wealth and human context of these important areas. Here, we examine the current state of our knowledge, building from earlier analyses with updated biodiversity data. The Global Mammal Assessment (Schipper et al. 2008), for example, provides substantially revised data on the status and distribution of Earth’s mammals, while recently compiled population (LandScan 2006) and poverty (CIESIN 2005) data sets provide important socio-economic context.

A total of 35 regions now meet the hotspot criteria, each holding at least 1,500 endemic plant species and each having lost 70% or more of its original habitat extent. Combined, the 35 hotspots once covered a land area of 23.7 million km², or 15.9% of Earth’s land surface, just less than the land area of Russia and Australia combined. However, as a result of the extreme habitat destruction in these regions over the past century, what remains of the natural vegetation in these areas is down to just 2.3% of the world’s land area (3.4 million km²), just greater than the land area of India. More than 85% of the habitat originally present in the hotspots has

Biodiversity Hotspots

Distribution and Protection of Conservation Priority
Areas

Zachos, F.E.; Habel, J.C. (Eds.)

2011, XVII, 546 p., Hardcover

ISBN: 978-3-642-20991-8