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Conservation of Biodiversity: How are We Doing?

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Summary. A question rarely raised in discussions on biodiversity conservation, but surely the biggest question of all, is "How much time do we have left before the mass extinction underway surpasses our best efforts to contain it?" This prompts a further prime question because—and unlike all other problems, whether environmental or otherwise—the biotic crisis threatens to leave a severely impoverished planet for millions of years ahead; "Why do we not undertake the necessary actions to get on top of the problem before it gets on top of us?"

Keywords: mass extinction of species, tropical deforestation, forest fragmentation, delayed fall-out effects, time left for conclusive action, comparative costs, socioeconomic and political mobilization

Introduction: mass extinction: how fares the planet?

It is several decades since it was realized that the planet is into the opening phase of a mass extinction of species. Since then, scores of scientists have written hundreds of books and thousands of articles on the issue, and activists—whether governments, international agencies, or NGOs—have mobilized unprecedented efforts to stem the crisis. But while conservation resources—scientific skills, funding and the like, plus measures such as more protected areas—have increased greatly in the recent past, the problem has grown much greater, as leading habitats such as tropical forests have declined at ever-faster rates. The best efforts have hardly done more than slow the pace at which the mass extinction gathers momentum. This assessment is not defeatist. Rather, it is realistic, and it is necessary to keep a keen eye on the deteriorating situation. It is one thing to ask "How much better are we doing than before?", it is another thing to ask the ultimate question, "Are we doing enough?"

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This paper raises a basic issue. How much progress has been made, how far are conservation efforts falling short, and how much time is left before the extinction problem exceeds human reach, and further best efforts become no more than salvage affairs? An assessment along these lines will perforce be exploratory at best, even speculative, but it should illuminate a crucial aspect of the prospect ahead. The reader is asked to view this paper as a best-judgement exercise, that is beset with many uncertainties, rather than a technical scientific affair with definitive conclusions.

Destruction of tropical forests

Tropical forests are central to the issue. They share two unique characteristics. First, they are exceptionally rich in species, containing at least half, and perhaps two thirds of Earth's species in just one twentieth of Earth's land surface. Second, they are being destroyed faster than any other extensive biome (freshwater systems may well be declining as fast or faster, but they cover an expanse less than one tenth as much as tropical forests, and they harbor far fewer species). The planet has already lost at least half of the forests, and the rest are being effectively eliminated (grossly degraded as well as destroyed outright) at rates of between 1 and 2 percent per year (Myers, 1996; Matthews, 2001; Pimm, 2002; for a dissident view of this contentious issue, see Achard *et al.*, 2002).

The fact that half of the forests have been lost, does not mean the loss of half of their species. Far from it. But there is sound reason—not conclusive, but persuasive—that every year there could be tens of thousands of species (not just plants and vertebrates, but also invertebrates) that go extinct (a few) or are 'doomed to die' (many; for clarification of this latter factor, see below). These extinction estimates are not definitive, rather they are rough and ready, but they are enough to make the point (Pimm and Raven, 2000; Ehrlich, 2001; Wilson, 2002).

Tens of thousands of extinctions per year, whether present or prospective, may not sound like much out of a putative planetary total of 10 million species. Whatever the true rate, what counts is the pace at which extinctions are accelerating. The current rate is between 100 and 1000 times, conceivably still more times, greater than the prehistoric rate (Myers, 1990; Pimm *et al.*, 1995; Raven and McNeely, 1998; May, 2001). However approximate these and other extinction estimates may be, they are advanced here with the sole purpose of gaining an 'intellectual lock' on the mass extinction underway—not only how large it is, but how fast it is overtaking attempts to prevent it.

On top of tropical forest extinctions are those in other biomes. Numerous as they doubtless are, especially in aquatic systems, both terrestrial and coastal, they do not match those in the forests (if only for the reasons given above), which must rank as the prime locus of the mass extinction. Of course all biomes have their own rationales for urgent action, and a focus on tropical forests does not mean—the point is emphasized—that other biomes should suffer neglect in deference to tropical forests.

Fragmentation of tropical forests

Probably as important as outright destruction (let alone gross degradation) of tropical forests is fragmentation (Turner, 1996; Schelhas and Greenberg, 1996; Laurance and Bierregaard, 1997). In the Philippines, for example, a mere 8000 km^2 remains of the 270000 km^2 of original forests. The country still remains exceptionally rich in species. Almost entirely within the forest remnants there are 5832 endemic plant species, or 77 percent of all the Philippines' plants (the British Isles, roughly the same size, have only 20 or so endemic plants). The forests also contain 518 endemic non-fish vertebrate species (the British Isles, 1 species), making up 47 percent of all the country's non-fish vertebrates (Myers *et al.*, 2000). In addition, it can reasonably be assumed that there is a roughly similar proportion of endemic invertebrates (Strong *et al.*, 1984; Samways, 1996; Price, 1997). Altogether endemic species in the Philippines must total tens of thousands.

Fragmentation has reduced the relict forests to patches, ranging in size from 1000 km^2 to less than one km^2 (Gillison, 2000; Heaney, 2002). All these fragments, and especially the smaller ones, will, for reasons of the well established theory of island biogeography (MacArthur and Wilson, 1967; and for its many qualifications, *e.g.* the metapopulations factor, see Rosenzweig, 1995; May and Stumpf, 2000; Ney-Niffle and Mangel, 2000; Heaney, personal communication, 2001) generally prove too small to maintain their species in perpetuity. Through processes of ecological equilibriation, they will suffer 'delayed fallout effects,' meaning that many species will eventually disappear through loss of sufficiently large habitats, however strenuous the efforts of conservationists to protect them (Brooks *et al.*, 1999; Pimm and Raven, 2000; Laurance *et al.*, 2002). Indeed a critical minimum size to overcome the fragmentation problem will probably need to be tens of thousands of km^2 in light of the low population densities of many species (Rosenzweig, 1995; Soule and Sanjayan, 1998; Laurance *et al.*, 2002). Due to slow decompression times among other factors, the fallout processes will often take an extended period to exert their full depletive impact; in some instances, decades or even centuries. But the ultimate effect will be the same.

These delayed-fallout species have long been known to biologists as 'doomed to die' or 'living dead' (Janzen, 1986; 2001; Samways, 1996; Turner, 1996; see also Brooks *et al.*, 1999). A good proportion of the tens of thousands of endemic species in the Philippines can surely be described that way. And all this arises, a mini-mass extinction underway, in just 0.1 percent of all tropical forests.

There is similar fragmentation in other tropical forests. The Eastern Arc forests of Tanzania, comprising only 2000 km^2, are split into no fewer than 128 patches ranging from over 100 km^2, to just a few km^2 (Lovett, 1999). The Atlantic forest of Brazil is reduced in two-fifths of its expanse to fragments smaller than 100 km^2, and in one quarter, to fragments smaller than 1 km^2 (Dean, 1995; Brooks and Balmford, 1996). Other severely fragmented forests include those of MesoAmerica, the tropical Andes, the Caribbean, West Africa, Madagascar, India, Thailand, Indo-China, Indonesia, and Polynesia/Micronesia, all of which are so species rich, and so threatened by habitat loss that they qualify among the 25 biodiversity hotspots worldwide (Myers *et al.,* 2000). If all remaining habitats in the hotspots were to be preserved, which is an idealistic prospect, there would still be an eventual loss of 18 percent (Pimm and Raven, 2000) of their 133000 plant species and 9650 nonfish vertebrate species, plus much larger numbers of their invertebrate species, conceivably totalling over 400000 species.

Also in the wake of fragmentation, forests will suffer desiccation through local climatic changes (Meher-Homji, 1992; Salati and Nobre, 1992). Others will experience acidification (Innes and Haron, 2000). Certain such factors will operate with dynamic inertia and with synergized interactions, making their impacts all the greater (Laurance and Cochrane, 2001). As with fragmentation, many of these processes will exert an increasingly adverse effect for a good way into the future, no matter what vigorous attempts are made to resist the process.

Moreover, desiccation and other forms of environmental degradation will apply, also in nonforest zones such as savannahs. Desertification in many areas will have the capacity to expand its impact through built-in momentum.

Finally, there is enough global warming in store through past greenhouse gas emissions to impose significant habitat loss through climatic dislocations, such as disruption of rainfall regimes (Laurance *et al.*, 1998; Malcolm *et al.*, 2002). This will ensue no matter what counter-efforts are made. In the Succulent Karoo and the Cape Floristic Province hotspots, for instance, certain scenarios postulate that temperature and precipitation changes could well eliminate the great bulk of their habitats (Midgley *et al.,* 2001). In addition, a different sort of threat from global warming, an even more severe one, seems set to eventually overtake several hotspots in tropical forests. As temperature bands migrate away from the equator, vegetation communities will seek to follow (Malcolm *et al.,* 2002; Walther *et al.*, 2002). But as the remnants of the Cape Floristic Province try to migrate southwards, they will have nowhere else to go, for the most part, but into the ocean. A few vegetation communities could seek accustomed climate regimes by migrating up mountains, and other communities might gain some relief through maritime effects, but the scope is limited. The same applies to southern Madagascar, New Caledonia, southwestern Australia and southern New Zealand; and in the northern hemisphere with northwards migrations, it applies to the southern littoral sector of the Mediterranean Basin, the Caribbean islands, northern Philippines, eastern Malaysia, and northerly parts of Indonesia.

As a result of the potential biodiversity depletion that humankind has already generated, it is realistic to prognose that there would be large numbers of extinctions in, say, a post-2020 world, even if it were relieved of humankind's existence. For sure, this is a highly pessimistic prognosis, and the writer is anxious to avoid undue doom and gloom. As much as possible must be done to limit the biotic debacle ahead. But humankind must bear in mind the ultimate constraint: the scarcest conservation resource is time.

How much time is left?

This is not only the biggest question of all, it is surely the toughest. There is insufficient scientific knowledge and understanding available to attempt anything beyond a preliminary and exploratory answer. But the question is so crucial that it warrants the best response that can be devised, however tentative that may be. An assessment, however rough and ready, could throw light on the degree of urgency that should be deployed, how far humankind is falling short, and what extra efforts should be envisaged.

A major factor in the mass extinction, therefore, lies with the momentum of processes that lead to loss of habitats and other components of ecosystems. It will prove exceptionally difficult to even slow the destruction of tropical forests among other key biomes, let alone to stop it altogether, let alone to reverse it. There is need to do much more than establish more parks and reserves, imperative though this is. Moreover, landless peasants, wild fires, diseases, freak weather phenomena and climatic processes take no notice of protected areas' boundaries; already a good share of tropical forest parks and reserves have undergone encroachment by subsistence farmers.

Fortunately there are many other cogent reasons, apart from safeguarding species, to justify greater protection of tropical forests, as witness their role in *e.g.* watershed functions and in carbon fixation. Insofar as this applies to other biomes too, a stage is being approached where most biodiversity can be saved only by saving most of the biosphere. Forests must be restored, deserts pushed back, water supplies protected, topsoil replenished, pollution reduced, and climate stabilized among many other measures—all of which should be measures undertaken for all manner of sound reasons, even if there were no biotic crisis. To this extent, conservation of biodiversity should be part of a win-win outcome, with multiplier effects in both directions. In fact, the many spin-off benefits of biodiversity conservation could often generate a cost-benefit ratio of at least 1:100, even more in developing countries (Balmford *et al.,* 2002).

Regrettably, there are no estimates of the length of time needed to achieve this ultimate goal. To gain a perspective on an effort of such an outsize scale, compare it with horizons postulated for major program in other spheres. The United Nations' Millennium Declaration has proposed a 15-year action plan to cut malnutrition by half (thus implying that it would be somehow acceptable to still have 400 million people left hungry). The same length of time is envisaged for halving the proportion of people without safe water; for reducing under-five mortality by two thirds; for enrolling all children in primary schools; and for halving the number of people in absolute poverty (United Nations, 2000; see also United Nations Development Program, 2001). These aspirations are modest enough, yet only about half of the countries concerned are on track, and the rest are lagging or are far behind. Malnutrition is being cut by just five million people per year, rather than the aimed-for 28 million people, and as many people endure absolute poverty as in 2000.

These 'best available' prognoses can serve as crude indicators, even though they are far from parallel with those for socio-economic programs. (Attempts could be made to determine what time horizons could apply to individual biomes and countries, but that is beyond the scope of this opinion piece.) To cut the destruction of tropical forests by half, could well take at least fifteen years, and the same for the associated problems of forest degradation and fragmentation. Given that the two sets of problems have combined annual rates today of roughly 2 percent, or at least 30 percent every 15 years, and given that the rates have been accelerating for several decades (Ehrlich, 2001; Matthews, 2001; Pimm, 2002; Wilson; 2002), a 'cut by half' goal might seem overly ambitious. Suppose too, that a roughly similar amount of time should be postulated to halve the other prime sources of habitat loss in savannahs, arid lands, wetlands, and other major biomes. That a target date of 2015 is not wholly arbitrary is confirmed by an experts report prepared by the United Nations Environment Programme for the recent World Summit on Sustainable Development (United Nations Environment Program, 2002).

It should also be borne in mind that cutting the loss of biodiversity habitats planet-wide by half, would probably do no more than slow the extinction rate, if only because of delayed-fallout impacts. True, this would be an exceptional accomplishment, given that best efforts to date have only slowed the rate at which extinctions are increasing. All the same, an advance of that order would still leave the planet with a mass extinction ahead: not so severe as a 'business as usual' scenario, but leaving it with the loss of perhaps one quarter, rather than one half of all species (the latter proposed by Ehrlich, 2001; Raven, 2002; Wilson, 2002). In other words, an extinction episode would occur greater than any since the demise of the dinosaurs and associated species 65 million years ago.

Of course a time horizon of 15 years is an arbitrary estimate. It may well be a good deal more than 15 years; or with urgent and incisive action of a vigor surpassing anything that has been accomplished to date, it could conceivably be less. Moreover, the figure will vary from biome to biome and from country to country. At all events it will mean that conservation gears will have to be shifted in radical style. Principal conservation campaigns have been underway for at least 30 years, and, notwithstanding many success stories, they have hardly made more than dents in an ever-expanding problem.

In face of this dismal prognosis, moreover, it must be admitted that all the depletive processes in question are not adequately understood. How soon might thresholds in major biomes be crossed beyond which ever-greater efforts will achieve ever-smaller impacts? There is scant attempt in relation to the problem to appraise the repercussions through broad-scope and in-depth research. Comprehensive and systematized efforts are required to confront the challenge in its full scope. Thus far, the effort has scarcely been delineated in principle, let alone programmed into practice. Indeed, there is no generally agreed research agenda for the conservation challenge, drawn up with targeted priorities. While a host of scientific issues clamor for attention, there is the spectacle of the United States' white tailed deer being subjected to over 7000 research theses and reports during the past 50 years, at a cost of at least $50 million, even though the species is far from threatened (Wildlife Management Institute, personal communication 2000). Rather it attracts still more funding to limit its numbers.

Needed: a shift in perspective

The forgoing implies the need for an expanded approach for the conservation challenge. Certainly, conservationists have worked long and hard to preserve biodiversity for half a century, until they have become exceedingly skilled at many of their tasks. But in addition to tackling problems, they might do more to tackle *sources of problems*: how to stifle problems before they ever develop? This means addressing those perverse subsidies totalling $2 trillion per year worldwide which are destroying forests, expanding deserts, reducing water supplies, fostering grandscale pollution, stimulating soil erosion, and even causing climate dislocation, among other forms of biodepletion (Myers and Kent, 2001). If the other developed countries were to follow the example of New Zealand and abolish their agricultural subsidies, that would release $350 billion of unneeded subsidies per year; and less than 5 percent of that needs to be assigned to biodiversity protection in order to increase current spending three times over. At the same time, phasing out the subsidies would go far to preventing further ecological injury to biodiversity habitats across millions of square kilometres. This is unlikely to be achieved overnight. Funds will have to be found from more conventional sources. What might it all cost? There is a variety of answers. To safeguard the 25 terrestrial hotspots could be achieved for roughly $2.5 billion over five years (Myers *et al.,* 2000), an outlay that could possibly reduce the species extinction spasm by an enormous one third. Some 35–45 percent of the Earth's estimated 10 million species are confined to these hotspots, where they are severely threatened.

A more ambitious effort lies with a global reserve network, covering 15 percent of each continent (*c.f.* only 8 percent of the biosphere today), and taking in all of Earth's principal habitats and hence the great majority of Earth's species, plus 30 percent of marine habitats; this could cost *circa* $50 billion per year (Balmford *et al.,* 2002). Still another estimate proposes $300 billion per year for the same purpose, plus the 'greening' of agriculture, forestry and fisheries, *i.e.* making them sustainable and non-destructive of biodiversity habitats outside protected areas (James *et al.,* 2001). Large as these sums might seem, they should be viewed in perspective. The largest, $300 billion, is no more than 0.7 percent of the global economy, and it is only 15 percent of subsidy supports for activities that lead to environmental degradation in the first place (plus gross economic distortion and slow down).

In terms of financial costs the job could certainly be accomplished; nor would other factors be insurmountable. To stem global warming, for instance (this ranking among the biggest sources of habitat loss in the eventual future), the technologies to replace fossil fuels are largely available (and with massive financial benefits in the long run) (Hawken *et al.,* 1999). The main obstacles are political, *e.g.* the special interest groups that maintain perverse subsidies despite their many environmental (and economic) costs. What is needed is a political commitment to an effort on a scale of the Manhattan Project to produce the first atom bomb. One such effort has been the Marshall Plan, with a bill of $90 billion (in 2001 dollars), though it is questionable if Harry Truman and George Marshall could get their inspiring initiative accepted today in light of the many lobbyists who would militate in favor of their special interests to the detriment of the Plan.

Note too a couple of other grandscale projects in recent decades, with costs (in 2001 US$) in the same order of magnitude: putting a man on the Moon, $100 billion; and the Missile Defence System, $150–240 billion. A third, though much smaller outlay was the Pathfinder probe to seek life forms (a few primitive slime moulds?) on Mars, at a cost of a mere $240 million, but an outlay half as much as the proposed annual budget to save all the 25 hotspots with their estimated total of roughly three million species.

So the problem seems to devolve into a case of societal vision, plus the political will to translate the vision into action. Various communities in the past have mobilized the institutional chemistry to achieve successes of a size proportionately far more costly than what is required to counter the biotic crisis. Notable examples are the building of the Pyramids in Egypt, and the Gothic cathedrals in Europe, both of which demanded the assignment of exceptionally large sections of contemporary economies and social capacities. Both were achieved through society-wide endeavour, voluntarily deployed.

Such an attempt could be made today, especially insofar as the long-term payoff would be far more enduring than the Pyramids and cathedrals have proved thus far? After all, if humankind fails to protect biodiversity at a time of unprecedented peril, the length of time it will take for evolution to come up with replacement species will be at least 1000 times longer than the Pyramids have been in existence. Should this not inspire humankind to expand a sense of what is at stake, and do it at least as effectively as the religious rationales for the Pyramids and the Gothic cathedrals?

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