BIODIVERSITY, ITS LOSS AND WHY IT MATTERS

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Introduction

'Biodiversity' is a term that describes the richness of life on Earth. However, this wealth is being eroded with such rapidity that it has become a major concern of our age. This paper sets out why. We look at what biodiversity is and where it is to be found. We survey briefly the drivers of biodiversity loss and also the different ways in which biodiversity is valuable, and not just to human society. Global efforts to conserve biodiversity achieve some successes that we must celebrate, but are yet to turn round a pervasive problem. We end by exploring how this should be seen as a distinctly Christian concern, and the unfulfilled role that the church can and must play.

What, and where, is biodiversity?

Biodiversity is a relatively modern term and has become accepted as a synonym for 'Life on Earth'. The word derives from 'biological diversity', and is defined as 'the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems'. Whilst the common currency of biodiversity-speak and action is the species (and we will concentrate on species as the main metric of biodiversity in this paper), the definition emphasises the multiple scales at which the diversity of life needs to be considered.

The Iberian Lynx (Lynx pardinus) mother and cubs. *Picture 1*

Many Critically Endangered Species, such as this felid from Southern Iberia, face the real possibility of extinction

Clearly, there is biodiversity everywhere, from the community of woodlice and spiders in a garden shed, to the areas that we consider truly wild. However, biodiversity is not evenly distributed around the world, and concentrations are particularly notable in tropical climates and especially tropical forests, which are considered to hold between one half and two-thirds of the total number of different animals and plants in the world [1,2].

Theories abound as to what lies behind these global patterns of species richness, from climate stability, to resource abundance and productivity, to geometrical and statistical reasons. The 'mid-domain effect', for example, predicts this phenomenon simply by the fact that species with large latitudinal distributions must be present in the tropics.

Remarkably, in an age of scientific advance and space exploration, we do not know what that total number of species is. Some species, such as micro-organisms, are much harder to recognise than others, and their habitats can be difficult to access if they are in the forest canopy or deep sea. Estimates of how many species there are globally vary between 4 million and tens of millions, and are often derived from courageous extrapolations. For example, one classic study used the relationship between body size and number of species of better-known animals to make estimates for lesser-known, smaller organisms[3]. Another study counted the numbers of canopy beetles associated with individual tree species and then scaled this up to the forest ecosystem[4]. Even among those species that have been described and catalogued, the current lack of a central, comprehensive database means that synonymy (the same organism going by different names) may be as high as 40% in some groups[5]. Initiatives such as Catalogue of Life[6] are seeking to address this problem.

The biodiversity crisis

The extinction of species is not new in the history of the Earth. Five waves of extinction dating back some 450 million years have been uncovered in the fossil record. Many scientists now believe that we are experiencing a sixth extinction at least as dramatic, associated with an unprecedented transformation of the world in the current, geological epoch of the 'Anthropocene'[7]. Estimates of the current rate of species loss range from 100 to 1000 species per calendar year for every one million extant species, many times more than what we infer to be the background rate in the past. Some 1200 extinctions have been actually documented over the past 400 years. Making predictions of future extinctions is difficult; calculations based on rates of habitat loss, and how the number of species changes with habitat area, are bounded by a large number of assumptions. Many species that are going extinct have yet to be discovered and named; in the analogy of John Dingell, the library is burning and we haven't even read its books[8].

What is driving this dramatic loss of biodiversity? Quite simply, a burgeoning human population, and its increasing demands for space and resources, is leaving less space and resources for nature. Some 30–40% of the world's net primary productivity is being appropriated by people[9] and our World Ecological Footprint has been overshooting the Earth's biological capacity since the 1980s[10]. The resulting habitat destruction has been recognised as a major problem for some decades, and

there is no sign of its abatement. On the contrary, as the number of the people in the world is projected to reach 10 billion this century, the demand for more food and biofuels is likely to impact even more on natural ecosystems. Even by 2050, it is expected that the global food demand will increase by between 70 and 110%[11]. This pressure on land and resources is most acute where there is most biodiversity: in the tropics. The population of Africa is set to quadruple, for example, and whilst there is a lot of room for increased efficiency of agricultural production, expansion of agricultural lands will be enormous, leading to the loss of old-growth forests, woodlands and semi-arid environments and their associated wildlife[12].

Other threats to biodiversity exacerbate the impact of habitat loss. They include over-exploitation, whether of forest trees such as the mahoganies highly sought after for their timber, or numerous examples of over-fishing. The hunting down of the passenger pigeon, from population sizes once peaking at 3–5 billion, to extinction, is one of the most dramatic examples of over-exploitation. Artificially moving species around the world is also a major problem worldwide. When they get out of control, they can cause major environmental damage, for example costing some $137 billion a year in the United States to sort out[13]. Aggressive competitors, or new predators, have led to extinctions, including many small and vulnerable island populations of endemic animals and plants. One documented case is that of the cahow, a seabird, whose nests in Bermuda were dug up by introduced pigs and predated by introduced cane rats. However, in this case there has been a happy ending: though considered to have gone extinct in the 1600s, it was rediscovered in 1906 and circa 75 pairs survive today following remedial action[14].

Pollution, diseases, human disturbance and climate change are further factors in biodiversity loss. Climate change has emerged as a major threat to both biodiversity and society, and science struggles to keep pace with its rapid developments. As a result of climate change, organisms become mal-adapted in their changing home environments, and struggle to migrate across fragmented landscapes. Changes in seasonal timing can disrupt finely-tuned food chains. Enhanced CO_2 levels in the atmosphere lead not just to the greenhouse effect, but also ocean acidification and associated threat to corals and other marine calcifying organisms, whilst rising seas levels are likely to inundate biodiverse ecosystems. Some 300 endemic species in three island ‘hotspots’ of biodiversity are potentially threatened by loss of their habitat in this way[15].

Given all these threats, what are the implications for life on earth, and for society? In other words, how do we count the true cost of losing biodiversity?

Biodiversity values

We care about biodiversity loss because we depend on the wealth of animals and plants for our own survival. Biodiversity provides our food, much of our shelter, many of our medicines. These are the so-called 'direct use values'. But there are lots of indirect ones too: those often hidden functions that natural ecosystems perform such as the cycling of nutrients upon which are agricultural systems are based, regulating the climate, and controlling the availability of water resources. The yields of some of our crops depend on pollination by bees and other insects. Biodiversity is enjoyed recreationally for its colour, inspiration, beauty, variety and curiosity – we pay to visit nature reserves and natural parks, to watch birds, and we spend hours enjoying nature programmes on television.

All of these provisioning, supporting, regulating and cultural/recreational functions of biodiversity have become known as 'ecosystem services', and much conservation policy and practice is now driven by this concept. Efforts are made to calculate their monetary value, such that the conservation of biodiversity can somehow be internalised and supported by the world's economic markets. Notable among these attempts is The Economics of Ecosystems and Biodiversity (TEEB) Report, led by the Deutsche Bank economist Dr Pavan Sukhdev[16]. Amongst its findings was that forest loss costs society between $2–5 trillion per year, representing 7% of global GDP and dwarfing losses made on the financial markets during the recent economic crisis. Other such studies concentrate on the local or regional level, including the Valuing the Arc (the Eastern Arc mountains of Tanzania) project, which investigated in detail the values of carbon storage, tree species and forest birds, amongst other facets of local ecosystems[17].

Such approaches are not without their critics, who point out that sometimes ecosystems services can be provided by non-native species, or species-poor modified environments, whilst species of no recognised value – the desert tortoise or ephemeral pool invertebrate – could lose out[18,19]. But more importantly, conservation is likely to be seriously undermined if the emphasis on economic justification for conservation is allowed to outweigh non-economic arguments. For many, whether out of moral, ethical or religious motivation, the most compelling argument for biodiversity conservation rests in the intrinsic value of nature, rather than its use values to human society. To criticise traditional conservation practice and champion the 'new conservation science' focused on human welfare, risks disenfranchising those who would otherwise have much to give in time or funds to conserving biodiversity for its own sake[20].

Solutions

Biodiversity conservation approaches are myriad, ranging from ex-situ to in-situ, practical to political, species-focused or ecosystem-based. The latter dichotomy summarises traditional approaches in which, on the one hand, individual endangered species such as the black rhino are targeted with remedial actions, and on the other, reserves such as the Yellowstone National Park are created to preserve intact habitats and their wildlife. Sometimes a species of particular popular appeal can draw in funding not only for its own conservation but that of its habitat and associated wildlife; at other times its conservation can have wider import for associated species. The terms 'flagship' and 'keystone' or 'umbrella' species have been coined for such instances[21]. Protected area coverage is now statistically very significant in many parts of the world; some 21% of Europe and 32% of the Amazonian and other Neotropical broadleaf moist forests have some conservation designation[22,23]. IUCN global Red List assessments are the best means of establishing the conservation status of the world's fauna and flora, and help inform 'gap analyses' which determine the extent to which the protected area networks safeguard the most threatened species, and where new areas need to be established. New Red Lists for ecosystems are now being developed and will inform further where major gaps need to be plugged in our spatial conservation planning[24].

Rainforest near Manaus,Amazonia *Picture 2*

Tropical forests hold over one half of the world's animal and plant species

Species conservation and protected areas are driven or underpinned by biodiversity policies and legislation. For example, the Natura 2000 network of protected sites has been established in fulfilment of the demands of two European Community environmental directives: those for Birds, and Habitats and other species. This legislation has been described as the most ambitious supranational policy in the world aiming to conserve biodiversity through land use regulation[25]. Meanwhile in the Unites States, the Endangered Species Act (ESA), passed by Congress in 1973, has – as of January 2014 – listed 2054 species as endangered or threatened. The ESA makes it unlawful to harm the listed species, but beyond that, it also aims to recover these species through

landowner agreements, habitat plans and other measures[26]. International legislation and agreements include the Convention on International Trade in Endangered Species (CITES), aiming to control the harmful trade of wild fauna and flora, and the Convention on Biological Diversity (CBD), the most significant over-arching framework for international cooperation on biodiversity conservation. State signatories to this convention are obliged to develop biodiversity strategies (e.g. the UK Biodiversity Action Plan), and these increasingly recognise the need to take biodiversity conservation into every sector and policy area, whether energy, business, or agriculture. Whilst the importance of agricultural landscapes for biodiversity has been under the spotlight for some time, interesting discussion has recently arisen around the question of whether conserving biodiversity in farmland, or in areas put aside for nature, represent the most effective way forward: the so-called land sharing or land sparing debate[27].

There have been notable successes in all of the above approaches, and they need to be celebrated. Success on the front lines of conservation can give us 'Wild Hope'[28]. Nevertheless, it is difficult to escape a sense of foreboding as international targets for biodiversity conservation are spectacularly missed, and as the prospect of a world population of 10 billion people threatens to send the Earth to a catastrophic tipping point[29]. Where do we go from here?

A Christian response

There is both a distinct Christian commentary and a distinct Christian contribution to be made in the field of biodiversity conservation. The Christian commentary is based on the Biblical celebration of biodiversity, and the Biblical story of the fall of the world. The former brings coherency to the understanding of the intrinsic worth of the natural world that we share this planet with: quite apart from representing God's provision for humankind, it is above all God's handiwork, proclaimed good and enjoyed by Him and with an inherent capacity to praise Him[30]. From the Bible we come to see that we, and the living creatures around us, are all part of one community of creation and this commonality is important in our understanding of stewardship. Stewardship should be exerted with caring responsibility for other creatures and we should recognise its limitations in the context of God's active creativity and care of His world: there will be times and places to let be instead of intervene; our filling the land should not be at the expense of other land animals[31]. But the crisis facing biodiversity today shows all too clearly that humankind is failing in its duty of care, and the Bible helps us to see how this predicament is a consequence of sin entering the world. It can be understood as part of the curse of separation from God, but also mechanistically where the links between the fallenness of people, and ruin in the environment they inhabit, are closely linked[32].

The distinct Christian contribution to biodiversity conservation stems not from any wild hope based on human achievement in saving the world's habitats and species, but instead, an eschatological hope. God has not finished with the world, and the climax of His story is the new heavens and new earth, in which His creation is released from its bondage to decay into the glorious future kingdom of God[33]. This provides Christians with the motivation and indeed imperative to participate in God's work in the world, getting their hands dirty in its messiness as they anticipate (rather than achieve) the liberation of creation[34]. That is why we enjoy a rich heritage of Christians pioneering missions of mercy to the poor and sick. With the strong advocacy and educational work of the John Ray Initiative, and pioneering practical examples provided by A Rocha[35], together with other initiatives and organisations, the Church is belatedly awakening to discover parallels in nature conservation and other environment concerns. Whilst it has recently been observed that conservation is mostly about working with people, Christians will go a step further to say that it is all about the human heart. It is only a turnaround in our perception of the world, its origin and destiny, which can make a true difference to our relationship with it. This presents as much a challenge for the Church corporately and its gospel message and mission, as it does for Christian individuals, families and communities to model what this looks like through integrating environmental concern into their own discipleship.

Biography

Dr Will Simonson is a researcher in the Forest Ecology and Conservation Group, Department of Plant Sciences, University of Cambridge. There, he combines traditional field recording with novel remote sensing technologies to study Mediterranean woodlands and their biodiversity. He has a long association with A Rocha, and with his wife Rachel and family was based at its centre in Portugal for eight years.

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Picture 1 Lynx Ex-Situ Conservation Programme, licensed under CCB, http://commons.wikimedia.org/wiki/File:Two_Iberian_Lynx_cubs_with_mother.jpg

Picture 2 Neil Palmer, CIAT, used under CC BY, http://commons.wikimedia.org/wiki/File:Amazon_CIAT_%283%29.jpg