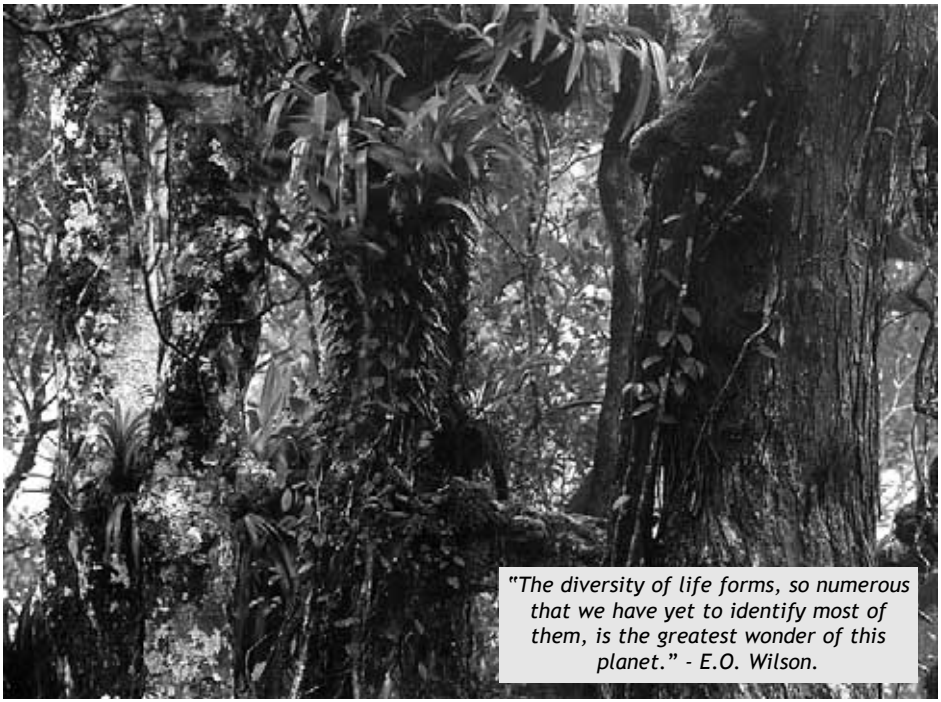
Biodiversity And Its Loss...

What Does It All Really Mean?



"The diversity of life forms, so numerous that we have yet to identify most of them, is the greatest wonder of this planet." - E.O. Wilson.

The word *biodiversity* beautifully and succinctly captures a fundamental idea: life on earth is extraordinarily diverse and complex. However biodiversity is a commonly used and misused term in EF! circles and others. In a speech to the Royal Geographical Society last year, John Prescott, Minister for Environment, used the work biodiversity 11 times. Afterwards he was askedwhat the word meant, and he candidly said, "I don't really know." Below I discuss what biodiversity means, who we share our planet with, what are the prime reasons for biodiversity loss, the purported reasons for conserving biodiversity, their philosophical underpinnings (highlighting those that fit in to a revolutionary political agenda) and finally sketch some possible future scenarios for us and our fellow life-forms on earth.

Say the word biodiversity and it conjures many images, perhaps positive: a majestic beech woodland, a bird of prey gliding the thermals, a steamy tropical rainforest teeming with life—perhaps negative; caged birds to be smuggled for the pet industry, the razed ground of a woodland once occupied by activists, fire ripping through a tropical rainforest. I hope most readers had positive images, as biodiversity literally means the diversity of life, with no connotations of oppression and/or destruction. Beyond the obvious—a contraction of the words biological diversity—the word in scientific circles means the diversity of life in all its forms, and at all levels of organisation. The 'all its forms' bit reminds us that biodiversity includes plants, fungi, bacteria, other micro-organisms, invertebrate animals (like insects and worms), vertebrates (literally animals with backbones) like birds, and mammals including you and I. The idea of levels of organisation of life is a little more complicated, but essentially there are three major levels, genetic, organismal (or species) and ecological diversity, which are discussed below (see *Table 1*).

Unlike most new scientific terms the word biodiversity has entered the accepted vocabularies of science, the media, mainstream politics, radical politics and the public at large. The word biodiversity arose in the context of, and has remained wedded to, con-

cerns over the loss of the natural world and its inhabitants. Environmental destruction is so evident, to so many, with so much information arriving that things are spiraling downwards that this new, complex, scientific term has been widely adopted by disparate groups—all with their own spin on what biodiversity is and means.

Organismal Diversity

I am an organism, as are you, as are trees and birds; organisms are units of life. Therefore despite the unusual word, organismal diversity is the diversity of these units of life. All these units of life that are very similar are grouped into species, like us and our fellow humans, or carrots, or oranges etc. This level of the organisation of life generally receives the most attention. People commonly want to know the number of specific types of organism, like sycamore trees, or potato plants, or common sparrows—asking questions such as: how many bird species are there in a piece of woodland? Being able to identify species, while sometimes difficult, is an important base-line for our understanding of our surroundings, as James Lovelock, scientist and originator of the Gaia hypothesis put it; "We are so alienated from the world of nature that few of us can name the wild flowers or insects of our locality or notice the rapidity of their extinction."

Scientists use a system of two words written in Latin to name each species. First is one word to describe the general grouping called the genus, the second the exact type called the species. This allows people around the world to know exactly what is being discussed: *Quercus velutina*, black oak, is different from *Quercus alba*, white oak, but are both oaks and are similar enough to share the same genus. However attempts to classify the natural world are more complex than most people realise. Perhaps the most common definition of a species is groups that are, or are potentially, interbreeding natural populations. Or more simply, if the individuals can mate and produce offspring then they are of the same species. Many people classify European and North American brown bears as the same species, even though they have been separated for over 10,000 years, and don't travel from Romania to Canada to have sex! Or what about gray wolves and coyotes in the US—they occasionally interbreed (possibly producing rare red wolves), so are they really the same species? The situation gets far messier with plants where it has been estimated that 70% of flowering plants owe their origins to the process of different species getting together producing new hybrid species. There are now at least 7 different concepts that address what a species is. Nature, as usual, foils attempts to be neatly catagorised into ordered boxes!

Table 1 Elements of biodiversity. (After Heywood & Baste 1995.)

Ecological diversity	Genetic diversity	Organismal diversity
Biomes		Kingdoms
Bioregions		Phyla
Landscapes		Families
Ecosystems		Genera
Habitats		Species
Niches		Subspecies
Populations	Populations	Populations
	Individuals	Individuals
	Chromosomes	
	Genes	
	Nucleotides	

A Brief History Of Life...

The first multicellular organisms appeared on Earth about 4,500 million years ago. Organisms began to colonise the land about 440 million years ago. By 290 million years ago the dinosaurs had flourished and died out. At 250 million years ago mammals appeared. Humans arrived on the scene 1.8 million years ago. On average a species lasts 1 to 10 million years before extinction. The number of species on the planet has varied tremendously over the past few hundred million years. The general pattern has been an increase in the number of species, as rates of speciation have exceeded extinction. However at 5 points throughout this time period there have been mass-extinction's. We are currently in the middle of the sixth wave of extinction—for the first time caused by humans.

What is sure is that regardless of the woolly bits around what is a species, there are lots of them out there in the world. How many species are there on Earth? Obviously the best way to find out would be to go out and count them. Unfortunately this is easier said than done, due to the low political priority making funds and training scarce. To date approximately 1.8 million species have been described, and even this figure is a best guess as there is no central register to compile new species names (ecological science is very decentralised!). The actual number of species we share the planet with could be anywhere between 3.6 and 111 million species, with a current knowledge best guess being about 13.6 million different species on Earth (see *Table 2*). The problems of trying to estimate species numbers without the time and staff to do extensive collections is extreme-

ly complex, with several methods available, which are not addressed here (see *Further Reading* list at the end of this article for details). However, as *Table 1* shows, species are one part of a hierarchy of classifying the full range of the diversity of life, from Kingdoms, down to species, to populations of individuals, to each individuals genetic makeup.

Ecological Diversity

It is easy to define an ecosystem conceptually: it is a group of interacting organisms (often called a community) and the physical environment they inhabit at a given point in time. Flying over the countryside in an airplane you see these ecosystems—blue patches and ribbons that are lakes and rivers, dark green patches of woodland, and so on. While easily seen from the air, to decide where one ecosystem finishes and another starts is a fools goal—the web of interactions does not have clean breaks. Where exactly does the lake edge end and the land begin? A second problem in distinguishing ecosystems is that ecologists think about ecosystems at different scales in space. A pool of water that collects in a hollow of a large tree is home to some algae and small invertebrates, and for the inhabitants can be considered an ecosystem. But when an ecologist concerned with grizzly bears talks of the Greater Yellowstone Ecosystem they are referring to 50,000 km^2—enough habitat for a grizzly bear population! Again nature defies to be put into neat little boxes. The key to understanding the ecosystem concept is that it is a human construct to help us organise our understanding of ecological phenomena and communicate it. So when you hear someone talk about a woodland ecosystem, get them to be more specific—what other ecosystems might it contain?

Even when we decide how to delineate a set of ecosystems, we then have the great problem of classifying them into different types. How different do two areas have to be to classified as different, given that all ecosystems are unique, given their unique history and different population levels of each species? There is no standardised method for distinguishing ecosystems. For example, one person's tropical rain forest, is another's lowland tropical moist forest, is another persons evergreen tropical wet forest. A useful approach has been to employ a hierarchy, firstly separate land (terrestrial) from aquatic, then aquatics into freshwater and marine etc.. Other methods often involve classifying climate, geology or land form (e.g.: mountainous). Again if someone talks about a woodland ecosystem, get them to be more specific about what they mean—what soil type is it on, common or rare, which species are common?

Genetic Diversity

At the smallest end of the scale of levels of the organisation of life is genetic diversity. In short, the diversity of life is fundamentally genetic. There is a functional hierarchy from the blueprint of life, DNA (deoxyribonucleic acid) to the organism we see, say a toucan or a fern. Genes consist of DNA connected onto long chains called chromosomes. These genes code for specific proteins that form the basis of cells, and thus whole organisms. At any of these levels we can look for genetic variation, for example, between two populations of different species or variation between two populations of the same species, or variation within a single population of a single species.

Genetic diversity is fundamental to the survival of all species. Imagine if human genetic diversity were

Table 2 Approximate numbers of described species (in thousands) currently recognized and estimates of possible species richness for groups with more than 20 000 described species and/or estimated to include in excess of 100 000 species. The reliability of all estimates is likely to vary greatly. (After Hawksworth and Kalin-Arroyo 1995.)

		Number of estimated species			
	Described species	High	Low	Working figure	Accuracy of working figure
Viruses	4	1000	50	400	Very poor
Bacteria	4	3000	50	1000	Very poor
Fungi	72	2700	200	1500	Moderate
'Protozoa'	40	200	60	200	Very poor
'Algae'	40	1000	150	400	Very poor
Plants	270	500	300	320	Good
Nematodes	25	1000	100	400	Poor
Arthropodsi					
Crustaceans	40	200	75	150	Moderate
Arachnids	75	1000	300	750	Moderate
Insects	950	100 000	2000	8000	Moderate
Molluscs	70	200	100	200	Moderate
Chordates	45	55	50	50	Good
[Others	115	800	200	250	Moderate]
Totals	1750	111 655	3635	13 620	Very poor

eroded losing our Y chromosome—there would be no men left. Humans are all different, this is good, as we'd get confused and bored if we were all the same, and in common with all other species, having a diverse population allows us to collectively face the future with more certainty. Take the *HIV* virus which causes *AIDS* as an example. If this were to infect every single human on earth, the vast majority would die, but because of our genetic diversity some would be naturally immune to the effects of the *AIDS* virus, and thus future populations would have no worries about *AIDS* (as their parents would have passed on their immunity). This is the same mechanism by which insects eventually overcome pesticides in farming (and why genetically modifying foods to produce their own pesticides is not sensible) and bacteria overcome antibiotics (and why the pharmaceutical industry trying to get us to use more antibiotics is madness).

Inbreeding—mating between relatives—is one major cause of decreased genetic diversity. This happens often in species with very small population sizes, as they don't have much choice except mating with a relative. Close relatives will likely share some of their genes as they have one or more ancestors in common, and of course genetic diversity decreases, as does the survival chances of the individual due to a rapid build-up of deleterious genes (hence there are probably good evolutionary reasons why incest is a no-no).

Why Does Biodiversity Matter?

"When I am hungry, a date palm gives me food. When my belly is full, behold, the tree is beautiful."
- A Jordanian Bedouin herder and gatherer.

Life on Earth is abundant, diverse, complex and can be organised on different interlinked levels—but why does any of this matter? The short answer is, without genetic, organismal and ecological diversity reasonably intact you would be dead, as you'd have no food to eat, a radically different climate to live in etc. Try to imagine a planet where dead things did not decompose, or where plants did not replenish oxygen. At the most basic level we can form two categories as to why biodiversity is important: its use and non-use value. I'll briefly note some of the most important uses of biodiversity. However, this is to show the reader the real-world situation: a great many uses are not desirable or sustainable, but happen.

The most fundamental benefit we derive from other species with whom we share the planet is in our food. We use other species to obtain food somewhere between two extremes. At one end farming where land is completely re-engineered for the growth of food species, be it maize or cattle, and at the other collecting wild foodstuffs, where the land is relatively intact and food is taken from where it grows in nature, for example hunting wild boar or collecting fungi. Obviously from many angles obtaining foodstuffs from the collecting end of the extreme is most preferable; the ecosystem is relatively intact, most species are preserved, genetic diversity is not reduced, food is local, fresh, little transport costs, meaningful interaction with nature etc.. This is obvious, as given a free choice why do children go off blackberry picking? Why is fishing so popular? And how many of us as children went off to try and grow lines of perfectly identical vegetables? (see *Why The Rush For Farming?* box). Currently after 10,000 years of farming and a few hundred years of capitalism, we have a situation where out of about 250,000 species of flowering plants, less than 3000 are regarded as a food source, and about 200 domesticated for food while 90% of the per capita plant food supply of 146 countries is supplied by 103 plant species. In the animal world the number of species used is even more restricted.

Another major use-value of biodiversity is medicine. Extracts from organisms have been used by humans for millennia to treat illness, with millions of

Why The Rush For Farming?

In the past all foodstuffs were obtained via collecting from the wild, but for the last 10,000 years the trend has been entirely in the direction of intensive farming. It is demonstrably bad for biodiversity, as globally one-third to one-half of the earth's land surface has been transformed by humans, the biggest contribution by farming. In the UK very little ancient woodland remains, most having been cleared for farming. Why the rush for farming? Farming provided greater production rates, used in the past for local consumption, but now as marketable commodities. In a system where competitive trading is a precursor to survival who would wander in the woods when you could chop them down, sell the timber, invest the profits in stocks or more land, then grow cash commodities and let the cycle continue? Even if you did wander in the woods, the woods would probably have been stolen from you. Farming is centralising, formal and conducive to accumulating power and wealth, collecting wild foodstuffs is inherently informal, decentralised and local.

people using traditional medicines every day. The reason is simple: many species have evolved chemical defenses to protect themselves from natural enemies or to subdue prey, or survive certain conditions. These compounds are effective as they are biologically active, with properties that disrupt the physiology of the target organisms. These are the same properties utilized by medicines either as defenses against human pathogens or to alter our own physiology in some desired way. Biodiversity provides, for free, the building blocks of the lucrative pharmaceuticals industry. However only 5,000 of 250,000 species of flowering plants have been investigated as potential sources of new treatments. If these species are not there in the wild, then new or revived old medicines, whether via the local herbalist or a transnational corporation, will not become available.

A further major use of other species has been in biological control, that is using organisms to control pests, usually those that attack foodstuffs. Biological control has been very successful, but is rarely noted as once the control organisms are established, that's it, you don't need to do anything else. Also the stars of the show are not sexy, mainly nematode worms, mites and micro-organisms. For example it was a fly called *Ptychomyia remota* that ended infestations of coconut in Fiji. Of importance regarding biodiversity is the fact that these agents are usually rare and from a limited area where the pest originated from. For example the parasitoid *Epidinocarsis lopezi*, responsible for the spectacular control of the mealybug that eats cassava in Africa was eventually collected from a small number of localities in Brazil and Bolivia after extensive searches throughout Central and South America. If small chunks of nature reserves are preserved and nothing else, these useful species may be lost.

Other uses of our fellow species are non-food materials, most importantly wood, but also fibers, resins, gums, adhesives, rubber, oils and waxes, agricultural chemicals include pesticides, perfumes. Also there is a great deal of recreational use, especially for people from industrialised nations including hunting, fishing, harvesting plants for gardening, harvesting for pets and what's known as 'ecotourism'.

Non-use values of biodiversity are those uses where the organisms are not taken or used as commodities in any way, for example the benefits of ecosystem services, the intrinsic value of biodiversity, using biodiversity spiritually, for educational purposes, or leaving options open to the future.

Putting A Price On Nature's Bounty

How much is the world worth? According to some ecologically minded economists, about US$33.3 trillion dollars, that's over twice the combined GDP's of the worlds 194 countries. Basically they first agreed on a list of 17 categories of good and services provided by nature, including processes such as nitrogen fixation and resources such as crop varieties and plant-derived pharmaceuticals. They then partitioned the earth in 16 specialised environment types (biomes) and judged which serviced each biome provides, then from published estimates looked at how much it would cost to replace each service for each hectare of a given biome providing the service. It graphically shows how little emphasis is placed on life-support mechanisms by states and corporations under capitalism. Suicidally little, in fact. (See *Science* magazine, Vol. 276, page 1029, 16 May 1997).

Ecosystem services are the free benefits we get from relatively intact ecosystems, which are of incalculable value (but see *Putting A Price On Nature's Bounty* box). Where would we be without ecosystems maintaining the gaseous composition of the atmosphere, contributing to the maintenance our current climate, water recycling and purification, generating and maintaining soils, converting the essential plant nutrients nitrogen, phosphorus and sulphur into forms useable by most plants, holding soils in place and binding them, disposing of wastes, maintaining global cycles of the important elements carbon, nitrogen, phosphorous and sulphur, absorbing air pollutants? It is these free ecosystem services—the functioning of ecosystems—that enable humans to obtain the food, fiber, energy and other material needs for survival.

A second non-use value is the use of the natural world for spiritual enlightenment, or less grandly, and more commonly for spiritual uplift, the feelings produced when waking to the sound of birdsong, or seeing a red squirrel dart across a woodland (which is probably why so many people take themselves off to quiet beaches or go walking in the hills in their precious days off from paid employment). Further on from that are those who value species and perhaps ecosystems (see *Do Ecosystems Have Intrinsic Value?* box) as having intrinsic value, that is they have value in and of themselves without any reference as to whether they may be useful to us now of in the future. Biodiversity is also used for education-

al purposes—ecosystems are wonderful models for showing children and adults how everything can be connected to everything else. Biodiversity has inspired many cultural activities, for example painting, moreover much of human culture and the human experience is bound up in biodiversity—we evolved within it—however much we try to deny it and separate ourselves from it.

Do Ecosystems Have Intrinsic Value?

Does an ecosystem have intrinsic value independent of the intrinsic value of the constituent species? The issue depends on the complex and controversial question: are ecosystems tightly connected, synergistic systems of closely evolved species plus their environment, or are they merely a loose assemblage of species that happen to share similar habitat needs and end up interacting together to some degree because they are in the same place at the same time? It's the kind of question that probably has no answer, other than that it probably lies somewhere in the middle. However it does make us think about ecosystem structure. If the answer is the former, each ecosystem is evolutionarily unique and can never be replicated, and hence is easier to acknowledge its intrinsic value. If it is the later and species just live there because it's convenient, then ecosystems could, in theory, be put together from their constant parts and it's the individual species with the intrinsic value, as there's little more than a bunch of species living together.

Finally, the most commonly asserted non-use value has been the option for future use category, that is we should save species that may be potentially useful and as we don't know what might be useful in the future we should save lots of species. There is much to be said for this idea in principle, as it's sensible, as extinction is forever, even if it is a Bodyshop sponsored cliche, and intergenerational justice could be served here.

However the unsaid implication is that we must save things as they are free precursors to wealth and power for the elite. This leads to measures such as gene banks, where companies can get hold of genetic material to help further consolidate their position, and are of little relevance to most people, rather than areas of habitat of varying degrees of wildness near peoples homes where nature can be readily interacted with and possibly used by the community in the future.

Ways Of Seeing The Natural World

"...that which befalleth the sons of men befalleth beasts; even one thing befalleth them: as the one dieth so dieth the other; so that a man hath no pre-eminence above a beast; for all is vanity."

- Ecclesiastes 3:19.

Other species are used, utilised and valued in many ways, but why those ways and not others? Different people ascribe different values to the same thing, a tree is many things to many people, beauty, profit, a home for wildlife, furniture, a source of food. Also people's values change over time, and depending on their current condition, for example being hungry or full, or due to the culture they happen to live in, or over longer time-scales as our attitude to Wolves demonstrates: once reviled as evil (think of Little Red Riding Hood) now championed in ecological circles as an embodiment of wildness. As an example of cultural diversity take a look at attitudes towards rats. In most places they are considered vermin, indeed, on the Isle of Man, one must never say the word, only spell it out 'ar-ay-tee', as saying rat is bad luck. However in Nigeria they are relished as food sell for more than beef or pork, while in Brasil Yanomami Indians tuck into them regularly. In the Indian Hindu temples of goddess Bhagwati Karniji rats are fed and protected. The same goes for many other species.

Despite this cultural diversity peoples attitudes to other species and ecosystems, some academics have suggested that in western countries at least, attitudes often seem to fall around three basic sets of ethics. We should examine these groupings, seeing the potential advantages, pitfalls and practical and political fallout of adopting a certain ethical stance regarding other species. One of these stances is the Romantic-Transcendental Preservation Ethic, which in essence says that nature is a temple that is soiled by the activities of humans. It says we should commune with nature when we visit it, like it is some god. There is obviously a high priority on establishing nature reserves and parks where nature is relatively intact and that we are encouraged to visit.

This romantic ethic is the stance behind many environmental non-governmental organisations (NGOs): think of their brochures full of requisite photos of the natural world and their campaigns to save virgin rainforest, or save whales in their habitats untouched by the hand of man. This stance calls for fairly pristine areas to be preserved. Perhaps it is no coincidence that only those wealthy enough to travel there

can visit pristine nature, that these wealthy people make donations to the NGOs that campaign for their wilderness, and that it provides beautiful photos to aid fundraising without having to tackle social issues as pristine areas with no or few residents are to be protected.

This deification of pristine nature first leads to voyeurism, not true interaction with nature—you visit nature not live in it. Nature is kept in a separate box from both humans and society. It can also lead to serious anti-human policies, as seen by the actions on the World-Wide Fund For Nature (WWF) and other NGOs expelling indigenous people from newly created reserves. People and nature, despite the worship, are separate, so nature is merely there to feed an anthropocentric need for voyeurism. This viewpoint offers few problems for the elite, or capitalism in general, as all efforts go into saving the most beautiful areas and species which become booming tourist attractions, and therefore pay for themselves much like any other commodity—anyone fancy seeing the lions on a private game reserve in Africa? Indeed celebrated US naturalist John Muir who used this platform for political action in the last century ended up forming the now huge NGO The Sierra Club, now embroiled in controversy about whether to join other US environmental NGOs and back racist US policy to 'protect' the US environment from immigration by Latinos. Despite the regular use of this ethic within radical ecological circles, it is, in my opinion, in no way linked to progress towards a free and ecological society. We should denounce it when it is mentioned.

A second way of seeing the natural world known as the resource conservation ethic, which essentially believes that nature consists solely of natural resources and should be used to provide the greatest good to the greatest number of people for the longest time. The idea is not to plunder the land, but to use it in a way that distributes benefits fairly and efficiently among many people. It advocates wise, judicious use so that future generations will not be shortchanged. Also by recognizing aesthetics as a resource some preservation of relatively intact nature is possible (thus dealing with the romantics critiqued above). This is the dominant ethic put forward today by the government, business, the media and most scientists: they are usually at best deluding themselves, and at worst lying but this is essentially what they say. Nobody says, I will leave our grandchildren with nothing so I can make a profit now, it is all talk of cost-benefit analyses, fairness to stakeholders… In essence this is no different from the perpetual campaigning from government and business that they are there for us, and they are working hard so we can all have a better life. As obviously the elite serves, in the main, the elite, their use of the resource conservation ethic is because it best serves their interests. Both the resource conservation and romantic ethic both place nature in anthropocentric (people-centred) terms—nature offers only utility to humans, nothing more.

The final, and perhaps minority view of nature, is the Evolutionary-Ecological Land Ethic. Darwin and many others have shown that humans are but one species of many created through evolution by natural selection. If we evolved from other animals and we have intrinsic value then surely the other products of evolution have intrinsic value, regardless of their usefulness to us, runs the logic. This is effectively expressing equality in ecological terms. It implies we are part of ecosystems, not separate from them, and that we can and should interact with other species, as all species interact with others in a web of life. However, we should do this with responsibility, in a manner which recognises the intrinsic value of other species and whole ecosystems. For those who want a free, equal and ecological society this is clearly the attitude to take. This is a radical departure, not about what nature can do for us, but how do we relate with our partner in life. This forces very different questions to be asked, not merely whether to develop land as carefully or as efficiently as possible.

High Biodiversity Good And Low Biodiversity Bad? Or How To Measure Biodiversity

Is it stupid to ask what's the biodiversity of this woodland? I hope, given that biodiversity is some sum of genetic, organismal and ecological diversity, that attempting to obtain a single number for the biodiversity of somewhere is rubbish, and that those that say it is should be exposed. Species number, or richness—the total number of different species in a given area or habitat—is often used as a measure of biodiversity. When people talk about high biodiversity, they usually mean an area contains a lot of species. Measuring species number is sensible, as species are relatively easy to monitor, and the extinction of species is a major manifestation of the biodiversity crisis. By measuring species richness we also capture some of the other facets of biodiversity, as these species usually all live in the same area.

Measuring some component of biodiversity, whether ecosystems, species richness or genes, is rife

with problems; from the practical, like finding the species in the first place, to working out what species they are. But whatever the measurement the number is trying to strike some balance between two different components: the number of entities (e.g: species) and their degree of difference (dissimilarity). Imagine looking at the biodiversity for a pure piece of grassland of only one species of grass and either (i) another species of grass or (ii) a population of rabbits. The species richness, one measure of diversity, would be two for both ecosystems, even though they are quite different—as all the emphasis is on the number of entities, not the level of dissimilarity. I could find biodiversity indices, used by scientists, that could prove either of these two ecosystems had the highest biodiversity.

Many people seem to believe that high biodiversity, usually meaning high species richness, is somehow good and low biodiversity is somehow less good. How many times have environmental campaigners used the phrase as diverse as a tropical rainforest! Or Britain's answer to the tropical rainforest!? Firstly I will show why this idea is wrong, and secondly why I think so many people think high species richness is good, per se. On a global scale it is ridiculous to assign extra value only to high species richness, as we would only ever end up trying to stop the destruction of tropical rain forests and coral reefs, as they have the highest species counts—should we abandon all the worlds arctic zones, as they contain many fewer species than temperate and tropical areas? Of course not. At a local level the idea of the-greater-the-number-of-species-the-better is also not sensible. Imagine a piece of oak woodland: if a species goes locally extinct, the number of species goes down and this is bad. However if Rhododendrons and other species invade our woodland, the number of species goes up. Despite the increase in the measurement of one facet of biodiversity, this is clearly a bad thing as Rhododendrons inhibit woodland regeneration and begin to oust other species.

Why do so many people believe high species numbers are intrinsically a good thing? I think an answer lies with our friends the NGOs again. Purported high biodiversity is often used to compare different areas to decide which to attempt to save and which to allow to be destroyed, or to fight for scare NGO funding to attempt to save and area. If, as is usual, there are too many areas to try to protect, then biodiversity (usually meaning species number) is often used as an objective method of distinguishing what to fight, with high biodiversity areas being the winners. This leads to an attitude of low biodiversity areas being of less worth than other areas. This fits with the philosophical underpinnings of the Romantic-Transcendental Preservation Ethic—the eternal search for the purest, greatest, most spiritually uplifting ecosystems. And leads to complete absurdities: biodiversity inflation gets underway as having high diversity is key to having a chance of not being razed to the ground. And we end up back with Britain's answer to the tropical rainforest type slogans. The end result seems to be that the few relatively unaltered pieces of habitat are therefore pitted against each other on the basis of spurious biodiversity numbers, the public is misled, and were all no nearer to getting to the roots of the problems and stopping habitat destruction.

What Happens If Species Are Lost? Or How Much Biodiversity Do We Need?

"'We are losing half the subject matter of English Poetry,' wrote Aldous Huxely, after reading Rachel Carson's Silent Spring. '*He should have added we are in danger of losing the poets too.'"* - on the back cover of Silent Spring Penguin paperback edition.

If all facets of biodiversity have intrinsic value then nothing short of all biodiversity is valuable and should be maintained. Even those that believe in nothing but their personal well-being should realise, that there is only one earth and whether you like it or not, our fate is bound up with biodiversity. Even the most blinkered technocrat should definitely save our few hundred species that provide the vast majority of the worlds food and medicines, along with the other major benefit of biodiversity: the services provided by ecosystems like water purification, holding soil in place etc. Thus a crucial question, in purely survivalist terms is: how much biodiversity can we alter, or lose, before we threaten our own existence? In ecological terms we need to ask: how does the loss of species relate to the provision of important ecosystem services. There are four ways in which ecosystem processes might respond to reductions in the numbers of constituent species (see *Figure 1*), in addition to the unlikely outcome that there is no relationship. Firstly the diversity-stability hypothesis predicts that ecological communities will have less productivity (energetic efficiency) and be less well able to recover from disturbance (either natural or human-induced) as the number of species decreases (see *Figure 1a*). In short, the more species, the more

stable an ecological community is and the better able to continually supply free service.

Secondly the rivet hypothesis likens the species in an ecosystem to the rivets holding together an aeroplane. The loss of a few rivets go unnoticed, because they may be redundant, or other species take up the slack, but beyond some threshold further species losses will bring about a catastrophic collapse (see *Figure 1b*). So we can lose some species, with few problems, but lose too many, and we don't know how many is too many, and disaster strikes. Thirdly the redundant species hypothesis segregates species into what are called functional groups, that is different species that fulfill similar ecological roles, for example, all the plants that fix nitrogen from the atmosphere. Ecosystem processes function as normal if species are lost, provided there are representatives in each of the functional groups. Thus lots of species can be lost, as long as some remain from each of the groups that maintain the ecological functions (see *Figure 1c*). Fourthly, the idiosyncratic response hypothesis suggests that as diversity changes so do ecosystem functions, but the amount and direction of change is totally unpredictable because individual species are unique and have varied and complex roles (see *Figure 1d*). In short, losing species is dicing with disaster, as ecosystem responses are unpredictable and potentially catastrophic.

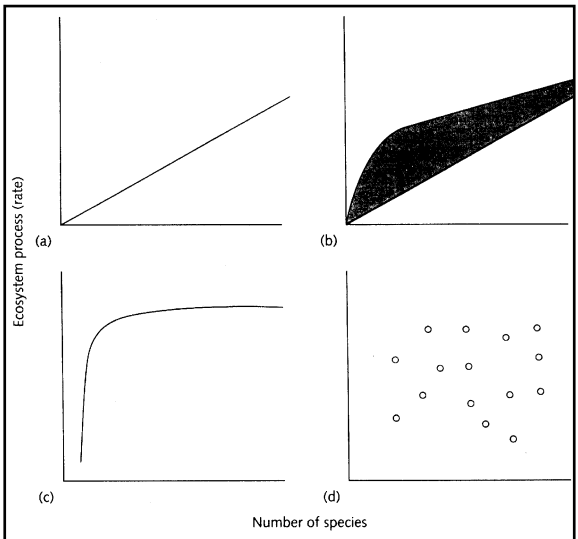


Figure 1 Possible relationships between ecosystem processes and the number of species in communities as predicted by (a) the diversity–stability hypothesis, (b) the rivet hypothesis, (c) the redundancy hypothesis and (d) the idiosyncratic hypothesis. (After Johnson *et al.* 1996.)

From the experiments to date it is unclear which hypothesis best reflects reality. The obstacles to overcome in answering this most pressing of questions are formidable, as it is difficult to distinguish cause and effect (do differences in ecosystem function result from differences in diversity, or vice versa), avoiding changing other factors in experiments, not just diversity, taking answers from small experiments on a few species to large areas of nature with many species, and performing all the necessary combinations of species in an experiment, which even for a few species is huge. Of course, the short answer is that the amount of biodiversity to preserve depends upon the kind of existence we would like to enjoy. However I personally find it incredible that we even have to have a debate about species being in any way redundant or worth allowing to live. Who would condemn all of big-beat techno functionally redundant because we have the Chemical Brothers, or all English landscape painters functionally redundant because we have paintings by Constable?

What's Going Wrong? Extinction and the Biodiversity Crisis

"20% of all bird species are now extinct."
- E. O. Wilson.

It is a seeming paradox that over 90 % of all species that have ever lived are extinct, but that in modern times there are more species on Earth than at any other time in geological history. This is because the rates of creation of new species has exceeded the number of species going extinct. However, throughout the 3.5 billion year history of life on Earth the clock of extinction has not run smoothly. There have been five periods though geological time where huge numbers of species have become extinct, taking millions of years to recover. The best known mass extinction, at the end of the Cretaceous period, which led to the extinction of the dinosaurs and 75-95% of all species alive at the time, was most likely to have occurred due to the impact of an asteroid and the dust clouds which it generated. We are currently at the leading edge of the sixth major extinction of life on Earth—of our own, human, making.

How many species are going extinct? This, in short is impossible to say, as we don't even know how many species there

are on Earth to start with! Also, how do you record an extinction? How long before you give up searching and decide it's not actually there? In the distant past early humans probably caused the extinctions of many large mammals and birds through hunting. More recently, since 1600 there have been over 1000 recorded extinctions, with over half of those this century. The problem is that many species have been, and will be lost, before they have ever been recorded. One method around this is to note that the average lifespan of a species is approximately 1-10 million years, but that recorded extinctions correspond to a average lifespan of only 10,000 years, while rough calculations suggest that current trends may lead to average lifespans of only 200-400 years. Thus extinction rates are upto 10,000 times the natural rate of extinction of one species per year.

Two factors make this depressing scene more so. Firstly there is a process know as extinction debt. That is, there is a time-lag between activities, such as deforestation, and their full effects to be realised. Many species may persist for some time even though the populations of which they belong have ceased to be viable. For example trees which live for hundreds of years may be there, but if they are not in a reproducing population they are actually the living dead. Also extinction is the loss of all local populations, but the losses of individual populations, and major reductions in population levels of a species both represent insidious forms of erosion of biodiversity, even if the extinction of all populations did not occur. And of course it is local populations that people interact with and gain benefit from. For example, it may be important on one level for me to know, say, cherry trees exist in the US, but if populations near me were missing, this is of no use if I want to pick and eat cherries.

Why is there this massive assault on the other life forms we share our planet with? There are four proximate, major causes of species loss: firstly, destruction of habitat (including habitat fragmentation), for example when a woodland is destroyed the species it contains are destroyed, as seen by the example of the maize species *Zea diploperennis* found on a single hillside in Mexico in the 1970s only one week before it was to be destroyed. This is the only perennial maize species ever found. Secondly, alteration of habitat by chemical pollutants, for example the widely known effects of the pesticide DDT on bird species throughout the world, along with acid rain, heavy metal pollution and the like. Thirdly, displacement by introduced species. Humans either intentionally or accidentally, are introducing species to areas where they would not normally occur. These introductions range from entirely harmless to catastrophic, for example, when the brown tree snake found its way to the island of Guam of 18 native bird species 7 became extinct and another four are so rare their survival is unlikely. Fourthly, some species are threatened by overharvesting by humans. The obvious example is fishing—20% of the world's freshwater fish are either extinct of in a state of dangerous decline, marine stocks are also worryingly low. Other examples include hunting for fur, bird's egg collectors and collecting for the pet industry.

These four explanations for the loss of populations and species are not, of course, the ultimate reasons—one has to ask why habitat is destroyed or chemicals released into the environment. I do not have space to go into ultimate causes, however two are obvious: the capitalist regime we live under and numbers of humans on Earth. Briefly, under capitalism, everything, from our own time to food we eat is commodified, as is the natural world. Nature is only worth its exchange-value, without reference to biology. Habitats are not destroyed by magic. Someone pays for it to happen. Land is to be bought, sold and exchanged for profit. This is exceptionally grave for species with reproductive rates lower than the expected rate of return expected on capitalist investments. This is why annual crops are preferred, as returns are yearly—the short-term—and rates of reproduction high. This is why a 3 year rice-growing project is, for a capitalist, always more attractive than a 500 year sustainable timber extraction project.

Let's Make A New Planet... The Case Of Biosphere 2

Scientists tried to make a materially closed system the same as the earth to support 8 adults completely for 2 years. With plants, animals, soil, water, air and climate it cost over US$200 million dollars and hundreds of peoples time to make. It completely failed. Surprise changes in the environment included a dramatic fall in oxygen levels and rise in carbon dioxide, a rise in nitrous oxide concentrations, overloading of water systems with nutrients and the extinction of all pollinators (e.g. bees etc.). In short, all our technology, ingenuity, financial resources and technical skills cannot build a system to provide for 8 humans—let alone a life support mechanism that natural ecosystems provide for free.

The second ultimate cause of species loss is the extremely controversial subject of high human population levels. It is a fact that 6 billion people now inhabit the Earth, and that 6 billion people need more space, land for growing crops, and material goods than 3 billion. It is an uncomfortable fact that we live on a finite planet and that the more humans there are the less space there is for the other life forms we share this planet with. We should take these simple truths onboard, while making every effort to attack those who use population arguments as cover for racism and coercion.

Possible Future Scenarios?

Of all the possibilities for the future I merely wish to sketch out two areas which I think are interesting and may be little known to *DoD* readers: thinking about climate change and biodiversity, and thinking about class in relation to biodiversity.

Humans are altering the gaseous composition of the atmosphere: levels of carbon dioxide are over 40% higher than they were before the industrial revolution (see *Figure 2*). This is causing the Earth's climate to heat up. The effects of climate change and, for example, habitat loss will act together. In essence as the Earth heats up it is expected that species will migrate towards the north and south poles, to keep with a temperature and climate they evolved in. Most species can move to track long-term changes in temperature, plants throw out seeds transported by animals or the wind, birds can fly etc.. If temperature changes are too fast for species to keep up, then extinctions may occur. In the past less rapid changes in climate have forced species to move. Barriers to their movement, such as mountain ranges, have caused extinctions. Currently there are serious human-made barriers to species movement, such as farms, cities and roads. Current estimates are that forest trees need to be moving towards the poles at a rates of tens of kilometres per decade, faster than trees have ever been documented to move. Also, as species respond to climate change as individuals, not communities, ecosystems will be broken up and new communities assembled and re-sorted from the remnant species of older communities that can tolerate the new conditions and whichever new species that manage to arrive. Thus they will also need to cope with new predators, competitors and diseases, further increasing changes of population extinctions.

In terms of humans and our relationship with biodiversity, perhaps globally there will become a new class conflict which revolves not over owning the means of production, but over control of biodiversity as this is a fundamental precursor to our survival. It has been suggested that there are three classes of people in terms of relations to biodiversity: ecosystem people, biosphere people and ecological refugees (I'm not sure I believe this, but it's an interesting way of looking at the world).

Ecosystem people are forest dwellers, peasant farmers, herders and fishers in the mostly non-industrial world who primarily rely/depend on the species within the ecosystem in which they live to meet the bulk of their material requirements, for example, gathering wild foodstuffs, grazing animals, low input agriculture for local consumption. There well-being is closely tied to the ecosystem of which they are a part. Their lives are generally reasonably sustainable as they have, as a minimum, a stake it maintaining their ecosystems as they provide their material needs. Ecosystem people are generally not well plugged into global markets.

Biosphere people are mostly people from the West/First World and the elite of the non-first world, who, in relation to biological resources practice high input industrialised agriculture and animal husbandry for the markets. Biosphere people have access to the resources of much of the whole Earth's biosphere: we can go and buy Caribbean mangos, Pacific tuna fish, or a fur coat from Far East Russia. These resources are brought to biosphere people through an increasingly integrated global market.

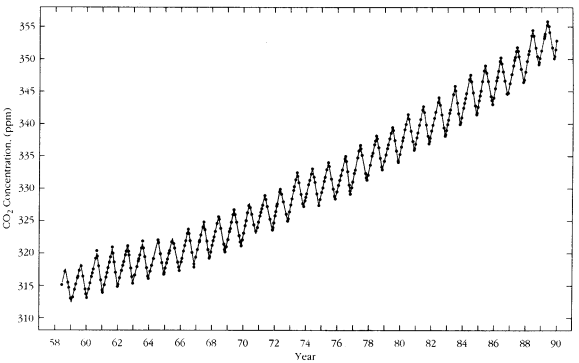


Figure 2 Monthly variations in the concentration of atmospheric CO_2 content at Mauna Loa Observatory, Hawaii, observed with a continuously recording nondispersive infrared gas analyzer. The yearly oscillations reflect seasonal variations in the amount of photosynthesis; the dots indicate monthly average concentration. (Data courtesy of Climate Monitoring and Diagnostics Laboratory, Environmental Research Laboratory, NOAA, Boulder, CO, 1991.)

The most important point about biosphere people is that they do not depend on the species or ecosystems of any particular locality for their immediate well being. However they do have an interest in maintaining a healthy pleasing environment in their immediate vicinity and therefore tend to shift pressure to distant localities: hence the locations with large houses are usually beautiful and exclusive. This is how 60% of Japan can be covered in forest cover (one of the highest in the world)—as it gets all its timber needs from South East Asia and Brazil. Thus pressure generates to efficiently extract and then exhaust resources in distant locations, especially in the Third World, where the mostly ecosystem people are, therefore creating the third category of humanity: the ecological refugees.

Ecological refugees are people deprived of traditional access to species and ecosystems in their immediate vicinity. Probably the majority of Third World city dwellers are ecological refugees. Examples are numerous: peasants who have migrated to the Amazon, ousted from their land in the South of Brazil by export-orientated agribusiness, or basket weavers in India pushed out by large scale paper production for export. Also the UK city dwellers' ancestors were ecological refugees, thrown of their land by enclosure, forced into the cities to work in factories. Ecological refugees have no stake in ecosystems, and as is the case with migrants into tropical forests, do destroy and degrade ecosystems.

It is obvious that ecological refugees are increasing in number, at the expense of the ecosystem people. It is also obvious that the biosphere people control both the ecosystem people and the refugees. Again it is the elite minority coercing the majority. Not that the biosphere people and their capitalist system of social relations go unopposed. The radical social movements throughout the world based on peasants movements and the urban poor, such as Brazil's landless peasants movement, the Movimento Sem Terra (MST), or Mexico's Zapatistas, who oppose capitalism, are in these ecological terms ecological refugees struggling against biospheric oppressors.

In conclusion, I hope I have made the reader aware of the fundamental importance of biodiversity, that the root cause of biodiversity loss is probably capitalism, as this system take no account whatsoever of biology, and the number of humans on Earth, as the more there are of us, the less room there is for our fellow life forms. Without radical, if not revolutionary change, and a move towards seeing the natural world ecocentrically, life will be at best grimmer than at present for most people. I hope I have provided the tools to allow the reader to understand, critique and expose the underlying agendas of why governments, the media, some scientists and most NGOs adopt certain positions on biodiversity and its conservation. I'll finish with two quotes:

"…the worst thing that will probably happen—in fact is already well underway—is not energy depletion, economic collapse, conventional war, or even the expansion of totalitarian governments. As terrible as these catastrophes would be for us, they can be repaired within a few generations. The one process now ongoing that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly our descendants are least likely to forgive us."
- E.O. Wilson.

"There is only one thing in life that you have to do, and that is die. Everything else is optional."
- Anonymous.

Further Reading

The most important scientific information is reported, replete with much jargon, in scientific journals. Ones to take a look at are: *Science*, *Nature*, *Ecology*, *Ecological Monographs*, *Journal of Ecology* and the quite readable, and most radical, *Conservation Biology*.

General ecology textbooks give a good introduction and overview to modern ecology. Good ones are:
Begon, M, Harper, JL, and Townsend,CR, 1996. *Ecology: Individuals, Populations and Communities*. (Sinauer Associates Press, Sunderland, MA, USA.)
Kormondy, E.J. 1996. *Concepts in Ecology. (*Prentice-Hall International, London, UK.)

For an overview of Conservation Biology try:
Hunter, ML, Jr, 1996. *Fundamentals of Conservation Biology.* (Blackwell Scientific Publishers, Oxford, UK.)

For a 'popular science' personal and interesting view of Biodiversity try:
Wilson, EO, 1992. *The Diversity of Life*. (Penguin Books, London, UK.)

Overviews of Biodiversity, including the book that first coined the word:
Gaston, KJ, and Spicer, JI, 1998. *Biodiversity: An Introduction*. (Blackwell Scientific Publishers, Oxford.)
Wilson, EO, Editor, 1986. *Biodiversity*. (National Academy Press, Washington DC, USA.)

Conservation and Ethics:
Callicott, JB, 1990. *Whither Conservation Ethics? (*Conservation Biology, Volume 4, pages 15 to 20.)
Kellert, SR, 1996. *The Value of Life: Biological Diversity and Human Society.* (Island Press, Washington DC, USA.)

Biodiversity and Climate Change:
Peters RL and Lovejoy, TE Editors. 1992. *Global Warming and Biological Diversity.* (Yale University Press, New Haven.)