Humans: The Scourge of Planet Earth

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Humans now dominate ecosystems to such an extent that pure ecology has all but vanished from the face of the earth! Multitudinous anthropogenic effects include overpopulation, many different kinds of pollution of the atmosphere, water and land (and the manifold effects of such pollution on the health and livelihood of plants and animals, including ourselves), habitat destruction and fragmentation, endangered species, loss of genetic variability, extinction, disruption of natural ecosystems, human transportation of organisms and resultant homogenization of earth's biota, evolution of microbes that infect humans as hosts, and murder rates among humans.

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Humans seem to delight in animal motifs — thus, we have automobiles, airplanes, and athletic teams named after various animals: cougar, jaguar, lynx, mustang, pinto, ram, eagle, falcon, nighthawk, roadrunner, and the list goes on. Zoos are a popular form of entertainment, particularly for children. Yet, at the same time, many people feel threatened by a free-ranging wild creature, even by a tiny mouse or a harmless snake. Indeed, urbanization is now so complete that, aside from cockroaches and songbirds (and perhaps while on vacation), most of us seldom encounter wild animals.

What is the essential difference between a wild animal versus one in a cage? Clearly, a rattlesnake behind glass does not pose nearly as much physical danger to a human observer as does a wild snake. For the study of many kinds of biological phenomena, there is no difference between a caged specimen, so long as it remains alive, and its wild cousin. The constrained one still has intact cells, molecules, physiological processes, and, to some extent, behavior. But the caged animal, removed from its habitat, is out of context — it has been stripped of its natural history and it no longer interfaces with the environment to which it is adapted and in which it evolved.

A captive animal is analogous to the word “love” clipped out of a D. H. Lawrence novel: you don’t even know if it’s a noun or a verb, let alone who loves who!
The biological discipline of ecology deals with the myriad of ways in which organisms (plants, animals, and other heterotrophs such as bacteria and fungi) interact with, influence, and are in turn influenced by their natural surroundings. Wild plants and animals in their natural communities constitute the subject matter of ecologists. To these scientists, caged organisms might as well be dead for they have no ecology. Ecology differs from other sorts of biology in that its perspective is directed upward and outward from the individual organism to its environment. Other kinds of biology focus on organismal and suborganismal processes and thus involve a reductionistic viewpoint. Ecology has a more holistic perspective.

The Urgency of Basic Ecological Research

In one sense, ecology is doubtlessly the oldest and most basic science. Primitive humans simply had to have been astute natural historians to survive. As a more rigorous scientific discipline, however, ecology promises to be the shortest-lived science of all time. The word itself seems to have been first used in Germany in the late 1860s by E. Haeckel, but did not come into common use until 1895, when J. Warming used it in a book title. The first scientific society, the British Ecological Society, was founded in 1913. The earliest textbooks were published in 1927 (Elton) and 1929 (Weaver and Clements). Ecology is thus barely a century old and would seem doomed not to celebrate much of a bicentennial, for by then most natural ecological systems will surely be long gone. Although this realization is saddening, this "doomsday ecologist" nevertheless urges everyone to learn as much ecology as he or she can if for no reason other than simply because very soon we will need all of it that we can possibly get.

Ecology and environment are words frequently encountered in the news and popular media, almost invariably bandied about in conjunction with humans and their environment. As often as not the terms are misused, especially by politicians and other advertisers. Many people now use "ecology" to refer primarily to applied and human ecology. "Ecologist" has been equated with "rabid environmentalist" (as a result, real ecologists now refer to themselves as population biologists!). The basic science of ecology is not synonymous with a study of the effects of people on their own surroundings and on other organisms, but in fact represents a much broader and more fundamental class of subject matter. Some problems facing humans today illustrate what can happen when ecological systems are not used wisely in accordance with sound ecological principles.

Most people consider the study of biology, particularly ecology, to be a luxury that they can do without. In the interests of obtaining "well-rounded" students, many medical schools no longer even require that premedical students major in biology. The study of basic biology is not a luxury at all, but rather an absolute necessity for living creatures. Despite our anthropocentric (human-centered) attitudes, other life forms are not irrelevant to our own existence. For example, an understanding of basic parasitology is needed to control epidemics in human populations. Similarly, a knowledge of basic principles of community organization and ecosystem function is essential for wise exploitation of both natural and agricultural ecological systems. Beyond such anthropocentric (human-oriented) arguments, one can argue that other species have a right to exist, too, as proven products of natural selection that have adapted to natural environments over millennia. With human populations burgeoning and pressures on space and other limited resources intensifying, we will need all the biological knowledge that we can get. Ecological understanding will prove to be particularly vital.

There is a great urgency to basic ecological research simply because the worldwide press of humanity is rapidly driving other species to extinction and destroying the very systems that ecologists seek to understand. No natural community remains pristine. Unfortunately, many will disappear without even being adequately described, let alone remotely understood. As existing species go extinct and even entire ecosystems disappear, we lose forever the very opportunity to study them. Knowledge of their evolutionary history and adaptations vanishes with them: we are thus losing access to biological information itself. Indeed, "destroying species is like tearing pages out of an unread book, written in a language humans hardly know how to read" (Rolston 1985). Just as ecologists are finally beginning to learn to read this "unread" and rapidly disappearing book of life, they are encountering governmental and public hostility and having a difficult tim

Global Weather Modification

Earth's atmosphere is unusual in that it has a relatively high oxygen content (about 21 per cent). Most other planets have a reducing atmosphere. The free oxygen in today's atmosphere was probably produced largely by the activities of primary producers. The most plausible hypothesis to explain our planet's rather unusual atmosphere is that activities of living organisms, particularly green plants and certain bacteria, play vital roles in the building and maintenance of air. Photosynthetic activities of plants utilize carbon dioxide and water to produce oxygen as a by-product, along with energy-rich reduced carbon compounds, such as glucose. Free oxygen is released into the atmosphere by an inanimate process, too. High in the atmosphere above the ozone shield, ionizing solar radiation dissociates water vapor into molecular hydrogen and oxygen. Free oxygen is left behind as the light hydrogen atoms escape into outer space. In a reduced atmosphere, oxidation quickly uses up such free oxygen. Both of these oxygen-generating mechanisms have been important; dissociation was probably much more significant billions of years ago before the ozone layer was formed than it is at present (it will become more important as the ozone layer is further thinned by the release of chloroflourocarbon gases). Ozone depletion has also increased ultraviolet radiation at the surface, which has almost certainly increased the frequency of skin cancers (though these may not be easily detectable for another decade).

Our atmosphere is in a complex quasi equilibrium, but CO_2 concentration has risen steadily for the last quarter of a century and continues to rise due to deforestation and burning of fossil fuels. Over the past 30 years, consumption of fossil fuels has more than doubled carbon emissions. Per capita CO_2 production is so high that to generate this amount of CO_2 metabolically, every man, woman, and child on earth would have to eat their own body weight in potatoes every day. This increase in atmospheric carbon dioxide has enhanced atmospheric heat retention and would have produced global warming sooner except for a fortuitous spin-off of atmospheric pollution – particulate matter increased earth's albedo (reflectance of solar irradiation), so that less solar energy penetrates to the surface (volcanic ash in the atmosphere has the same effect). Until recently these two opposing phenomena more or less balanced one another, but now the balance has clearly shifted and the "greenhouse effect" is leading to rapid global warming. Long-held meterological records the world over are being broken: the past 7-8 years have been the hottest years on record; a few years ago, the lowest low pressure zone ever recorded in late summer was followed in the next winter by the highest high pressure area ever measured during recorded history.

Desertification has been greatly accelerated during the past century due to above-mentioned processes. Arid areas are in a more precarious and perilous position than wetter areas. As the population burgeons, the last remaining natural habitats are rapidly being destroyed. Earth's atmosphere is being altered at an ever increasing rate, leading to rapid weather modification. There is some concern that agents of infectious disease, such as malaria and cholera, will spread as a result of climatic change. Lyme disease spreads with mouse epidemics and these could be more extreme now than they were when millions of passenger pigeons competed with mice for acorns. Moreover, new types of infectious diseases such as ebola, fungi, and hantavirus, appear to be emerging, possibly as a result of habitat destruction and climate change. Global warming is having its impact on virtually all plants and animals, including humans, and its effects will continue to intensify into the forseeable future. Crop failures would seem to be inevitable.
Empty shelves in supermarkets will eventually awaken people to the dire danger of tampering with earth's atmosphere, but by then it will be much too late to rectify the situation. People will be appalled that scientists cannot restore the atmosphere to its former condition. But, there can be no quick "technological fix" for earth's maligned atmosphere. The continuing existence of all the denizens of this poor beleaguered planet, including ourselves, will ultimately depend more on our ecological understanding and wisdom than it will on future technological "advances."

Unlimited cheap clean energy, such as that much hoped for in the concept of cold fusion, would actually be one of the worst things that could possibly befall humans. Such energy would enable well-meaning but uninformed massive energy consumption (i.e., mountains would be levelled, massive water canals would be dug, ocean water distilled, water would be pumped and deserts turned into green fields of crops. Heat dissipation would of course set limits, for when more heat is produced than can be dissipated, the resulting thermal pollution would quickly warm the atmosphere to the point that all life is threatened, perhaps the ultimate ecocatastrophe. (Die-hard technologists will no doubt argue that we will invent ways to shoot our excess heat out into space.)

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Soil development from bare rock, or primary succession, is a very slow process that often requires centuries (soil losses due to erosion caused by human activities are serious and long-term). Typically, natural soils underneath grasslands are considerably deeper and richer in both organic and inorganic nutrients than are the natural soils of forested regions.

The marked effects some soil types can have on plants are well illustrated by so-called serpentine soils, which are formed over a parent material of serpentine rock. These soils often occur in localized patches surrounded by other soil types; typically the vegetation changes abruptly from nonserpentine to serpentine soils. Serpentine soils are rich in magnesium, chromium, and nickel, but they contain very little calcium, molybdenum, nitrogen, and phosphorus. They usually support a stunted vegetation and are relatively less productive than adjacent areas with different, richer soils. Indeed, entire floras of specialized plant species have evolved that are tolerant of the conditions of serpentine soils (particularly their low calcium levels). Introduced Mediterranean "weeds" have replaced native Californian coastal grasses and forbs almost everywhere except on serpentine soils, where the native flora still persists.

Litter fall is high in tropical forests, but it does not accumulate to nearly as great an extent as it does in the temperate zones, presumably because decomposition rates are very high in the warm tropics. As a result, tropical soils tend to be poor in nutrients (high rainfall in many tropical areas further depletes these soils by leaching out water-soluble nutrients). For both reasons, tropical areas simply cannot support sustained agriculture nearly as well as can temperate regions (in addition, diverse tropical communities are probably much more fragile than simpler temperate-zone systems).

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More than half of all accessible surface fresh water is used by humans. Ships releasing ballast water have dispersed exotic species of invertebrates worldwide – many of these have wreaked havoc on aquatic systems. Freshwater aquatic systems everywhere are polluted and threatened – one third of the world's freshwater fish are threatened or endangered and many freshwater amphibians (especially frogs) are considered threatened. Human wastes, particularly plastics, release large amounts of estrogen mimics that are concentrated in natural food webs and are increasingly becoming a very serious threat to the continuing health and viability of humans and many other animals (Colburn et al. 1996). Reduced sperm counts and infertility, as well as higher incidences of prostate and breast cancers, could well be caused by these hormone mimics.

Genetic Engineering

Modern molecular biotechnological tools, such as restriction enzymes and gene splicing, now enable geneticists to transfer particular genes from one organism to another. For example, the firefly gene for luciferase has been successfully transfered to tobacco, resulting in transgenic bioluminescent plants. Human insulin and growth hormones are now routinely produced in chemostats of E. coli bacteria that have had human genes spliced into their genomes. Some researchers have even proposed using such transgenic bacteria as live vaccines (the genetically-altered bacteria would live within humans and would confer them with resistance to particular diseases such as hepatitis). Such recombinant DNA technology has also enabled us to produce useful new life forms such as pollutant-eating bacteria that can help us to clean up what's left of our environment. Research is in progress to transfer nitrogen-fixing genes into crop plants. There are legitimate concerns, however, about the safety of research on such man-made transgenic organisms, particularly the possibility of accidental release of virulent strains that might attack humans. Such concerns have been addressed by implementation of strict containment procedures for recombinant DNA products, as well as by selecting and creating host organisms for foreign DNA that are incapable of surviving outside the laboratory.

Obviously, genetically engineered organisms must eventually be designed for release into nature (indeed, genetically engineered tomatos are now being grown commercially). Another concern is that genetically-engineered organisms could have adverse effects on other species in natural ecosystems. We already have enough natural pests and certainly don't want man-made ones!

Unfortunately, we still know far too little to engineer ecological systems intelligently (obviously genetic engineers should work hand in hand with ecological engineers). Still another problem is the human tendency to allow short-term financial returns to override long-term prospects.

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Murder Rates Among Humans

All sorts of biological phenomena vary in a more-or-less orderly fashion with age. For example, reproduction begins at puberty and its rate is seldom constant but more usually differs between young versus older adults. Similarly, the probability of living from one instant to the next is a function of an organism's age as well as the conditions encountered in its immediate environment. The probability that humans will commit murder is both sex-specific and age-specific (Figure 1.1). Such age-sensitive events are not fixed, of course, but are themselves subject to natural selection and hence vary over evolutionary time. (As one possible example, the age of onset of menarche appears to be decreasing in many human populations.)

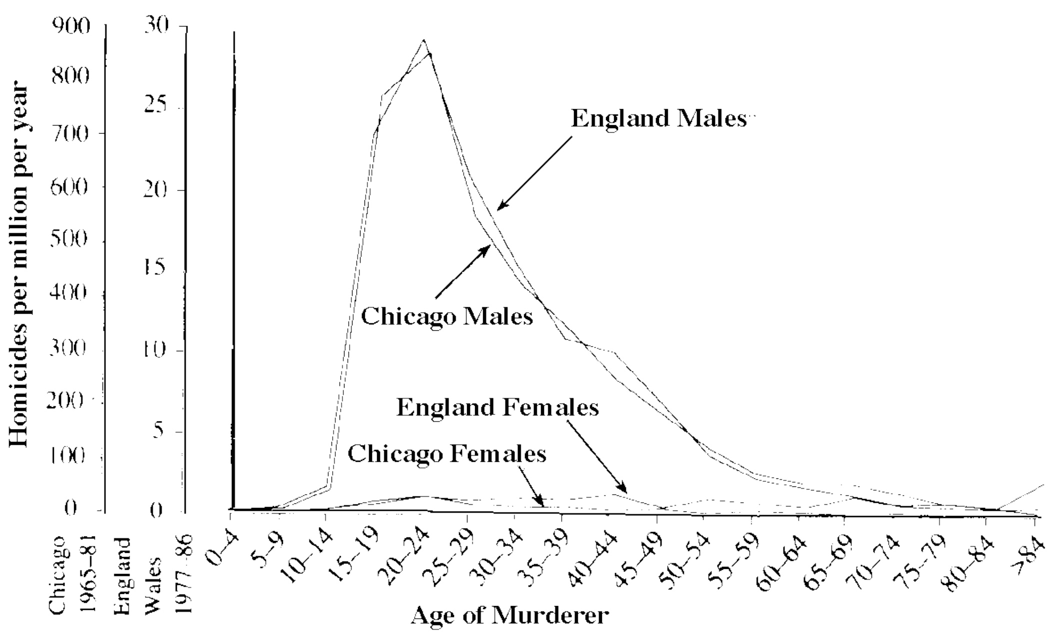

Figure 1.1. Age and sex-specific rates of killing nonrelatives of one's own sex in the United Kingdom and Chicago over the same period. Although murder rates are 30 times higher in Chicago, shapes of the curves are nearly identical in both places. Murders are almost invariably committed by young men, not by females or by older males. [Adapted from Daly and Wilson (1988).]

Demographic and Environmental Stochasticity

Genetic drift can cause allele frequencies to fluctuate and can even result in a polymorphic locus becoming fixed. In small populations, processes analogous to genetic drift occur which can cause populations to fluctuate in size. Because births and deaths are not continuous but sequential discrete events, even a stable population will fluctuate up and down due to random sequences of births and deaths. If a run of three births in a row is followed by only two deaths, the population will increase by one individual, if only temporarily. Conversely, a run of two births could be followed by several deaths, causing a decrease. Very small populations can even random walk to extinction! Another type of random influence is termed environmental stochasticity — this refers to stochastic environmental changes that affect the intrinsic rate of increase. Both demographic stochasticity and environmental stochasticity cause population sizes to fluctuate in small populations.

Human Overpopulation

During the past 40 years, the human population, world wide, has doubled from about 3 billion people to almost 6 billion. 6,000,000,000 is a rather large number, difficult to comprehend. Each year, the human population increases by nearly 100 million, a daily increase of more than one-quarter of a million souls. Each hour, every day, day in and day out, over 11,000 more people are born than die.
Most people hold the anthropocentric opinion that Earth exists primarily, or even solely for human exploitation. Genesis prescribes: "Be fruitful, and multiply, and replenish the earth, and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth" (my italics). We have certainly lived up to everything except "replenish the earth."

The human population explosion has been fueled by habitat destruction — we are usurping resources once exploited by other species. Tall grass prairies of North America have been replaced with fields of corn and wheat, native American bison have given way to cattle, etc. In 1986, humans consumed (primarily via fisheries, agriculture, pastoral activities, and forestry) an estimated 40% of the planet's total production (Vitousek et al.

1986). Today we consume more than half of the solar energy trapped by plants. More atmospheric nitrogen is fixed by humanity than by all other natural terrestrial sources combined. Humans have transformed nearly one half of the earth's land surface. More than half of all accessible surface fresh water is now used by humans. Freshwater aquatic systems everywhere are polluted and threatened. Fish and frogs are seriously threatened. All the oceans have been heavily overfished. Many species have gone extinct due to human pressures over the past century and many more are threatened and endangered. Nearly one quarter of Earth's bird species have already been driven extinct by innane human activities such as introductions and habitat destruction. Over a hundred species of plants and animals go extinct every day due to habitat destruction by humans.

People everywhere today stand ready to rape and pillage their wildernesses ("wastelands") for whatever they can be forced to yield. Raw materials, such as ore, lumber, and even sand (used to make glass), are harvested in vast quantities. Big companies enjoy privileged status, excluding the public from extensive areas, producing great ugly clear cuts, vast strip mines, deep open pit mines, instant but permanent, man-made mountains, eyesores paying testimony to the avaricious pursuit of timber, precious metals and minerals. Deforestation is nearly complete in many parts of the world. Overgrazing is rampant. Grasses and the shrub understory have been virtually eliminated over extensive areas. It is quite instructive to come upon a fenced graveyard, and to see a small patch of country as it must have been before the land rape by the pastoral industry. Native hardwoods are wasted to make charcoal and burned for firewood. Lumberjacks will soon be out of work whether or not the remaining timber is cut. Should forest habitats be saved? Is there enough left to save? This sort of pillage continues. Virtually everywhere, often with governmental subsidies and incentives, forests, deserts, and scrublands are being levelled and turned into fields for crops. Many of these fields are marginal and will soon have to be abandoned, transformed into great man-made vegetationless deserts. More dust bowls are in the making. In some regions, replacement of the drought-adapted deep rooted native vegetation with shallow rooted crop plants has reduced evapotranspiration, thus allowing the water table to rise, bringing deep saline waters to the surface. Such salinization reduces productivity and seems to be irreversible. Some deserts have so far been able to resist the tidal wave of advancing human exploiters, but some people dream of the day that technological "advances," such as water plans to move "excess" water or distillation of sea water, will make it possible to develop desert regions (i.e., to replace them with vast agricultural fields, or even cities). Antonyms, such as "sustainable development," are strung together into oxymorons by biopoliticians and developers in an attempt to make all this destruction and homogenization seem less offensive.

Most people consider basic biology, particularly ecology, to be a luxury that they can do without. Basic biology is hardly a luxury; rather it is an absolute necessity for living creatures such as ourselves. Despite our anthropocentric attitudes, other life forms are not irrelevant to our own existence. As proven products of natural selection that have adapted to natural environments over millennia, they have a right to exist, too. With human populations burgeoning and pressures on space and other limited resources intensifying, we need all the biological knowledge that we can possibly get. For example, in this day and age, a primer on "how to be a successful venereal microbe" has become essential reading for everyone!

Ecological understanding is particularly vital. Basic ecological research is urgent because the worldwide press of humanity is rapidly driving other species extinct and destroying the very systems we need to understand. No natural community remains undisturbed by humans. Pathetically, many will disappear without even being adequately described, let alone remotely understood. As existing species go extinct and even entire ecosystems disappear, we lose forever the very opportunity to study them. Knowledge of their evolutionary history and adaptations vanishes with them: thus we are losing access to biological information itself.

Only during the last few generations have biologists been fortunate enough to be able to travel with ease to remote wilderness areas. Panglobal comparisons have broadened our horizons immensely. This is a fleeting and unique opportunity in the history of humanity, for never before could scientists get virtually anywhere. However, all too soon, there won't be any even semipristine natural habitats left to study.

Nearly twenty years ago, in a setpiece of rational thought that deserves much more attention than it has so far received, Garrett Hardin (1968) perceived a fly in the ointment of freedom, which he explained as follows:

"The tragedy of the commons develops in this way. Picture a pasture open to all. It is to be expected that each herdsman will try to keep as many cattle as possible on the commons. Such an arrangement may work reasonably satisfactorily for centuries because tribal wars, poaching, and disease keep the numbers of both man and beast well below the carrying capacity of the land. Finally, however, comes the day of reckoning, that is, the day when the long-desired goal of social stability becomes a reality. At this point, the inherent logic of the commons remorselessly generates tragedy.

As a rational being, each herdsman seeks to maximize his gain. Explicitly or implicitly, more or less consciously, he asks, "What is the utility to me of adding one more animal to my herd?" This utility has one negative and one positive component.

1) The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly +1.

2) The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsman, the negative utility for any particular decision-making herdsman is only a fraction of -1.

Adding together the component partial utilities, the rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. And another; and another . . . But this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own interest in a society that believes in the freedom of the commons. Freedom of the commons brings ruin to all."

The tragedy of the selfish herdsman on a common grazing land is underscored by the rush to catch the last of the great whales and the ongoing destruction of earth's atmosphere (ozone depletion, acid rain, carbon dioxide enhanced greenhouse effect, etc.). Global weather modification is a very real and an exceedingly serious threat to all of us, as well as to other species of plants and animals.

Over the past few hundred years, we humans have drastically engineered our own environments, creating a modern-day urbanized indoor society that simply did not exist a mere few centuries ago. Indeed, only 500 human generations ago (about 10,000 years) we were living in caves under stone age conditions! Our only source of light other than that of the sun, moon and stars, was firelight from campfires – replaced now with television sets glimmering in the dark! (We're using oil to generate electricity and sending fossil sunlight back out into space!) Once, "primitive" hunter-gatherers who regularly walked extensive distances and worked hard to collect enough food to stay alive, we lived in intimate small clan groups planning and plotting to somehow survive winters (greed may have been an evolutionary advantage) – we struggled to escape all sorts of natural hazards long since eliminated, but replaced with new and markedly different dangers. We propelled ourselves into a complex, brand new, human-engineered urban world with artificial lights, electricity, air conditioning, computers, email, money, shopping markets (= ample cheap food for many), antibiotics, drugs, cars, airplanes, long-distance travel, overcrowding, regimentation, phones and television.

Humans simply haven't had time enough to adapt to all these novel environmental challenges – today, we find ourselves misfits in our own strange new world (someone dubbed us "Stone Agers in the fast lane"). Health consequences of this self-induced mismatch between organism and environment are many and varied: anxiety, depression, schizophrenia, drug abuse (including both alcohol and tobacco), obesity, myopia, diabetes, asthma and other allergies, impotency, infertility, birth defects, bullets, new microbes and resistant strains, environmental carcinogens and other toxins. Convincing arguments suggest that we have actually produced all these maladies as well as many more. Amazingly, we have managed to create a world full of pain and suffering unknown to our stone-age ancestors just a few hundred generations ago. What a magnificent accomplishment!

People sometimes ask “what is the carrying capacity for humans?” Six billion of us occupy roughly half of earth’s land surface, consuming over half the freshwater and using about half Earth’s primary productivity, but many of those persons are living in poverty and not getting adequate nutrition. Certainly if our population continues to double in the next 40 years as it did during the past 40, we will finally have reached our carrying capacity at 12 billion in the year 2040 – at that population density, humans will occupy all the earth’s surface (there won’t be any more wilderness or any wild animals), and we would be using every drop of freshwater as well as every photon that intercepts the surface!

The Evolution of Self Deceipt

Recent studies with young children have shown that the leaders among children are those who can lie more convincingly. Interestingly, the correlation between leadership and ability to be dishonest did not hold among adult women, although it does among adult males. These startling new discoveries have obvious implications in politics! Deceipt of others is fairly straightforward but self deceipt is an extremely interesting phenomenon worth closer scrutiny. We like to think that we perceive the world around us accurately. In a series of experiments, voices of human subjects were taped and played back to subjects who were wired up to a polygraph "lie detector." The polygraph measures electrical conductance across the skin's surface based on perspiration. Our skins, and presumably our subconscious minds, virtually always recognize tape recordings of one's own voice accurately. However, these experiments demonstrated two different forms of self deception. Sometimes, the conscious response of a subject to hearing his/her own voice is "No, that's not me," but electrical conductance in their own skin shows otherwise (the subconscious recognizes their own voice). Other times, a subject asserts "Yes, that's me!" to the voice of another person, but his/her skin indicates that the subconscious knows otherwise (i. e., the truth). People who fail to recognize their own voices and who project themselves into another person's voice typically have poor self images. Presumably, these people were being quite "honest" and genuinely felt that they were giving correct answers. In both situations, the person's conscious mind was deceiving themselves while their subconscious retained accurate information.

What possible adaptive value could such complex self deception have? The rather startling possibility is that self deceipt makes one a more effective "liar," enabling one to persuade other humans of some misinformation (imagine the benefits in politics and litigation!).

Indeed, the evolution of the subconscious mind itself would seem to be a necessary precursor for self-deceipt to even become possible. What the subconscious mind actually does with its veritable treasure trove of accurate perceptions remains an open question. My guess is that such information is exploited to maximize the reproductive success of individuals (without their own "knowledge")! The profound implications of self deceipt for politics are disturbing.

Indirect Interactions

Superimposed on direct pairwise interactions, more subtle indirect interactions are mediated through other members of the community concerned. Darwin anticipated the concept of indirect interactions and gave as an example interactions among cats, field mice, humblebees (bumblebees), and red clover. The bees pollinate clover, but field mice raid bee nests and eat bee larvae. Lots of clover grows around villages, presumably because cats keep mice populations down, allowing bumblebees to flourish which in turn assists clover. Darwin's staunch defender Huxley carried Darwin's example farther and noted that spinster's (who have lots of cats) facilitate Britain's naval prowess because strong sailors must be well fed and British beef thrives on clover. Here we have a long string with a pathlength of seven: spinsters —> cats —>mice —>bees —>clover —>beef —>sailors —>naval prowess!

Darwinian Medicine

Until recently, a common medical practice has been to “treat the symptoms” without asking whether or not symptoms represent host defenses or parasite manipulation. Physicians distinguish between “signs” and “symptoms” of disease with the former being objective, and the latter, subjective manifestations of the disease. Inflammation is a major “cause” of disease in many infections such as tuberculosis. Fever and inflammation are often viewed as totally undesirable and medications sucha as aspirin that reduce both are often prescribed. Studies with desert iguanas have demonstrated that these lizards select higher body temperatures when they are infected with parasitic microbes than they do when uninfected. Moreover, if infected lizards are prevented from being able to attain higher temperatures, the microbes prosper and infected lizards suffer. A recent study demonstrated that use of drugs to reduce fever prolonged the time required to clear malarial parasites from the blood of human children in Gabon. Some fevers appear to be adaptive responses to infection, harming microbes more than their hosts. Similarly, inflammation may often be an integral part of the healing process. During an influenza infection, iron levels in the blood are reduced, prompting physicians to prescribe iron additives — however, low iron levels appear to be a host defense against microbes, essentially starving them out. Providing supplemental iron could actually assist the microparasites!

Microparasites with short generation times evolve rapidly. Many microbes, such as the HIV virus, actually evolve during the course of infection within a single host! Resistant microbes have evolved in direct response to contact with antibiotics and will continue to do so. Overuse of antibiotics selects for resistant strains. When antibiotics are fed to our food animals to enhance yield, resistant bacteria evolve that are passed on to humans. Genes for resistance to antibiotics are actually transfered between different species of bacteria via exchange of plasmids -- in 1976, a strain of gonhorrea got genes from the human intestinal bacterium Escherichia coli that code for an enzyme which destroys penicillin, instantly creating a powerful new antibiotic-resistant strain of gonhorrea. Many children now suffer from chronic ear infections (Otitis media), a poorly vascularized anatomical location that is difficult to reach with traditional antibiotics – by selecting for resistant microbes, we may have inadvertantly caused this malady. Health care authorities are concerned that we may not be able to treat such antibiotic resistant strains. “Darwinian medicine” refers to adopting an evolutionary approach to medical treatment, anticipating how and why microbes will evolve in response to their environments (as manipulated by humans). Ewald (1994) suggests that we might actually be able to manipulate evolution of disease microbes in ways that would benefit humans. In their excellent book “Evolution and Healing,” Neese and Williams argue that natural selection has molded a wide variety of human emotions such as anxiety, sadness and depression – such traits could well be adaptations that enhance fitness.

Conservation Biology

Someone said “Once humans were surrounded by wilderness and wild animals, but now we surround them.” Urbanization and habitat destruction havc reduced the populations of almost all non-human species, some to the critical point of near extinction. Many basic ecological principles have obvious and important applications. For example, optimal yield to maximize sustained harvests have long been goals in wildlife management and fisheries biology. Even so, we have overfished the oceans. An emerging discipline of conservation biology seeks to conserve natural habitats and maintain biotic diversity. Biodiversity constitutes a valuable resource worthy of preservation for many different reasons. Consider some of the anthropocentric ones. Genetic strains of plants with natural resistance to pests are valuable to humans because their genes can be exploited to confer resistance on future crop plants.

Approximately one drug in four originated in a rainforest: these include analgesics, diuretics, laxatives, tranquilizers, contraceptive pills and cough drops. Antibiotics were first discovered in fungi, but have now also been found in many species of plants as well. Secondary chemicals of plants have proven to be a vast reservoir for useful pharmacutical products. Clinically proven drugs derived from higher plants include: morphine, codeine, atropine, quinine, digitalis, and many many others. Bark of Pacific yew trees contains taxol, which has proven to be an effective agent in the treatment of certain ovarian cancers. To date, scientists have examined only about one percent of existing plant species for useful pharmaceuticals.

In conservation biology, a debate has arisen about whether it is better to have a single large reserve or several small reserves (the so-called SLOSS debate). Because a single large reserve will support only a single population, if this should go extinct that species will be lost; whereas with several smaller reserves, if a population goes extinct in one, it can still re-invade and re-establish itself from another reserve.

Conservation biologists attempt to estimate the minimum viable population size for endangered species. A minimum viable population is the threshold population size for persistence, one that is just large enough to minimize the probability of extinction from all forms of stochasticity (genetic, demographic, and environmental) over a reasonably long period of time. When a population is reduced to a very small size, it must go through a genetic bottleneck which can greatly reduce genetic variability and enhance chances of extinction. Conservation biologists often study the genetics of small populations. Demographic and environmental stochasticity can also result in increased probabilities of extinction. A population viability analysis assesses the current status of a species and systematically determines the conservation measures needed to prevent its extinction. Vulnerable age classes that require protection for persistence of endangered species can be identified and protected.

Basic demographic parameters were calculated for six populations of the endangered Bonnelli's eagle *Hieraaetus fasciatus* in Spain and France from field data obtained over 15 years (Real and Manosa 1997). Average annual productivity ranged from 0.36 to 1.24 young/pair and average annual adult survival from 84% to 96%. Preadult survival (from fledging to recruitment) was estimated at 10%. All populations were declining at annual rates ranging from –7.3 to –1.1%. A 3x3 Leslie matrix was constructed. No statistically significant disagreement was observed between predictions of this Leslie matrix model fitted to population parameters and real trends, but some populations declined faster and others more slowly than expected. Differences were interpreted as a result of differential emigration, recruitment rates, or pre-adult survival not accounted for by the model. Because intrinsic population growth rate was about four times less sensitive to changes in preadult survival than to changes in adult survival, and about ten times less sensitive to changes in fecundity and predispersal survival, conservation efforts should be directed towards increasing adult and preadult survival. Mortality must be reduced by reducing or eliminating both power line casualties and direct persecution by humans.

For many species, combined effects of habitat loss, habitat fragmentation, small population size, genetic and demographic stochasticity, toxic pollution, and climatic changes are overwhelming – Soulé calls the resulting situation an “extinction vortex” which, like a whirlpool, seems to conspire to pull many existing populations down to precariously low densities or even actual extinction.

Tall grass prairie covered hundreds of thousands of square kilometers in the midwestern United States just a few hundred years ago; today, this natural community has virtually disappeared. No-one knows what grasslands in California were like a century ago – hundreds of species of introduced Mediterranen grasses have largely replaced the original native California grasses. Lowland tropical rain forest is now being destroyed at an alarming rate. Natural communities of all sorts are rapidly being replaced by overgrazed pastures, eroded fields, artificial lakes, golf courses, roads, parking lots, shopping malls, and housing developments. None of the earth's natural communities remain pristine; all have been disturbed either with pesticides and other pollutants or by way of introductions and extinctions of species. Even the disturbed remnants of the earth's biomes are continually being broken up into smaller and smaller isolated patches or habitat islands (Figure 1.2). As would be expected from the equilibrium theory of island biogeography, faunal and floral diversities are decreasing in such isolates as species go extinct locally (some species, such as the passenger pigeon, have been entirely eradicated). Larger species of animals at higher trophic levels disappear before smaller species and those at lower trophic levels. Habitat fragmentation poses a serious threat to many species, including the Spotted Owl, the Golden-cheeked Warbler, and the Black-capped Vireo. Cowbirds have increased greatly in abundance due to human clearing, which has diminished core habitat and increased edge effects. Cowbirds, which are brood parasites on many small songbirds, used to be uncommon, but have increased markedly in abundance due to the increase in amount of edge habitat. Many small songbirds have suffered greatly as a consequence of the resulting increase in brood parasitism. Unfortunately, much remains to be learned about these vanishing natural communities and their inhabitants.

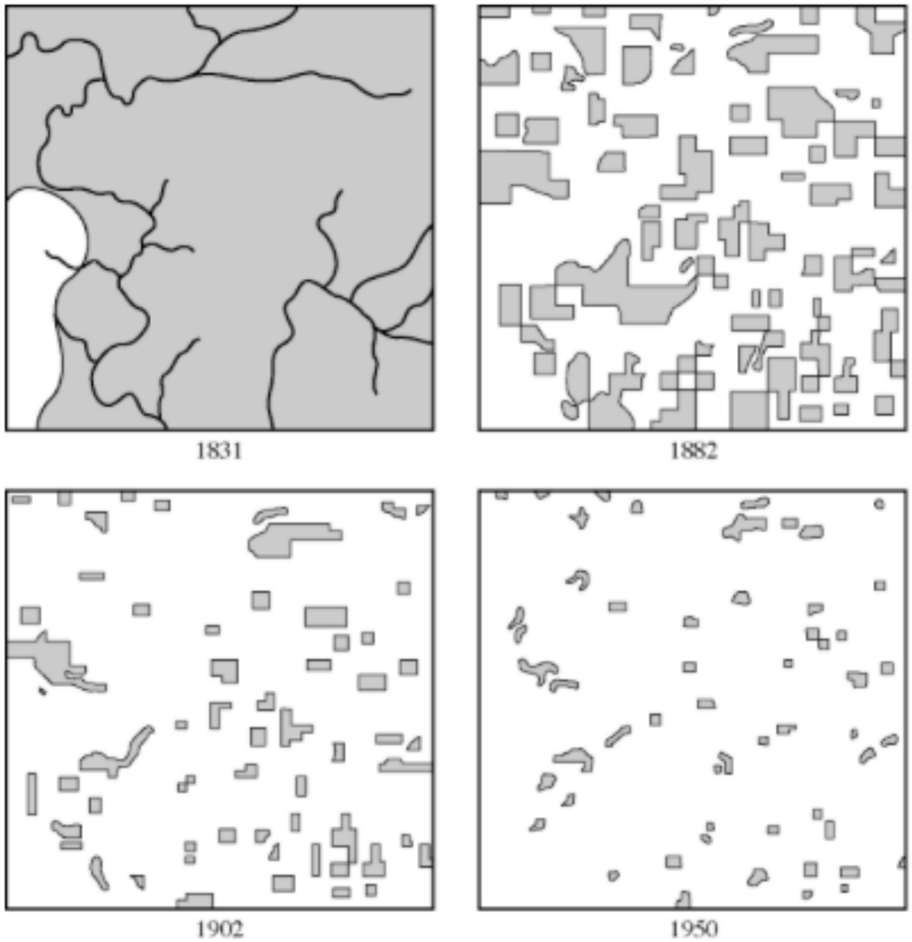

Figure 1.2. Changes in the distribution of forest due to human influence from 1831 to 1950. Imagine what it must look like today! The total area depicted, in Wisconsin, is about 10 km on a side. Fragmentation of the forest has created many very small habitat islands. [From J. T. Curtis, "The Modification of Mid-latitude Grasslands and Forests by Man," in W. L. Thomas, Jr., ed., Man's Role in Changing the Face of the Earth. Copyright © 1956 by The University of Chicago.]

Biogeographic principles can be used profitably in designing natural preserves to protect endangered habitats and species. Assume that it is desirable to maintain as great a diversity of plants and animals as possible. Clearly, a single large and contiguous reserve will generally be superior to a number of smaller reserves covering an equivalent area. All else being equal, protected areas should be as diverse as possible. Further, the ratio of edge to area should be minimized. Provision of dispersal corridors or "stepping stones" of natural habitat between larger reserves enhances migration and increases diversity (a species can go extinct in one preserve but reinvade from an adjacent one).

We have now come full circle. In closing, let me remind you of the rapidly disappearing but still unread "book of life" (Rolston 1985): We must move quickly to preserve as much as possible and to read the disappearing pages before they are gone forever.

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