Biodiversity Discovered

Solving the Mystery of the Global Species Count and Exploding the Myth of the Sixth Extinction

by [Thomas W. Kral]

Executive Summary

The "Biodiversity Crisis" has gained significant attention in recent years as the worlds' leading ecologists and environmentalists warn us that plant and animal species are going extinct in ever increasing numbers; this demise, commonly referred to as "The Sixth Extinction", being largely caused by human destruction of habitat and the consumption of natural resources. Acting on this impending doom, governments worldwide have been greatly stepping up wildlife protection and habitat conservation measures.The Biodiversity treaty signed by 153 nations in 1992 at the Rio Earth Summit, places species preservation at the forefront of the global environmental agenda, with staggering political, social and economic ramifications affecting virtually everyone.

Despite the emphasis placed on this dilemma, scientists concede that shockingly little is actually known about global biodiversity and extinction rates in the first place. Because of this, estimates are subject to wild speculations. Currently, these range anywhere from 10 million to upwards of 100 million species; based on these totals, ecologists have projected rates of 27,000 extinctions each year to as much as half of all living species to disappear in our lifetime!

For the first time, the total number of living species on earth, as well as actual extinction rates, have been calculated from reliable data. At most, there are 3.63 million species and the extinction rate is 3 to 5 species annually, vastly differing from the much higher estimates embraced by environmentalists and accepted by many policy makers.In light of the factual evidence presented herein, the entire issue of biological conservation needs to be reevaluated and various endangered species laws in both the United States and abroad reformed or abolished.

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Introduction

Preserving our planet's irreplaceable flora and fauna in the race against extinction has become the most dramatic of all environmental issues. With its flashy media appeal, the "biodiversity crisis" is now a household term. Controversies over the U.S. Endangered Species Act (ESA), and similar laws enacted by other nations, place it squarely in the mainstream of political debate.

Mankind has always realized that sensible conservation in the form of game management helps to maintain viable hunting and fishing grounds, while also providing open spaces and natural beauty for everyone to enjoy. Because of this basic appeal, the public at large is generally supportive of wildlife protection - up to a point. In the words of former U.S. Interior Secretary Manuel Lujan, who in 1992, was asked to comment about reauthorization of the ESA "I voted for the Endangered Species Act when I was in Congress, but I was thinking of saving tigers and elephants and rhinoceroses and those kinds of animals." But when asked to speculate on a host of future invertebrate proposals such as the Cave Mold Beetle, Lujan commented "I thought maybe we need to save the fungus that grows and causes athletes foot. That's how ridiculous this whole thing has gotten" (1).

The dramatic shift in conservation policy between passage of the Endangered Species Act in 1973 and the present, is attributable to a small band of biologists initially concerned about the destruction of tropical rain forests.In 1979, Norman Myers, a British biologist, first published his alarming estimates of species he believed were being lost as a direct proportion to the amount of rainforest being cleared (later I will return to this claim and describe its fatal flaws). Like any academic field, there is a strong camaraderie among conservation biologists, and Myers' cause was soon joined by Jared Diamond, Paul Ehrlich, Thomas Eisner, Daniel Janzen, Thomas Lovejoy, Peter Raven, and Edward O. Wilson; a clique which Wilson jokingly calls the "rainforest mafia"(2). Nearly all of the present consensus on conservation biology originates from this handful of researchers.Because Paul Ehrlich and Edward O. Wilson are both prolific writers and excellent speakers, they have received the most media attention and thus are most familiar to the public.

The belief that an ever increasing human population was causing massive habitat destruction and species extinctions fitted very well into Ehrlich's apocalyptic view of *The Population Bomb* first published in 1968.The anti-social sentiment of restricting human activities in favor of preserving wildlife falls into great favor with most environmental organizations who spend significant portions of their budgets on public relations, lobbying and fundraising activities, which are often used to help finance biased scientific research, and political campaigns to place sympathetic policymakers in positions of influence.

Efforts to maintain the consensus of this ever increasing juggernaut of public opinion is aggressively supported by nearly all ecologists, most of them dependent on environmental grants and other handouts for their livelihood.Any dissenting views are harshly attacked and discredited. One such critic, Julian Simon, who noted that the widely accepted mass extinction rates were "utterly without scientific underpinning" and are "pure guesswork", is assaulted by Richard Leakey in his book *The Sixth Extinction*, declaring that "Professor Simon is the Dr. Pangloss of the environment" and labeling him an "anti-alarmist" (3).But critics like Simon have good reason to be skeptical.

Behind the facade of a unified front, ecologists cannot agree amongst themselves as to the severity of the crisis at hand. As Edward O. Wilson puts it "biologists agree that it is not possible to give the exact number of species going extinct; we usually turn palms up and say the number is very large" (4). More to the point, depending on the authority, the disparity between estimates ranges from 17,000 species lost a year to more than 100,000 (5), and some researchers like Paul Ehrlich push this number much higher (6)!What are these estimates based on? Typically nothing more than unsupported or "anecdotal" evidence coupled with extrapolations based on projected losses (7).Blinded with science, baffled by statistics, and often tempered with boredom, layperson and politician alike turn their palms up as well, believing that somehow, the "experts" must be "right".

This problem ultimately stems from a gross lack of published scientific data, as biologists concede that they actually know little about most of our planet's organisms (8). Current findings are based on scant real information, which, when coupled with personal opinion, leads to wild speculations and hence, the wide disparity of extinction rates. The one thing biologists do unilaterally agree on is that coming up with an accurate extinction rate rests on first knowing how many living species there are, because extinction rates are always calculated as a percentage of total biodiversity.Numerous researchers have attempted to do just that.

The Known Approaches to Estimating Species Diversity

The most simple of the approaches to calculating biodiversity is to compare the ratio of known to unknown faunas. In 1985, Peter Raven postulated that for birds, mammals and other well known animals, there are roughly twice as many tropical species and temperate climate species.If this were true of all organisms, then of the 1.5 million species already described, and two-thirds of these being temperate zone species, the world total would be 3 million (9). We now know this approach to be inaccurate because birds and mammals comprise only a tiny fraction of all life forms and are not at all indicative of species such as insects, which are often 10 times as numerous in a given tropical location than for a temperate area.

In a similar vein but now recognizing that insects are the most numerous species group, Stork and Gaston (1990) estimated that the total number of insects ranged from 4.9 to 6.6 million species. This was based on examining the well known insect fauna of Britain and comparing its ratio of butterflies to other insects found there.Then applying this ratio to the 15,000 to 20,000 species of butterflies worldwide, they estimated a range for the number of all insects (10). Probably not realizing it, Nigel Stork was hitting close to home with this approach, but only 3 years later, he would sharply revise his figure upward to 12.5 million species (11) using more questionable data. By then the frenzy to enhance the species count was well under way, primarily because of the next estimate.

The whole species diversity debate started with a sampling technique conducted back in 1982 by the Smithsonian's Terry Erwin in the jungles of Panama.This is the well publicized experiment which cast the spotlight on rainforest diversity. Erwin used the "bug bomb" method in which he fogged the tree canopy with insecticide and collected thousands of dying insects as they fell into a number of big funnels placed on the forest floor beneath.From these samples gathered over three seasons from the same spot, tentative numbers were then available, from which Erwin drew his conclusions. He calculated that there are 163 species of beetles living in the canopy of a single species of tree. In turn, there are about 50,000 species of tropical trees worldwide, so this comes out to 8,150,000 species of beetle. Then, assuming that beetles represent 40% of all arthropod species, and finally that there are twice as many arthropods (mostly insects) in the canopy than on the ground, came up with a rounded estimate of 30 million species for the world's rainforests (12).

In analyzing this impressive total, colleagues noted several problems.Other research summarized by Nigel Stork has shown that the host-specific beetle to plant ratio is typically 4, far less than 163 species - most plant-eating beetles have many hosts.I found that beetles comprise only about 25.5% of all insects, not 40%, and other researchers point to even lower percentages. Finally, samples taken in other rainforest locations indicate that the 2:1 ratio in favor of the canopy in Erwin's estimate should be reversed (13). Edward O. Wilson felt that "if the true total is within 10 million of that number either way, it will be sheer luck" (14).Despite the high probability for error, this estimate was embraced by environmentalists who used it to not only show how little we know about earth's diversity, but immediately connected it to Norman Myers' claim of species loss linked to rainforest destruction, which, when plugged into that formula, produces astronomical extinction rates!Stork would later comment that "Inevitably, the figure of 30 million species has become a political tool" .

Recently, Erwin has raised the ante at least another three-fold. Based on a "preliminary" analysis of more beetle samples collected in Brazil, Ecuador and Peru, Erwin now believes the 30 million figure is too conservative, and feels that the overall species total is actually closer to 100 million (16),(17)!

Finally, there is mere opinion and pure guesswork, such as the 13.6 million species "working estimate" developed by a United Nations-sponsored "consensus" effort. The data used: a survey of the world's leading experts on each group of living organisms, simply asking each what they felt the speculative total was.In a big contrast to Erwin's pumped up estimates, he discredits the diminutive 13.6 million total as the product of "armchair biology", because it is not based on any real experimental data (18).

Until someone comes forward with the hard evidence to produce a conclusive number, the Holy Grail of evolutionary biology - the global species count, will continue to be the subject of wild speculation.For the first time, that evidence and conclusive total is presented below, based not on opinion or consensus, but on real and verifiable data.

Insects Are the Key

The answer to solving the biodiversity riddle begins with a re-examination of what we do know so far, namely that insects constitute most of the world's known species. At last count, there are approximately 1.75 million living species known to science, but their precise classification and standing are yet to be worked out (I will return to this later). For clarity, the more agreed-upon figure of 1,413,000 life forms (animals, plants, fungi, protozoans, bacteria and viruses) so far identified and known to science is considered. Of these, about 751,000, or 53%, of these are insects. This becomes more acute when insects are taken as a percentage of the 1,032,000 known animal species, in which they would now comprise about 73% of this total (19) **(see figure 1.)** Whatever way you cut up the biodiversity pie, insects make up a very big slice.

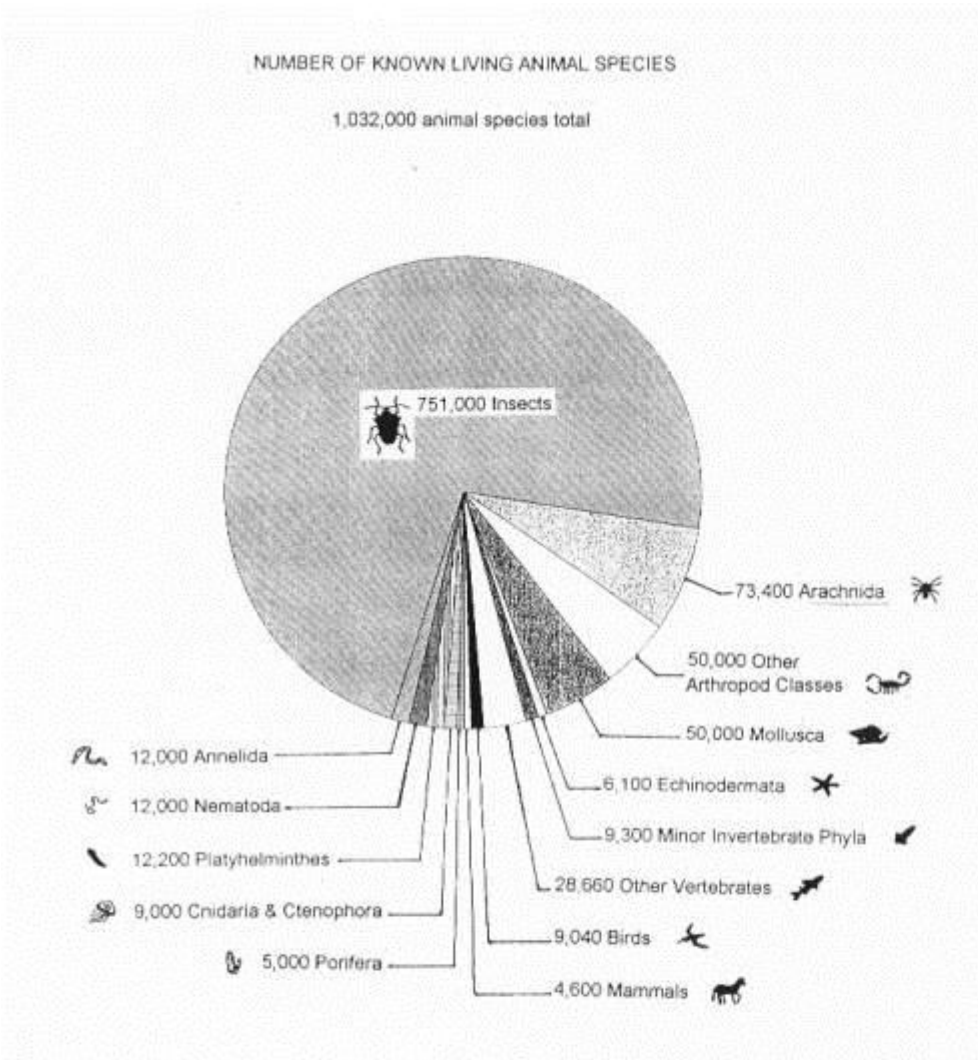


Figure 1 (after Wilson)

Now let's look at insects by themselves **(see figure 2.)** In the Insect class there are at least 32 orders (major divisions), but only 4 of these really stand out; they are 1). Beetles

(Coleoptera); 2). Butterflies and Moths (Lepidoptera); 3). Flies, Mosquitos & Gnats (Diptera); and 4). Wasps, Ants & Bees (Hymenoptera).All total, these four orders make up more than 80% of all known insects, the other 28 orders only about 20% (20).If we could find out how many species there are in one of the four big insect orders, then we can accurately estimate the total number of insects, and ergo, total biodiversity.

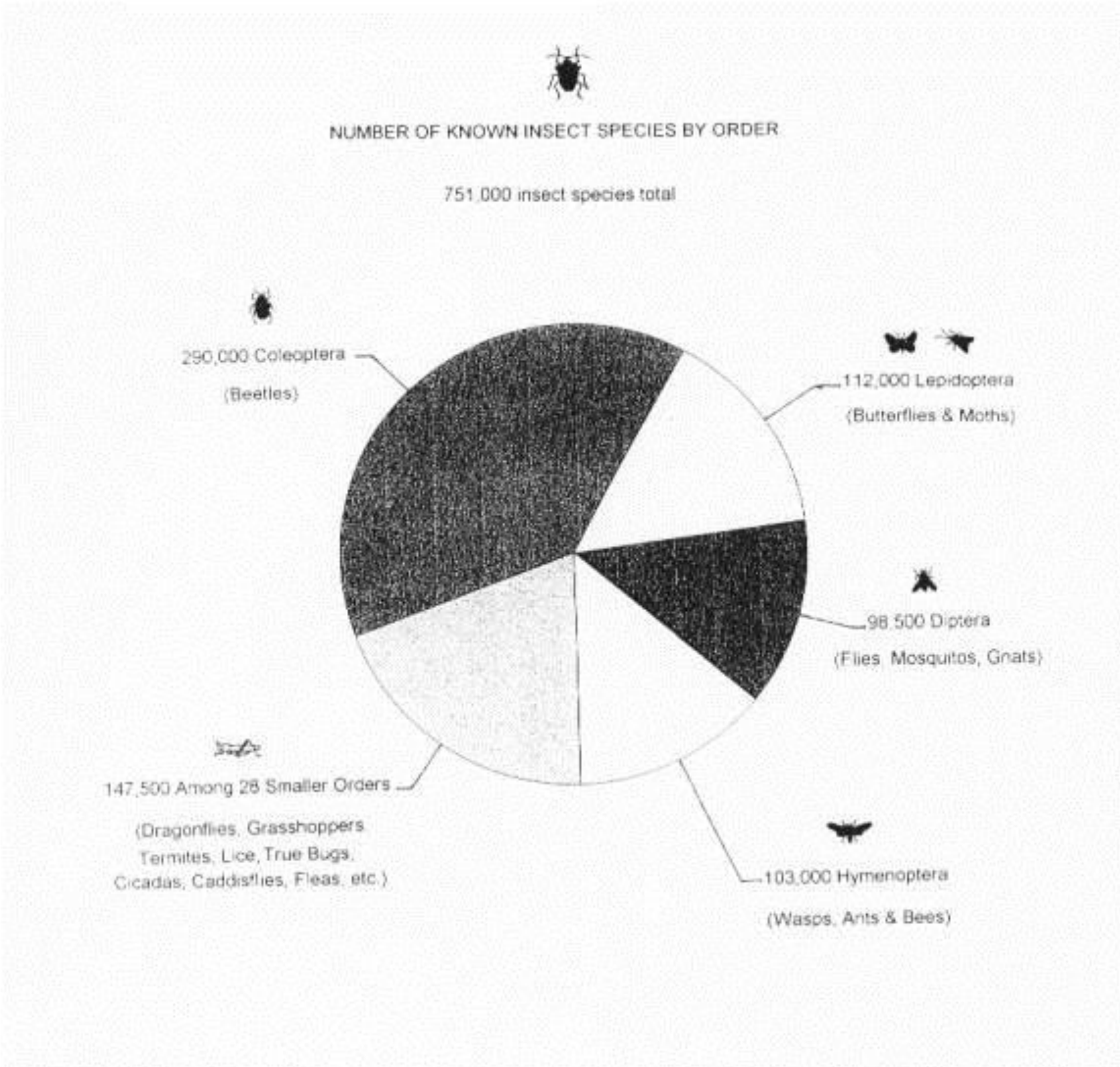


Figure 2

In June 1997, for the first time ever, a complete checklist of all insects known to occur in North America was published. *Nomina Insecta Nearctica* catalogued 95,694 species described up to the end of 1994. Interestingly, this number, broken down into how many species there are in each order, roughly follows the global pie chart in figure 2, in that beetles make up about 25.3%, Butterflies & Moths 12.2%, Flies 20.7% and the Ants & Bees 21.3%.Together, these four "mega-orders" comprise 79.5% of the insects. All other orders make up the remaining 20.5%. But what really makes this checklist important is that taxonomists (people who classify organisms) are running out of new North American species to describe. According to Dr. Robert Poole, who compiled the list; "The number of new species being described has declined exponentially in the last two decades" (21). Very true. In 1970, there were about 88,600 described species (22), yet in over 20 years, the several thousand entomologists working on North American insects could only muster about 7,100 new species.No doubt, new species will continue to be found in North America, but the *rate* of discovery has dropped off sharply, as the fauna of an entire continent has become very well studied. But the field narrows even further.

Based on the new checklist, there are 11,673 species of Butterflies and Moths (Lepidoptera), described from North America, this up a mere 673 species since 1970 when about 11,000 species were known. Of all the major orders of insects, butterflies and moths are always the best studied, hence fewer new species were found relative to other insects. One more refinement: in North America, there are 715 butterfly species (23), with the last distinctive species new to science discovered in New Mexico and described back in 1960 by, of all people, Paul Ehrlich (24). Among the elite 8-member "rainforest mafia", Paul Ehrlich, Thomas Eisner and Edward O. Wilson are noted entomologists, each sharing a lifelong passion for insects, like another bug collector - myself.Because of my familiarity with entomology, butterflies and moths in particular, I was able to recognize the key pattern to solving the whole biodiversity riddle.

The Butterfly Index

Ecologists have long recognized butterflies as the best group of insects for examining patterns of total biodiversity (25). Butterflies make excellent "indicator" species because they are conspicuous, colorful and large, for insects. Even the smallest of butterflies measuring only a centimeter or two are gigantic when compared to the pinhead size bodies of most insects.With their colorful and distinctive scaled wings, butterflies are by far, the easiest of all insects to identify to species. Because of this, they are favorites with collectors and naturalists. They were among the first of all insects to be thoroughly studied and catalogued, with most species having been discovered by the end of the Victorian Era; even conservative estimates recognize that at least 90% of the world's butterfly species have scientific names (26). Thus, unlike most other insects, we know how many butterfly species there are in the world.

At most, there are about 17,500 butterfly species worldwide (27), with other counts as low as 14,750 (28); this all depending on which species are recognized by which authority. Many butterflies that were once considered species are "dropped into synonomy" to the subspecies, or even variety category. Modern advances in species systematics increasingly demonstrate that at the genetic level, there are fewer, rather than more species, in a given well studied group. For example, in a comprehensive study of all New World Swallowtail butterflies (Papilionidae) published in 1994, what was once thought to be well over 200 species was reduced to 143 (29). Somewhat counteracting this decline is the fact that a few new butterfly species are still being found (usually the small and obscure kinds), albeit, their rate of discovery is quickly leveling off. With these two factors in mind, the 17,500 figure must be considered a *maximum* species total.

Using the comprehensive insect tally in *Nomina Insecta Nearctica*, the entire North American continent can be considered a model for worldwide insect diversity, broken down into orders. Thus, in slightly rounded numbers to account for the exponentially diminishing number of new species still being added: 25.5% of all insects are beetles; 12% butterflies & moths; 21% flies; 21% wasps, ants & bees; and the remaining 20.5% comprising the 32 smaller orders (30).These percentages also hold up worldwide, because of the process of *convergent evolution*, where different species in different regions resemble each other in convergent form and way of life. This is demonstrated as fact when considering that in every well surveyed region, beetles, butterflies & moths, flies, and bees are the four orders that always make up about 80% of a given insect fauna.

Continuing to use North American insect diversity as a model, the 715 well documented butterfly species account for 6% of all Lepidoptera (again rounded slightly to accommodate for the few new species of moths and even fewer new butterflies still being added). This percentage holds solid for all habitable continental land masses; only a few remote (Hawaii) or cool climate (New Zealand, Britain) islands have butterfly totals comprising less than 6%, but in these rare cases, the remaining moth fauna still brings the order Lepidoptera to around 12% of all insects for these regions. Therefore, first using butterflies to estimate the number of all Lepidoptera, and then applying all Lepidoptera as a percentage of all insect species makes accurate biodiversity calculations possible. This is the critical oversight that prevented Nigel Stork from calculating global biodiversity back in 1990 (31).

The other reason I base total biodiversity on both butterflies and moths is that both groups are readily collectable for any survey study. While most butterflies can be easily netted or observed during the daytime, almost all moths come to ultraviolet lights at night; no other major insect order can be surveyed this easily.

Based on the above findings, the following sequence of statements can be made:

- Butterflies are the best known of all insects, and are recognized as the best group for examining terrestrial biological diversity.
- There is a maximum of 17,500 species of butterflies.
- At both the continental and global level, butterflies comprise 6% of the order Lepidoptera.
- The order Lepidoptera comprises 12% of all insects.

Therefore, there are approximately 2,430,000 species of insects.

One more step; insects comprise approximately 67% of all living species; this last statement will be demonstrated shortly.

In only three simple steps, total biodiversity is calculated:

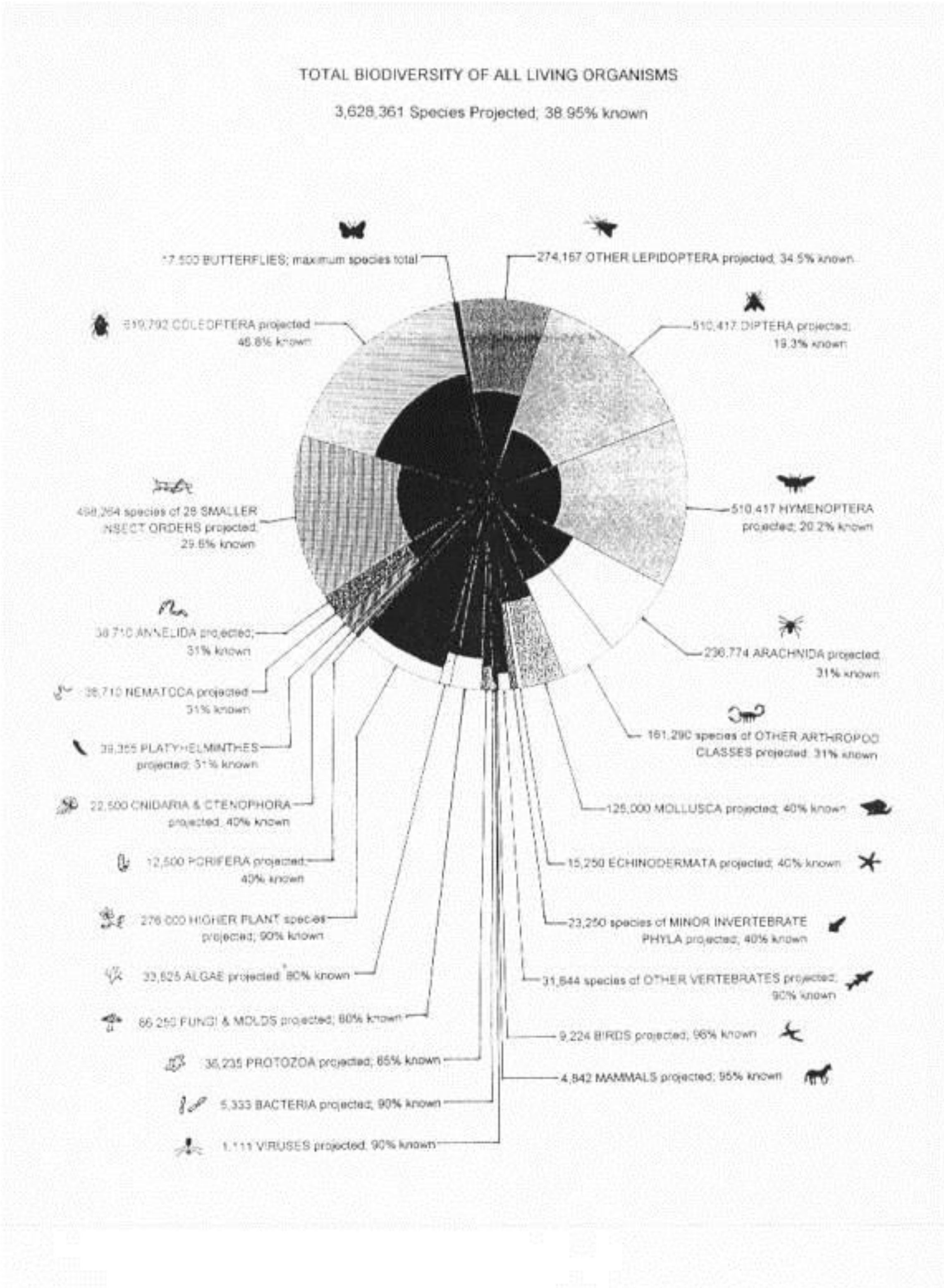
1). 17,500/.06 = 291,667 species of Lepidoptera

2). 291,667/.12 = 2,430,556 species of Insects

3). 2,430,556/.67 = 3,627,695 total biodiversity

In the following pie chart, **(see figure 3)** the total biodiversity of all living organisms is projected to be 3,628,361 species, minor rounding errors aside. The percentage of each group already known corresponds with the dark portions originating from the center of each slice. Totals of each of the large orders of insects are projected based on those percentages calculated from the North American continental model. Other primarily terrestrial invertebrate phyla are estimated to be 31% discovered, based on a comparison with the percentage of all insects known worldwide; as researchers encounter the same problems of inconspicuous size and difficulty in identifying these phyla. Other phyla which are primarily marine (Echinodermata, Mollusca, Porifera, etc.) are estimated to be 40% discovered, based on a study of invertebrates collected from the deep ocean in which 60% of the 798 species found during that expedition were new to science (32).

The remaining groups are much better known. Most mammals and birds have been described, but a few new species occassionally turn up from time to time (33); other vertebrates slightly less so, at perhaps 90%. Stationary organisms like flowering plants, algae and fungi are at least 80% known. Protozoa, bacteria and viruses extensively studied by microbiologists are also well described. Accurate percentages in the minor groups are difficult to pin down due to the propensity of respective authorities to exaggerate. Regardless, the vast 67% majority of the biodiversity pie, insects, can now be well documented.



TOTAL BIODIVERSITY OF ALL LIVING ORGANISMS
3,628,361 Species Projected; 38.95% known
17,500 BUTTERFLIES; maximum species total
274,167 OTHER LEPIDOPTERA projected; 34.5% known
619,792 COLEOPTERA projected 46.8% known
510,417 DIPTERA projected; 19.3% known
498,264 species of 28 SMALLER INSECT ORDERS projected; 29.6% known
510,417 HYMENOPTERA projected; 20.2% known
38,710 ANNELIDA projected; 31% known
236,774 ARACHNIDA projected 31% known
38,710 NEMATODA projected 31% known
161,290 species of OTHER ARTHROPOD CLASSES projected 31% known
38,355 PLATYHELMINTHES projected; 31% known
22,500 CNIDARIA & CTENOPHORA projected; 40% known
125,000 MOLLUSCA projected; 40% known
12,500 PORIFERA projected; 40% known
15,250 ECHINODERMATA projected; 40% known
276,000 HIGHER PLANT species projected; 90% known
23,250 species of MINOR INVERTEBRATE PHYLA projected; 40% known
33,525 ALGAE projected; 80% known
31,644 species of OTHER VERTEBRATES projected; 90% known
66,250 FUNGI & MOLDS projected; 80% known
9,224 BIRDS projected; 96% known
36,235 PROTOZOA projected; 85% known
4,842 MAMMALS projected; 95% known
5,333 BACTERIA projected; 90% known
1,111 VIRUSES projected; 90% known

Figure 3

Abstract Extinctions

Though considerably more than the 1.4 million species known, the documented 3.63 million species estimate is a big let-down from those 10 to 100 million estimates that environmentalists were levitating towards.Edward O. Wilson, using "cautious parameters" of only 10 million species and an extinction rate "on the low side" of 0.27%, calculated an annual loss of 27,000 species(34).Based on that same formula of species loss as a proportion of area being cleared, but instead using the 3.63 million figure, the annual extinction rate would still be 9,800 species!However, if one were to ask for an itemized list of all these species that are supposedly doomed to extinction each year, you would not be able to get such a list, because the 0.27% annual extinction rate is a purely theoretical abstraction! So, if the estimates given by the world's experts are flawed, what is the real extinction rate?

All of the theoretical extinction rates have at least one thing in common, they are calculated as a percentage of total biodiversity, most of it comprised of insects.Thus, if these rates held true, there must be thousands of insects disappearing each year.However this isn't true.The same butterfly index used to calculate world biodiversity can now be used to help determine actual extinction rates. How many butterflies have gone extinct? The fact that there are NO confirmed butterfly extinctions, for any species, places the number at practically zero (35)! In fact, as a whole, almost no insect species have gone extinct.

The extinction rate among all other species is not much more impressive.Since 1600 AD, only about 1,000 species are recorded as having become extinct; this translates to about 2-3 species a year.This fact is irksome to the doomsayers, who counter "Why so few species actually have been recorded as extinct is evident from how little we know about the number of species on earth and their distribution" (36). But consider the following: Even when using the liberal biodiversity estimate of 30 million insect species, of which only 751,000 are known to science, we could at least detect the health of the 2.5% of the insect species that ARE known to science under this scenario. If we then use Wilson's extinction rate of 0.27% applied to only the known insects, there would still be 2,028 *described* insect species disappearing right before our eyes every year, but the present fact that almost no modern-day insect species has gone extinct proves these estimates wrong. When coupled with the fact that we do know there are about 17,500 species of butterflies worldwide (most of them tropical), and none of these have gone extinct, it's safe to say that the extinction rate of all insects is nearly zero, even in the rainforests. Ergo, insects make up about 67% of all life forms, so when this is factored in, extinction rates are very low indeed!

Everyone's heard of the Passenger Pigeon and the Dodo Bird, and it would be incorrect to say that man hasn't accelerated the extinction rate somewhat.The number of birds and mammals that are believed to have gone extinct since 1600 is 1% of the known species (37), or about 136 kinds. This translates to one extinction every three years. Consider this the worst-case actual scenario for losses among vertebrates.From here, the extinction rate drops precipitously, but the second most vulnerable organisms appear to be flowering plants; they are immobile and tend to speciate on remote islands and other small areas susceptible to total destruction by both natural and man-made causes (38).

Unfortunately, the actual list of the recorded 1,000 extinctions since 1600 (39) appears to be unavailable in the literature; but if we assume this rounded number is accurate, and add a large percentage to account for undescribed species, then very liberally applying this to the 33% of all living organisms that are NOT insects, amounts to an extinction rate of only 3 to 5 species a year(40).Finally, there likely were some insect extinctions during the last 400 years, because a few extirpations can be verified on a regional level (41). Thus adding at least one insect extinction a year also seems reasonable on a global scale.

All considered, the true rate of biological extinction averages 3 to 5 species per year.

Since the above statement seriously conflicts with the much higher extinction rates derived by the theoretical approach recognized by most ecologists, an analysis of the methodology and critical flaws inherent in that approach needs to be examined.

The idea of estimating species loss as a direct proportion to an area being cleared began back in 1963 when Edward O. Wilson and Robert MacArthur developed a sort of sliding scale or *area effect* showing a consistent relationship between the area of islands and the number of species living on them.The larger the island, the more different species that lived on it, specifically, the number of species doubles with every tenfold increase in area. But the rule can also be stated in reverse: a tenfold *decrease* in area cuts the number of species in half (42). Assuming that tracts of rainforest were like ever-shrinking islands, the notion was spawned that habitat destruction effected the same kind of linear species loss.

Ironically, Wilson conducted another island experiment that effectively nullifies the above thesis as it applies to human-caused extinctions. In 1966, he selected four tiny mangrove islands in the Florida Keys, documented how many species lived on each island, then hired a pest-control company to kill every animal inhabitant (mostly insects), effecting a complete extinction process. He wanted to see how long it would take for the islands to be re-colonized and at what levels of species abundance. In less than a year, the species abundances were back to their original levels (43). This experiment was modeled on the famous volcanic eruption of the Indo-Pacific island of Krakatau in 1883, in which life forms quickly re-colonized the island after it was left barren by the initial blast.

Julian Simon and Aaron Wildavsky, commenting that "we have found no reports of such empirical evidence" relating an amount of tropical forest removed to a rate of species reduction, instead pointed out that despite considerable human activity which has reduced the original rainforests of Puerto Rico by 99%, there has not been a correspondingly massive extinction rate (44).The fact that none of Puerto Rico's butterfly species have gone extinct, undeniably confirms this.A look at other intensely inhabited islands in the Caribbean and elsewhere also shows no butterfly (or other insect) extinctions. Even in the worst-case scenario of the highly settled and industrialized island of Britain, there is a loss of only 99 kinds (which still thrive in mainland Europe) of its more than 22,000 insect species in over 100 years (45)! Thus, a turnover of natural habitat does not equate to a corresponding loss of species. Instead, the size of the land area, regardless of composition, determines how many species it will support, based on the correct model of island colonization.

Surprisingly, the species group Wilson, Myers and others used to correlate a demonstrable extinction rate to habitat loss are birds. They felt birds were good for measuring extinction because "they are conspicuous and easy to identify"(46).In fact birds are a poor and extremely biased measure of extinction. As the facts demonstrate, birds and certain other vertebrates are considerably more prone to extinction than the vast majority of organisms, especially insects.Wilson apparently gets around this by claiming that estimates apply to how many species will eventually go extinct as rainforests are cut back. He bases this on exponential decay, defining: "at first there are many species destined for extinction, which therefore vanish at a high overall rate; later, only a few are endangered, and the rate slows" (47).In one convenient step, Wilson explains away the immediate and obvious (though relatively few) bird extinctions, and claims the vast unknown losses soon to follow will be increasingly less noticed.Thus, a liberal extinction rate of 10 to 50% of birds during 100 years of human intrusion, is applied to all organisms. Even Wilson admits this data "seemed too good to be true"(48) for such a "depressing" decay model - actually, it IS too good to be true.

For one thing, the 10 to 50% bird extinctions are modeled on the local decline of Barro Colorado, an area that was transformed into a 17-square-kilometer island as Gatun Lake formed, during construction of the Panama Canal; thus erroneously confusing an area actually diminished by water inundation with a larger land area merely cleared of some forest. But further contaminating their data was a disregard for the vast differences in insect biology. Unlike birds, which lay only a few eggs, insects lay hundreds of eggs, reproducing in great numbers and with short life-spans, have a quick succession of broods (49).They also adapt very well to human intrusion and are virtually impossible to exterminate by merely killing individuals, (50) as any gardener struggling to keep pests at bay will attest to.For these reasons, the extinction rate among insects is extremely low.

Thus, the fatal flaws with the area-effect as applied to extinction rates are two-fold. The most serious stems from the assumption that clearing away rainforest or other natural areas effectively constitutes a diminished "island" or elimination of the land area altogether. In other words, for Wilson or Myers's theoretical approach of extinction to be a true model, the land area itself would have to literally disappear into the ocean, not just be altered. Framed another way: if the World Wildlife Fund's dire prediction "by the year 2050, half of all the species alive today could be lost forever" (51) scenario held true, then instead of 75% of the earth being covered by ocean today, it would be over 97% covered in 50 years.Secondly, no scientist should be comparing birds to insects!

Fitted into the known global pattern of the extinction process; a region may experience the disappearance of a few birds, mammals and other mostly large creatures, as well as some localized plants, but the underlying biodiversity, most of it resilient insects, remains virtually intact.Because of this consistent pattern, the new global biodiversity and extinction rate calculations described herein can also be applied locally to any given land area; their uses are especially impressive in the field of urban ecology.

Self-fulfilling Prophecies

Despite only being able to document perhaps 1,000 actual extinctions during the last 400 years, ecologists are quick to point to burgeoning lists of tens of thousands of species "threatened" with extinction and untold millions more "unknown" species passing into oblivion.Like a massive tidal wave about to drown much of the planet, the wave of an ever-increasing human population seems about to cripple the crucible of life itself. Though always placed at our doorstep, this threat never materializes. Across the board, predictions made by the doomsayers only 10 or 20 years ago, about millions of species being driven to extinctions by the year 2000, are clearly proven false, as mankind embraces the new millennium. Yet, their prophecies persist.

The concept of a mass extinction spasm caused solely by humans has gained wide attention. It has been especially popularized by Richard Leakey in his book, *The Sixth Extinction*, though Leakey is actually a latecomer to the biodiversity crisis, merely borrowing and building on ideas set forth years ago by members of the "rainforest mafia". Generally, biodiversity on earth has experienced five prior mass extinctions, the latest of these occurring 65 million years ago with the passing of the Dinosaurs (52).Extinction spasms are measured against a normal "background" extinction rate of about one species per one million species a year. Thus when compared to the present "theoretical" extinction rates of 27,000 to 100,000 species annually, it would appear that another spasm is underway. on the order of 1,000 to 10,000 times the natural rate (53). But this, too, can be proven erroneous.

Applying the firm estimate of 3.63 million living species on earth to the background extinction rate of one species per million, indicates a present natural extinction rate of 3-4 species a year. Compared to this, the present extinction rate averaging 3 to 5 species annually is only one species, on average, above the natural process, this slight overage mostly attributable to the extinction of larger vertebrates like birds and mammals; the following quote by Edward O. Wilson inadvertently confirms this.

> "In western North America, just behind the retreating glacial front, the grasslands and copses were an American Serengeti. The vegetation and insects were similar to those alive in the west today - you could have picked the same wildflowers and netted the same butterflies - but the big mammals and birds were spectacularly different" (54).

The evolutionary process of extinction, whether natural or human induced, shows a tendency to eliminate large species like dinosaurs and Woolly Mammoths, least able to adapt to new conditions, in favor of smaller, more adaptable organisms like insects.

Animals like pandas and rhinos face the possibility of extinction (at least in the wild) but such large and very distinctive species are in the acute minority. In a recent issue of *National Geographic* devoted to biodiversity, a foldout poster portrays a Xerces Blue Butterfly as an extinct species (55). In reality, *Glaucopsyche lygdamus xerces* is nothing more than a local variant of a common butterfly with a distribution spanning most of the North American continent (56). Other American butterflies now listed under the Endangered Species Act are also nothing more than localized indistinct "subspecies" of common and widespread species. Without locality labels, the experts usually can't tell them apart, and certainly the layperson isn't going to distinguish one rare tiny blue butterfly from a host of other common blue species flying in the same locality - that is, if these inconspicuous organisms are noticed at all!

Padded with thousands of trivial "subspecies" the ever-growing international Endangered Species lists are complemented with thousands more "threatened" species, most of the above listed for no particularly good reason. For example, the authors of the study on New World Swallowtail butterflies, while whittling the count down to only 143 distinct species, claim that 40 of these are considered threatened by international IUCN standards. Typical reasons include widespread species that "need watching" or species that simply occur on an island, and thus are more prone to possible decline (57). Germany lists 34% of its insects and other invertebrates as threatened or endangered (58), many of them, in fact, laughably common. Other countries now impose blanket protection of everything, all stemming from the superstitious belief in the myth of the Sixth Extinction.

Feeding the frenzy is the related notion that any loss in biodiversity translates into a priceless genetic loss (59). Occasionally, some plant like the abundant Pacific Yew, found to contain taxol, has value in fighting cancer. Scientists then developed synthetic versions so the drug could be mass-produced (60).But such discoveries are far more the exception than the rule. Thomas Eisner, a diligent promoter of chemical ecology or "bio-prospecting" once testified before Congress that insects must be protected because studying them may reveal medical benefits (61). Some insects do contain usable chemicals, but Bombadier Beetles and Tiger Moths are abundant species groups; in these cases, the ordinary backyard is as good a place to go bio-prospecting as a rainforest.Consider the following: an indistinct "endangered species" isn't going to contain any chemical benefit that couldn't be found in a similar but common species.Further, if an organism is extremely rare or local, it contributes little, if anything, to the health of an entire ecosystem - it's the common species that generate most of the biomass.

Environmentalists have immortalized a quote by Edward O. Wilson who argues "every scrap of biological diversity is priceless, to be learned and cherished, and never to be surrendered without a struggle"(62). But is this a rational goal? Under its Endangered and Threatened Species Protection Act, the state of Florida lists the Central American Malaria Mosquito (Anopheles albimanus) as an endangered species (63).Is it ethical or even feasible to willfully submit to the blind servitude of the creature? Should we restore the Small Pox virus to its former range?Should we stand back and let nature take its course with AIDS? (64). Clearly, our stewardship of biodiversity has to have some reasonable limits.

Suggested Solutions

When Nigel Stork first estimated a total of 4.9 to 6.6 million different insects based on the ratios of species found in Britain, he might have well been on his way to being the first to solve the biodiversity riddle. Instead, Dr. Stork later revised his figures sharply upwards to 12.5 million species (65). From inflated estimates like this, ecologists claim that the vast majority of extinctions are insects, yet it has long been common knowledge to most professional entomologists that the indicated extinction rate among insects is nearly zero! (66). In what may turn out to be one of modern history's greatest examples of "group think", this debacle seriously questions the ability or willingness of ecologists to do accurate and unbiased studies.

Policy makers have long recognized the issue of "junk" or "bad science". In 1994 Congressional Representative Don Young introduced legislation aimed at correcting abuses of the Endangered Species Act by trying to implement an external peer review process (67); however, it was vigorously opposed by environmentalists.This plan should be reintroduced in a more comprehensive form. The peer review process would involve astute individuals and groups from fields outside biology, who could subjectively analyze the true validity of biodiversity issues and any applicable laws.

The Endangered Species Act and similar legislation has become overburdened with species and subspecies listings having no real ecological or public benefit. As demonstrated, the organisms least in danger of extinction, and least beneficial as individual species among 2.43 million kinds are insects. Insects, and other terrestrial invertebrates, should be completely eliminated from any and all protective legislation across all levels of government.

During its recent reauthorization process, several members of Congress proposed amendments to the Endangered Species Act. These are too extensive to discuss here, but many of the objections centered around property rights. At issue is the burden on property owners having to pay for expensive environmental impact studies, only to find that their land has been condemned because of some protected species. This financial and economic burden should be shifted to the very environmental groups and government agencies causing all the red tape. If biologists and environmentalists are spending their own money, they will be more judicious in identifying real ecological problems instead of looking for ways to secure lucrative funding. Only if an outside peer review committee determines that a genuine, verifiable public benefit exists, would the plaintiffs be compensated for their actions. Otherwise, taxpayer and property owner alike are being held responsible for the dubious environmental objectives of a few. This is like making everyone pay for very expensive tickets, when only a few actually want to go and see the movie.

Such measures would also help eliminate problems in the environmental community itself. John C. Sawhill, former President of the Nature Conservancy, once commented about the difficulty in setting priorities amidst a hyperbole of environmental confusion."The conservation lexicon is littered with superlatives: the most, the best, the rarest. Problems are invariably 'critical' and the situation always 'grave'....environmentalists have used incomplete or flawed scientific evidence to dramatize the deteriorating health of our environment." He continues that "All environmental organizations have at some time or another cried wolf, without adequate justification... I am convinced that this will hinder, rather than help, our efforts to protect the environment" (68).

There's nothing wrong with individuals or groups desiring to save a local population of some small blue butterfly, but the cost of this purely emotional passion should be carried out in the private sector. However, a reasonable alternative would be for governments to offer an additional elective tax imposed on those wanting to pay for such conservation measures, while at the same time reducing taxes for everyone else.These funds could also be used to fully compensate local government or private property owners willing to sell land or conservation easements, and pay for studies and peer review processes.

Conclusion

Now that the air has been let out of the over-inflated tires of the biodiversity bandwagon, it will be hard for many world leaders to accept that they have been taken for a ride.Environmentalists were quick to criticize former president George Bush's refusal to sign the Convention of Biological Diversity on behalf of the United States at the 1992 Earth Summit in Rio de Janeiro. But in retrospect, president Bush made the correct choice in the face of hyperbole and a dangerous trend towards human subjugation to the creature.Conservation biology needs to be guided by real data and rational decisions, rather than bad science and misguided emotions.

Endnotes

1. *Wings, Essays On Invertebrate Conservation*, (The Xerces Society, Winter 1992), News Briefs, page 20.

2. Wilson, Edward Osborne, *Naturalist*, (Warner Books, 1994), p. 356-358.

3. Leakey, Richard E., and Roger Lewin, *The Sixth Extinction, (Anchor Books, Doubleday, 1995), p. 236.*

4. Wilson, Edward Osborne, The Diversity Of Life, (W. W. Norton & Company, 1993), p. 255.

5. ibid., Wilson, p. 255 "the number of species doomed each year is 27,000." ibid., Leakey, p. 236.

6. Stork, Nigel E., "Measuring Global Biodiversity and Its Decline," in Biodiversity II, (National Academy of Sciences, 1997), p. 63 "50% of species [extinct] by 2000 or soon *after, Ehrlich and Ehrlich (1981).*

7. Wilson, Edward Osborne, The Diversity Of Life, (W. W. Norton & Company, 1993), p. 255.

8. Stork, Nigel E., "Measuring Global Biodiversity and Its Decline," in Biodiversity II, (National Academy of Sciences, 1997), p. 41.

9. ibid, p. 47.

10. ibid, p. 48; the ratio is 67:22,000 - butterflies:insects.

11. ibid, p 57; projected numbers after Hammond, 1992; Stork, 1993.

12. ibid, p. 50-51.

13. ibid, p. 52-55.

14. Wilson, Edward Osborne, The Diversity Of Life, (W. W. Norton & Company, 1993), p. 140.

15. Stork, Nigel E., "Measuring Global Biodiversity and Its Decline," in Biodiversity II, (National Academy of Sciences, 1997), p. 52.

16. Morell, Virginia, "The Variety of Life" in National Geographic, Vol. 195, No. 2, (February, 1999), p. 16.

17. Tangley, Laura, "How Many Species Are There?" in U.S. News & World Report, (August 18/August 25, 1997), p. 79.

18. ibid, p. 79.

19. Wilson, Edward Osborne, The Diversity Of Life, (W. W. Norton & Company, 1993), p. 134.

20. ibid, p. 134.

21. Poole, Robert W., NOMINA INSECTA NEARARCTICA:A Checklist of the Insects of North America, (Entomological Information Services, 1997). Order percentages of 95,994 total species are derived from Coleoptera 24,229 species; Lepidoptera 11,673 species; Diptera 19,782 species; Hymenoptera 20,366 species; Other 28 Smaller Orders 19,944 species.

22. Borror, Donald J. & Richard E. White, A Field Guide to Insects: America north of Mexico (Houghton Mifflin Compnay, 1970), p. 56.

23. Miller, Lee D., and F. Martin Brown, A Catalogue/Checklist Of The Butterflies Of America North Of Mexico (The Lepidopterists' Society, Memoir No. 2, 1981) lists a total of 763 species.

Scott, James A, The Butterflies Of North America (Stanford University Press, 1986) revised the above total to 679 species.After an extensive review of subsequent taxonomic revisions and personal communications with other knowledgeable lepidopterists, I fix the reliable number to 715 distinct species.

24. Miller, Lee D., and F. Martin Brown, ibid., p. 108, Sandia mcfarlandi P. Ehrlich and Clench. Ent. News, 71: 138 (1960) Type Locality -- La Cueva Canyon, W. Slope Sandia Mtns., Bernalillo Co., New Mexico.

25. Robbins, Robert K, and Paul A. Opler, "Butterfly Diversity and a Preliminary Comparison with Bird and Mammal Diversity" in Biodiversity II, (National Academy of Sciences, 1997), p. 69.

26. ibid, p. 69 and p. 79.

27. ibid, p. 71.

28. Scott, James A., The Butterflies Of North America (Stanford University Press, 1986), p. 111-112.

29. Tyler, Hamilton A., Keith S. Brown, and Kent H. Wilson, Swallowtail Butterflies of the Americas (Scientific Publishers, Inc., 1994), p. 34.

30. 715 butterfly species divided into 11,673 Lepidoptera (aggregate of butterflies and moths) is 0.0613, but since there are still a small minority of undescribed North American moths, and very few possible cryptic (undetected, taxonomically obscure) butterfly species, rounding the percentage of butterfly species down to 6% accomodates for any still-undescribed species.

31. In his approach (1990), (ibid), described in "Measuring Global Biodiversity and Its Decline" (1997), Nigel Stork compared the ratio of 67 species of British butterflies to 22,000 British insects, which, when applied to a global estimate of 15,000 to 20,000 butterflies, indicated a total of 4.9 to 6.6 million species of insects worldwide.If Stork would have, instead, applied the ratio of 2,900 species of all British Lepidoptera to the 22,000 insects, he would have found them to comprise 13% of all insects.

32. Stork, Nigel E., "Measuring Global Biodiversity and Its Decline" in Biodiversity II, (National Academy of Sciences, 1997), p. 58.

33. Wilson, Edward Osborne, The Diversity of Life, (W. W. Norton & Company, 1993), p.

148-149.

34. ibid., p.280.

35. Scott, James A., The Butterflies Of North America, (Stanford University Press, 1986), p. 111.

36. Stork, Nigel E., "Measuring Global Biodiversity and Its Decline" in Biodiversity II, (National Academy of Sciences, 1997), p. 45 -- "And yet only about 1,000 species are recorded as having become extinct in recent years (since 1600)"; p. 60.

37. ibid., p. 60.

38. Morell, Virginia, "The Sixth Extinction" in National Geographic, Vol 195, No. 2, (February, 1999), p. 51, 55.

39. Stork, Nigel E., "Measuring Global Biodiversity and Its Decline" in Biodiversity II, (National Academy of Sciences, 1997), p. 45, I was unable to locate a comprehensive list of the reported 1,000 documented extinctions mentioned.

40. Of the known 1,413,000 organisms (after Wilson, The Diversity Of Life, 1993), 662,000 of these are non-insect.Applying the known extinction rate of 1,000 species in 400 years to 662,000 is 2.5 species per year.The ration of known to unknown non-insect organisms is 662,000:1,197,359 (33% of 3,628,361 species total projected biodiversity is 1,197,359).Thus 2.5 species per year divided by 0.55 = 4.5 extinctions, or 4 to 5 extinctions per year.

41. Stork, Nigel E., "Measuring Global Biodiversity and Its Decline" in Biodiversity II, (National Academy of Sciences, 1997), p. 61 and Table 5-7 on p. 64; Of more than 22,000 species of British Insects, 99 species have not been seen since 1900. Assuming these are extinct, and understanding that the highly settled and industrized island of Britain represents an upper bound, the maximum extinction rate is one insect species per year. None are global extinctions, as these 99 species can still be found in mainland Europe. The fact that no butterfly species, and virtually no other insect is known extinct demonstrates a global extinction rate so low that known to unknown ratios would not apply.

42. Wilson, Edward Osborne, The Diversity Of Life, (W. W. Norton & Company, 1993), p. 220-221.

43. ibid., p. 223-225.

44. Simon, Julian L., and Aaron Wildavsky, "Extinction; Species Loss Revisted" in NWI Resource, Volume 5, issue 1 (National Wilderness Institute, Fall 1994), p. 8.

45. ibid., see Note 41 above.

46. Wilson, Edward Osborne, The Diversity Of Life, (W. W. Norton & Company, 1993), p. 279.

47. ibid., p. 279.

48. ibid., p. 279.

49. Powell, Jerry A., California Insects, (Stanford University Press, 1979), p. 359-360.

50. Pyle, Robert M., R. Bentzien and P. Opler, "Insect Conservation" in Annual Review of Entomology, Vol. 26; 1981, p. 241.

> *"..there are no documented cases of extinctions or even local extirpations of insect populations due to indiscriminate collecting... Attempts to eliminate local populations of a bee and a butterfly by intensive collecting in the course of population studies had, in fact, the opposite effect; target populations actually <u>increased</u> in subsequent years (E. G. Linsley, P. R. Ehrlich, personal communications)....four decades of wide use of organic pesticides have not resulted in the extinction of any insect... More normally, insecticide usage causes only temporary reductions and changes in the relative abundance of native insect populations."*

51. WWF Atlas Of The Environment, second edition, (Harper Perennial, 1994), p. 127.

52. Leakey, Richard E., and Robert Lewin, The Sixth Extinction, (Anchor Books, Doubleday, 1995), p. 47.

53. Wlison, Edward Osborne, The Diversity Of Life, (W. W. Norton & Company, 1993), p. 280.

54. ibid., p. 247.

55. "Millennium In Maps: Biodiversity" in National Geographic, Vol. 195, No. 2, (February 1999).

56. Scott, James A., The Butterflies Of North America, (Stanford University Press, 1986), p. 399.

57. Tyler, Hamilton A, Keith S. Brown, Jr., and Kent W. Wilson, Swallowtail Butterflies of the Americas, (Scientific Publishers, Inc., 1994). p. 177, 182-183. Example species listed for "indeterminate" or "poorly known" reasons include <u>Papilio aristor</u>, <u>P. caiguanabus</u>, and <u>P. thersites</u> -- there are many other examples. IUCN is "The World Conservation Union."

58. Wilson, Edward Osborne, The Diversity Of Life, (W. W. Norton & Company, 1993), p. 258; "In western Germany, 34 percent of 10,290 insect and other invertebrate species were classified as threatened or endangered in 1987." Note: this list includes <u>every</u> German butterfly species except 3 common Cabbage Whites considered pests (Pieris napi, P. rapae, and P. brassicae).

59. ibid., p. 281-310, in the chapter titled "Unmined Riches," Wilson points to some examples of useful organisms (mostly plants) to convey the message of total genetic preservation.

60. Norton, Rob, "Owls, Trees, And Ovarian Cancer" in Fortune Magazine (February 5, 1996), p. 49.

61. Wings, Essays On Invertebrate Conservation, (The Xerces Society, Winter 1992), News Briefs, p. 20.

62. Wilson, Edward Osborne, The Diversity Of Life, (W. W. Norton & Company, 1993), p. 32.

63. Wood, Don A., Legal Accomodation Of Florida's Endangered Species, Threatened Species And Species Of Special Concern, 1 July 1991. The description of the Central American Malaria Mosquito's endangered status was prepared by L. Philip Lounibos.

64. Lewis, Martin W., Green Delusions: An Environmentalist Critique of Radical Environmentalism, (Duke University Press, 1992), p. 37, "Equally generous is the position of those Earth First! members who hopefully look to AIDS as nature's antibody to the human plague".

65. Stork, Nigel E., "Measuring Global Biodiversity and Its Decline" in Biodiversity II, (National Academy of Sciences, 1997), p. 57, Figure 5-7 shows "The projected number of species for different taxa based on an estimated global total of 12.5 million species (after Hammond, 1992, Stork, 1993);"

66. Scott James A., The Butterflies Of North America (Stanford University Press, 1986), vi. In the preface, Dr. Scott acknowledges colleagues, Paul Ehrlich included, who reviewed the book, and many other contributors, myself included, who were aware of Scott's comment on page 111 that "No butterfly species in the rest of the world has become extinct either, as far as is known."

67. Bouwsma, Angela, DEN NEWS, No 245, 12-23-94 (The Bureau Of National Affairs Inc, 1994) A-9, A-10. In response to the defeated HR 1490, Rep. Don Young commented that he would "attempt to put into law what the Endangered Species Act was meant to be" emphasizing that "no species would be put on the threatened list or the endangered list without 'biological, scientific review... The science should then be subject to external peer review... Some federal regulatory agencies have not been reviewed for 40 years."

68. Sawhill, John C., "The Boy Who Cried Wolf, From The President" in Nature Conservancy, vol. 43, No. 5, September/October 1993, p. 5.

| back |