

# WHERE ARE THE CORPSES?

by Willis Eschenbach



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## ABSTRACT

The record of continental (as opposed to island) bird and mammal extinctions in the last five centuries was analyzed to determine if the “species-area” relationship actually works to predict extinctions. Very few continental birds or mammals are recorded as having gone extinct, and none have gone extinct from habitat reduction alone. No continental forest bird or mammal is recorded as having gone extinct from any cause. Since the species-area relationship predicts that there should have been a very large number of recorded bird and mammal extinctions from habitat reduction over the last half millennium, I show that the species-area relationship gives erroneous answers to the question of extinction rates.



Figure 1. The Object of My Quest — The Corpse of an Extinct Bird.

## BACKGROUND

A recent study in Nature [Thomas 2004] stated that 37% of all species might soon go extinct because of habitat reduction due to global warming. This same prediction of impending mass extinctions from habitat reduction due to global warming has been made a number of times recently, for example in a book by Professor Michael Benton of Bristol University (Benton 2003), as well as in studies by Parmesan and Yohe (Parmesan 2003) and Root et al. (Root 2003).

Habitat reduction has also been cited as being responsible for the continuing extinction of species which is said to have already happened due to the cutting down and fragmentation of tropical forests (Wilson 1995, 2001). For example, a recent study in Conservation Biology (Harris 2004) opens by saying that “Intense deforestation causes massive species losses.” Wilson says that due to habitat reduction we are in the “sixth great wave of extinctions”, comparable in size to the five previous great waves of extinctions in geological time. (Wilson 1992).

Reading these kinds of claims over and over again made me think, “Well, if there’s been all of those claimed extinctions of birds and mammals ... where are all the corpses? What are the names of all the extinct birds and mammals”? This research paper investigates these claims that habitat reduction from temperature change and deforestation has led and will continue to lead to the extinction of a large number of species.

A few clarifications are in order.

This study is not about estimated, predicted, or calculated extinctions. It is an analysis of the actual historical record of extinctions, with the purpose of understanding the nature and size of extinctions from historical habitat reduction.

By extinction I never mean local extinction. I have analyzed total extinctions of species (not subspecies). Local extinction is a separate and valuable study, not covered by this work.

I am not referring to “almost extinct,” “on the brink of extinction,” or “reportedly extinct.” I am discussing the actual extinction of species as confirmed by the relevant authorities.

## **METHODS**

In their seminal work, “The Theory of Island Biogeography”, MacArthur and Wilson further explored the “species-area” relationship (MacArthur 1963). This relationship, first stated mathematically by Arrhenius in 1920, relates the number of species found to the area surveyed as a power law of the form  $S = C * a^z$ , where “S” is species count, “C” is a constant, “a” is habitat area, and “z” is the power variable (typically .15 to .3 for forests). In other words, the number of species found in a given area is seen to increase as some power of the area examined.

By surveys both on and off islands, this relationship has been generally verified. It also passes the reasonability test — for example, we would expect to find more species in a state than we find in any one county in that state.

Does this species-area relationship work in reverse? That is to say, if the area of a forest is reduced, does the number of species in the forest decrease as well? And in particular, does this predicted reduction in species represent species actually going extinct? One of the

authors of “Island Biogeography” thinks so. In 1992, E. O. Wilson wrote that because of the 1% annual area loss of forest habitat worldwide, using what he called “maximally optimistic” species/ area calculations, “The number of species doomed [to extinction] each year is 27,000. Each day it is 74, and each hour 3.” (Wilson 1992).

If we have lost 27,000 species per year since 1992, that’s over 300,000 species gone extinct. In addition, Wilson said that this rate of forest loss had been going on since 1980, so that gives us a claim of over well over half a million species lost forever in 24 years, a very large number.

Wilson also wrote, “Some groups, like the larger birds and mammals, are more susceptible to extinction than most.” (Wilson 1995) So, following Wilson’s lead to see if the extinction claims are true, I have investigated the timing and number of mammal and bird extinctions in modern times (the last 500 years) which are due to habitat reduction.

There are many different estimates of species loss, varying by orders of magnitude. I have seen extinction claims as high as “one species per minute” (over half a million extinctions per year, 10 million species extinct in 20 years) quoted in a number of places. However, I wanted facts, not estimates.

There are two main lists used by scientists to keep track of the facts of extinction. One is the “Red List”, maintained by the International Union for Conservation of Nature and Natural Resources (IUCN), which lists species which are either extinct or at risk of extinction. The Red List database can be searched online at [redlist.org](http://redlist.org).

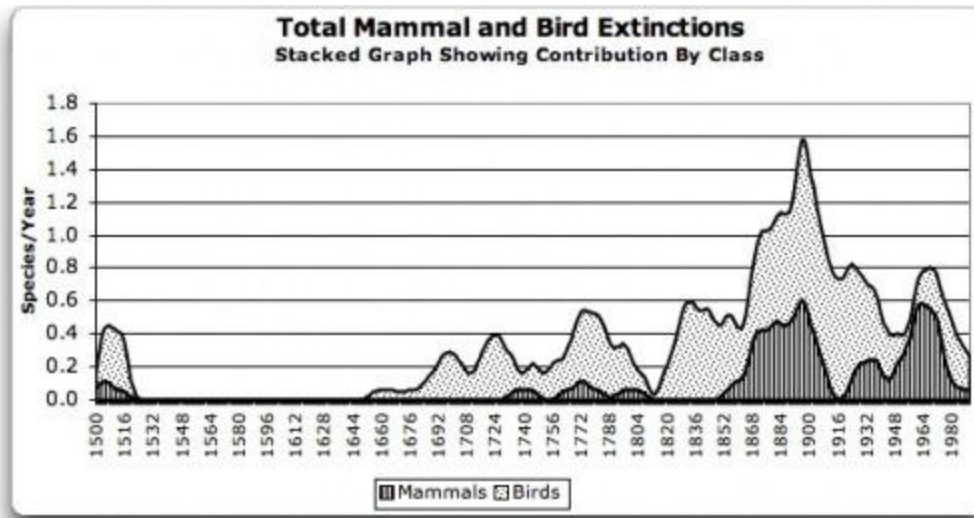
The other is the CREO list, from the Committee on Recently Extinct Organisms at the American Museum of Natural History. Their database is online at [creo.amnh.org](http://creo.amnh.org). The CREO has established very clear criteria for declaring a species extinct, not extinct, or unresolved. The criteria include precise definitions for such things as adequate taxonomy (including DNA comparisons if available), sufficient hypodigm (actual specimens of the species), and adequate surveying of the species’ habitat to verify extinction. Starting afresh, they have then uniformly applied these criteria to the historical record of purported extinctions of mammals and fish in the last 500 years.

The conclusions of the CREO list are noted in the Red List, and vice versa. Although the two lists are very similar, I find the CREO list to be more thoroughly investigated and more uniformly and scientifically based than the Red List, so I have used it for mammal extinctions (it does not yet cover birds).

## **TIMING AND SIZE OF THE EXTINCTIONS**

The bulk of the extinctions took place in several waves, as Europeans expanded outwards in successive centuries. Island after island has seen specialized native species driven extinct by

imported species. These invader driven extinctions peaked in about 1900, but are still going on.



**Figure 2 – Stacked graph of the historical extinction rates for birds (grey) and mammals (black). 17 year Gaussian average of the data from Red List (birds) and CREO (mammals). Note the peak rate of 1.6 bird and mammal extinctions per year, and the most recent rate of 0.2 extinctions per year.**

Figure 2 shows see the complete record of every known bird and mammal extinction. In general, the timing reflects the various phases of the expansion of a variety of European species, including humans. Starting from the Caribbean extinctions in the 1500's, extinctions continue through the age of exploration in the 1700's and the colonial period of the 1800s. This wave of "alien species" extinctions peaked around 1900 at 1.6 extinctions per year. Extinction rates have dropped since then, with the most recent value being 0.2 extinctions per year.

Wilson's claim that 27,000 extinctions per year have been occurring since at least 1980 means that there should be 26 bird extinctions and 13 mammal extinctions per year, a total of 39 bird and mammal extinctions per year.

The historical extinction rate, however, has never been greater than 1.8 per year, far below the 39 extinctions per year claimed. In addition, the most recent rate is lower than it has been since about 1830. Looking at the entire bird and mammal extinction record, there is no sign of the hundreds of extinctions that Wilson says have already occurred.

I was not interested, however, in all of the mammal and bird extinctions. In particular, I was not interested in mammals and birds that had gone extinct on islands from the introduction of alien species. I was looking for Wilson's predicted extinctions, those due to habitat reduction.

So I divided all of the extinctions into two groups. The first group is the extinction of those species living on isolated islands or on Australia, where species were (and still are) easily driven to extinction by the depredations of imported dogs, foxes, mongoose, rats, human hunters, goats, pigs, snails, cats, sparrows, frogs, starlings, and various plants, as well as the usual assortment of imported human, animal, and plant diseases. I will call this group of extinctions “island” extinctions. Please don’t write to tell me Australia is not an island. It is grouped with the islands because of the nature of the extinctions there, which were caused by imported alien species.

The second group is the extinction of the continental species, the mass of the world’s species, those species that live on the continents (Asia, Europe, Africa, North America, South America, and Antarctica.) I will call this group “continental” extinctions.

It is not widely appreciated how much island extinctions have dominated the total record of extinctions. Here are the extinct mammal species, showing island extinctions and continental extinctions:

**Count of Extinct Mammal Species**

<u>Island vs. Continental</u>	<u>Country</u>	<u>Total</u>
Extinct Island Mammal Species	Various	58
Extinct Continental Mammal Species	Mexico	1
Extinct Continental Mammal Species	Algeria	1
Extinct Continental Mammal Species	South Africa	1
Extinct Continental Mammal Species	Subtotal	3
Grand Total Extinct Mammal Species		61

Data – <http://creo.amnh.org>

Of the 4,428 known mammal species (Red List 2004) living in Asia, Europe, Africa, North America, South America, and Antarctica, only three mammals have gone extinct in the last 500 years. These were the Bluebuck antelope, South Africa; the Algerian gazelle, Algeria; and the Omilteme cottontail rabbit, Mexico.

Turning next to birds, when we are studying the extinction of species, birds have a very useful trait — they are extremely visible. Nearly all of them fly up where we can see them; they make distinct and identifiable noises; many are brightly colored; none are too small to

see; many roost in trees so they can be seen from afar with binoculars; in all, they are perhaps the most visible of all classes of life. Because of this, they are well-known to humans everywhere — all 129 extinct birds have a common name, for example, which is not the case with other classes of animals. Based on where the birds breed, here’s how the data from the Red List divides out between continental and island bird extinctions:

### Count of Extinct Bird Species

<u>Island vs. Continental</u>	<u>Country</u>	<u>Total</u>
Extinct Island Bird Species	Various	123
Extinct Continental Bird Species	Mexico	1
Extinct Continental Bird Species	Guatemala	1
Extinct Continental Bird Species	Colombia	1
Extinct Continental Bird Species	US	2
Extinct Continental Bird Species	Canada, US	1
Extinct Continental Bird Species	Total	6
Grand Total Extinct Bird Species		129

Data – <http://www.redlist.org>

We see the same pattern with birds as with mammals. Of the 128 extinct bird species, 122 of them were island extinctions. Of the 8,971 known continental bird species (Red List 2004), 6 have gone extinct.

Looking at the reasons for the continental bird and mammal extinctions, in chronological order we have:

Bluebuck, *Hippotragus leucophaeus*, 1800 – Red List says ” ... hunted by European settlers throughout the 1700s. The last of the species was killed around 1800.”

Labrador Duck, *Camptorhynchus labradorius*, 1878 – “Shooting and trapping on the winter quarters were certainly proximate factors in the species’ extinction. Overharvest of birds and eggs on the breeding grounds could also have been a factor.” (Red List)

Algerian gazelle, *Gazela Rufina*, 1894 – Reason for extinction unknown, this species known only from an adult male skull and a flat skin. (CREO)

Carolina Parakeet, *Conuropsis carolinensis*, 1904 – Hunted for food and for the millinery trade, killed for crop protection and because it competed with bees. Also said to be affected by deforestation. (Red List)

Slender-billed Grackle, *Quiscalus palustris*, 1910 – “It had a small distribution in the Lerma marshlands, in the state of México, Mexico ... last recorded in 1910, and presumably became extinct soon after as a result of the draining of its tule-cattail and sedge habitat.” (Red List)

Passenger Pigeon, *Ectopistes migratorius*, 1914 – “... Newcastle disease, extensive hunting, and the breakdown of social facilitation”, plus a reduction in food supply (Red List).

Colombian Grebe, *Podiceps andinus*, 1950s – “ ... wetland drainage, siltation, pesticide pollution, disruption by reed harvesting, hunting and predation by introduced rainbow trout *Salmo gairdneri*.” (Red List)

Atitlán Grebe, *Podilymbus gigas*, 1986 (found only on Lake Atitlan, Guatemala) – “Its population dropped from c. 200 to 80 as a result of competition and predation by large-mouth bass *Micropterus salmoides*, introduced into the lake in 1960, but recovered to a high of 232 in 1975 when the numbers of bass plummeted. However, increasing pressure on breeding sites from local reed-cutting and from tourism development, along with the murder of the government game warden for the national park during the political unrest of 1982 and falling lake levels following the earthquake of 1976, drove the population down to 30 by 1983, and extinction by 1986. Drowning in gill nets and disturbance by increasing boat traffic have also been suggested as contributory factors.” (Red List)

(Interestingly, this bird has since been replaced on Lake Atitlan by a similar grebe of the same genus, *P. podiceps*. In fact, there is significant disagreement among biologists about whether *Podilymbus gigas* is just a subspecies of *P. podiceps*, but I have included it to be on the safe side.)

Omilteme cottontail rabbit, *Sylvilagus insonus*, 1991 – Reason for extinction unknown, species known only from 3 specimens collected in 1991. (CREO)

What can we conclude from this record of extinctions?

- 1) When European species met isolated local species, a number of the local species died. The Australian and island species were extremely vulnerable to pressure from imported humans, mammals, birds, plants, and diseases. 95% of all recorded bird and mammal extinctions are island or Australian species.



- 2) When the European species arrived, Australia and most islands had been separated from the continents for forty million years or so. The initial introduction of European species into island habitats was a one-time event. While alien species will always be a problem for islands, this massive onslaught of the first coming of the European species will never be repeated — there are no places left with forty million years of isolation.
- 3) Total habitat destruction drove one bird to extinction.
- 4) While habitat reduction has been claimed as contributing (in an unknown degree) to three continental bird extinctions, to date no continental mammal or bird has been seen to go extinct due to habitat reduction alone.

Three continental mammals have gone extinct — one antelope hunted to extinction, and a rare rabbit and a rarer antelope gone from unknown causes.

Six continental birds have gone extinct — 3 prolific terrestrial bird species hunted to extinction, and 3 single-habitat freshwater bird species hunted, drained dry, eaten by fish, and polluted to extinction.

This historical record of 9 continental extinctions in 500 years contrasts starkly with Wilson's predictions of over thirty continental bird and mammal extinctions per year, each and every year. Even if his numbers were off by an order of magnitude, we should be seeing more than 3 continental extinctions per year from habitat reduction since at least 1900, which totals around 300 continental extinctions. We simply have not seen those extinctions, in fact there's only 9 continental extinctions in the 500 year record.

Finally, let us examine Wilson's claim that due to forest habitat reduction, "The number of species doomed each year is 27,000." (Wilson 1992)

Bird species make up about .1% of all species, and mammal species are about .05% of all species (IUCN 2000). Using Wilson's figure of 10 million total species, he is claiming about 16 continental bird extinctions (27,000 species doomed times 8,433 continental bird species per 10,000,000 species) and 11 continental mammal extinctions (27,000 species doomed times 3,921 continental mammal species per 10,000,000 species) per year, for a total of 34 predicted continental bird and mammal extinctions per year. (I have used Wilson's figure of 10 million species on earth, although modern estimates vary. Using Wilson's figure allows the total number of species to cancel out in the calculation.)

In 1988, Wilson said that a 40% reduction in forest habitats had already occurred (Wilson 1988). Using Wilson's "maximally optimistic" z value of .15 and his 1% annual forest loss, with 40% habitat reduction in 1988, the total species loss to up to 1998 should be 1,088 continental bird and mammal extinctions. Over a thousand continental bird and mammal extinctions predicted, and not one of them shows up in the record.

## WILSON'S EXPLANATIONS OF THE DISCREPANCY

Professor Wilson has offered two explanations for the discrepancy between his predictions of massive extinctions and the lack of corresponding extinctions in the historical record. His explanations are:

- 1) That it is not known whether species have gone extinct recently, as species cannot be declared extinct for 50 years.
- 2) That the species do not go extinct immediately, but can take up to 100 years to die out.

Regarding the first explanation, Wilson has written: "To declare a species officially extinct, not only does a species have to be known to science and absent from captive populations, but the World Conservation Union (IUCN) demands that the 'species (is) not definitely located in the wild during the last 50 years' (Collar et al. 1992, p. 1025). This is an extremely conservative criterion, particularly when indirect evidence strongly indicates that extinction rates are accelerating." (Wilson 2001)

However, this 50 year criterion is not used by the IUCN, nor by CREO. For example, as quoted above, the IUCN Red List 2000 showed the last Atitlan Grebe dying in 1986. The data source for the listing is "BirdLife International. 2000. Threatened Birds of the World. Lynx Editions". This means that the species was declared extinct by the IUCN only 14 years after the last Atitlan Grebe died. And the CREO lists the most recent mammal extinction as occurring in 1991, only a nine-year lag.

If Wilson's criteria were used, there could be no extinctions in the IUCN Red List 2000 where the species was last recorded later than 1950. But in fact, there are 10 birds and 5 mammals in the Red List 2000 that were last recorded after 1950. Thus Wilson's first explanation is not correct.

Professor Wilson's other explanation for the lack of predicted extinctions is that they do not happen at once. He says that the "species in a reduced habitat may take from 25 to 100 years to go extinct", and that research has shown that the rate of these delayed extinctions drops off exponentially with time (Wilson 2001). While this seems plausible, even if it were true it wouldn't keep us from seeing the predicted extinctions.

We can see why by applying the exponential die-off to the 1,088 bird and mammal extinctions said to have occurred by 1998. Let's assume all 1,088 of them fatally lost habitat at some point since 1948, but they won't die out for 100 years. 1,088 species lost in 50 years (1948-1998), that works out to 21.76 per year, about 22 species "doomed to extinction" each year since 1948.

With exponential decay, to still have one species of 100 left alive after 100 years, the exponent needs to be  $1 - (1/100)^{(1/100)}$ , or .045. This means that 4.5% of the remaining doomed species should go extinct each year.

But if we had doomed 22 bird and mammal species to extinction every year since 1948, and only 4.5% of the doomed species went extinct each year, then by 1960, of the 261 predicted eventual bird and mammal extinctions, we should have seen 65 extinctions. By 1980, of 696 predicted eventual extinctions, we should have seen 340. And by the year 1998, of the 1,088 extinctions predicted by species-area calculations, we should have seen 672 actual extinctions of continental birds and mammals.

We have seen none. Even if Wilson's predictions were off by an order of magnitude, we still should have seen 67 extinctions from habitat reduction since 1948. We have seen none.

Pimm et. al. (Pimm 1995) argues that extinctions in eastern North America support the species-area relationship. His findings are marred by several inconvenient facts. First, according to the Red List, two of the four extinct species he cites (Ivory Billed Woodpecker and Bachman's Warbler) are not listed as extinct.

Second, the other two species (Passenger Pigeon and the Carolina Parakeet) were not just eastern forest dwellers, but ranged widely over both forest and fields. Birdlife International says of the Carolina Parakeet "Birds were wide-ranging but their typical habitat was cypress and sycamore trees along rivers and swamps." It describes the Passenger Pigeon's habitat as "Ectopistes migratorius was found in forest in eastern and central Canada and the USA, occasionally wandering south to Mexico and Cuba."

Third, and most important, both the Carolina Parakeet and the Passenger Pigeon were extensively hunted. The Passenger Pigeon in particular was subjected to what was possibly the most concentrated hunting of any known bird. The Carolina Parakeet, the only North American parakeet, was hunted for its valuable bright feathers. No bird species could survive that type of intense hunting. Claiming that these extinctions were caused by habitat loss ignores the main cause, hunting.

The Atlantic Coastal Forest records also contradict Pimm's claims. The cutting of the Atlantic Coastal Forest in Brazil has been going on for decades, with over half of the forest cut down by 1960 (Mendonça, 1994), and only 10% of the forest currently remaining (Harris, 2004). There are 179 endemic bird species in the forest, according to Pimm and Harris (Harris, 2004). From this 90% deforestation, the species-area relationship predicts 52 bird species doomed to extinction. Including the 100-year exponential decay, we should have already seen some 25 birds go extinct in the Atlantic Coastal Forest, with 27 more to come. In fact, no birds from the Atlantic Coastal Forest are recorded as having gone extinct, and only one bird (Alagoas Curassow) from the Atlantic Coastal Forest is extinct in the wild. (The fate of the Alagoas Curassow is not surprising, and once again is not related to habitat but to hunting. Because it is a very large bird, almost a metre tall, and has always been heavily

hunted for food, Birdlife International says, “The extinction of this species was forecast almost as long ago as its discovery”. And that’s been a while, as Linnaeus first scientifically described it in 1740.)

Harris and Pimm (Harris, 2004) further argue that the species-area relationship predictions for the Atlantic Coastal Forest are validated by the fact that a number of birds of the forest are threatened with extinction, but this is a circular argument – many of these birds are listed as threatened with extinction solely because of reduced habitat.

While scientists might have missed a few of the predicted extinctions, the odds of them missing every one of these hundreds of claimed extinctions are nonexistent. These are birds and mammals, the most studied and best-known classes of animals on earth. Yet after all of the habitat reduction in all continents in 500 years, we have only seen 9 continental mammal or bird extinctions. There is no sign of the hundreds of bird and mammal extinctions predicted by the species-area relationship.

### RED LIST BIRDS

Wilson says his estimates are supported by “The velocity of passage of species through the categories in the World Conservation Union (IUCN) Red List of Threatened Species, from less endangered to extinct.” (Wilson 2001)

This claim creates an image of thirty birds or so moving a step towards extinction each year. But this is not the case for two reasons — the change in the count of birds at risk is far too small for this to be true, and the number of birds in the highest risk category (Critically Endangered) has actually decreased. Figure 3 shows the velocity of passage of all bird species through the Red List from 2000 to 2004. There is no significant change in the numbers of birds in any category.

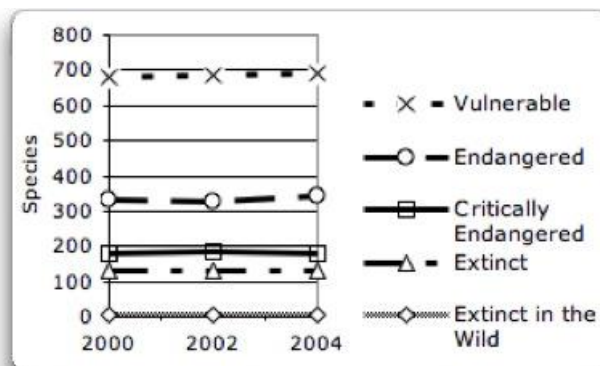


Figure 3. Red List Birds By Category, 2000-2004. None of the categories have changed significantly since the first records in 2000. Vulnerable and Endangered birds have increased slightly, although part of this may be because habitat reduction is incorrectly considered as a major threat. Extinctions are unchanged at 129. Extinct in the Wild increased by 1. The

number of Critically Endangered birds has decreased by 3 since 2000, one bird moving towards extinction and two birds moving away from extinction.

## **FOREST BIRD AND MAMMAL EXTINCTIONS**

Finally, here is what I consider the most surprising fact to emerge from my research. In all the continents, we have never seen a single forest bird or mammal go extinct from any cause whatsoever. None of the nine extinct continental birds and animals was a forest dweller.

This unexpected lack of continental forest bird and mammal extinctions can easily be verified by searching the online Red List. Go to <http://www.redlist.org/search/search-expert.php?kingname=ANIMALIA&phynome=CHORDATA&claname=AVES>. Select “Forest” as the habitat, “Extinct” as the category, and all areas of the world except Oceania and the Caribbean as the location. The search will reveal only three Hawaiian island forest birds. The same search can be done for mammals (replace AVES in the URL with MAMMALIA), and reveals the same pattern – the only extinctions listed are five island forest bats. In all of the continental forests of the world, there has never been a single recorded bird or mammal extinction.

This lack of even one continental forest bird or mammal extinction, in a record encompassing 500 years of massive cutting, burning, harvesting, inundating, clearing, and general widespread destruction and fragmentation of forests on all of the continents of the world, provides a final and clear proof that the species-area relationship simply does not work to predict extinctions.

## **SUMMARY OF METHODS**

Reliance on the species-area relationship’s predictions of extinctions is an accepted tenet of the biological and ecological sciences. I, on the other hand, say it doesn’t work. Extraordinary claims require extraordinary evidence.

I have therefore presented four separate lines of evidence establishing the failure of the species-area relationship to predict extinctions:

- 1) Current Overall Extinction Rates — The most recent total bird and mammal extinction rate in all parts of the world, both islands and continents, is about 0.2 extinctions per year (see Fig. 1). This is down from a peak of about 1.6 extinctions per year a century ago. There is no sign of the nearly 40 bird and mammal extinctions per year predicted by the species-area relationship. Nor is there a rise in the rates — in fact, they have generally fallen for the last hundred years, while habitat destruction has increased during that time. Wilson, using the species-area relationship, claims the extinction rates are 200 times higher than what the data actually shows. (In reality, his claim that extinction rates

are 200 times higher than what the data shows is the extraordinary claim requiring extraordinary proof.)

- 2) Total Continental Extinctions — None of the nine recorded continental bird and mammal extinctions were from habitat reduction. But no matter the reason for their extinction, the total number of extinctions is way too small. Nine continental bird and mammal extinctions in 500 years is a very, very long way from the thousand plus continental bird and mammal extinctions predicted on the basis of the species-area relationship.
- 3) Birds on the Red List — There has been no significant change in the numbers of birds in the highest risk categories of the Red List in the four years since its creation.
- 4) Forest Extinctions — There are no recorded continental forest bird or mammal extinctions from any cause. The species-area relationship says we should have seen hundreds and hundreds of forest bird and mammal extinctions from worldwide forest habitat reductions. We have seen no forest extinctions from any cause.

Each of these independent lines of evidence shows that the species-area relationship does not work, that the relationship predicts a large number of extinctions from habitat reduction while the data shows no extinctions from that cause. I have also examined Wilson's two explanations for this discrepancy, and I have shown that neither of them explains the lack of extinctions.

All of the conclusions drawn by these lines of evidence are very robust; in fact, they are all immune to a variation of an order of magnitude in the assumptions. That is to say, even if the predicted extinctions were only a tenth of what the species-area relationship actually predicts, the conclusion still stands in each case, that the species-area relationship gives incorrect predictions. And in particular, the total absence of continental forest extinctions in the 500-year record provides a final and absolute proof that the species-area relationship does not work to predict extinctions.

## CONCLUSIONS

I am concerned that this study will be mis-used to justify cutting any forest any time. Let me make clear what this study does not say.

*None of this implies that habitat destruction, forest fragmentation, or loss of species diversity are incidental or unimportant issues.*

The contrary is true. Diversity is vital to ecosystems; the more types of life in an ecosystem, the better the ecosystem works. Local extinctions can have large negative effects on the local area. Clear-cutting forests for agriculture can change the local climate. Cutting forests recklessly can drive fish species extinct through siltation. Nothing in this study detracts from

the need to provide reserves and parks and wildlife areas. In short, allowing for other species in our plans is essential.

*None of this implies that extinctions will either rise or fall in the future.*

This is an analysis of the historical record to date.

*And finally, none of this implies that habitat destruction has no effect on the risk of extinction.*

It clearly can and does have an effect; but the effect of habitat reduction appears to be too small to cause extinction by itself. In addition, habitat reduction appears to be mathematically unrelated to the extinction rate, and in particular the relationship is not represented by the species-area equation.

Extinction records do show that on all the continents of the world, there are no recorded cases of a forest bird or mammal that has gone extinct from any cause. This is despite the fact that humans have been reducing and fragmenting all natural habitats, including first the continental temperate forests and lately the continental tropical forests, for the 500 years covered by our extinction record. Five hundred years ago, reduced (fragmented) forest habitats were the exception. Fragmented forests are now the rule, about half the original forest worldwide is gone, and some places like the Brazilian Atlantic Coastal Forest and some “biodiversity hot spots” have lost 75% to 90% of their forests.

If the species-area relationship were correct in predicting extinctions, over these 500 years of forest (and other habitat) reduction, surely we would have seen at least a few dozen of the hundreds of predicted bird and mammal extinctions from this putative cause. But to date, no continental forest bird or mammal has ever gone extinct from any cause.

Given these four separate lines of evidence, I can only conclude that while the species-area relationship works well as a predictive tool for determining the number of species to be found by a survey, it fails completely when used to predict extinctions of continental bird and mammal species consequent to habitat reduction.

## **POSSIBLE EXPLANATIONS**

I don't know why the species-area relationship doesn't work to predict extinctions. I would have guessed it would work — it seems so reasonable. I do have some thoughts, however:

1. One possibility is that it does work, but that the “z” factor for extinctions is much, much smaller than the z factor for counting species in an area. After all, speciation and extinction are radically different processes — why should they have the same z factor? However, the lack of even one recorded continental forest extinction argues strongly

against this explanation, because with half the world forest gone with no extinctions, the “z” factor would have to be so small as to be meaningless.

Another possibility is that the exponential die-off could be very slow. Brooks et. al., for example, say it is on the order of 330 years to reach 1% (which is a 50 year half-life) (Brooks 1995). But if the die-off were over 1,000 years, rather than the shorter times stated by Wilson or Brooks, we still should have already seen 118 bird and mammal extinctions from the predicted 1088 “doomed” continental bird and mammal species. Even if the decay were 5,000 years, we still would have seen 25 extinctions from habitat reduction. In fact, we have seen none — so long die-off times cannot be the reason why the species-area relationship does not work.

2. The total lack of any data to corroborate the use of the species-area relationship to predict extinctions makes it very difficult to explain why the species-area relationship does not work. If it worked but gave answers that were usually too high or too low compared to the data, it would be possible to test various scenarios. However, with no recorded extinctions from habitat reduction, this is not possible.
3. In the 500-year period covered by the record of extinctions, forest habitat reduction has not completely destroyed any known continental bird or mammal species’ total possible habitat. If it had done so, we would most likely have seen the resulting extinction in the record — extinction from total habitat destruction is a possibility for any species, as happened to the Slender-billed Grackle.
4. However, given the amount of forests destroyed worldwide, the odds are very good that we have completely destroyed a number of known species original habitats.
5. This means that, although a species’ original habitat may be totally destroyed, under extreme external pressure it may successfully move to another habitat.
6. Forests are not cleared instantaneously. They are cleared over a period of years or decades, with nearby stands falling first and then more distant stands at a later date. This gives species time to move.
7. Species are incredibly adaptive and tenacious. Under pressure, many species are able to adapt to the changed circumstances by changing their preferred food, nesting sites, or other behaviors.
8. Evolution is alive and well, and can operate in human time (centuries rather than millennia) (Badyaev 2002, Pergams 2003). This implies that species may actually be evolving, as well as migrating, adapting, and changing, to keep from going extinct.
9. The one common thread of almost all recorded bird and mammal extinctions, both island and continental, is that one species actively goes out and hunts another species to extinction. Foxes, cats, mongoose, humans, rats, Newcastle disease, brown tree snakes,



all of these species and more have actively driven other species to extinction. Absent hunting, very few species have ever gone extinct.

In short, this all suggests that the answer to the question of why the species-area relationship doesn't work for birds and mammals is that they inconveniently refuse to die unless they are hunted down and killed one by one until the last one is gone. The species-area relationship doesn't work because life, once created, struggles endlessly to survive. Life breaks rules to survive, cuts bonds, crosses gaps, jumps barriers, changes habitats, life does anything to survive.

The species-area relationship doesn't work to predict extinctions because if you cut down half a forest, every single one of the resident bird and mammal species moves into the other half of the forest. They don't know that they're supposed to go extinct, no one told them, and so they do whatever they need to do to survive. And as the evidence shows, in fact they do make the move and they do survive — remember, despite massive forest habitat reduction, no continental forest bird or mammal has been recorded as going extinct in 500 years. No matter how the forest was cut, chopped, burned, and mangled, every one of the forest birds and mammals has somehow managed to survive — and that's why the species-area relationship doesn't work.

## **NEW OR MODIFIED THEORIES RELATING HABITAT AREA AND EXTINCTION**

10. At present, no theory attempting to mathematically relate habitat reduction to bird and mammal extinction can be tested because of the record – no continental bird or mammal has ever been recorded as going extinct from habitat reduction alone, and no continental forest bird or mammal has ever been recorded as going extinct from any cause.
11. Any new theory attempting to relate extinctions and habitat area must first correctly predict the past. It must first predict 500 years without a single continental forest bird or mammal extinction, during five centuries of massive historical forest habitat reductions on all continents, before looking to predict the course of future extinctions.
12. Although habitat reduction clearly can pose a threat to any species, the nature and size of that threat is not mathematically related to the amount of habitat reduction involved. Otherwise, we would have seen forest bird and mammal extinctions.

## **FINAL IMPLICATIONS**

13. Based on the 500-year historical record, there is only a weak relationship between habitat reduction and bird or mammal extinctions. Unlike real extinction threats like predation by humans or other species, habitat reduction has played only a minor part in extinction.

14. Accordingly, habitat reduction should be downgraded severely in the Red List of threats of extinction. At present, it is in first place on the List, giving a false impression of importance.
15. The use of habitat reduction as a large factor in determining the danger of extinction is a circular argument, creating “evidence” that seems to support the species-area relationship (more Red List species considered to be in danger of extinction because of habitat reduction). However, that “evidence” derives from assuming the species-area relationship works, and thus can’t be used as “proof” that the relationship works.

In other words, if the criteria for inclusion on the Red List include the species-area relationship idea of habitat reduction as a major extinction threat, the number of birds on the Red List cannot be used to determine whether the species-area relationship works. Only actual extinctions can do that — and looking at actual extinctions there is no evidence that the species-area relationship works at all to predict extinctions.

16. The listing of “habitat reduction” as a factor in extinctions is also suspect because habitat reduction is so common. At present, the majority of all bird and mammal species have a reduced habitat compared with 500 years ago, so “habitat reduction” could be cited for nearly any extinction. Generally, it seems to be a secondary factor, one that only comes into play when combined with a major factor such as hunting or poisoning.
17. The 500-year record includes the so-called “Little Ice Age” of the 1600 and 1700’s, when global temperatures were much lower than today. Claims that small climate changes can cause widespread extinction are thus discredited in two ways: one is that they rely on the species-area relationship; and the other is that the historical record shows no sign of these extinctions from small climate changes.
18. One or two or even a dozen missed bird or mammal extinctions would not change these conclusions at all, as the predicted extinctions are far too numerous to be challenged by such a small number.
19. Removing the idea of habitat reduction as a major extinction threat will allow us to focus on the real main modern extinction threat, that of invasive, predatory alien species, in particular humans.

For example, it is not the cutting of the African forests that is the main danger to the species living in the forests — it is the bushmeat trade, and the poaching for furs and body parts, which are putting species at risk. Hunting, both by humans and by invasive species, may well yet drive a number of species to extinction. This is the real extinction threat of the 21st century, the threat that we should be working to counter.

Finally, please don’t bother disputing this or that individual record of extinction. Yes, I realize that the Ivory Billed Woodpecker is likely extinct, despite what the official lists say. And I originally wrote this in 2005, so maybe another bird or mammal has gone extinct since then.

But changing the status of one or a few birds or mammals makes no difference to my thesis. We are looking for dozens and dozens of missing corpses, not one or a few.

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