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Where are all the Extinct Species?

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During the height of the scares over the effects of chemicals, when alarmists seemed to be claiming that every chemical was going to kill us, more rational observers commented that if all of this were true, people should be dying like flies. Then they asked rhetorically, "Where are all the dead flies?"

This anecdote seemed particularly relevant when reading: "Extinction risk from climate change," a paper published in the January 8, 2004 issue of *Nature* by Chris D. Thomas and 18 co-authors.[1] The authors present an apocalyptic view of the future. They studied 1100 species with limited geographic ranges and concluded that 15-37 percent of them would be committed to extinction by 2050. While the authors did not extend their projection to all species on Earth, the clear implication was that a large fraction of the Earth's species were at risk of extinction because of climate change. Such projections make eye-catching headlines, especially when promoted by early publication on the Web as *Nature*'s cover story for the week. The projections were picked up and more widely distributed by the BBC, CBS, NBC, the *New York Times,* the *Washington Post*, and many other media outlets. But do they have any basis in reality?

The best way to test projections of the future is against observations of the past. Thomas and his co-authors considered three ranges of projected temperature rise to 2050. The lowest was 0.8-1.7^{o}C, which was projected to result in about 18 percent of the species studied being committed to extinction. There is considerable debate over projections of future temperature rise and the validity of the IPCC emissions scenarios on which they are based, but this debate is secondary to a more fundamental question: Are the authors correct in their evaluation of the effects of temperature rise on species extinction? What we are interested in is the projected impact of 0.8-1.7^{o}C temperature rise. Since this is not a very large temperature rise, we should be able to test its projected impact against recent history.

The IPCC[2] concluded that global average surface temperature rose 0.6^{o}C during the 20th century. While there are legitimate questions about the accuracy of this estimate and the reasons for the temperature rise, surface temperature did rise by a noticeable amount during the 20th century. Given the sensitivity to temperature rise that the authors' projections imply, one would expect a significant number of species to have become extinct during the 20th century in response to the observed temperature rise. The authors point out that there is a time lag between temperature change and species extinction, hence their term "committed to extinction." However, roughly half the observed temperature rise of the 20th century took place from 1910 to 1940. Even with a time lag, we should have been able to identify a number of species that became extinct because of temperature rise.

If the above discussion seems a little imprecise, it is because of the uncertainties surrounding all discussions of species and their extinction. As noted in the Marshall Institute report *Climate Change and Ecosystem* [3], estimates of the total number of species on Earth range from 10 to 80 million, of which only some 1.6 million have been identified. Only a fraction of these species have the limited geographic ranges that would allow use of the calculation methodology developed by Thomas and his co-authors. However, even taking these uncertainties into account, it seems reasonable to assume that if a 0.8-1.7^{o}C temperature rise would commit to extinction 18 percent of species with limited geographic range, then 0.6^{o}C temperature rise should have resulted in a large enough number of species becoming extinct to be noticeable to biological researchers.

There are legions of researchers looking for evidence of the impacts of climate change on biological species. The IPCC[4] assessed data for over 500 species showing that temperature change had an effect on the range or behavior of 80 percent of them. This is as would be expected. Plants and animals are sensitive to climate. However, as Thomas and his co-authors report, climate change has been implicated in only one species extinction. If a 0.6^{o}C temperature rise is implicated in only one species extinction, is it reasonable to project that a 0.8-1.7^{o}C will commit hundreds of thousands or millions of species to extinction?

It is also interesting to compare the Thomas et al. projections against those of other groups concerned with species extinction. The UN Environmental Program (UNEP) and Convention on Biological Diversity are hardly unconcerned observers of the threat of species extinction, or unaware of the potential impacts of climate change on species. However, both organizations have recently published estimates of the risks of species extinction for all reasons that are more than an order of magnitude lower than those calculated by Thomas, et al. In 1995, UNEP's *Global Biodiversity Assessment* [5] estimated that 0.7% of species would become extinct over the next 50 years. In 2000, *Sustaining Life on Earth* [6], a publication of the UN Convention on Biological Diversity (CBD), estimated that 39,000 plant and animal species faced extinction if current trends continued. While the validity of the UNEP and CBD estimates is unknown, they stand in sharp contrast to the numbers generated by Thomas and his co-authors.

A large part of the reason that Thomas and his co-authors project such huge numbers for species extinction is two assumptions contained in their methodology. The first is that plants and animals can only survive if the climate in at least part of their current range remains the same. The second is that there is a relationship between reduction in a species range and its probability of extinction. These two assumptions are interrelated in the author's methodology, which is described below.

The authors constructed a climate envelope for each species they studied, that is, they defined the temperature range that corresponded to the geographic range of the species. While they looked at the whole temperature range, what appears to be critical is the maximum temperature in the species' current range. The authors then looked at how temperature rise would affect temperatures within the species' current geographic range. If maximum temperature in all of the species current geographic range rose above today's maximum temperature, the species was assumed to be committed to extinction. If maximum temperature rose above today's maximum temperature in part of the range, the species' risk of extinction was calculated using an exponential relationship that the authors claim "… predicts adequately the numbers of species that become extinct or threatened when the area available to them is reduced by habitat destruction."

The authors' methodology fails to take into consideration two well-established factors. First, as Idso, *et al.*[7] have carefully documented, higher atmospheric concentrations of CO_2 make plants more heat tolerant, and less susceptible to extinction. If plants are better able to survive, then the animal species that depend directly or indirectly on these plants will also be better able to survive. Second, plants and whole ecosystems migrate in response to changes in climate. This is dramatically demonstrated in the fossil record, where fossilized pollen samples indicate that after the end of the last Ice Age, tree species migrated from the southern and central U.S. to northern Canada and Alaska.[8]

There is also good reason to question the validity of the relationship between habitat area and species survival. Both anecdotal evidence and scientific studies indicate that species are far more capable of surviving in fragmented habitats than would be indicated by the approaches the authors and others have used to calculate survival rates. For anecdotal evidence, one merely has to look at the eastern U.S., which was a much more highly fragmented habitat 150 years ago than it is today. Many areas that are tree-covered and relative "wild" today, such as the Catskill Mountains of New York and much of the state of Vermont, were nearly treeless in 1860. Yet almost all of the plant and animal species that were present before the land was cleared are still present. Applying the conventionally used methodology to this area would predict the loss of a high percentage of species.

Scientific studies confirm the anecdotal observations. As reported in the *New York Times*, scientists from Colorado State University and Iowa State University have found that species make better use of fragmented habitats than predicted by models of species extinction.[9]

The IPCC acknowledged that estimating the impacts of climate change on biological systems is a difficult task:

> Modeling changes in biodiversity in response to climate change presents some significant challenges. It requires projections of climate change at high spatial and temporal resolution and often depends on the balance between variables that are poorly handled by climate models (e.g. local precipitation and evaporative demand). It also requires an understanding of how species interact with each other and how these interactions affect the communities and ecosystems of which they are a part.[10]

The simplistic model that Thomas et al. used takes none of this complexity into account.

In conclusion, plants and animals are sensitive to changes in climate, and the potential for human emissions of greenhouse gases to impact climate is real. However, these two facts do not translate into the wholesale species extinction that Thomas and his co-authors project.

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[9] Samuels, S.H. (2002): Making the best of what remains of shrinking habitat. *New York Times*. Pg. D5, January 8, 2002.
[10] Gitay, H. *et al.*(2002): op.cit, Pg. 15.