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# Defining "Dangerous" Climate Change from the Perspective of Biodiversity and Human Health

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My expertise on climate change and its impacts stems from my core research program and multiple scientific publications on the biological impacts of recent climate change, from participating for the past 10 years as author and reviewer of reports by the Intergovernmental Panel on Climate Change (formed by the United Nations and the World Meteorological Organization), and from teaching a graduate-level course at the University of Texas in Global Environmental Change which covers relevant materials from atmospheric science, meteorology, climate modeling and carbon emissions scenarios as well as the biological impacts and projections of climate change on wild species.

I. Summary of the current state of climate science

**1) global warming is unequivocal**
**2) > 90% certainty that humans are the main drivers of global warming**

Greenhouse gases that have increased due to human activities include carbon-dioxide, methane, and nitrous oxide. Direct quotes from the recent Intergovernmental Panel on Climate Change (IPCC), 2007[1]:

"Warming of the climate system is **unequivocal**, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level."

"Most of the observed increase in globally averaged temperatures since the mid-20th century is *very likely* **[>90% certain**] due to the observed increase in anthropogenic greenhouse gas concentrations. "

II. Summary of current, observed impacts on natural systems and human health

1) We have quite a number of biological studies from the USA, and global analyses can help us to understand what is likely to be happening for regions with little data. It's clear that everywhere there's been measurable climate change, it has impacted wild species. With relatively small changes in recent temperatures (a global rise of 0.7 ° C over the 20th century), we've documented that half (50%) of all wild species for which we have long-term data have shown a response to local, regional or continental warming[2].

Global warming has affected every major biological group that has been studied (*e.g.* from herbs to trees, from plankton to fish, and from insects to mammals) and responses have been seen on all continents and in all major oceans[3,4]. In my most recent review, I surveyed

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[1] IPCC 2007. Climate Change 2007: The Physical Science Basis, Summary for Policy Makers. The Intergovernmental Panel on Climate Change Fourth Assessment Report. IPCC Secretariat, Geneva, Switzerland. Download pdf file available at: www.ipcc.ch

[2] Parmesan C, Yohe G. 2003. A globally coherent fingerprint of climate change impacts across natural systems. ***Nature*** 421:37—42. pdf file available on request from author

[3] Parmesan, C. and H. Galbraith. 2004 *Observed Ecological Impacts of Climate Change in North America,* Pew Center on Global Climate Change. Download of pdf file available from: www.pewclimate.org

biological impacts studies from major international English-language journals only and found an astonishing 866 papers representing data from thousands of species worldwide (Figure 1, literature review ends in Jan. 2006). There are hundreds of additional studies which were not included in this review because the journals were not in English or were not available at a U.S. university library. This and several other synthetic, global analyses published in the scientific literature have concluded that these observed changes in biological systems are indeed caused by climate changes associated with general global warming. The consensus among biologists that climate change has impacted a large part of the natural world now mirrors the level of consensus among climate scientists that the warming is caused by humans (in IPCC terms, we're more than 90% sure on both fronts)[1,2,3,4,5,6].

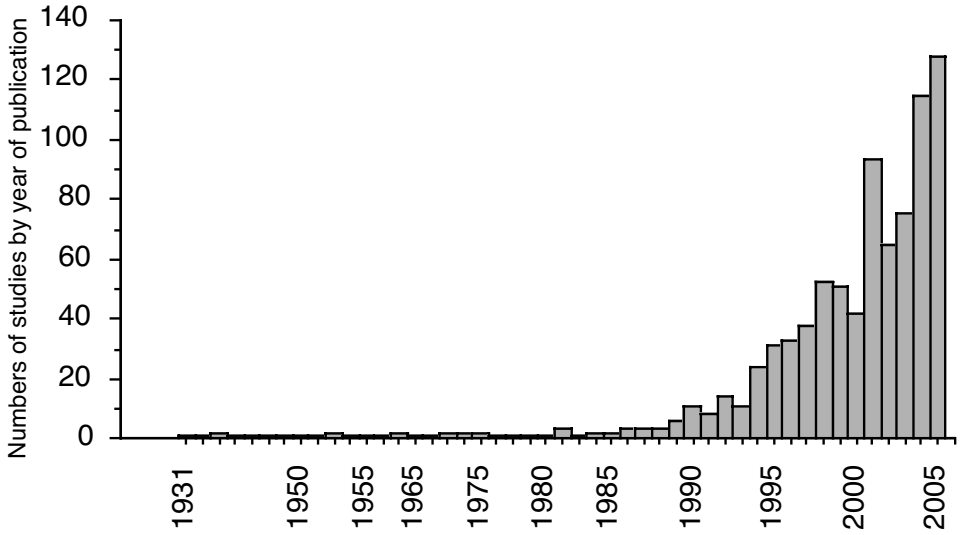


Figure 1. Numbers of papers by year of publication documenting a response of wild plants or animals to long-term changes in average temperature (from Parmesan 2006[4]).

2) Globally, we're seeing a strong consistent pattern of poleward movements of species ranges as well as upward movement in mountainous areas. Tropical species from Central America and Africa are moving into historically temperate zones of the USA and Europe, temperate species are moving into boreal zones of Alaska, Canada and Lapland, and true boreal species are losing total habitable area as woody shrubs invade the tundra, and as sea ice disappears.

3) Some species that are adapted to a wide array of environments - globally common, and what is often called weedy or urban species - will be most likely to persist. Rare species that live in fragile or extreme habitats are already being affected, and we expect that to continue. We are

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[4] Parmesan, C. 2006. Observed ecological and evolutionary impacts of contemporary climate change. ***Annual Reviews of Ecology and Systematics*** 37:637-669. pdf file available on request from author

[5] Root TL, Price JT, Hall KR, Schneider SH, Rosenzweig C, Pounds JA. 2003. Fingerprints of global warming on wild animals and plants. ***Nature*** 421:57--60

[6] IPCC 2007b. Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability, Summary for Policy Makers. ***The Intergovernmental Panel on Climate Change Fourth Assessment Report***. IPCC Secretariat, Geneva, Switzerland. Download pdf file available at: www.ipcc.ch

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