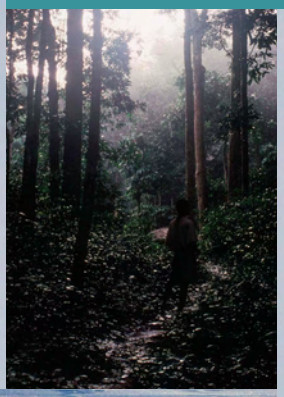
The Effects of Climate Change on Biodiversity in the United States

(U.S. Climate Change Science Program Synthesis and Assessment Product 4.3)



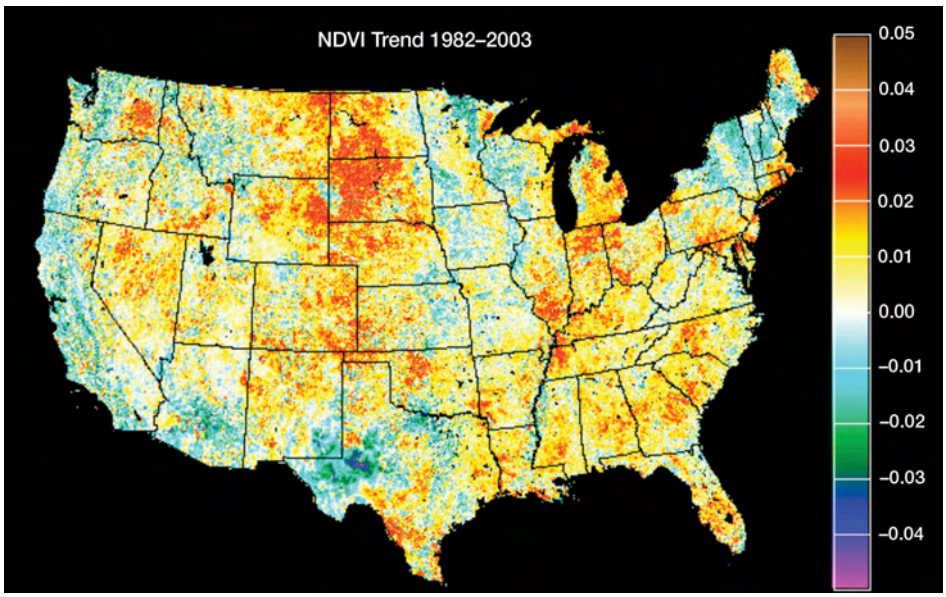
Biodiversity is a fundamental building block of the services that ecosystems deliver to human societies. Intrinsically important because of its contribution to the functioning of ecosystems, biodiversity – the variation of life at the genetic, species, and ecosystem levels of biological organization – is difficult or impossible to recover or replace once it is eroded. With robust scientific evidence showing that human-induced climate change is occurring, it is critical to understand how species diversity and sensitive ecosystems might be affected – the Synthesis and Assessment Product (SAP) 4.3 provides these insights.

Biodiversity Findings

Climate change is already affecting U.S. biodiversity and ecosystems, including changes in growing season, phenology, primary production, and species distributions and diversity. It is very likely that climate change will increase in importance as a driver for changes in biodiversity over the next several decades, although for most ecosystems it is not currently the largest driver of change. A team of authors – experts on the topic – completed an extensive review, analysis and synthesis of the relevant scientific literature related to biodiversity for the SAP 4.3 Biodiversity chapter. Some of the main findings from this chapter are featured below.

- Growing season length and net primary productivity (NPP) have increased significantly in the higher latitudes of North America. Over the last 19 years, global satellite data indicate an earlier onset of spring across temperate latitudes by 10 to 14 days.

- In an analysis of 866 peer-reviewed papers that explore the ecological consequences of climate change, nearly 60 percent of the 1598 species studied exhibited shifts in their distributions and/or phenologies over the 20- and 140-year time frame. Analyses of field-based phenological responses have reported shifts as great as 5.1 days per decade, with an average of 2.3 days per decade across all species.



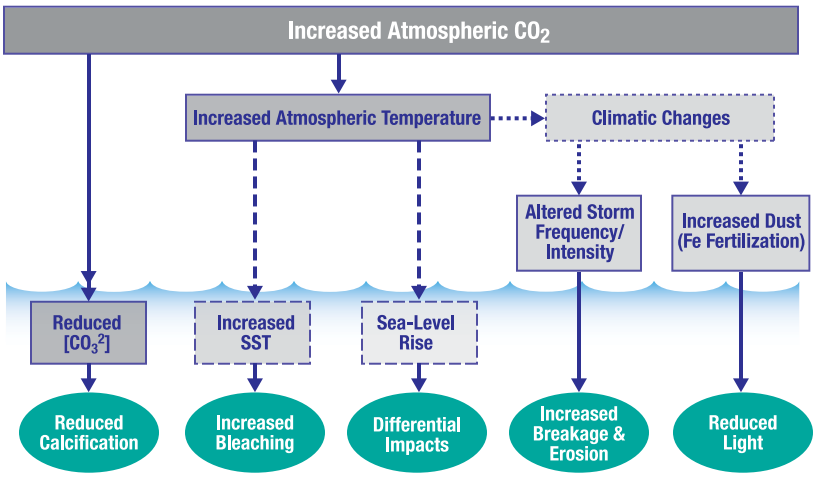
Changes in U.S. vegetation observed by satellite (NDVI, or Normalized Difference Vegetation Index) between 1982 and 2003 (NDVI units per year). The NDVI reflects changes in vegetation activity related to climate variability, land-use change, and other influences and shows substantial trends in much of the conterminous U.S. Figure provided by J. Hicke, University of Idaho, based on data from C. Tucker, NASA Goddard Space Flight Center.

Biodiversity Findings

- Corals in many tropical regions are experiencing substantial mortality from increasing water temperatures and increasing storm intensity, on top of a host of other ongoing challenges from development and tourism, increases in ocean acidity, unsustainable fishing, and pollution.

The figure depicts the various direct and indirect effects of changes in atmospheric CO_2 concentrations on coral reef ecosystems. Solid lines indicate direct effects, dashed lines indicate indirect effects, and dotted lines indicate possible effects. Fe=iron; SST=sea surface temperature, CO_3^2=carbonate iron.

Atmospheric CO_2 Effects on Coral Reefs



- The rapid rates of warming in the Arctic observed in recent decades, and projected for at least the next century, are dramatically reducing the snow and ice covers that provide denning and foraging habitat for polar bears.

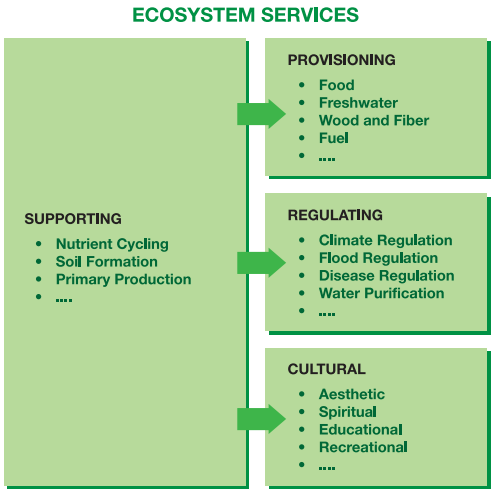
- There are other possible, and even probable, impacts and changes in biodiversity (e.g., disruption of the relationships between pollinators, such as bees, and flowering plants), for which we do not yet have a substantial observational database. However, we cannot conclude that the lack of complete observations is evidence that changes are not occurring.

Biodiversity Findings

- It is difficult to pinpoint changes in ecosystem services that are specifically related to changes in biological diversity in the United States. A specific assessment of changes in ecosystem services for the United States as a consequence of changes in climate or other drivers of change has not been done.

Findings Related to Current Observing Systems

- The monitoring systems that have been used to evaluate the relationship between changes in the physical climate system and biological diversity have three components: species-specific or ecosystem-specific monitoring systems, research activities specifically designed to create time-series of population data and associated climatic and other environmental data, and spatially extensive observations derived from remotely sensed data. However, in very few cases were these monitoring systems established with climate variability and climate change in mind, so the information that can be derived from them specifically for climate-change-related studies is somewhat limited. It is also not clear that existing networks can be maintained for long enough to enable careful time-series studies to be conducted.



Categorization of ecosystem services, from MEA 2005.

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