



# Long-term studies provide insights to diverse terrestrial and aquatic ecosystem dynamics

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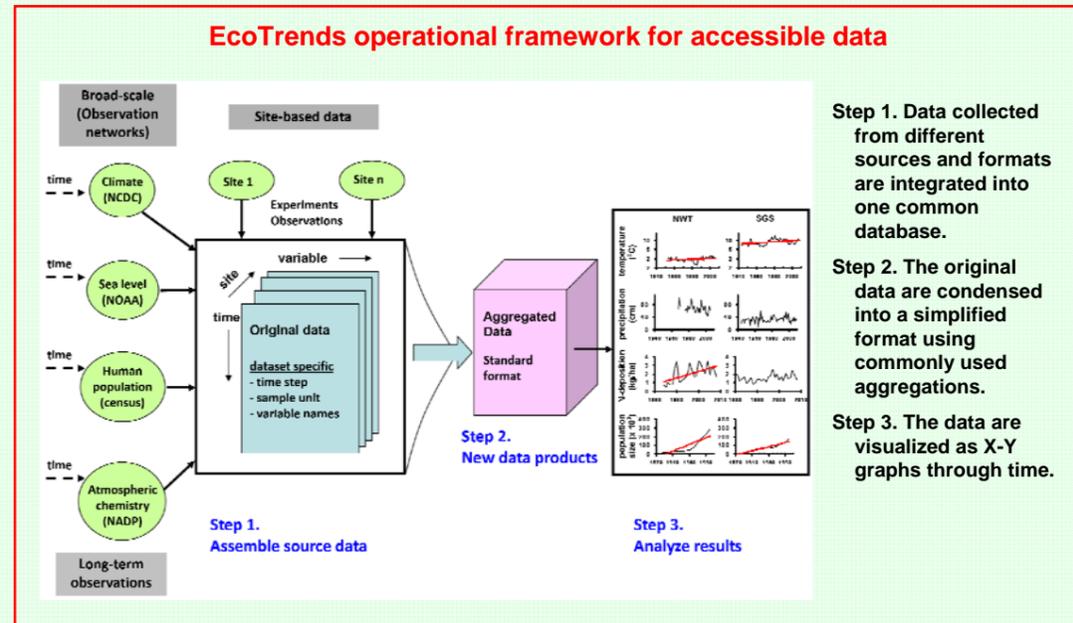


## Introduction

Environmental drivers are changing at local to global scales with corresponding effects on ecological dynamics. Large amounts of data have been collected to document these changes. However, much of the data remain inaccessible to a broad audience. Therefore, solutions to these environmental problems have been elusive. The EcoTrends Project is one of the first attempts to standardize, simplify, integrate, and visualize data from diverse terrestrial, aquatic, and marine ecosystems to promote understanding and synthesis by a broad audience.

To illustrate the value of comparing data, we present an analysis of trends in multiple global change drivers (climate, atmospheric chemistry, human activities) and in ecological responses for 50 sites representing terrestrial (deserts, grasslands, forests), aquatic (freshwater, marine), and urban systems.

These data and more are available on the EcoTrends website (<http://www.ecotrends.info>).



## Methods

### 1. Sites

- 50 sites are currently included
- 26 LTER sites
- 14 USDA Forest Service sites
- 7 USDA Agricultural Research Sites
- 3 sites of other agencies

### 6 ecosystem types are represented

- Arctic and alpine
- Aridlands
- Coastal systems
- Forests
- Temperate grasslands & shrublands
- Urban systems

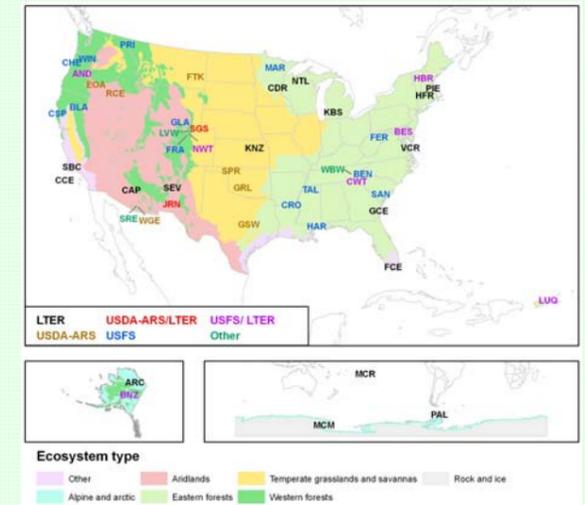
### 2. Variables: drivers and responses

#### Key drivers

- Climate: air temperature, precipitation, ice duration, sea level, streamflow, water clarity, water temperature
- Precipitation and surface water chemistry ( $\text{NO}_3$ ,  $\text{NH}_4$ ,  $\text{SO}_4$ , Cl, Ca)
- Human demography and economy: total population size, population density, %urban population

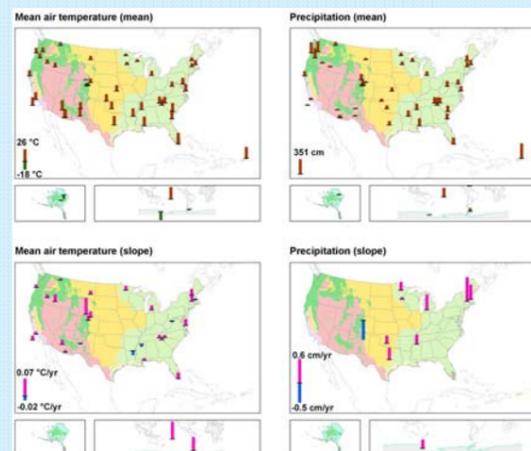
#### Key responses

- Net primary production, plant biomass & species richness, animal abundance & species richness



## Cross-site comparisons

### 1. Climate

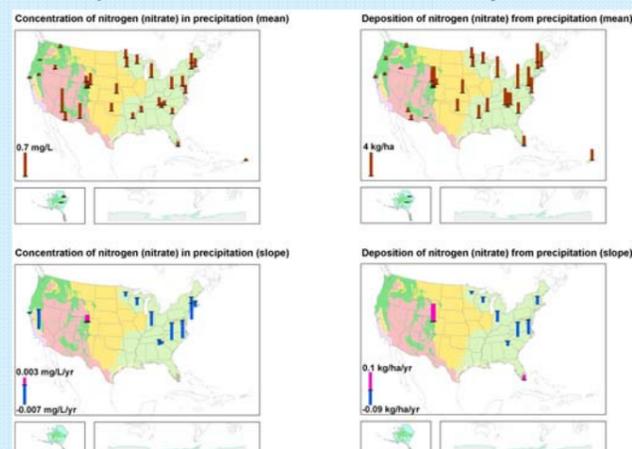


Mean air temperature has increased over time at 24 sites.

Annual precipitation has increased over time at 9 sites.

No obvious spatial distribution was present in either climate variable.

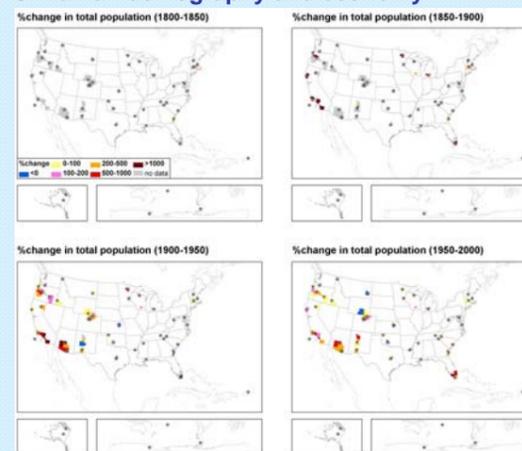
### 2. Precipitation and surface water chemistry



Deposition of nitrate in precipitation has decreased over time in eastern US, compared to the West.

This pattern reflects federal government policies that had different impacts geographically.

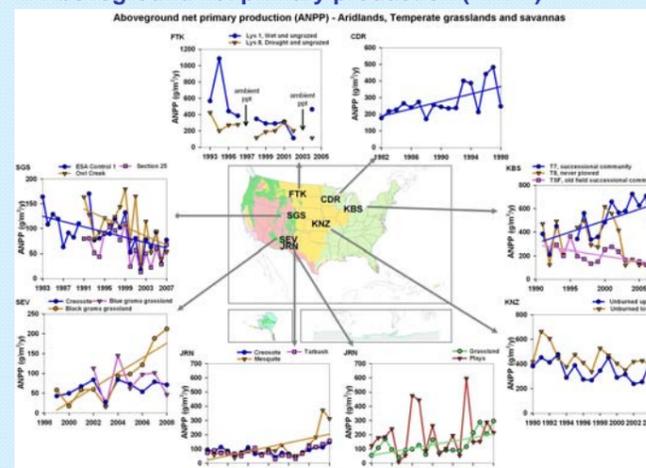
### 3. Human demography and economy



Human population density has increased at all sites, although at different rates.

The Eastern U.S. is more heavily populated than the West, although parts of the West, such as Phoenix, Arizona, have experienced some of the highest rates of increase over the past 50 years.

### 4. Aboveground net primary production (ANPP) - Aridlands, Temperate grasslands and savannas

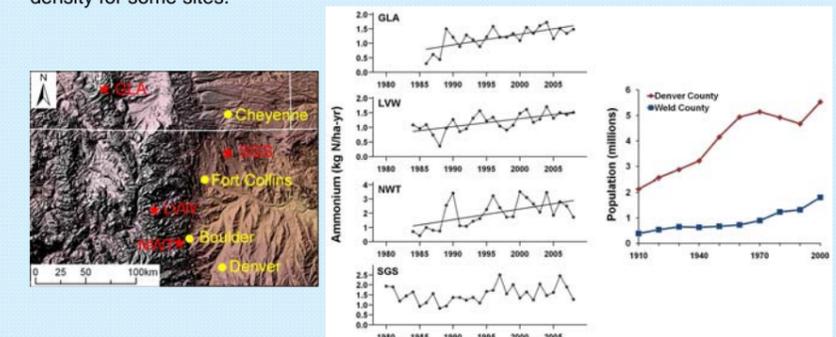


Biotic data reflect high spatial and temporal variability inherent in biological phenomenon.

### 5. An example synthesis study

Long-term data collected from multiple sites can be used to test hypotheses related to patterns and processes at broad spatial scales.

**Hypothesis:** changes in atmospheric deposition are related to changes in population density for some sites.



For three high elevation sites located in the central Rockies (GLA, LWV, NWT), ammonium deposition has increased through time, while there is no trend at the grassland site at lower elevation east of the mountains (SGS).

Spring and summer moisture at the mountain sites are mainly influenced by westerly upslope storm events from the Front Range; these storms provide an important source of atmospheric nitrogen deposition to explain trends at GLA, LWV, and NWT sites.

## Products

### Book

- Peters DPC, Laney CM, including Yao J et al. 2011. Long-term trends in ecological systems: a basis for understanding responses to global change. USDA Agricultural Research Service Publication No. XX. Washington, D. C.

### Paper

- Peters DPC. In review. Accessible ecology: synthesis of the long, deep, and broad. Trends in Ecology & Evolution.

### Website of data

- <http://www.ecotrends.info>