LTER

The
Long Term
Ecological Research Network

The Long Term Ecological Research Network

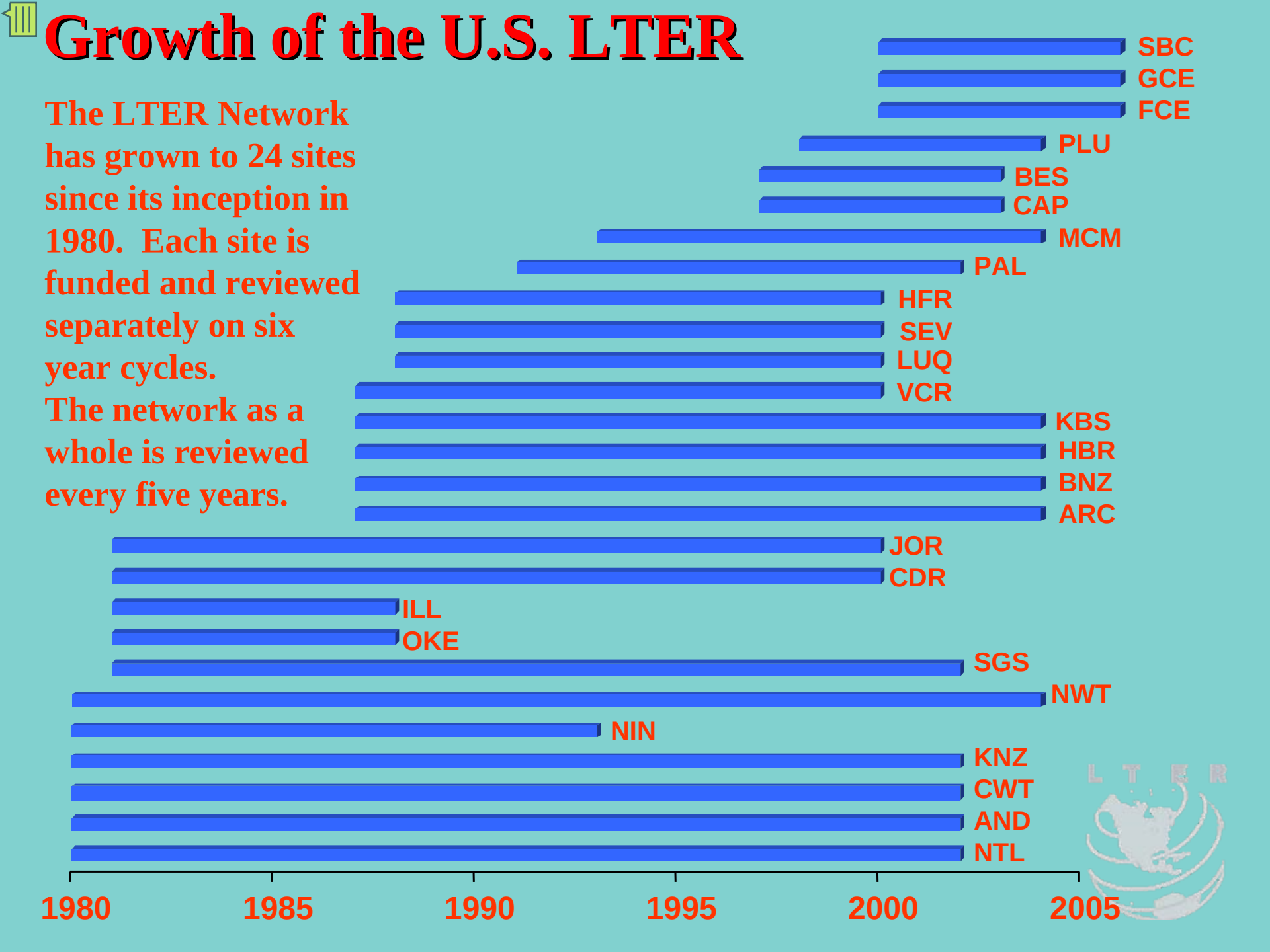
The Long Term Ecological Research (LTER) Network is a collaborative effort involving more than 1100 scientists and students investigating ecological processes operating at long time scales and over broad spatial scales.

LTER was established in 1980 by the National Science Foundation to support research on long-term ecological phenomena in the United States. The network now consists of 21 sites representing diverse ecosystems and research emphases.

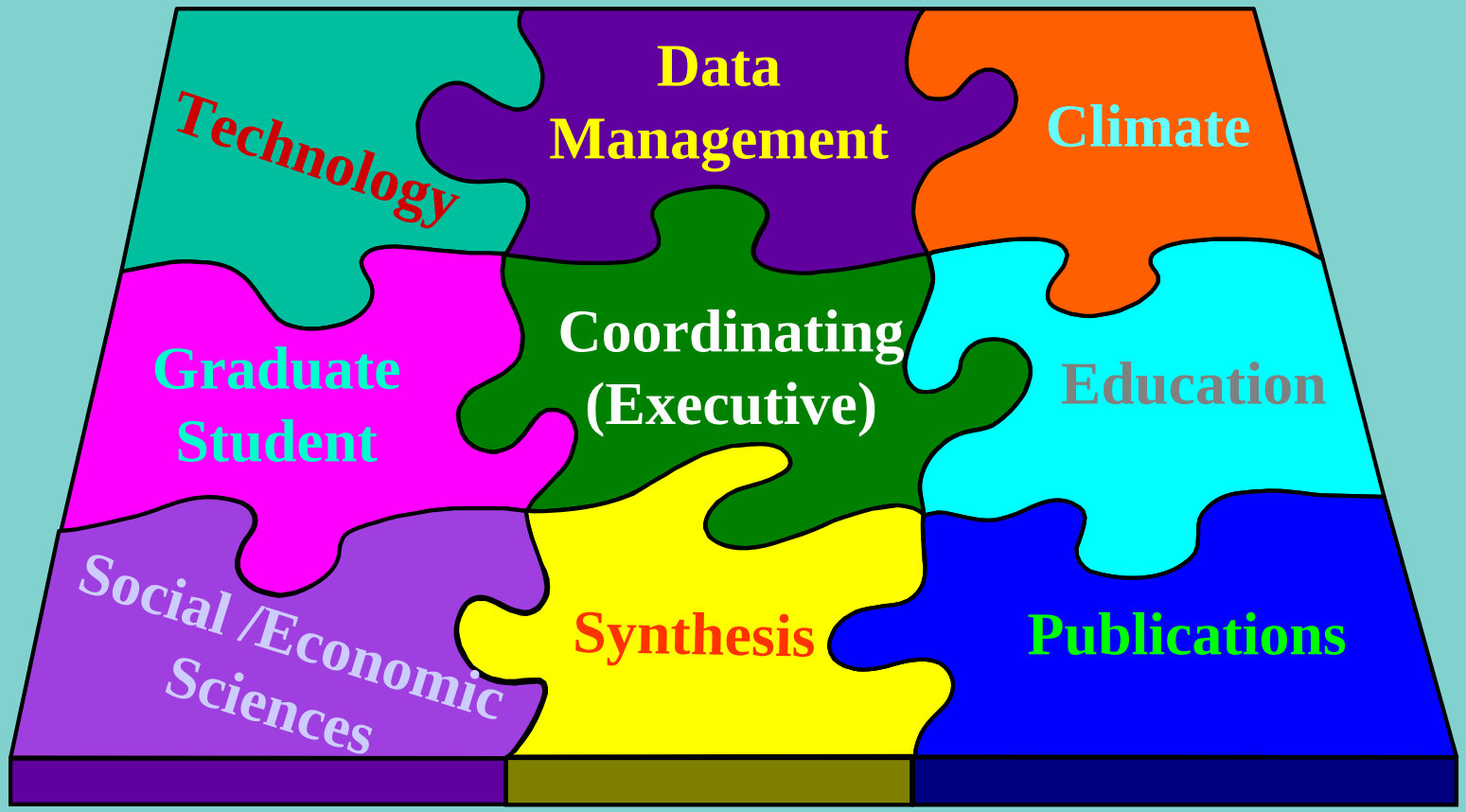
The LTER Network

Growth of the U.S. LTER

The LTER Network has grown to 24 sites since its inception in 1980. Each site is funded and reviewed separately on six year cycles.
The network as a whole is reviewed every five years.



Network Management

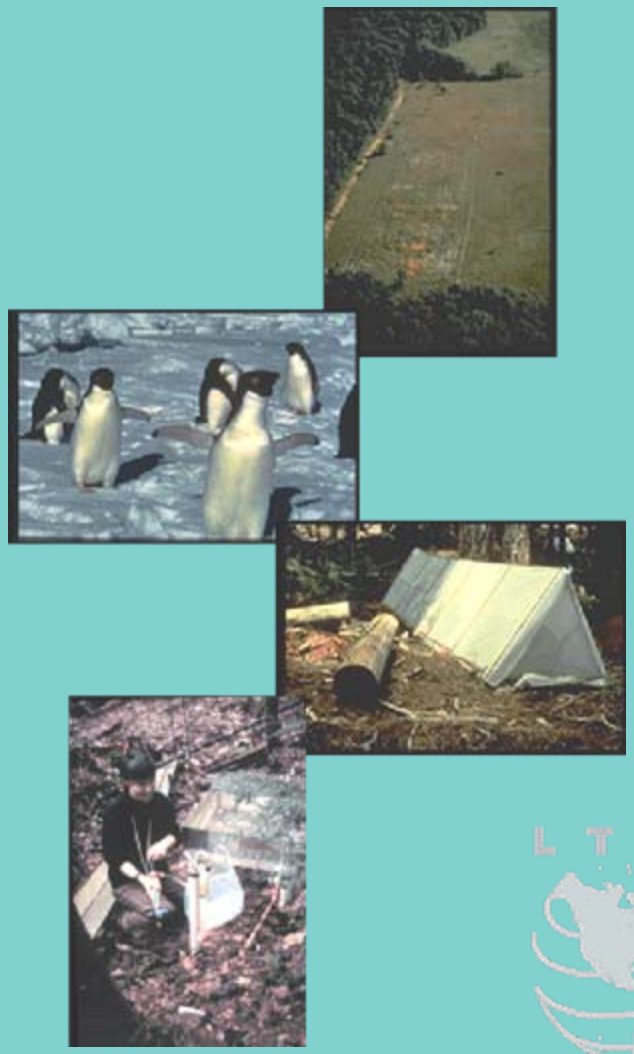


Mission of the Long Term Ecological Research Network

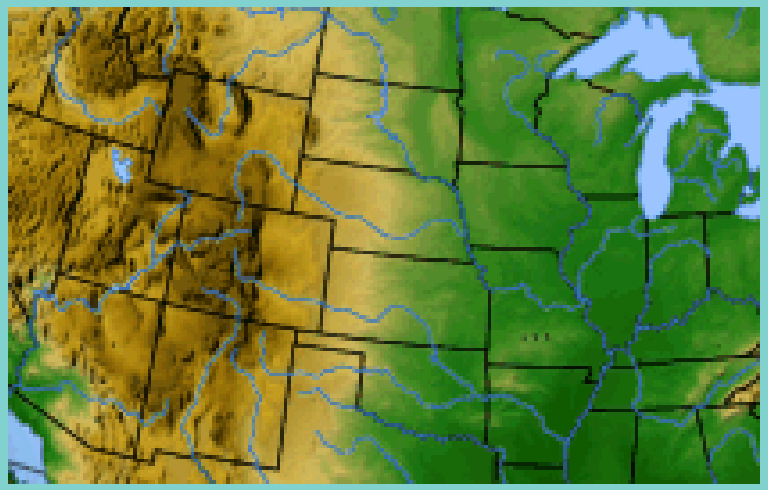
- Understanding general ecological phenomena that occur over long temporal and broad spatial scales
- Conducting major synthesis and theoretical efforts
- Providing information for the identification and solution of societal problems
- Creating a legacy of well-designed and documented long-term experiments and observations for use by future generations

LTER sites share a common commitment to long-term research on the following core topics:

- Pattern and control of primary production
- Spatial and temporal distribution of populations selected to represent trophic structure
- Pattern and control of organic matter accumulation in surface layers and sediments
- Patterns and movements of inorganic inputs through soils ground- and surface waters
- Patterns and frequency of disturbance



At LTER we believe that, understanding the world around us is like understanding a picture.



Only when you see the entire picture, can you truly begin to understand it.

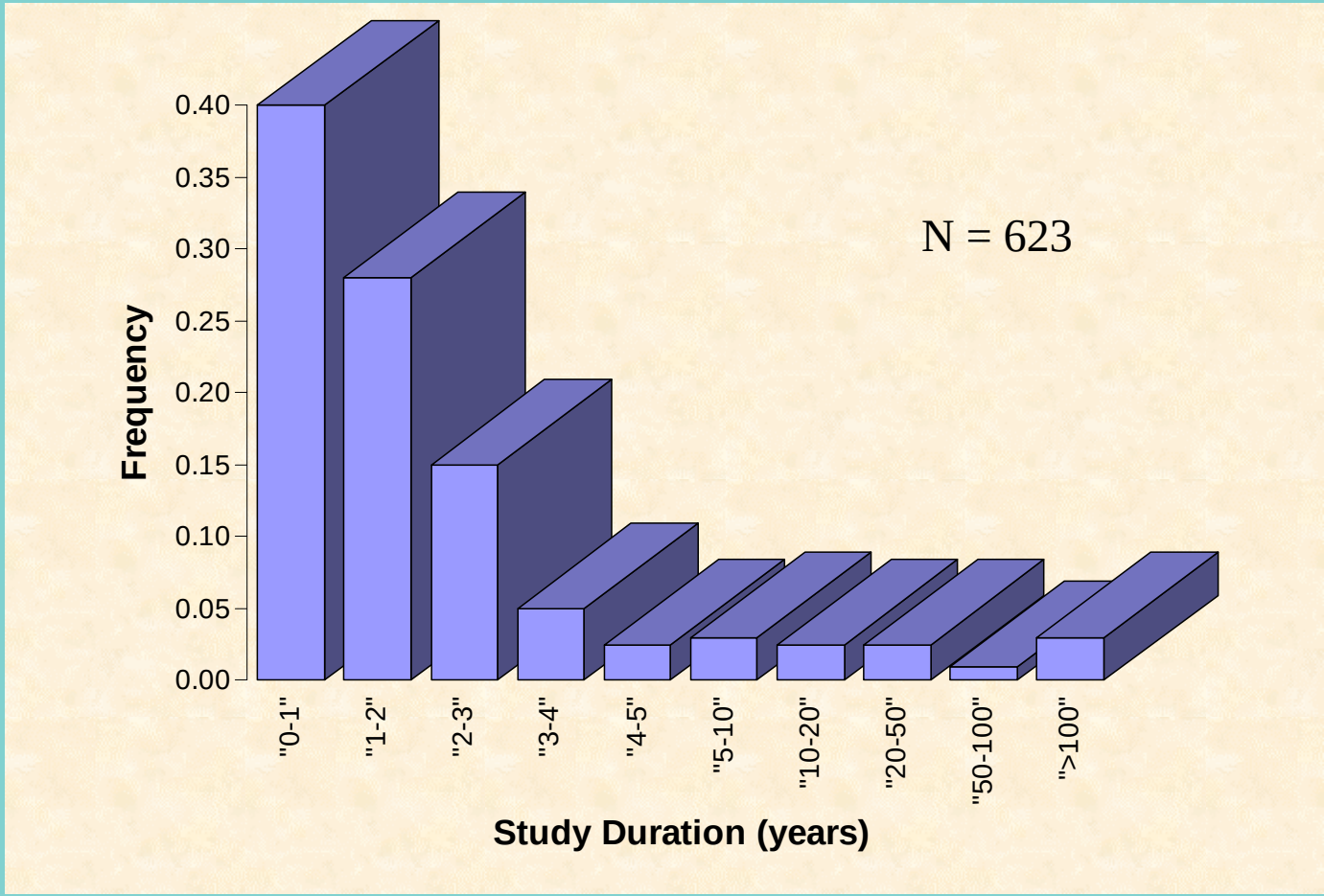
LTER works toward complete understanding of the environment

- Integrating
  - Long temporal scales
  - Broad spatial scales
  - Diversity of disciplines
- Committed to
  - Innovation in data management and wide accessibility of long term data

Long-term research is required to reveal:

- Slow processes or transients
- Episodic or infrequent events
- Trends
- Multi-factor responses
- Processes with major time lags

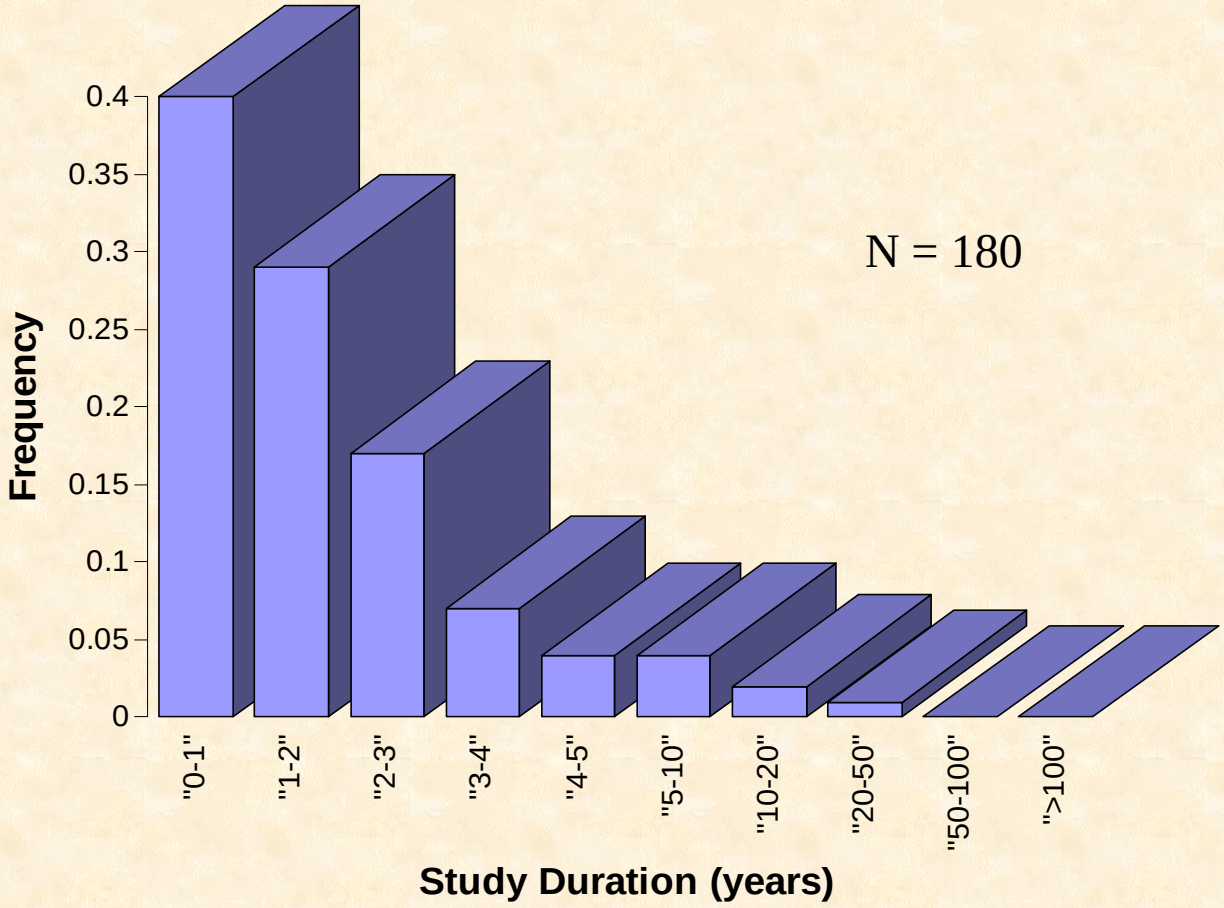
Duration of all observational and experimental studies



Eighty percent of studies in the ecological literature last less than three years

From Tilman, D. 1989. Ecological experimentation: strengths and conceptual problems. pp. 136-157. In Likens, G.E. (ed). Long-Term Studies in Ecology. Springer-Verlag, New York.

Duration of all experimental field studies

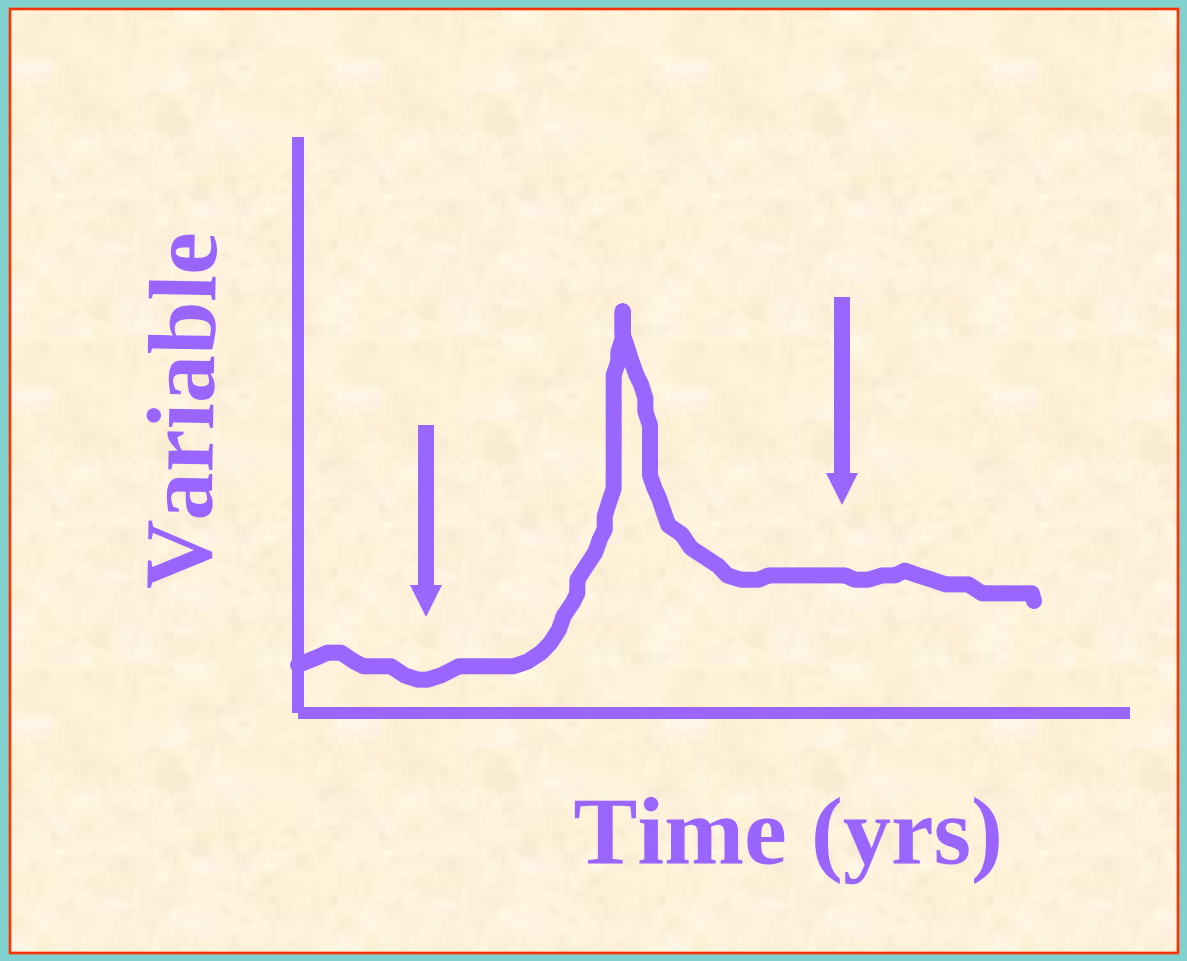


If only experimental studies are included, the bias increases. There are very few long-term experimental studies.

From Tilman, D. 1989. Ecological experimentation: strengths and conceptual problems. pp. 136-157. In. Likens, G.E. (ed). Long-Term Studies in Ecology. Springer-Verlag, New York.

The ecological literature in the United States is biased toward short-term results because typical research and research products are geared toward career development and are susceptible to changing issues in funding agencies.

Only 10 percent of studies capture unusual events



Unusual events reset systems. Short-term studies initiated before and after a rare event are viewing different system states.

Short-term research

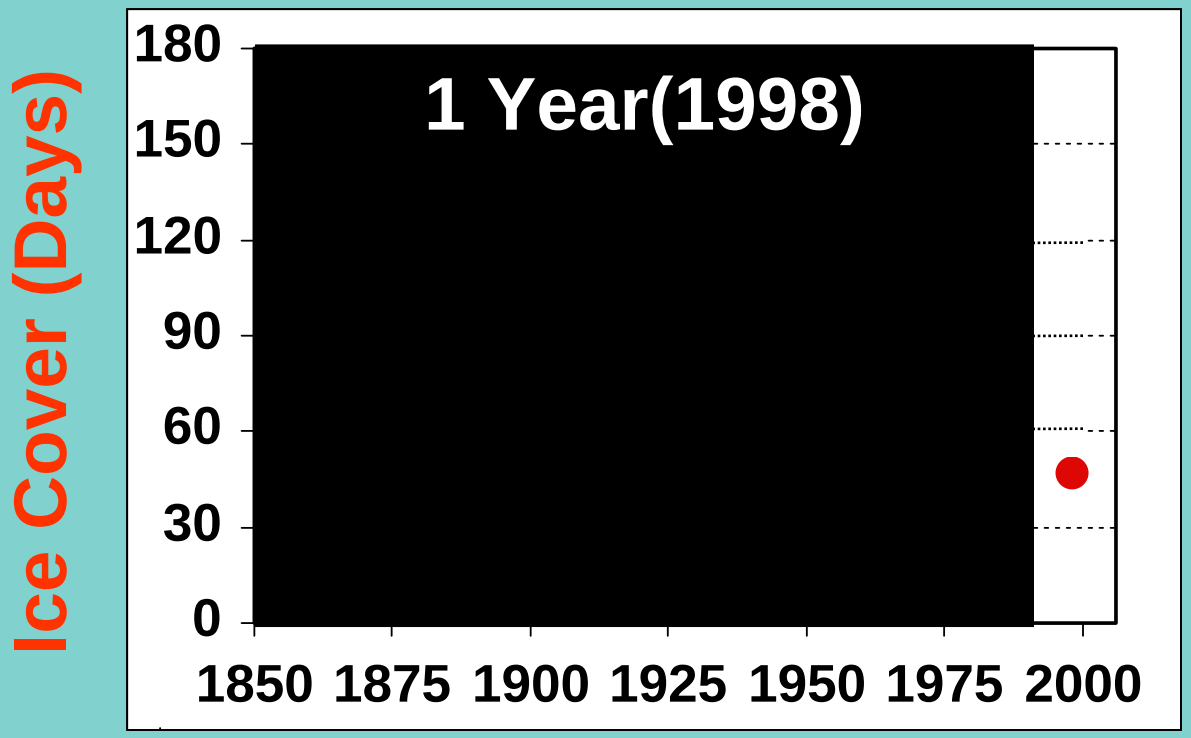
- Ignores long term processes and results
- May produce misleading results
  - Generalizations from short term data to longer periods often are incorrect
- May not identify trends
  - Trends are identifiable over time
- Does not account for long-term time lags

LTER research covers time scales from months to centuries

YEARS		RESEARCH SCALES	PHYSICAL RESET EVENTS	BIOLOGICAL PHENOMENA
10^5	100 MILLENNIA	PALEO ECOLOGY & LIMNOLOGY	• Continetal Glacition	• Evolution of Species
10^4	10 MILLENNIA			• Bog Succession • Forest Community Migration
10^3	MILLENNIUM		• Climate Change	• Species Invasion • Forest Succession
10^2	CENTURY	**LTER**	• Forest Fires • CO_2 Climate Warming	• Cultural Eutrophication
10^1	DECADE		• Sun Spot Cycle • El Nino	• Hare Population • Prairie Population
10^0	YEAR		• Prairie Fires • Lake Turnover	• Annual Plants • Plankton Succession
10^{-1}	MONTH		• Ocean Upwelling	
10^{-2}	DAY	MOST ECOLOGY	• Storms • Diel Light Cycle	• Algal bloom • Diel Migration
10^{-3}	HOUR		• Tides	

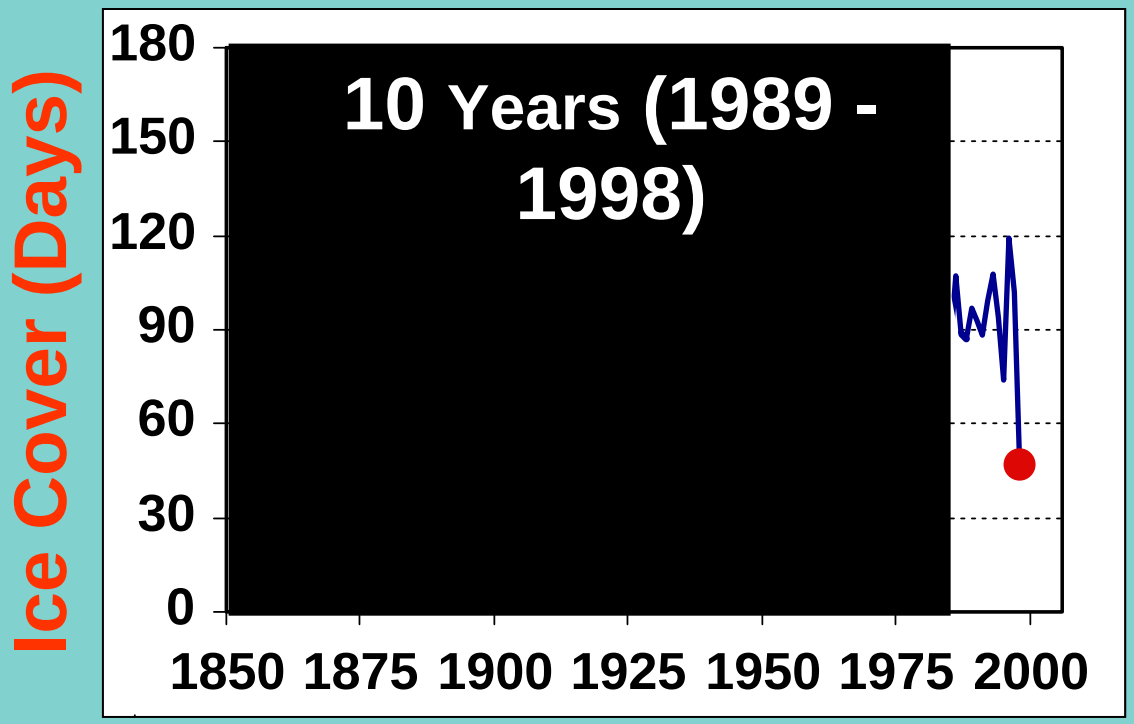
The time scales addressed by the Long Term Ecological Research Program fall outside the range of those typically addressed in other ecological research programs

Lake Mendota, Wisconsin



Lake Mendota, WI is an example of how long-term research provides insights not evident from short term studies. The graph above shows how long the lake was covered with ice in 1998. A study taken over one year (short-term) does not reveal much.

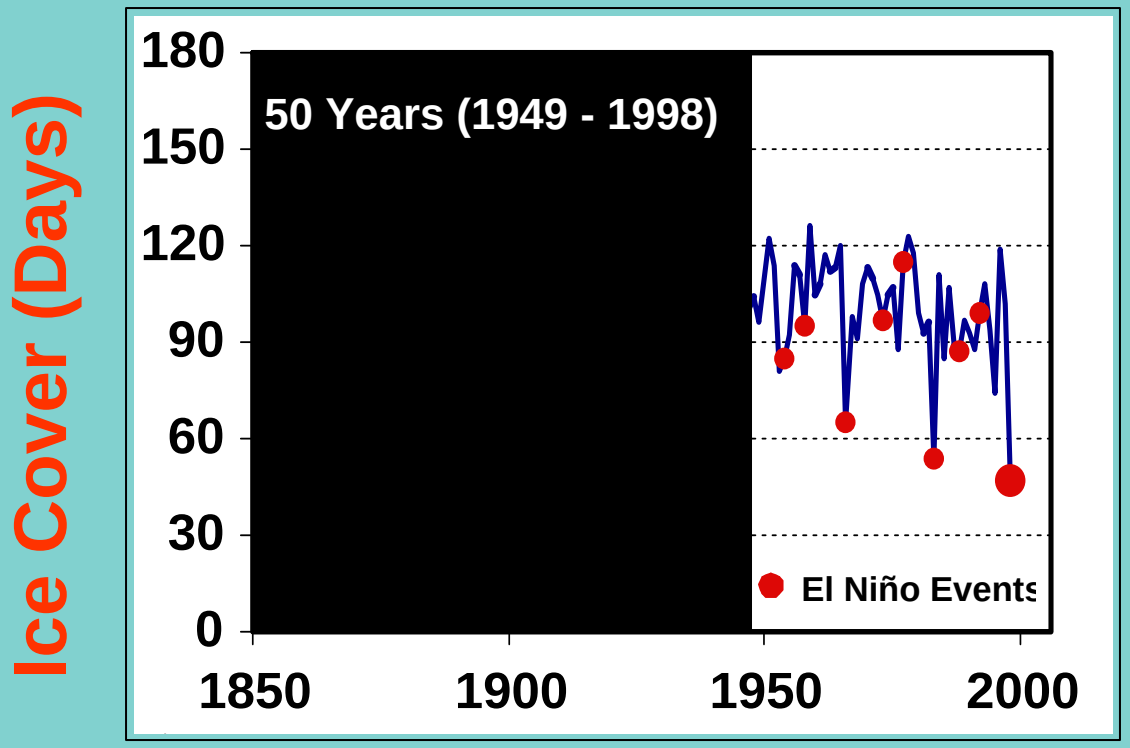
Ice breakup Research



Lake Mendota, Wisconsin

Research conducted over a decade reveals that duration of ice cover was unusually short in 1998.

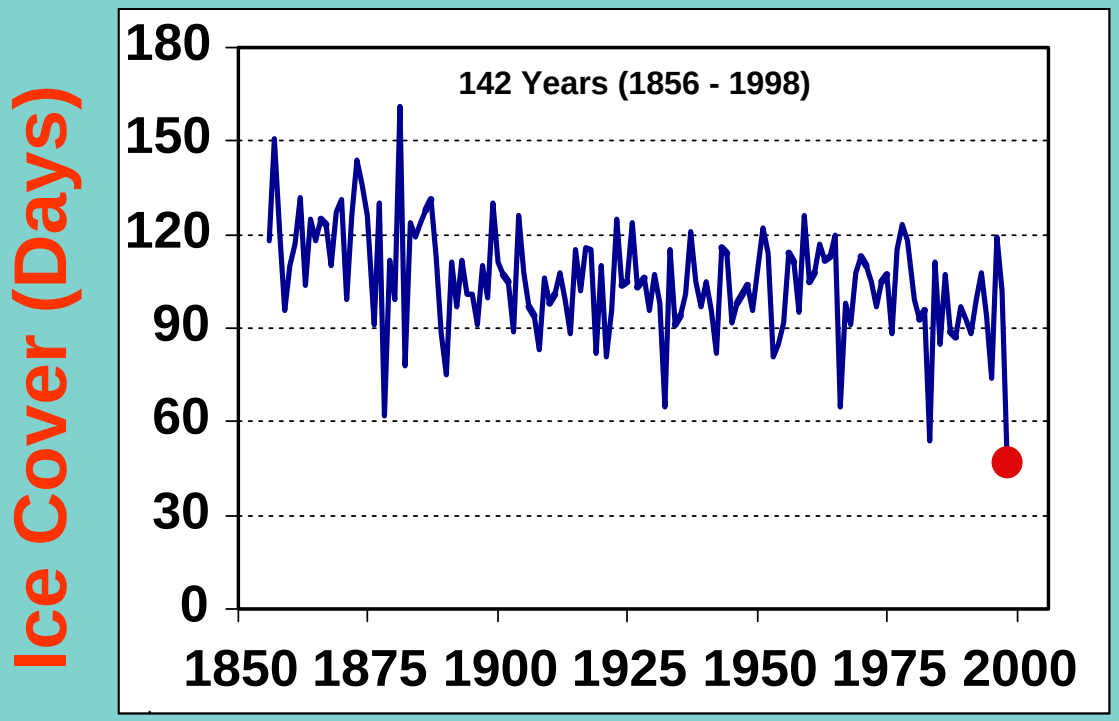
Ice Breakup Research



Lake Mendota, Wisconsin

Research over half a century reveals patterns in the lake's ice cover that coincide with global weather patterns and natural phenomena.

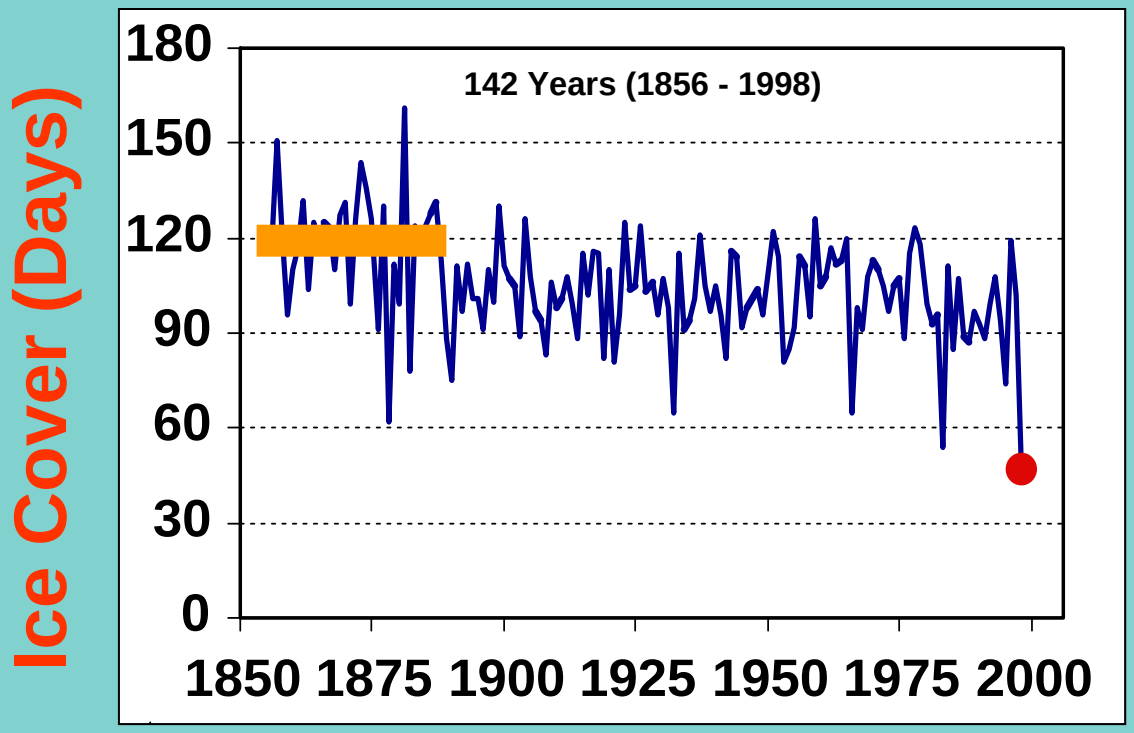
Ice Breakup Research



Lake Mendota, Wisconsin

Data for the past 142 years suggests a trend that is not evident from shorter data sets.

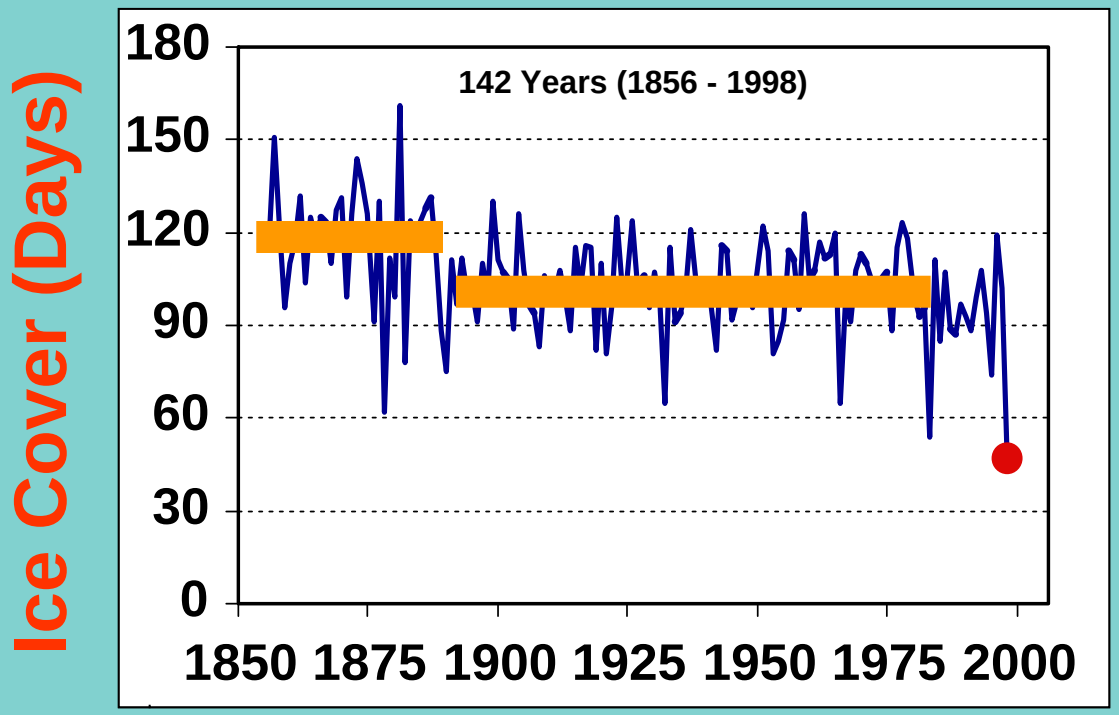
Ice Breakup Research



Lake Mendota, Wisconsin

The length of the data set permits statistical interpretations of trends over different time periods.

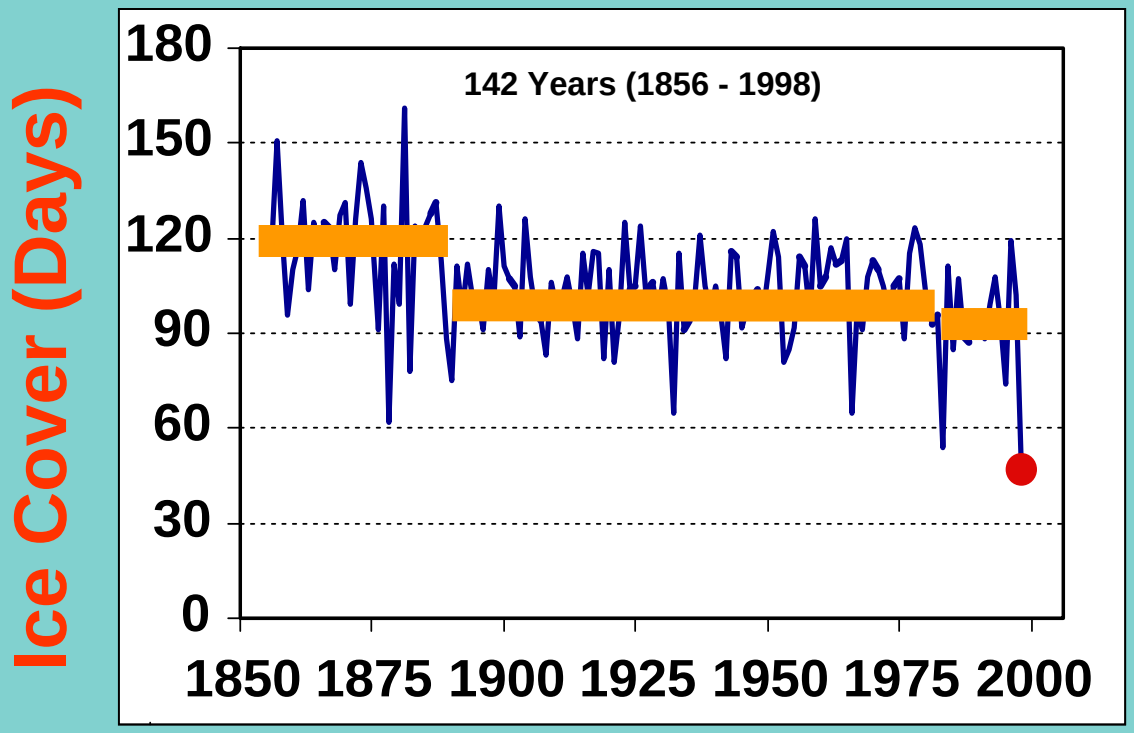
Ice Breakup Research



Lake Mendota, Wisconsin

As more data are added, distinct periods in lake response are identified.

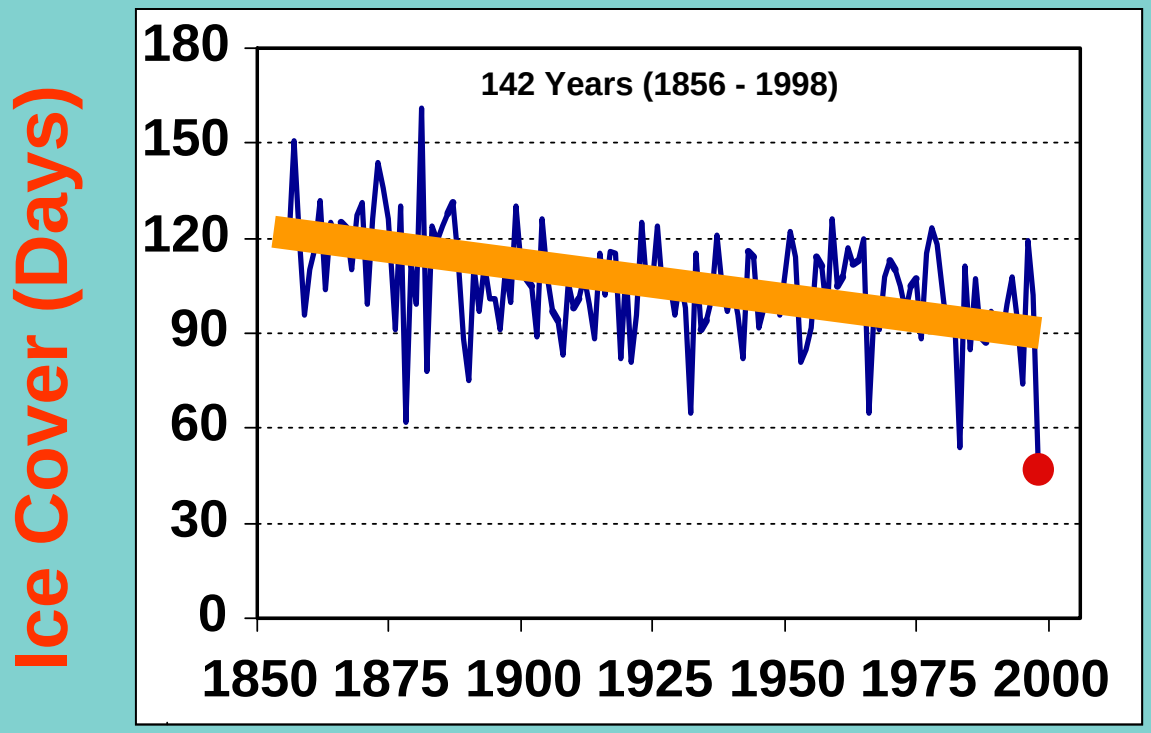
Ice Breakup Research



Lake Mendota, Wisconsin

The most recent data indicate another potential pattern.

Ice Breakup Research



Lake Mendota, Wisconsin

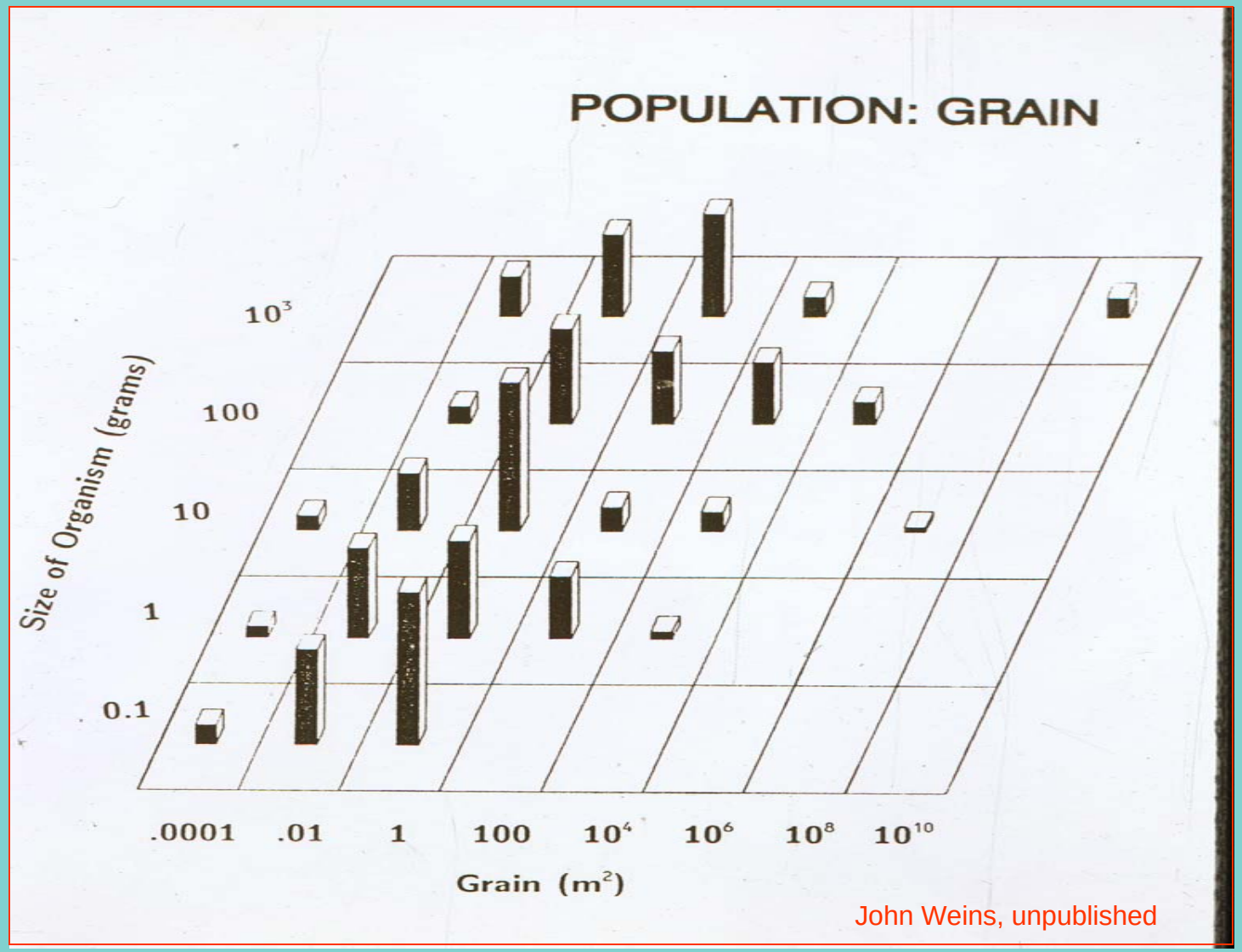
Analysis of all of the data together suggests a long term trend. Now an investigation into the reason for the trend can begin.

Research in the U.S.

– Most studies use a single scale of observation -

Commonly 1 m^2

– The literature is biased toward single and small scale results.



John Weins, unpublished

The most popular size for study plots is 1 m2 for organisms varying in size over several orders of magnitude.

Single scale research

- Significance of research results are unclear if a site's context in space is not understood
- Produces misleading results
- Does not allow for multi-scale analysis or inter-site comparison.

Long Term Ecological Research

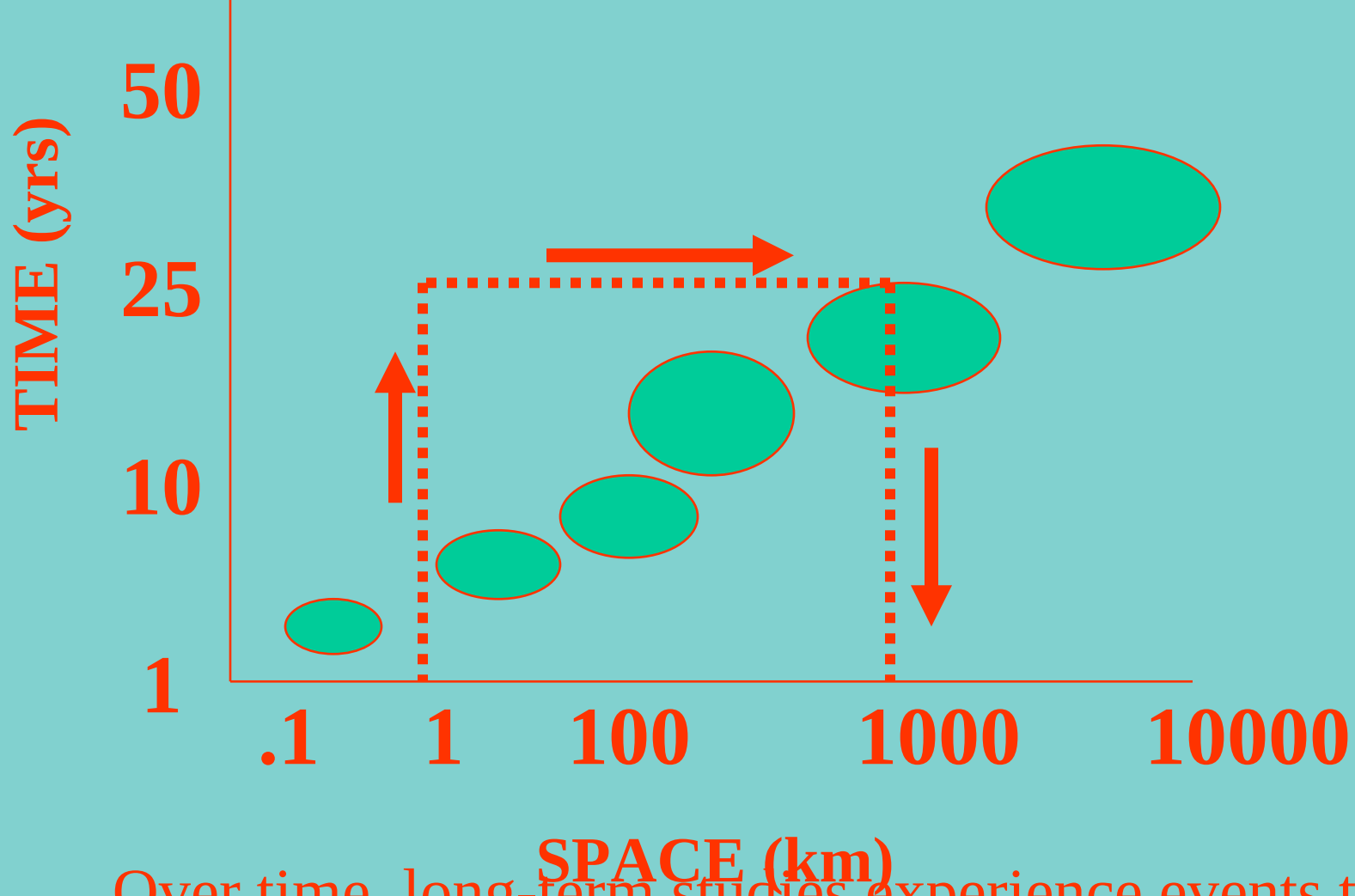
- Provides opportunities for multi-scale research and inter-site comparison
- Encourages comparative analysis across diverse ecosystems

Research over broad spatial scales

- Answers large scale questions concerning ecological phenomena
- Creates opportunities for comparisons between ecosystems across regional, continental, and global gradients
- Allows scientists to distinguish system features controlled by absolute and relative scales

AREA (m^2)	RESEARCH PROGRAMS
10^{14} GLOBAL 10^{12} CONTINENT 10^{10} REGION	GLOBAL SCIENCES (IGBP) / LTER / MOST ECOLOGY
10^{8} LANDSCAPE 10^{6} LANDSCAPE 10^{4} PLOT, PATCH 10^{2} PLOT, PATCH	
10^{0} SAMPLE POINTS	

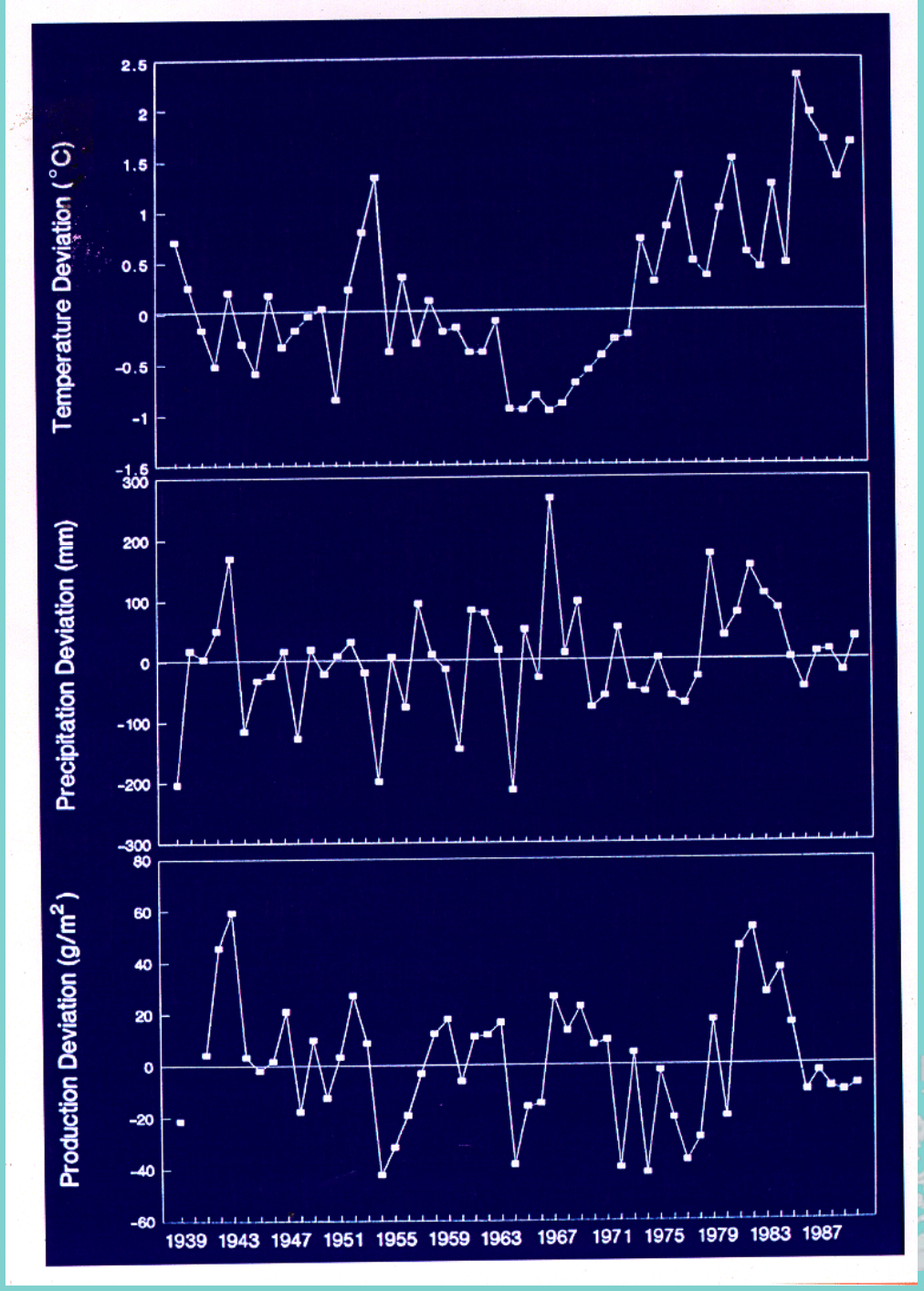
The spatial scales addressed by the Long Term Ecological Research Program fall outside the range of those typically addressed in other ecological research programs



Over time, long-term studies experience events that normally are associated with large spatial scales (e.g., droughts). Thus, long-term studies provide opportunities to extrapolate to larger spatial scales.

Short Grass Steppe LTER Site Colorado

An example: models relating precipitation and temperature to productivity broke down after a prolonged drought changed ecosystem conditions.



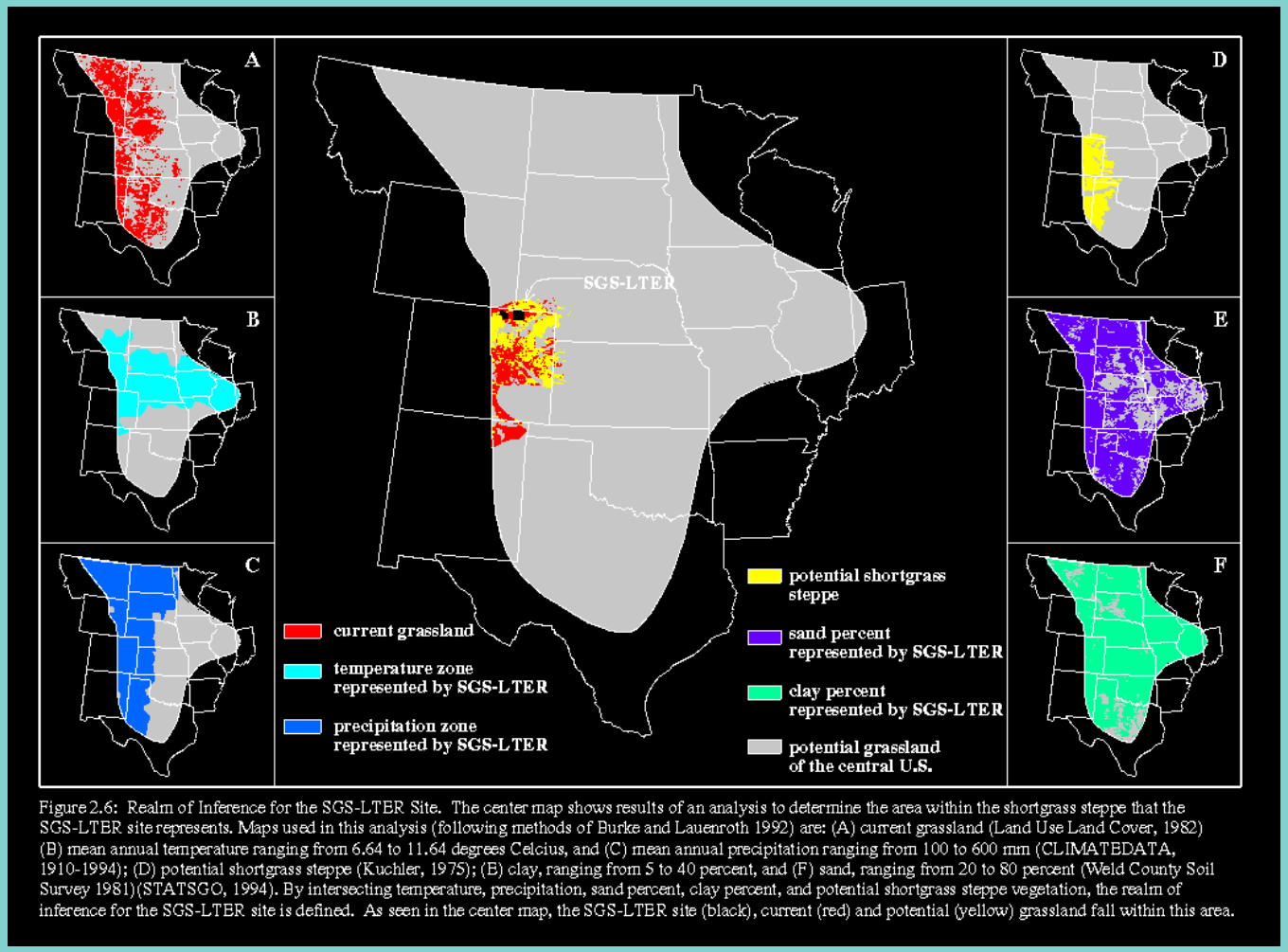
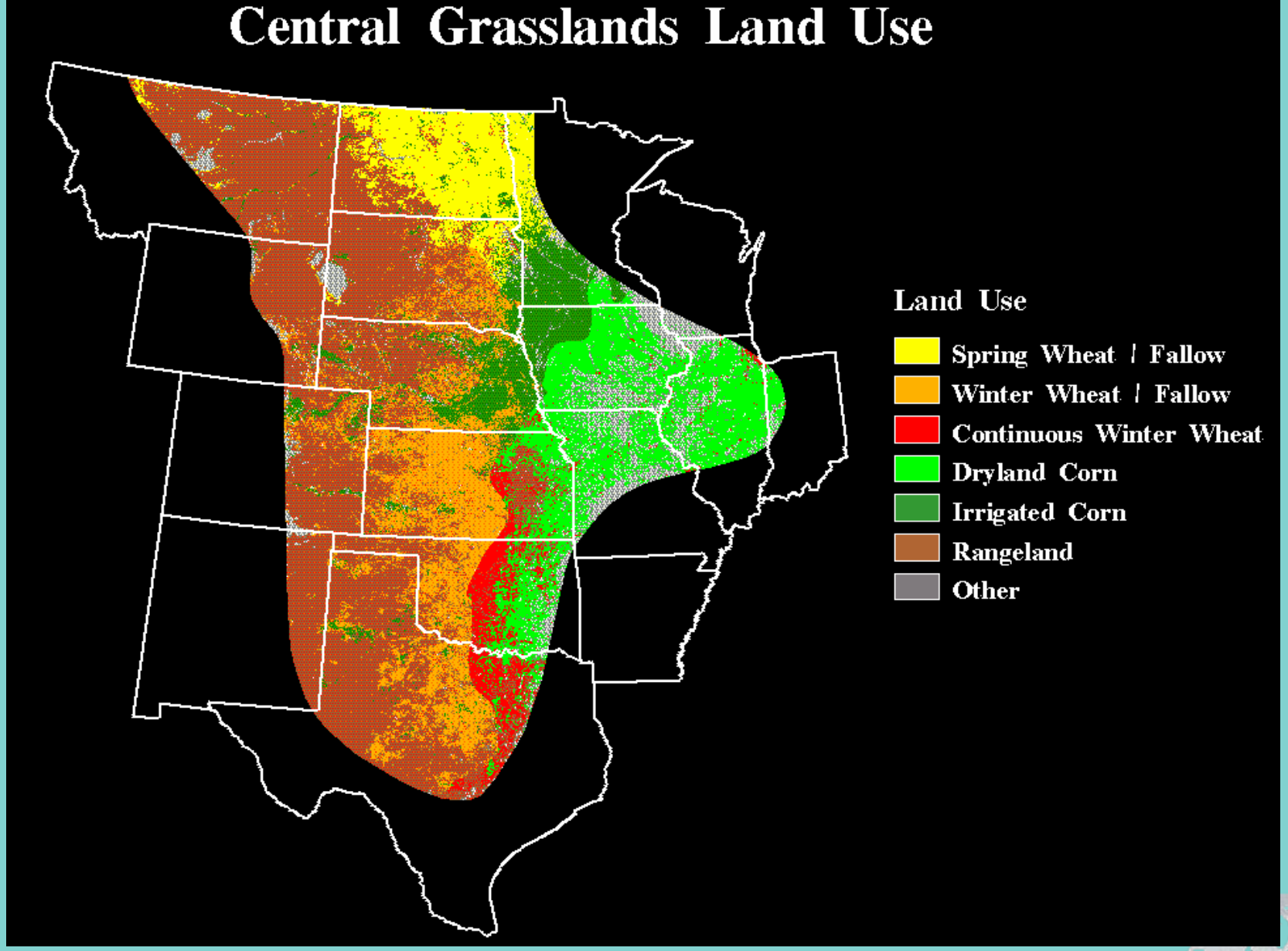
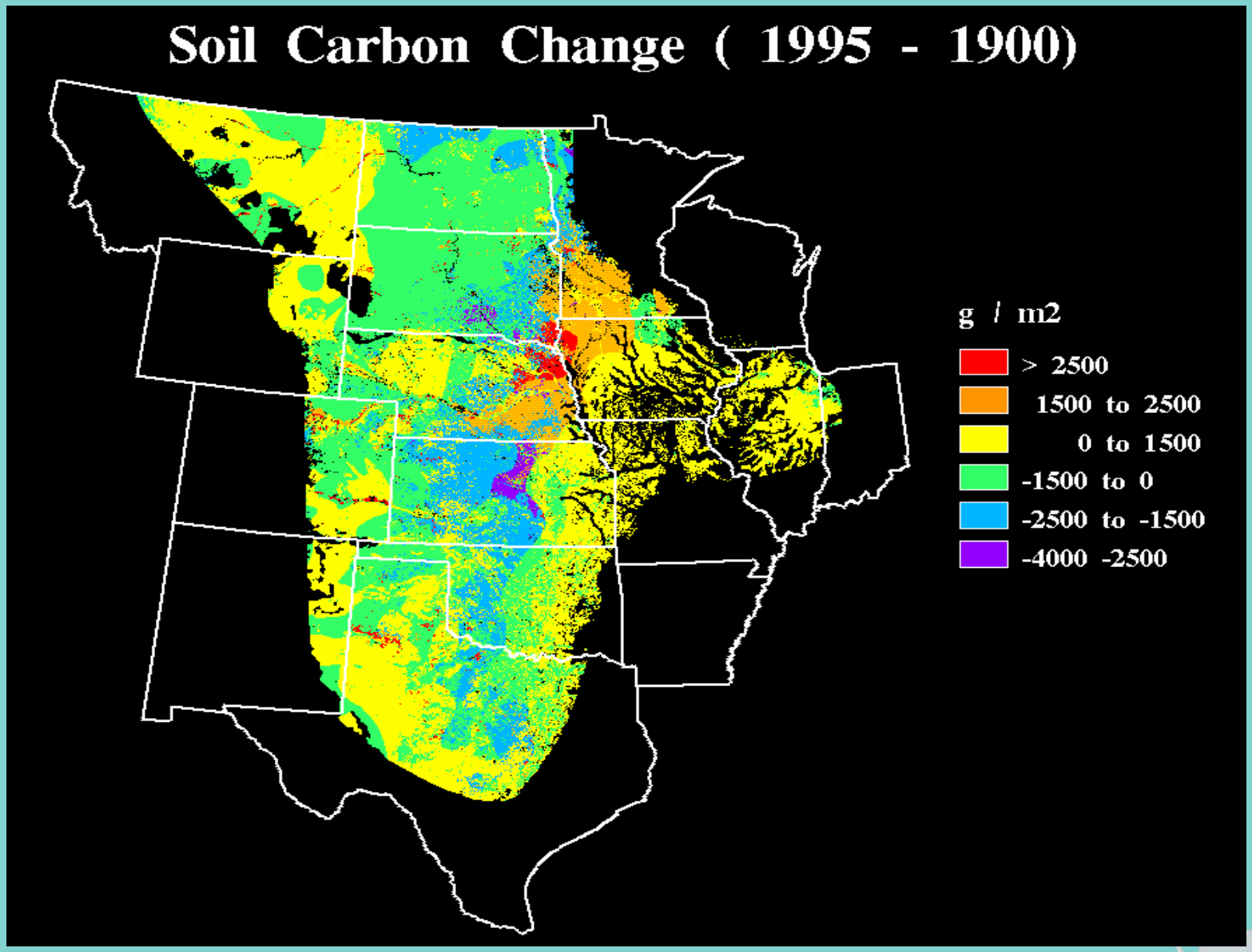


Figure 2.6: Realm of Inference for the SGS-LTER Site. The center map shows results of an analysis to determine the area within the shortgrass steppe that the SGS-LTER site represents. Maps used in this analysis (following methods of Burke and Lauenroth 1992) are: (A) current grassland (Land Use Land Cover, 1982) (B) mean annual temperature ranging from 6.64 to 11.64 degrees Celcius, and (C) mean annual precipitation ranging from 100 to 600 mm (CLIMATEDATA, 1910-1994); (D) potential shortgrass steppe (Kuchler, 1975); (E) clay, ranging from 5 to 40 percent, and (F) sand, ranging from 20 to 80 percent (Weld County Soil Survey 1981)(STATSGO, 1994). By intersecting temperature, precipitation, sand percent, clay percent, and potential shortgrass steppe vegetation, the realm of inference for the SGS-LTER site is defined. As seen in the center map, the SGS-LTER site (black), current (red) and potential (yellow) grassland fall within this area.

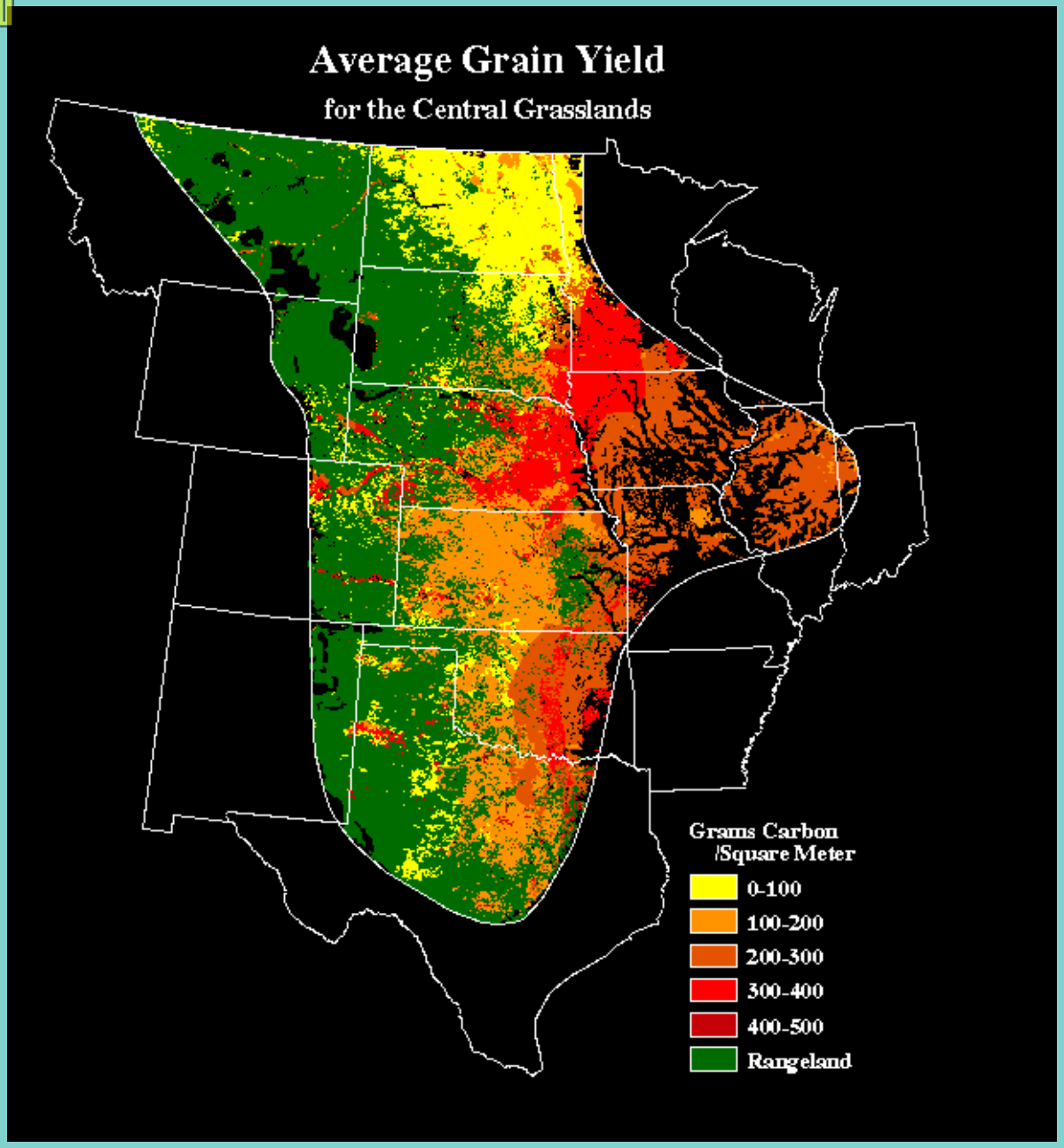
The preceding result prompted scientists at SGS to evaluate the inference space represented by their site. They found that their models applied to only a small fraction of the potential area of short-grass steppe.



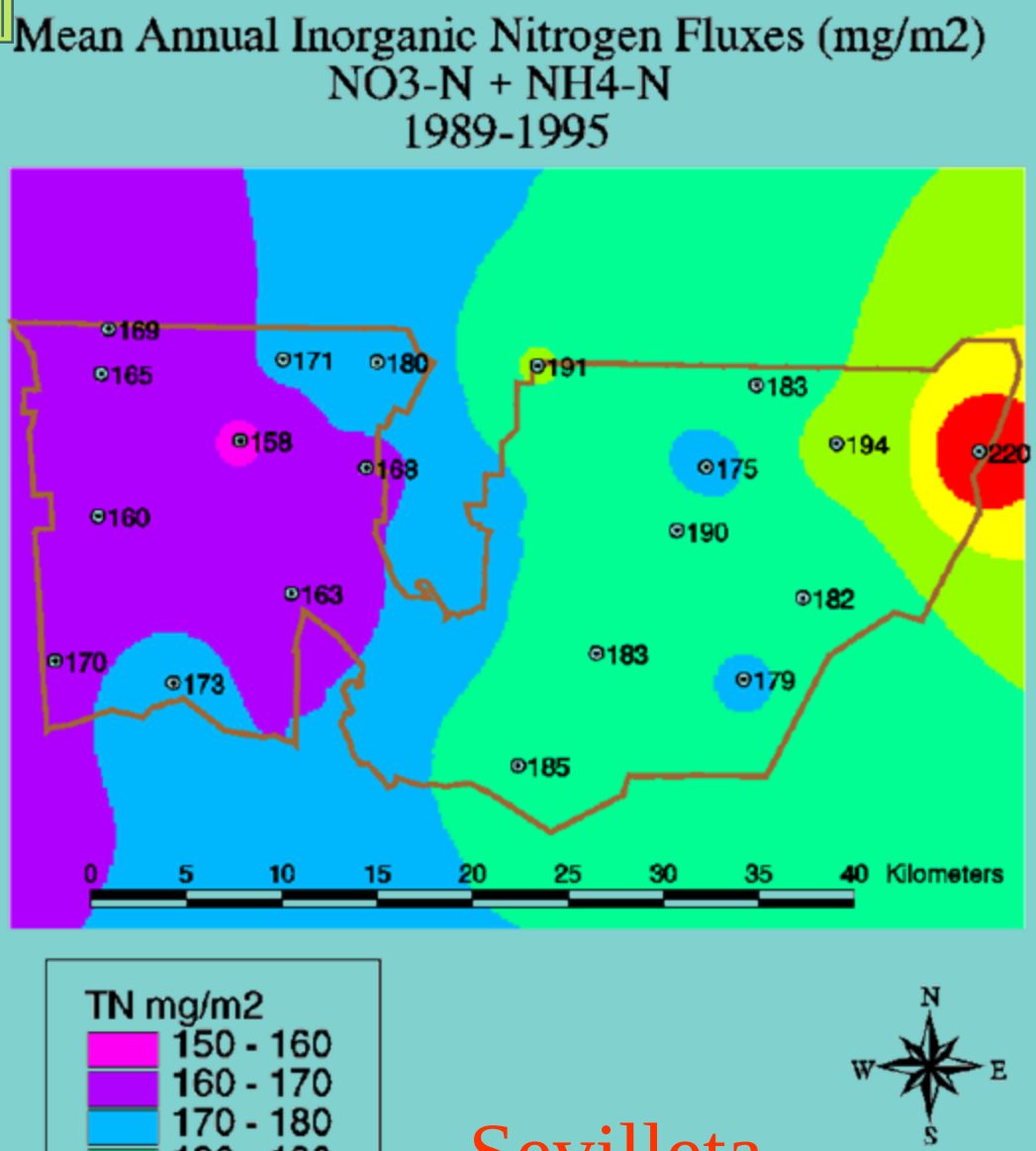
SGS scientists were prompted to modify the models to apply to larger scales by incorporating regional variation in parameters such as land use.



Improved data sets were needed for these modified models.



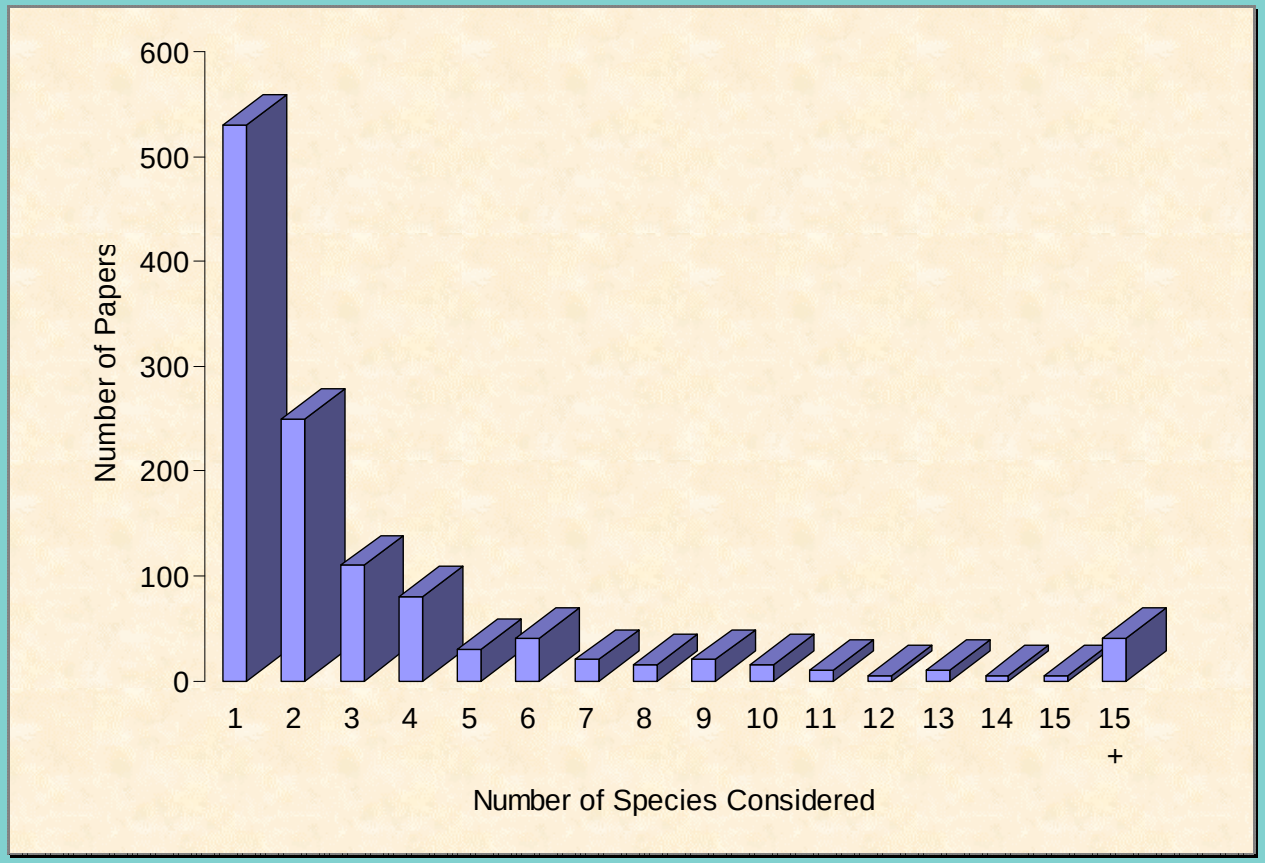
The modified models are able to predict regional trends that the original models could not.



Sevilleta
LTER
New Mexico

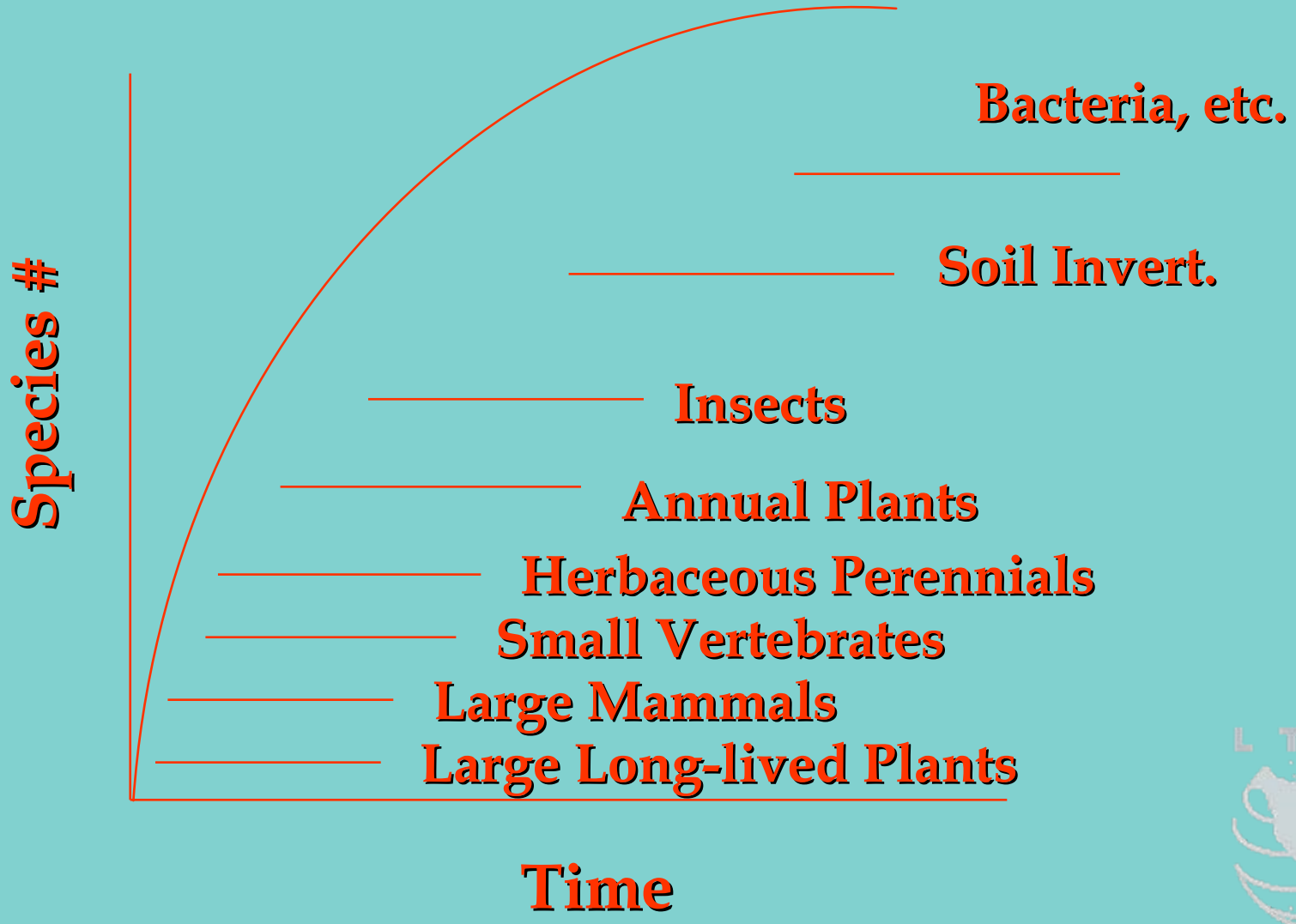
at the Sevilleta LTER site… Patterns of inorganic inputs and movements of nutrients. Here the spatial patterns of nitrogen depositon in rainfall are estimated with lightning location data.(*Gosz and Moore*)

Over 75 percent of studies reported in the literature look at only 1 or 2 species.



The literature does not represent the real complexity of species interactions in nature.

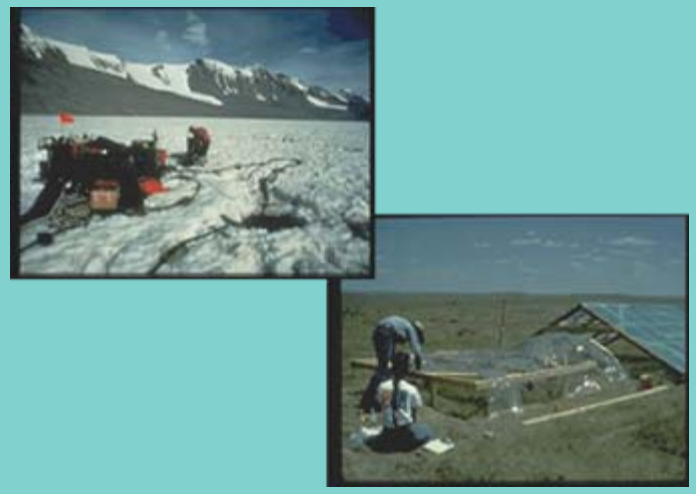
The longer a site (e.g., LTER) is studied, the more information we generate about biodiversity and its relationship with ecosystem functions and services.



Research in the U.S.

- Most academic departments, scientific societies, mission agencies, and scientific journals promote a single discipline emphasis.
- The literature does not demonstrate the integrated interdisciplinary approach necessary to understand complex systems.

Nature of Long Term Ecological Research



LTER sites range from arctic tundra to hot desert and from tropical rainforest to suburban watersheds

Because of this wide range and complexity of biomes no single discipline or field can be emphasized

Diversity of Disciplines

- Due to the nature of research conducted at the LTER Network a diverse group of scientists and researchers are needed.
- LTER has a multitude of scientists ranging from the physical sciences to the social sciences.
- LTER also works closely with government agencies, universities, and communities

21 sites comprise the LTER Network ranging from Alaska near the arctic circle to Antarctica.

Long-term research sites result in intensive activities by many individuals from many disciplines working on common areas that facilitate integration of information.

AN LTER SITE BECOMES A RESEARCH PLATFORM

Two new sites added in 1998 expand the scope to include multidisciplinary studies of human dominated ecosystems

Central Arizona - Phoenix

Baltimore Ecosystem Study

LTER

- LTER uses an integrated multidisciplinary approach that is necessary in understanding complex systems
- LTER offers outstanding opportunities for comparative studies
- LTER sites are contributing significantly to research on emerging environmental issues
- LTER is providing a better view of the world

THE IMPORTANCE OF CROSS-SITE SYNTHESIS

"The power of the network approach of the LTER program rests in the ability to compare similar processes (e.g., primary production or decomposition of organic matter) under different ecological conditions. As a result, LTER scientists should be able to understand how fundamental ecological processes operate at different rates and in different ways under different environmental conditions" (Risser Report, 1993).

Why do we need a Network Information System?

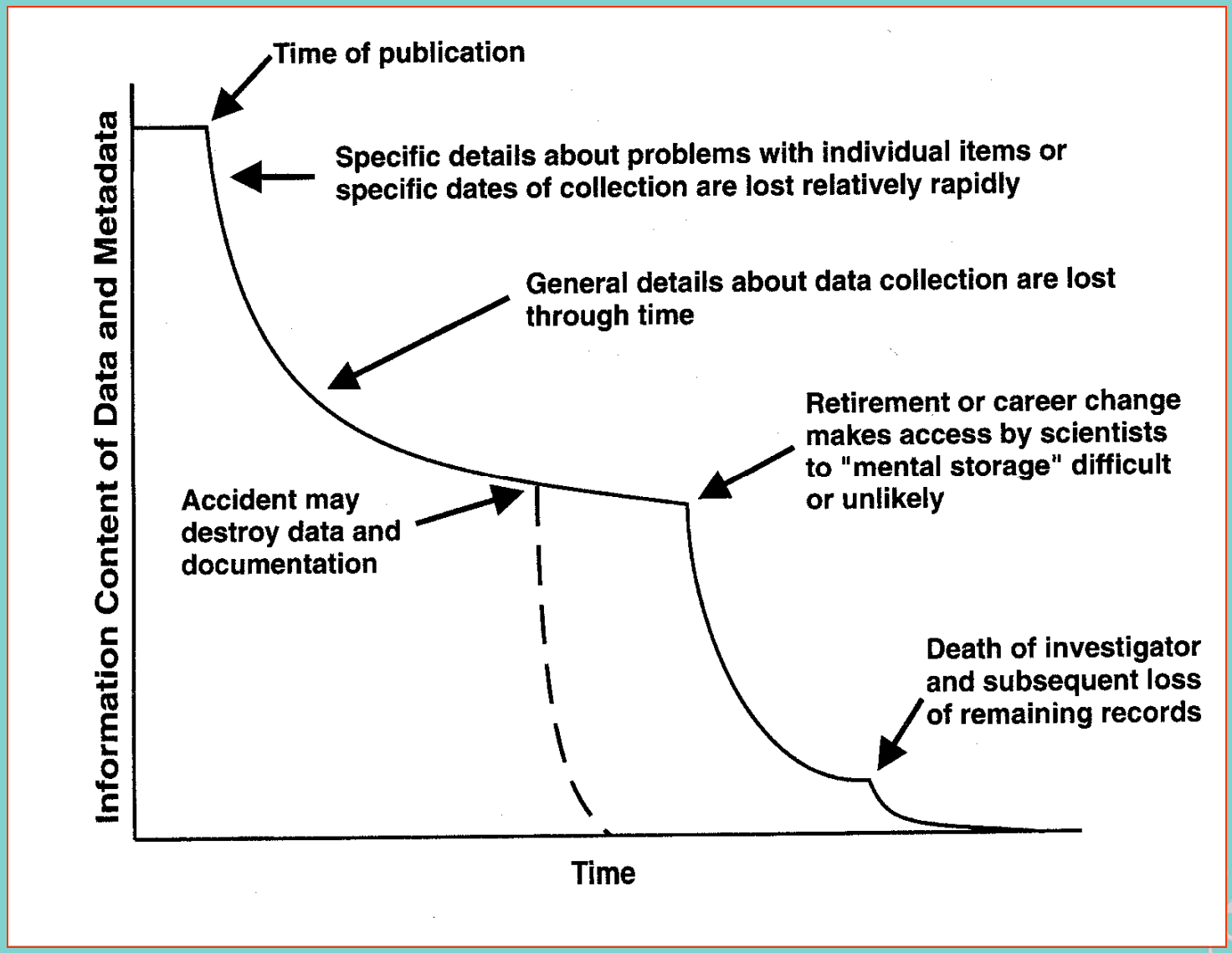
Modern ecology requires increased access to data and metadata distributed across multiple sites for synthesis and integration across broad spatial and temporal scales.

A major challenge to the U.S. LTER network in the coming decade is the design and implementation of an information system that seamlessly facilitates intersite research.

These binders contain 10 years of data collected in the Grassland section of the International Biosphere Programme, ca. 1978

Antiquated data storage system at Coweeta Hydrologic Laboratory—These binders contain more than 60 years of data collected from the watersheds there.

Information decay



Data loses value over time unless documented and archived.

The ecological information challenge

- Making information available to ecologists:
  - in ways they can **locate** the information they need
  - in forms they can readily use
- Fostering the synergy of information systems and scientific research
- Developing a flexible metadata model
- Increase utility of existing systems
- Increase access and query capabilities of data between sites

Science drives the need for information management

For the Sites

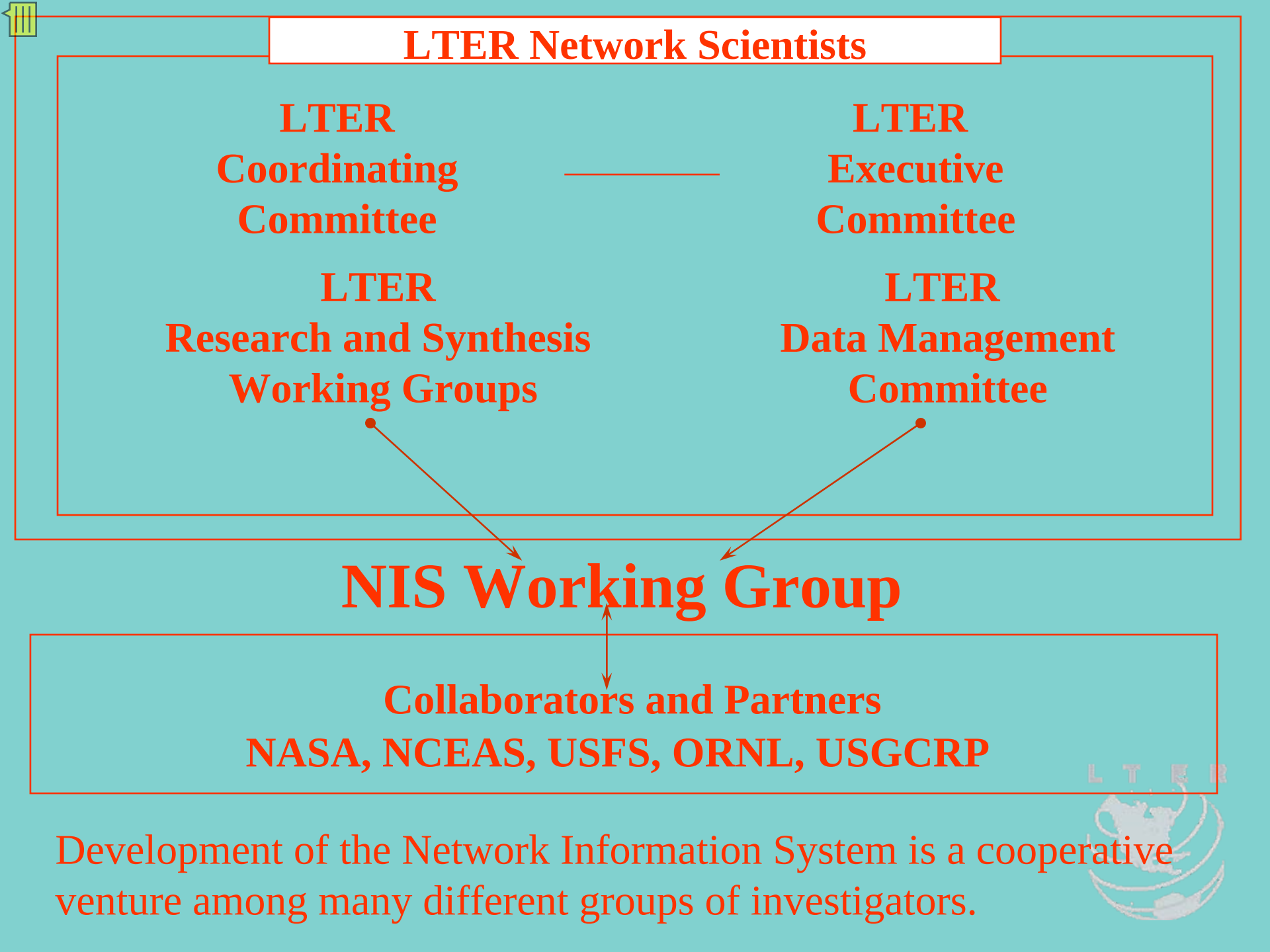
- Long-term studies depend on databases to retain project history

For the Network

- Cross-site studies require commun-ication and integration of data

For the Nation

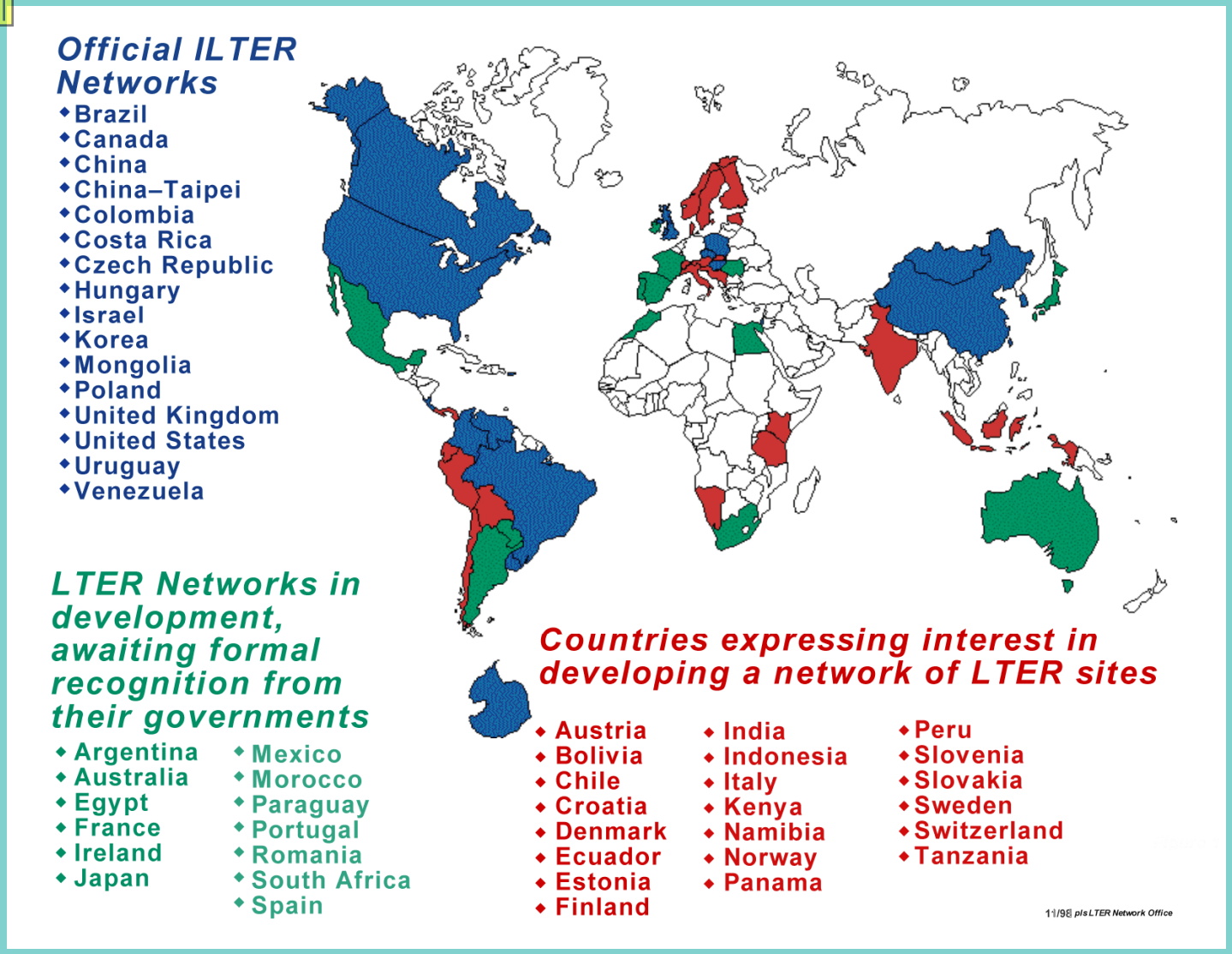
- Integrated, multidisciplinary projects depend on databases to facilitate sharing of data



Development of the Network Information System is a cooperative venture among many different groups of investigators.

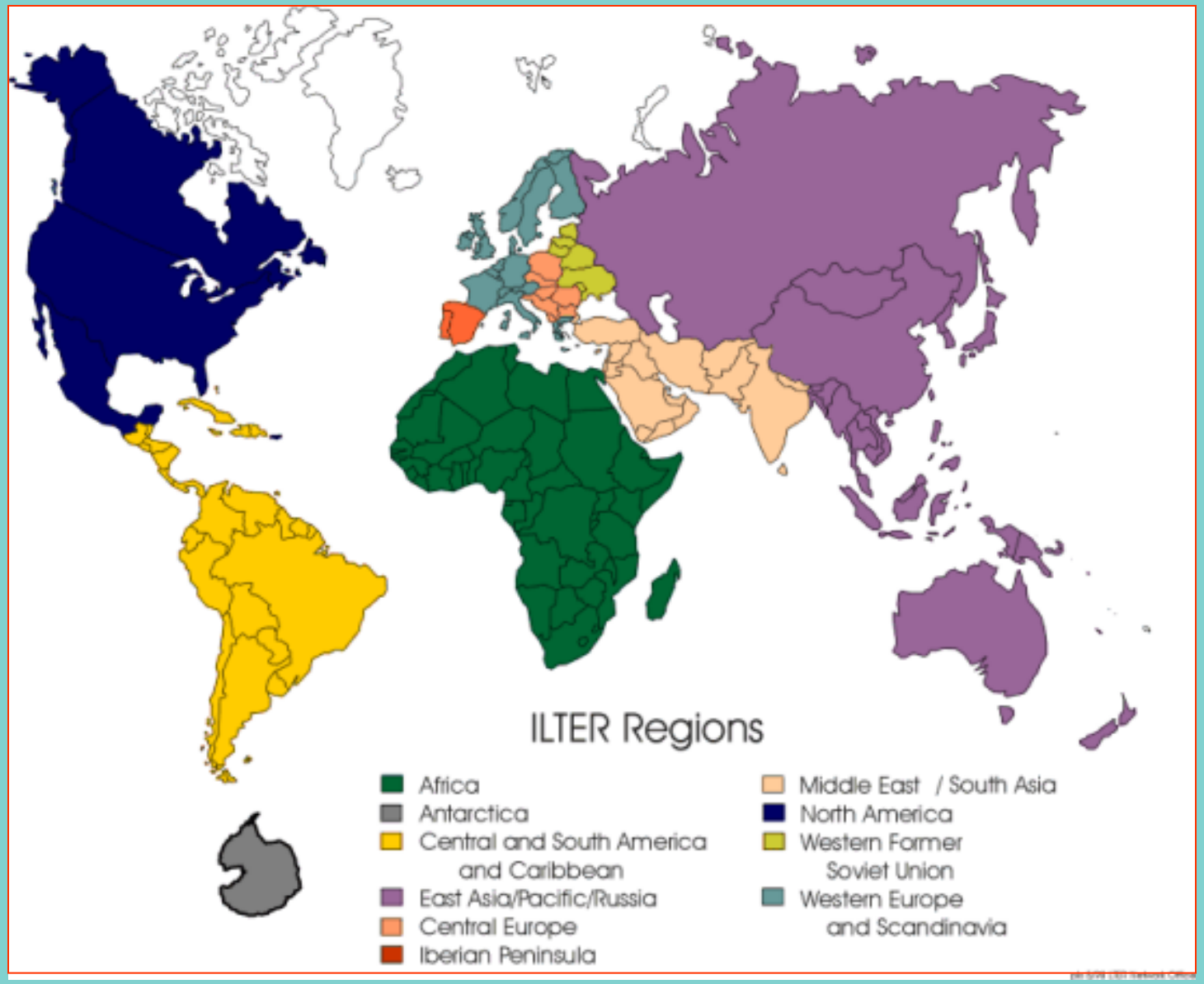
International LTER Network Information Management

Groundwork has been done, but there is a need for continued collaboration and cooperation among international information managers to establish international specifications for data exchange and information interoperability.



15 other countries besides the United States have developed LTER networks. Many other countries are in the process of initiating such networks.

ILTER Regions

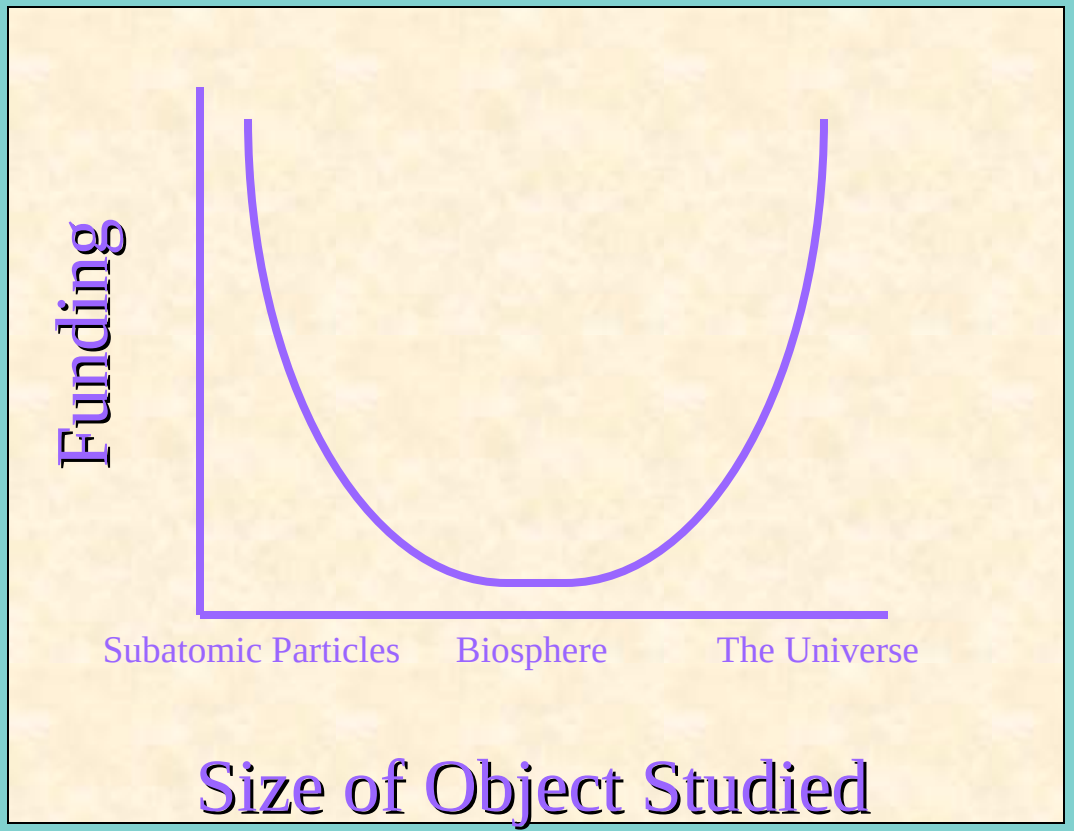


International LTER networks are organized into regional networks of networks

NORTH AMERICAN REGION

Regional networks are necessary because ecological systems do not respect national boundaries

Funding for megascience projects



By organizing into networks, ecological scientists can change the pattern of funding for their science.