USDA
United States Department of Agriculture

Agricultural Research Service

Technical Bulletin Number 1931

September 2013

Long-Term Trends in Ecological Systems:

A Basis for Understanding Responses to Global Change

Contents

Chapter 12

Long-Term Trends in Precipitation and Surface Water Chemistry

In this chapter, we first describe common methods to measure precipitation and water chemistry, as well as our rationale for the selection of variables in the book. We then show graphs of long-term data summarized across sites and by site for four major elements (nitrogen and sulfur, in precipitation as inputs and surface water as export, and calcium and choride). Examples of research questions that can be addressed using these data can be found in chapter 6. Data for additional elements are available on the EcoTrends website (http://www.ecotrends.info).

Methods of Measurements and Selection of Variables

One of the challenges associated with conducting cross-site analyses of long-term biogeochemistry data is that sites in different biomes focus on different research questions and use different approaches to address these questions. A second problem is that biogeochemical research has typically focused on measurements of the inputs to and losses from ecosystems rather than pool sizes and transfers among pools. Inputs often provide information on important drivers to ecosystem function. Losses provide an indication of the response of ecosystems to changes in environmental drivers. Losses or export of nitrogen in surface water depend on the ability of vegetation to retain nitrogen. This retention is affected by soil, vegetation, hydrologic properties, and climate. Nitrate is much more mobile than ammonium (which is often very low in streams) and is recognized as an indicator of watershed's nitrogen status. The ability of watersheds to retain nitrogen is important in preventing its movement downstream to waters that are sensitive to nitrogen-induced eutrophication (examples include the Chesapeake Bay and the Gulf of Mexico).

Although study of internal element pools and transfers among pools is essential to understanding ecosystem function, obtaining the data is often difficult and expensive and generally is not part of routine monitoring. Thus, no long-term data on soil chemistry are available for cross-site comparisons. However, cross-site comparisons from short-duration nitrogen fertilization studies are discussed in chapter 6.

In this chapter, we focus on measurements made using common methods for a relatively large number of sites (up to 34). As a result, we focus on (1) wet deposition and precipitation chemistry through data available either in the National Atmospheric Deposition Program (NADP; http://nadp.sws.uiuc.edu/) or from a site and (2) on surface water chemistry collected by each site.

Two measures of wet deposition are commonly obtained from precipitation (rain, snow) collected at a site: (1) concentration, expressed as milligrams per liter, is measured on a subsample of the precipitation collected and averaged based on the total volume collected (the volume-weighted concentration), and (2) total amount collected in a precipitation sample is converted to an areal basis (deposition expressed as kg/ha per year). In both cases, samples are collected frequently (daily or weekly, for example) and converted to a mean value for the entire year. In most cases, data were obtained for nitrate, ammonium, chloride, hydrogen (acidity as pH), and base cations (calcium, magnesium, potassium, and sodium). Nitrate is an important nutrient for the biota, although it can be toxic at high levels. The dominant source of nitrate emissions to the atmosphere is combustion of fossil fuels from transportation sources and electric utilities. Ammonium, which can be toxic at high levels, is an important byproduct of animal metabolism and fertilization. Sources and atmospheric deposition of ammonia (figure 12-9) typically vary more locally than those of nitrate, which tends to show strong regional patterns (figure 12-1). Additional elements and finer resolution data are available on the EcoTrends website (http://www.ecotrends.info). Concentrations of all of these solutes are changing in precipitation in response to changes in emissions of air pollutants, and these changes have implications for water quality and ecosystems. Mean surface water export data on an annual basis (mg/L) for nitrate, ammonium, sulfate, chloride, and calcium are shown here.

Graphs Showing Long-Term Trends

The remainder of this chapter is devoted to graphs showing trends in precipitation and surface water chemistry, displayed in two ways, to provide a sense of change across a range of spatial scales (continent, site) for each variable. First, we provide a summary of trends

at the continental scale using maps that show either the mean across years or the slope of the regression line (if significant) across time for each variable. Slopes are shown using either pink (positive) or blue (negative) bars; the height of the bar is the magnitude of the slope.

Following the continental-scale maps, we show data through time using three panels for each site and each variable: (1) concentration in precipitation (mg/L), (2) deposition in precipitation (kg/ha/y), and (3) concentration in surface water (mg/L). These panels allow comparisons between atmospheric deposition (inputs) and the amount of nitrogen lost from surface water each year. A line indicates a significant positive or negative trend through time ($p < 0.05$) based on simple linear regression, uncorrected for autocorrelation. The site graphs are organized by ecosystem type to allow comparisons of sites in the same ecosystem. For surface water, we show each site graph on a continental map with similar sites to allow direct comparisons among sites. Long-term means and regression coefficients can be found in Appendices 5-14.

Summary

Trends in nitrogen compounds vary through time within a site and spatially among sites because of the multiple forms of nitrogen in ecosystems with different sources and dynamics. Nitrates in precipitation are either decreasing (in the East) or not changing at most sites. Notable exceptions are sites in the Rocky Mountains (NWT) and sites with rapidly increasing urban populations near a research site (FCE). Patterns in nitrate export from streams and lakes are more variable in that some sites are increasing, some are decreasing, and many remain unchanged. Ammonium deposition either has not changed or is increasing over the past 20 plus years. Given that nitrate is not changing or is declining for many sites outside of the Rocky Mountains, ammonium is increasing in importance as a component of atmospheric deposition nationally. Nitrate and sulfate deposition are decreasing in many eastern sites, consistent with efforts to control emissions of acid-causing nitrogen and sulfur from power plants in that part of the country. Declines in nitrate deposition have not been as marked as declines in sulfate.

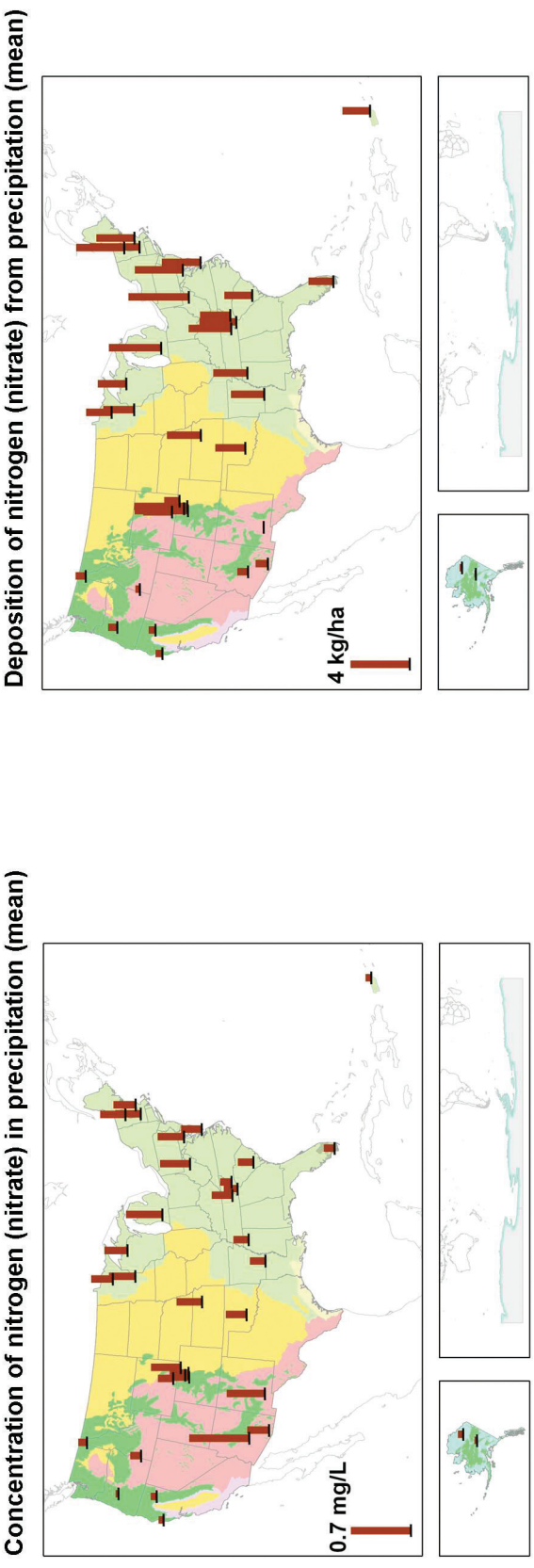


Figure 12-1. Continental patterns in nitrogen (nitrate) from precipitation: concentration (volume-weighted concentration, mg/L) and wet deposition (kg/ha). Top panels: long-term averages where positive values are red and negative values are green. Bottom panels: slopes of significant regression lines ($p < 0.05$) where positive values are pink and negative values are blue. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

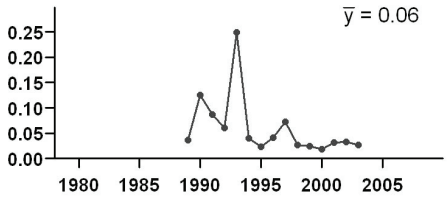
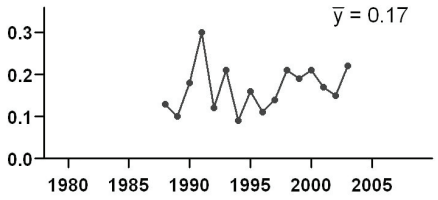
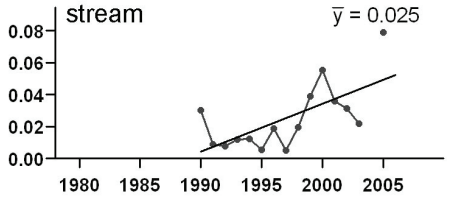
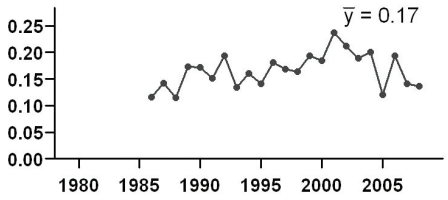
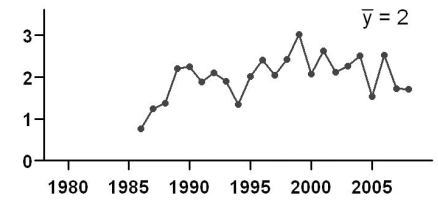
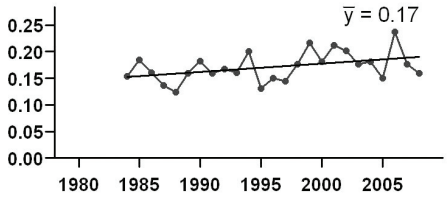
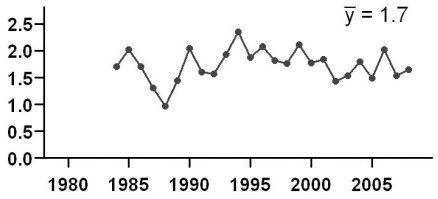
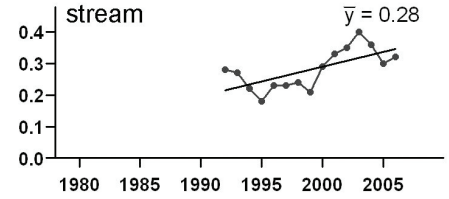
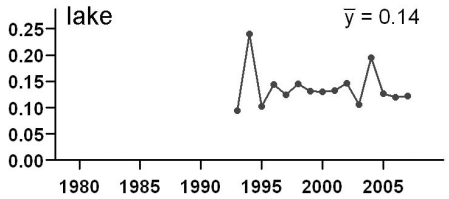
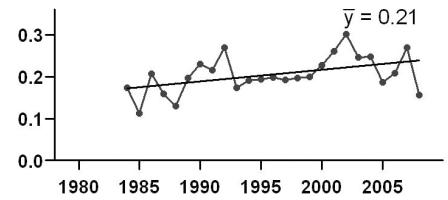
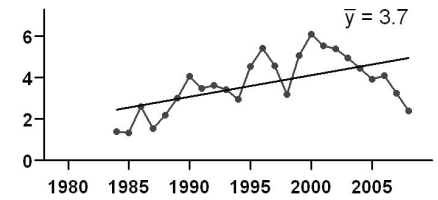
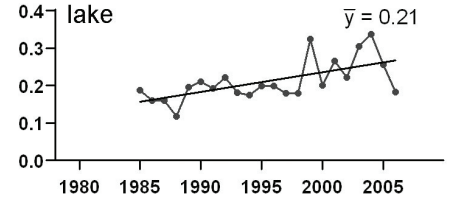
Site	Concentration of nitrate in precipitation (mg N/L)	Deposition of nitrate from precipitation (kg N/ha-yr)	Concentration of nitrate in surface water (mg N/L)
Arctic (ARC)			
Glacier Lakes (GLA)			NA
Loch Vale Watershed (LVW)			
McMurdo Dry Valleys (MCM)	NA	NA	
Niwot Ridge Research Area (NWT)			

Figure 12-2. Trends for each alpine and arctic site: nitrate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Arctic (ARC): NS, NS, 0.0030; Glacier Lakes (GLA): NS, NS, NA; Loch Vale Watershed (LVW): 0.0016, NS, 0.0095; McMurdo Dry Valleys (MCM): NA, NA, NS; and Niwot Ridge Research Area (NWT): 0.0028, 0.1035, 0.0052. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

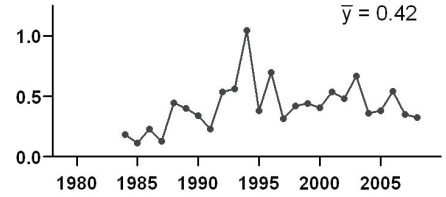
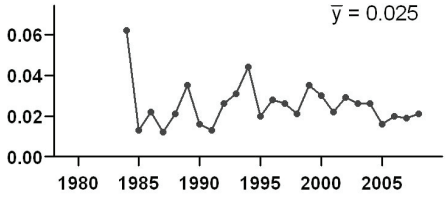
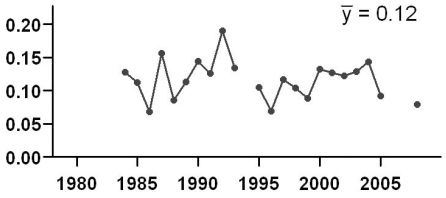
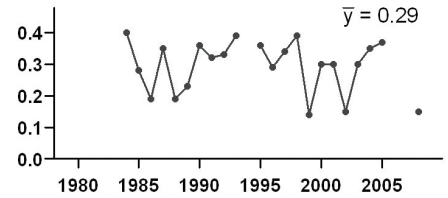
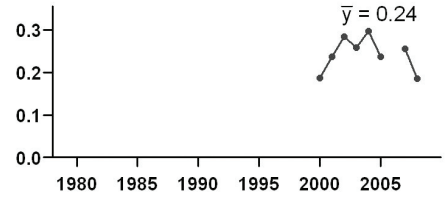
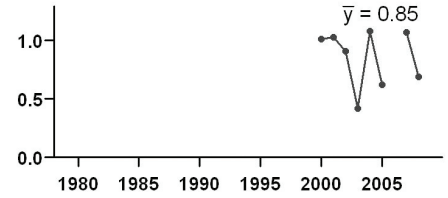
Site	Concentration of nitrate in precipitation (mg N/L)	Deposition of nitrate from precipitation (kg N/ha-yr)	Concentration of nitrate in surface water (mg N/L)
Jornada (JRN)			NA
Reynolds Creek Experimental Watershed (RCE)			NA
Walnut Gulch Experimental Watershed (WGE)			NA

Figure 12-3. Trends for each aridland site: nitrate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Jornada (JRN): NS, NS, NA; Reynolds Creek Experimental Watershed (RCE): NS, NS, NA; and Walnut Gulch Experimental Watershed (WGE): NS, NS, NA. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

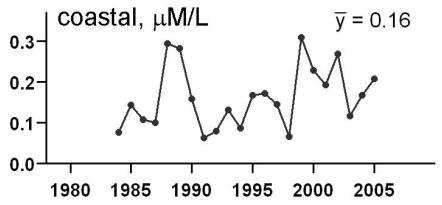
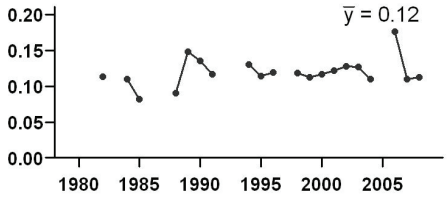
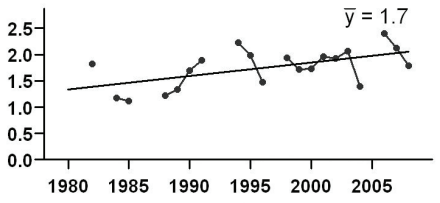
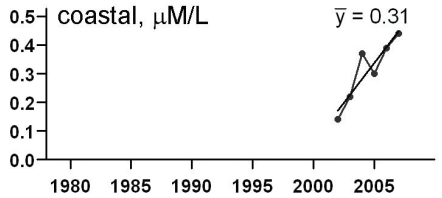
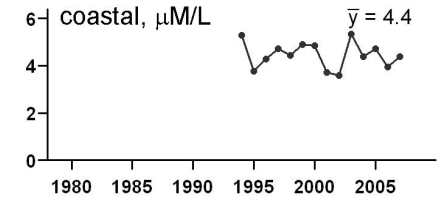
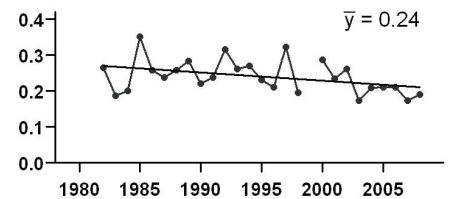
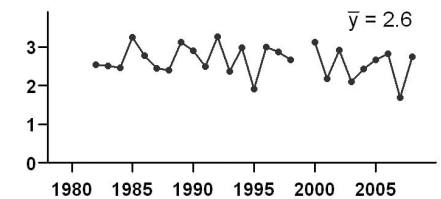
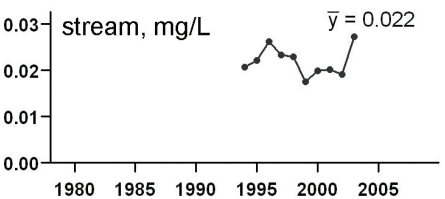
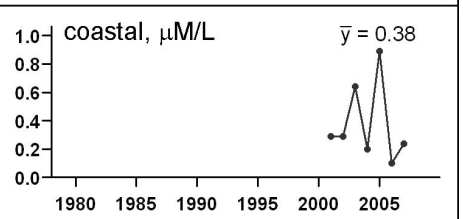
Site	Concentration of nitrate in precipitation (mg N/L)	Deposition of nitrate from precipitation (kg N/ha-yr)	Concentration of nitrate in surface water
California Current Ecosystem (CCE)	NA	NA	
Florida Coastal Everglades (FCE)			
Palmer Station, Antarctica (PAL)	NA	NA	
Plum Island Ecosystems (PIE)			
Santa Barbara Coastal (SBC)	NA	NA	

Figure 12-4 (coastal sites) continued next page.

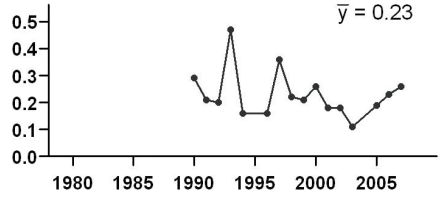
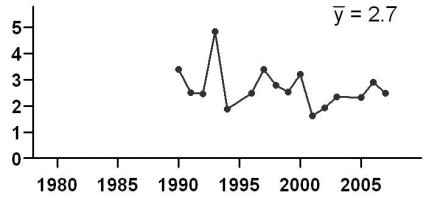
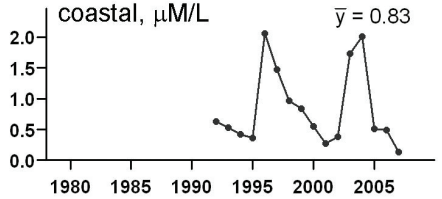
Site	Concentration of nitrate in precipitation (mg N/L)	Deposition of nitrate from precipitation (kg N/ha-yr)	Concentration of nitrate in surface water
Virginia Coast Reserve (VCR)			

Figure 12-4. Trends for each coastal site: nitrate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) California Current Ecosystem (CCE): NA, NA, NS; Florida Coastal Everglades (FCE): NS, 0.0259, 0.0554; Palmer Station, Antarctica (PAL): NA, NA, NS; Plum Island Ecosystems (PIE): -0.0022, NS, NS; Santa Barbara Coastal (SBC): NA, NA, NS; and Virginia Coast Reserve (VCR): NS, NS, NS. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

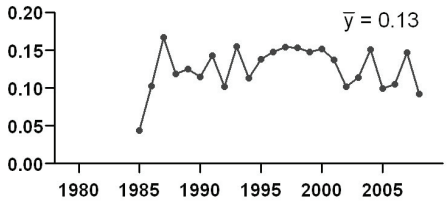
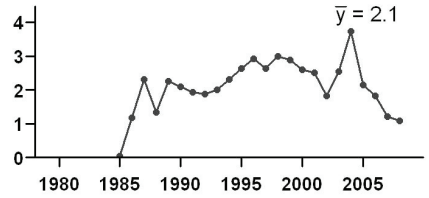
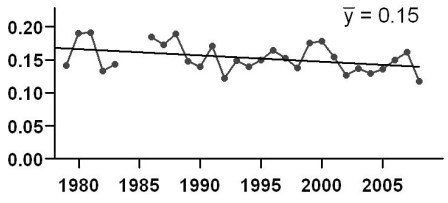
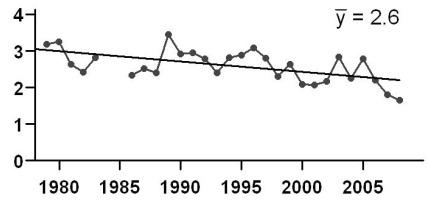
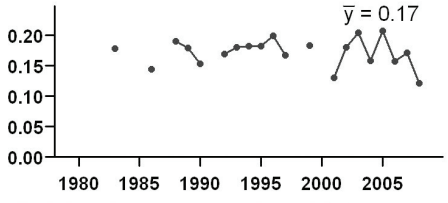
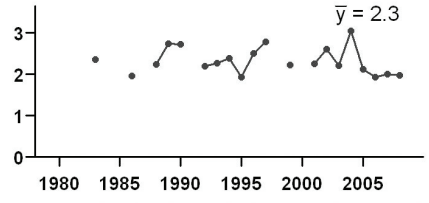
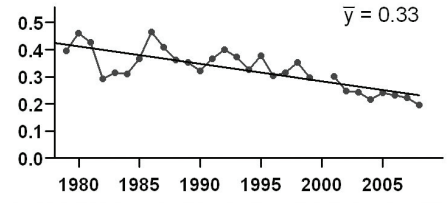
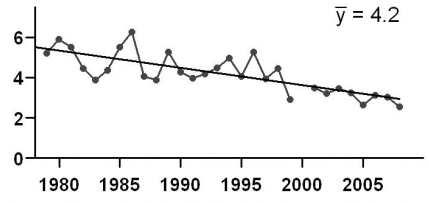
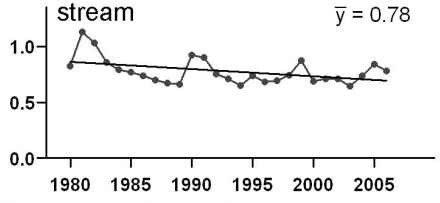
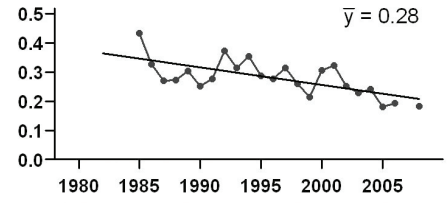
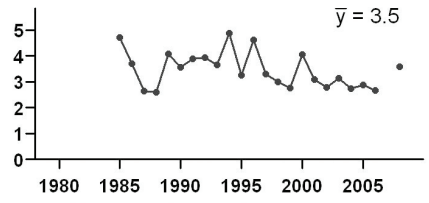
Site	Concentration of nitrate in precipitation (mg N/L)	Deposition of nitrate from precipitation (kg N/ha-yr)	Concentration of nitrate in surface water (mg N/L)
Bent Creek Experimental Forest (BEN)			NA
Coweeta (CWT)			NA
Crossett Experimental Forest (CRO)			NA
Fernow Experimental Forest (FER)			
Harvard Forest (HFR)			NA

Figure 12-5 (eastern forest sites) continued next page.

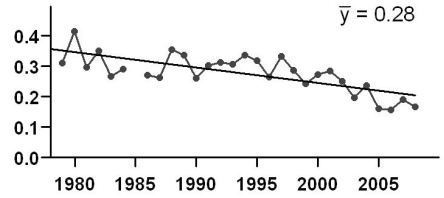
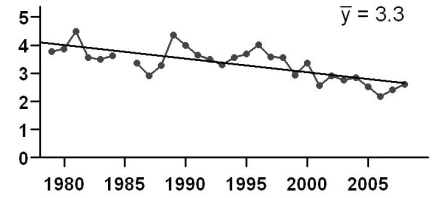
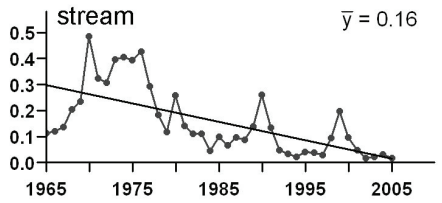
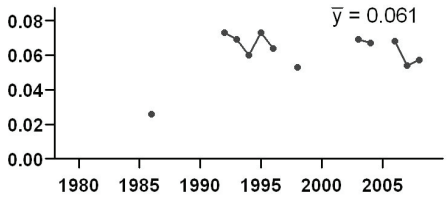
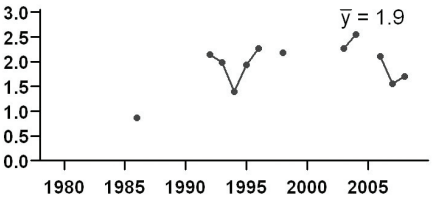
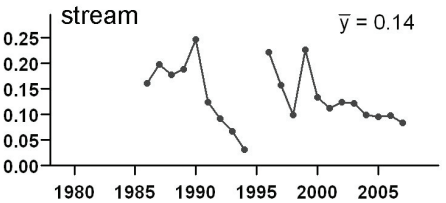
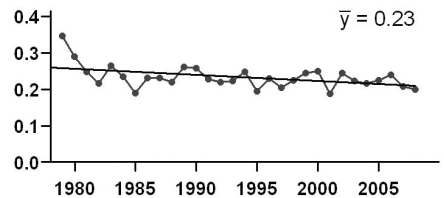
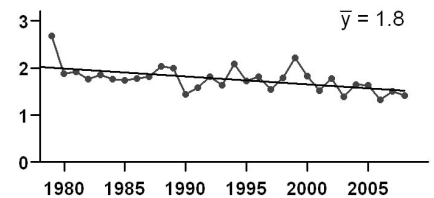
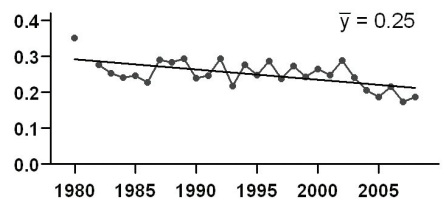
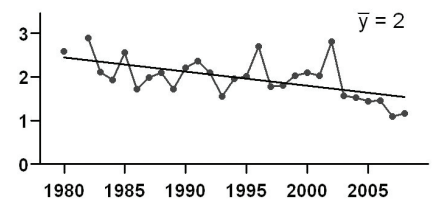
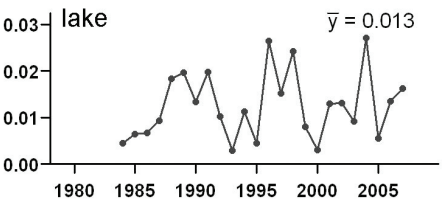
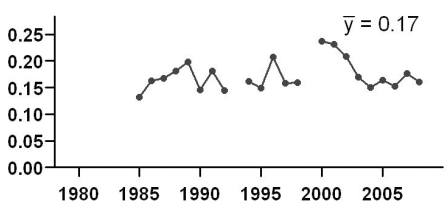
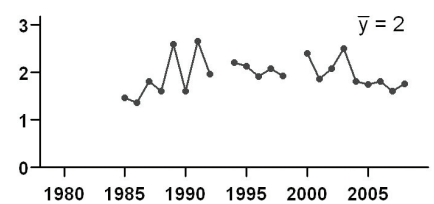
Site	Concentration of nitrate in precipitation (mg N/L)	Deposition of nitrate from precipitation (kg N/ha-yr)	Concentration of nitrate in surface water (mg N/L)
Hubbard Brook Ecosystem Study (HBR)			
Luquillo Experimental Forest (LUQ)			
Marcell Experimental Forest (MAR)			NA
North Temperate Lakes (NTL)			
Santee Experimental Forest (SAN)			NA

Figure 12-5 (eastern forest sites) continued next page.

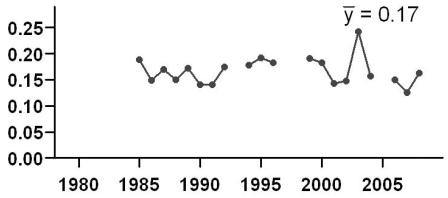
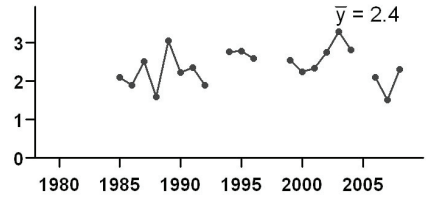
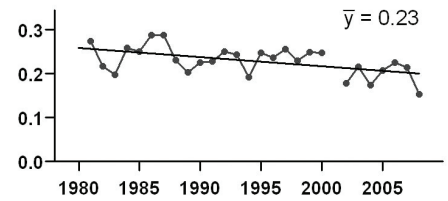
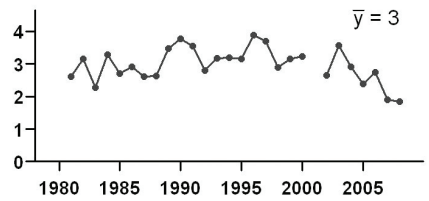
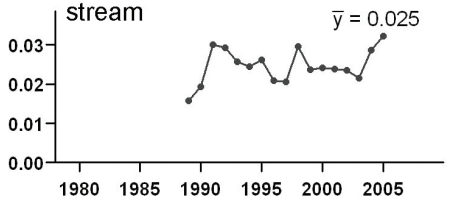
Site	Concentration of nitrate in precipitation (mg N/L)	Deposition of nitrate from precipitation (kg N/ha-yr)	Concentration of nitrate in surface water (mg N/L)
Tallahatchie Experimental Forest (TAL)			NA
Walker Branch Watershed (WBW)			

Figure 12-5. Trends for each eastern forest site: nitrate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Bent Creek Experimental Forest (BEN): NS, NS, NA; Crossett Experimental Forest (CRO): NS, NS, NA; Coweeta (CWT): -0.0010, -0.0282, NA; Fernow Experimental Forest (FER): -0.0064, -0.0857, -0.0064; Hubbard Brook Ecosystem Study (HBR): -0.0050, -0.0483, -0.0071; Harvard Forest (HFR): -0.0061, NS, NA; Luquillo Experimental Forest (LUQ): NS, NS, NS; Marcell Experimental Forest (MAR): -0.0017, -0.0170, NA; North Temperate Lakes (NTL): -0.0028, -0.0324, NS; Santee Experimental Forest (SAN): NS, NS, NA; Tallahatchie Experimental Forest (TAL): NS, NS, NA; and Walker Branch Watershed (WBW): -0.0021, NS, NS. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

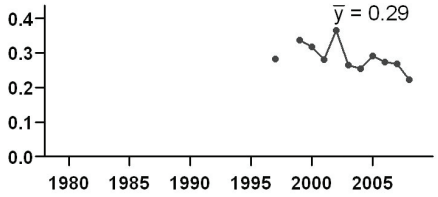
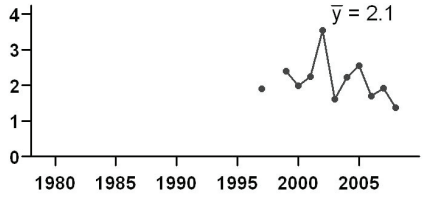
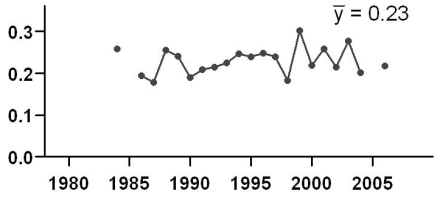
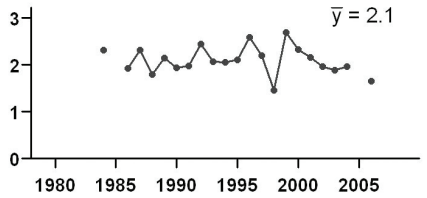
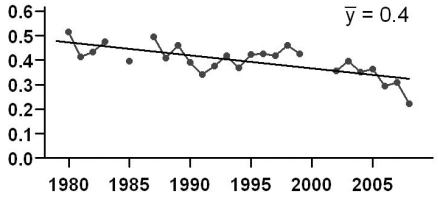
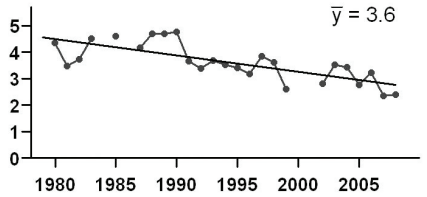
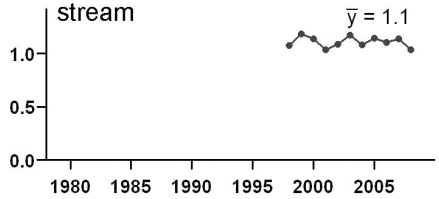
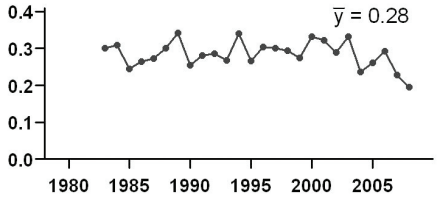
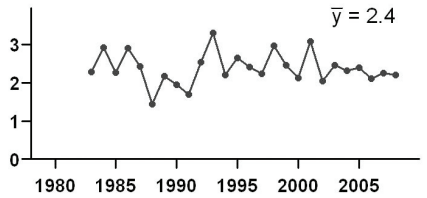
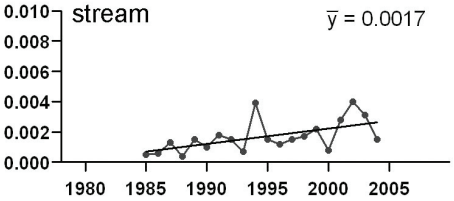
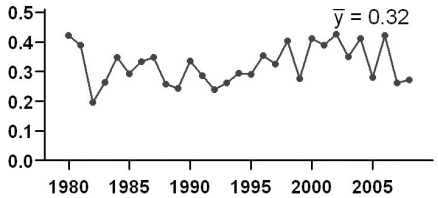
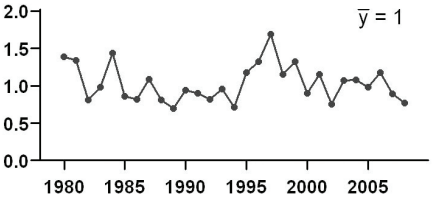
Site	Concentration of nitrate in precipitation (mg N/L)	Deposition of nitrate from precipitation (kg N/ha-yr)	Concentration of nitrate in surface water (mg N/L)
Cedar Creek Ecosystem Science Reserve (CDR)			NA
Grazinglands Research Laboratory (GRL)			NA
Kellogg Biological Station (KBS)			
Konza Prairie Biological Station (KNZ)			
Shortgrass Steppe (SGS)			NA

Figure 12-6. Trends for each temperate grassland and savanna site: nitrate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Cedar Creek Ecosystem Science Reserve (CDR): NS, NS, NA; Grazinglands Research Laboratory (GRL): NS, NS, NA; Kellogg Biological Station (KBS): -0.0053, -0.0620, NS; Konza Prairie Biological Station (KNZ): NS, NS, 0.0001; and Shortgrass Steppe (SGS): NS, NS, NA. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

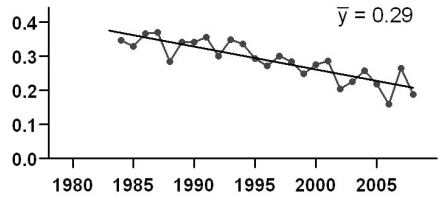
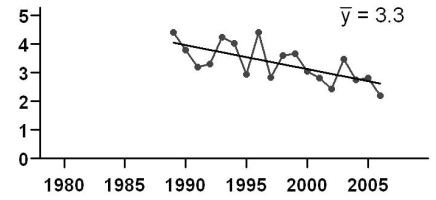
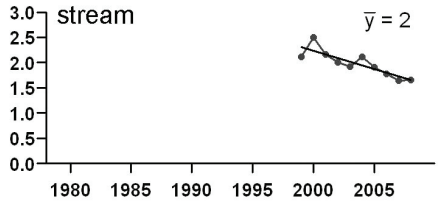
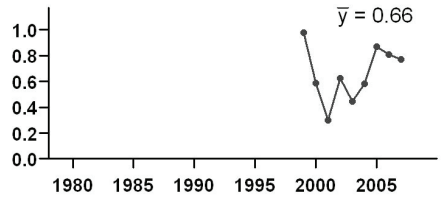
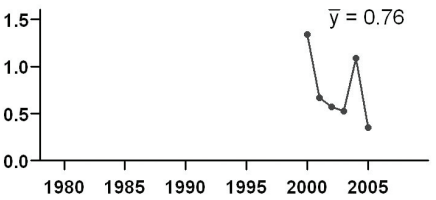
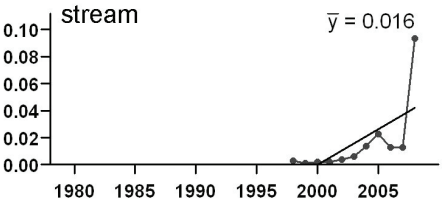
Site	Concentration of nitrate in precipitation (mg N/L)	Deposition of nitrate from precipitation (kg N/ha-yr)	Concentration of nitrate in surface water (mg N/L)
Baltimore Ecosystem Study (BES)			
Central Arizona-Phoenix (CAP)			

Figure 12-7. Trends for each urban site: nitrate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NS = not significant) Baltimore Ecosystem Study (BES): -0.0067, -0.0841, -0.0733 and Central Arizona-Phoenix (CAP): NS, NS, 0.0053. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

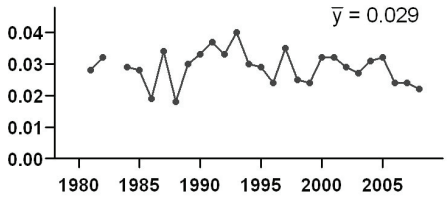
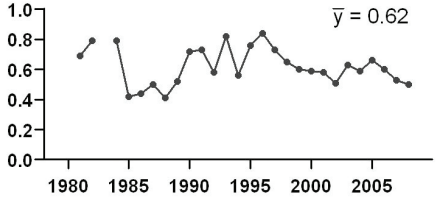
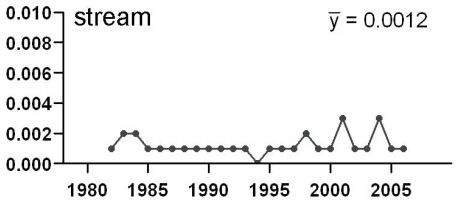
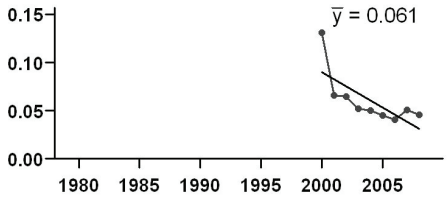
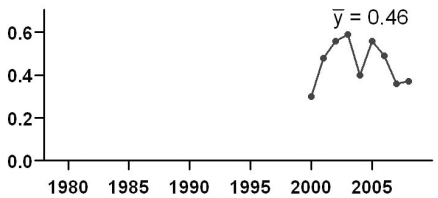
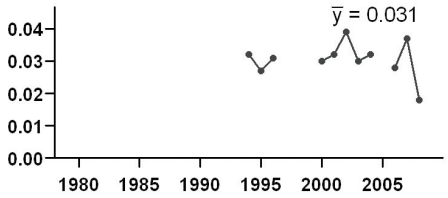
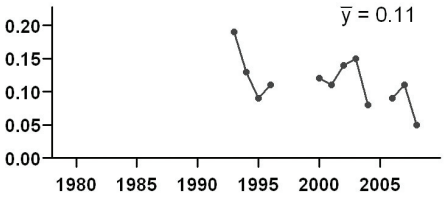
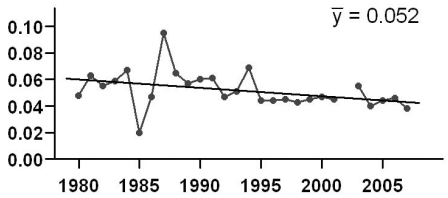
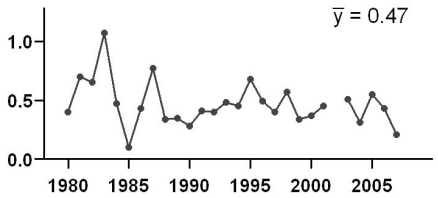
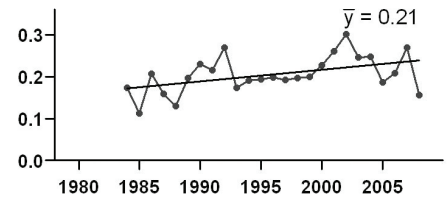
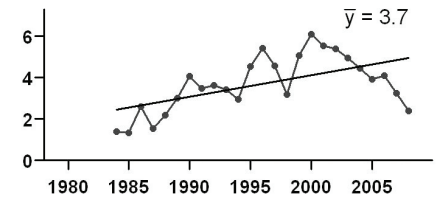
Site	Concentration of nitrate in precipitation (mg N/L)	Deposition of nitrate from precipitation (kg N/ha-yr)	Concentration of nitrate in surface water (mg N/L)
Andrews Experimental Forest (AND)			
Blacks Mountain Experimental Forest (BLA)			NA
Bonanza Creek Experimental Forest (BNZ)			NA
Caspar Creek Experimental Watershed (CSP)			NA
Fraser Experimental Forest (FRA)			NA

Figure 12-8 (western forest sites) continued next page.

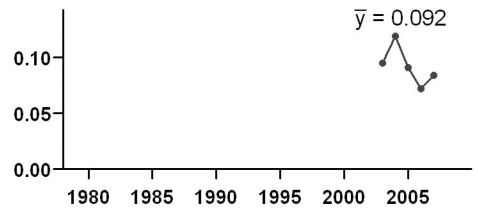
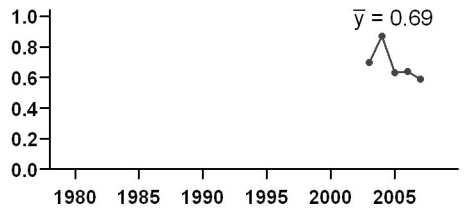
Site	Concentration of nitrate in precipitation (mg N/L)	Deposition of nitrate from precipitation (kg N/ha-yr)	Concentration of nitrate in surface water (mg N/L)
Priest River Experimental Forest (PRI)			NA

Figure 12-8. Trends for each western forest site: nitrate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) H.J. Andrews Experimental Forest (AND): NS, NS, NS; Blacks Mountain Experimental Forest (BLA): -0.0073, NS, NA; Bonanza Creek Experimental Forest (BNZ): NS, NS, NA; Caspar Creek Experimental Watershed (CSP): -0.0006, NS, NA; Fraser Experimental Forest (FRA): 0.0028, 0.1035, NA; and Priest River Experimental Forest (PRI): NS, NS, NA. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

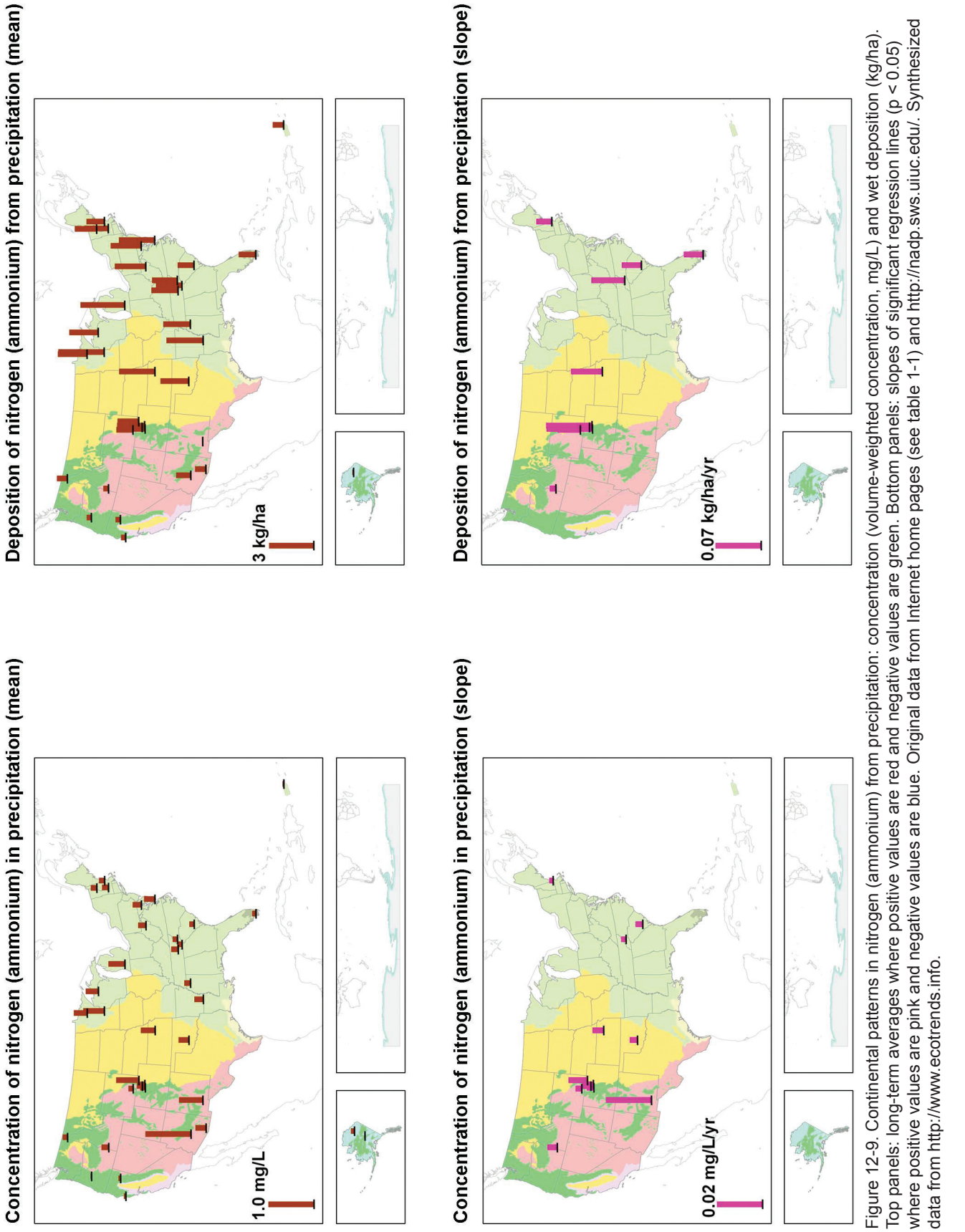


Figure 12-9. Continental patterns in nitrogen (ammonium) from precipitation: concentration (volume-weighted concentration, mg/L) and wet deposition (kg/ha). Top panels: long-term averages where positive values are red and negative values are green. Bottom panels: slopes of significant regression lines ($p < 0.05$) where positive values are pink and negative values are blue. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

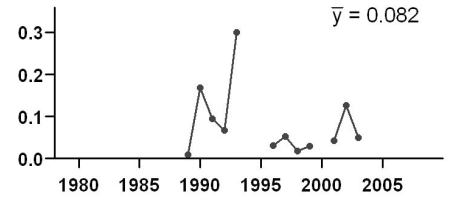
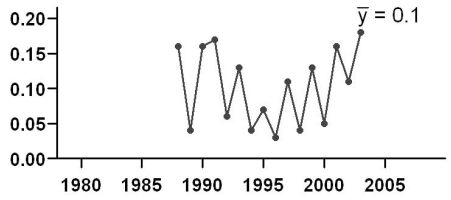
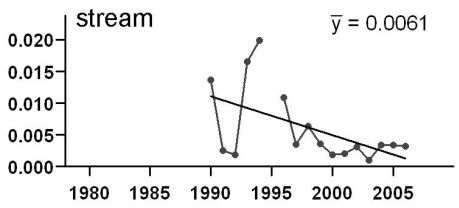
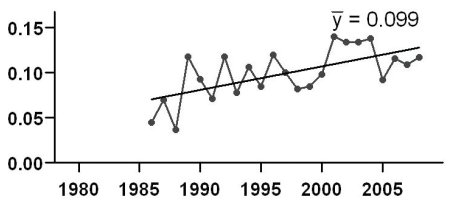
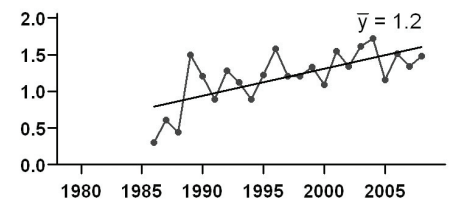
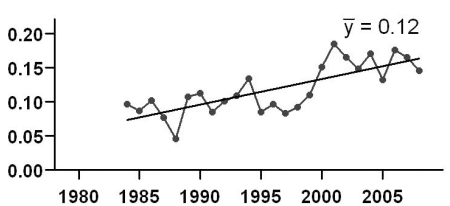
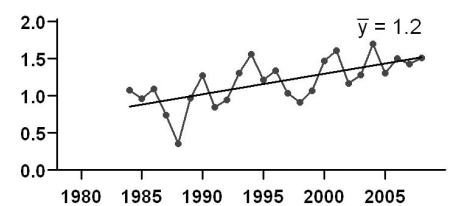
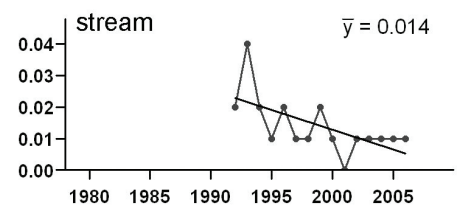
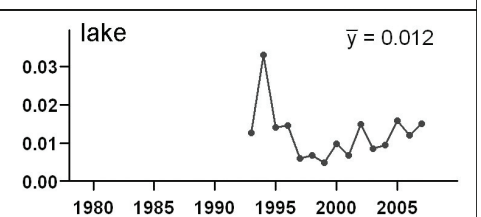
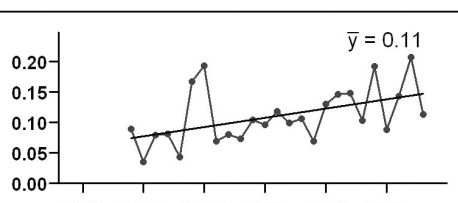
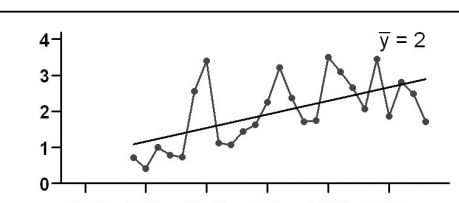
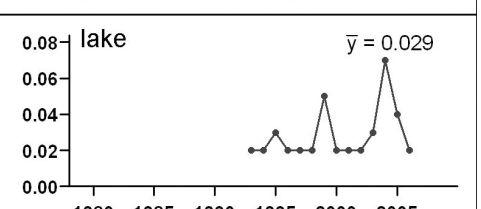
Site	Concentration of ammonium in precipitation (mg N/L)	Deposition of ammonium from precipitation (kg N/ha-yr)	Concentration of ammonium in surface water (mg N/L)
Arctic (ARC)			
Glacier Lakes (GLA)			NA
Loch Vale Watershed (LVW)			
McMurdo Dry Valleys (MCM)	NA	NA	
Niwot Ridge Research Area (NWT)			

Figure 12-10. Trends for each alpine and arctic site: ammonium concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Arctic (ARC): NS, NS, -0.0006); Glacier Lakes (GLA): 0.0026, 0.0371, NA; Loch Vale Watershed (LVW): 0.0038, 0.0273, -0.0013; McMurdo Dry Valleys (MCM): NA, NA, NS; and Niwot Range Research Area (NWT): 0.0030, 0.0748, NS. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

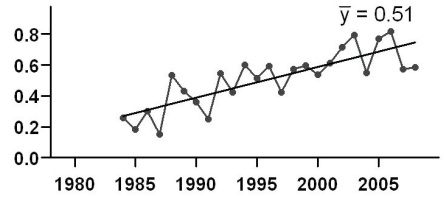
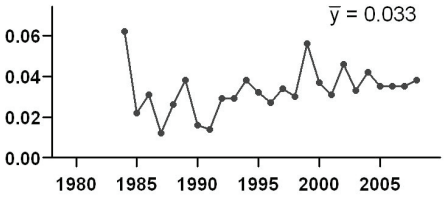
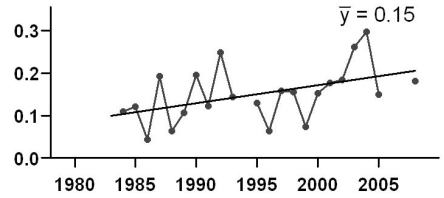
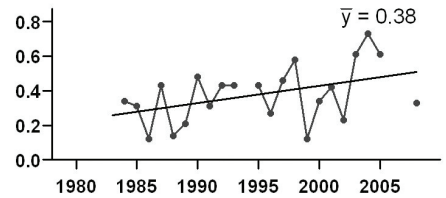
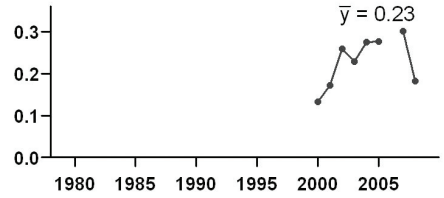
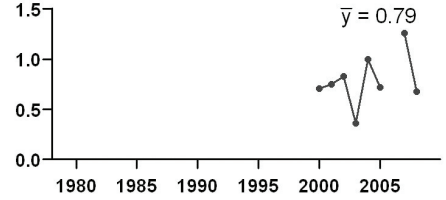
Site	Concentration of ammonium in precipitation (mg N/L)	Deposition of ammonium from precipitation (kg N/ha-yr)	Concentration of ammonium in surface water (mg N/L)
Jornada (JRN)			NA
Reynolds Creek Experimental Watershed (RCE)			NA
Walnut Gulch Experimental Watershed (WGE)			NA

Figure 12-11. Trends for each aridland site: ammonium concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Jornada (JRN): 0.0199, NS, NA; Reynolds Creek Experimental Watershed (RCE): 0.0042, 0.0100, NA; and Walnut Gulch Experimental Watershed (WGE): NS, NS, NA. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

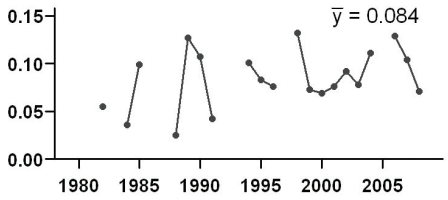
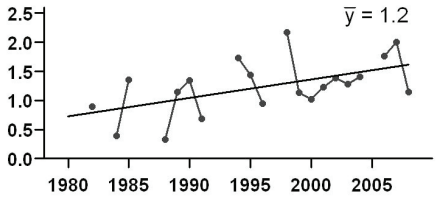
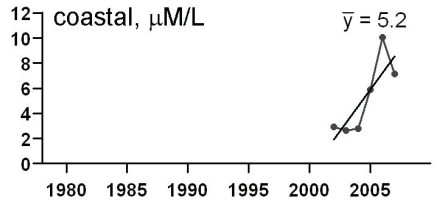
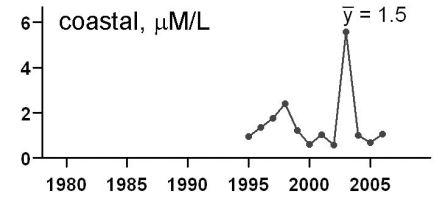
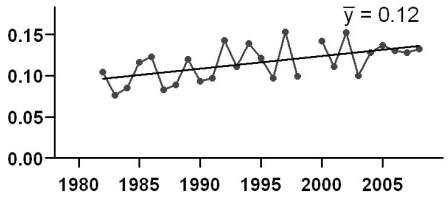
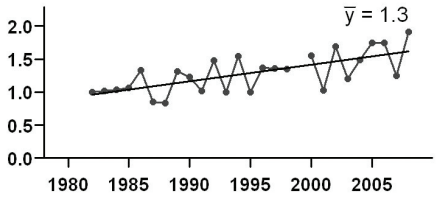
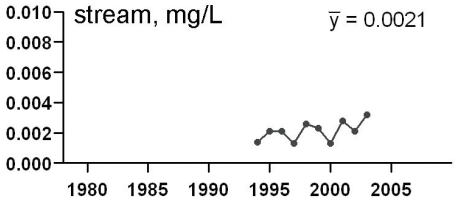
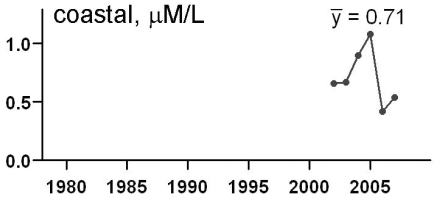
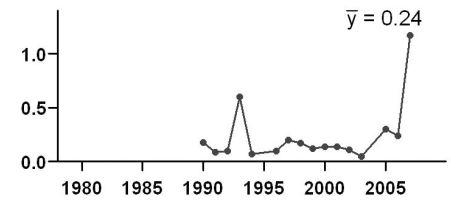
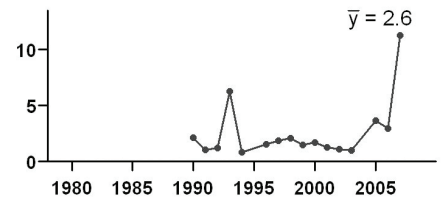
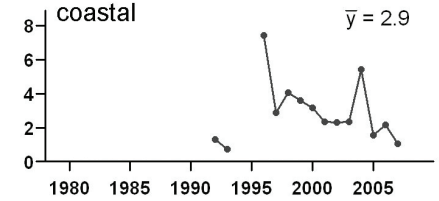
Site	Concentration of ammonium in precipitation (mg N/L)	Deposition of ammonium from precipitation (kg N/ha-yr)	Concentration of ammonium in surface water
Florida Coastal Everglades (FCE)			
Palmer Station, Antarctica (PAL)	NA	NA	
Plum Island Ecosystems (PIE)			
Santa Barbara Coastal (SBC)	NA	NA	
Virginia Coast Reserve (VCR)			

Figure 12-12. Trends for each coastal site: ammonium concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Florida Coastal Everglades (FCE): NS, 0.0317, 1.3249; Palmer Station, Antarctica (PAL): NA, NA, NS; Plum Island Ecosystems (PIE): 0.0015, 0.0250, NS; Santa Barbara Coastal (SBC): NA, NA, NS; and Virginia Coast Reserve (VCR): NS, NS, NS. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

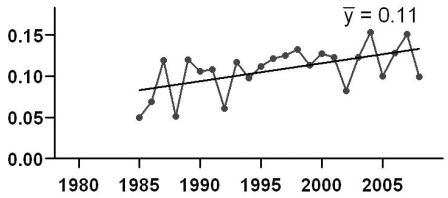
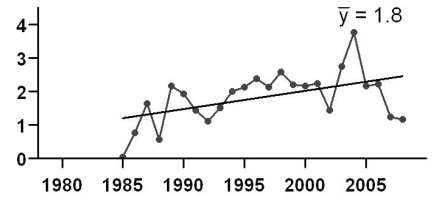
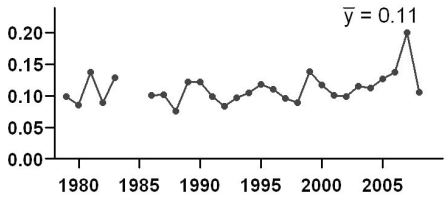
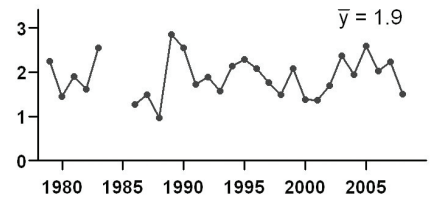
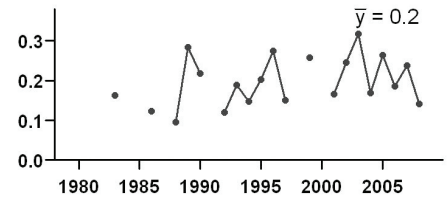
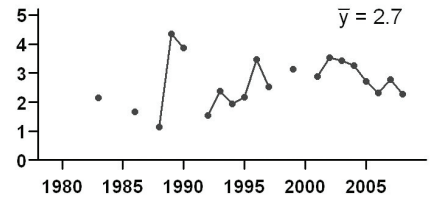
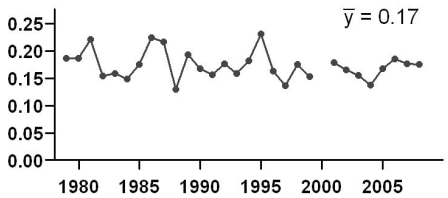
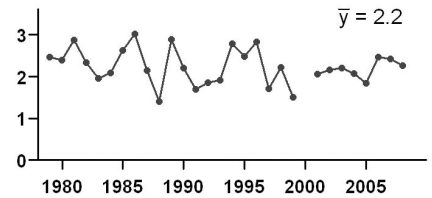
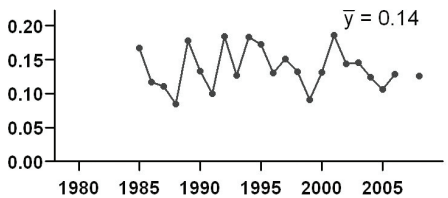
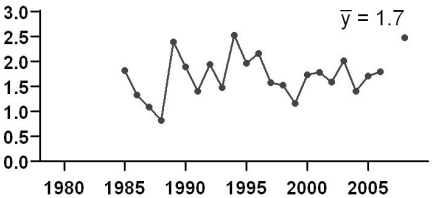
Site	Concentration of ammonium in precipitation (mg N/L)	Deposition of ammonium from precipitation (kg N/ha-yr)	Concentration of ammonium in surface water (mg N/L)
Bent Creek Experimental Forest (BEN)			NA
Coweeta (CWT)			NA
Crossett Experimental Forest (CRO)			NA
Fernow Experimental Forest (FER)			NA
Harvard Forest (HFR)			NA

Figure 12-13 (eastern forest sites) continued next page.

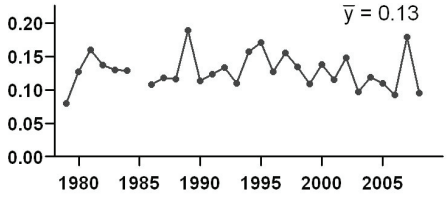
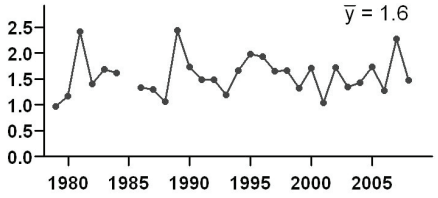
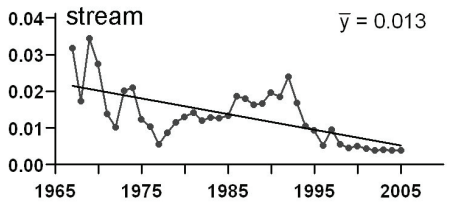
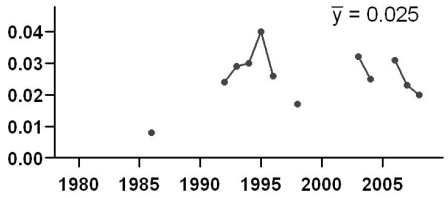
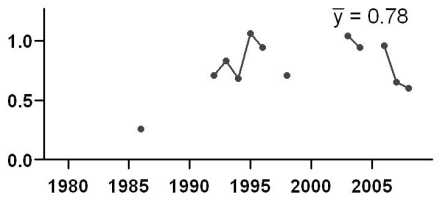
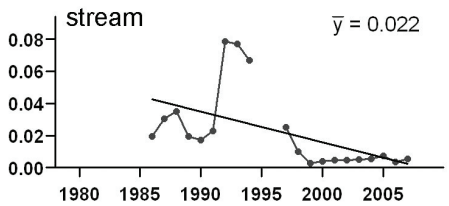
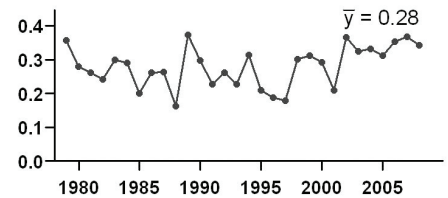
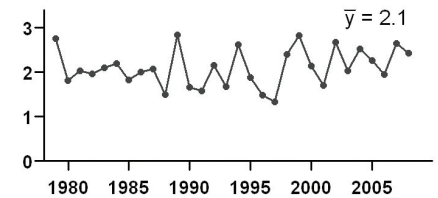
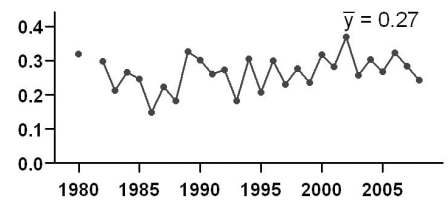
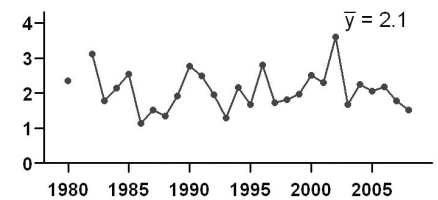
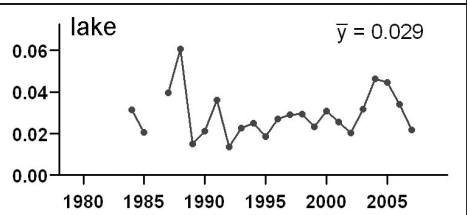
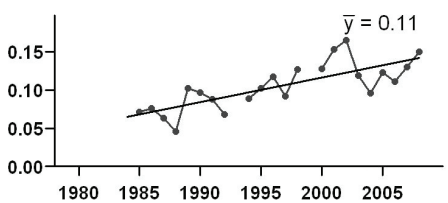
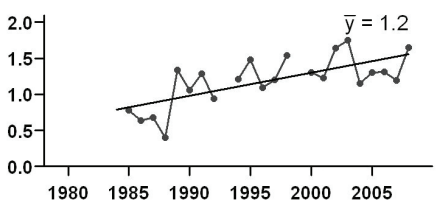
Site	Concentration of ammonium in precipitation (mg N/L)	Deposition of ammonium from precipitation (kg N/ha-yr)	Concentration of ammonium in surface water (mg N/L)
Hubbard Brook Ecosystem Study (HBR)			
Luquillo Experimental Forest (LUQ)			
Marcell Experimental Forest (MAR)			NA
North Temperate Lakes (NTL)			
Santee Experimental Forest (SAN)			NA

Figure 12-13 (eastern forest sites) continued next page.

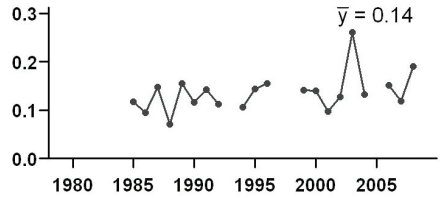
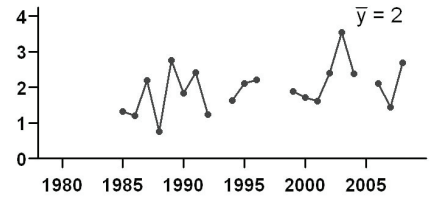
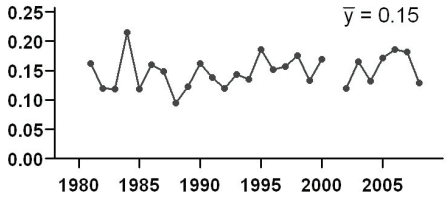
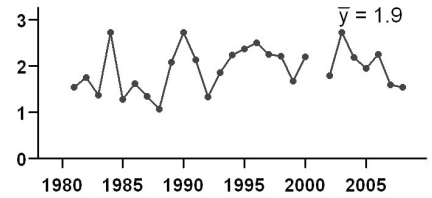
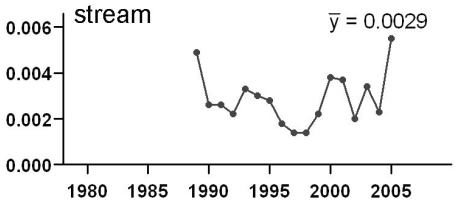
Site	Concentration of ammonium in precipitation (mg N/L)	Deposition of ammonium from precipitation (kg N/ha-yr)	Concentration of ammonium in surface water (mg N/L)
Tallahatchie Experimental Forest (TAL)			NA
Walker Branch Watershed (WBW)			

Figure 12-13. Trends for each eastern forest site: ammonium concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Bent Creek Experimental Forest (BEN): 0.0022, 0.0545, NA; Crossett Experimental Forest (CRO): NS, NS, NA; Coweeta (CWT): NS, NS, NA; Fernow Experimental Forest (FER): NS, NS, NA; Hubbard Brook Ecosystem Study (HBR): NS, NS, -0.0004; Harvard Forest (HFR): NS, NS, NA; Luquillo Experimental Forest (LUQ): NS, NS, -0.0019; Marcell Experimental Forest (MAR): NS, NS, NA; North Temperate Lakes (NTL): NS, NS, NS; Santee Experimental Forest (SAN): 0.0032, 0.0320, NA; Tallahatchie Experimental Forest (TAL): NS, NS, NA; and Walker Branch Watershed (WBW): NS, NS, NS. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

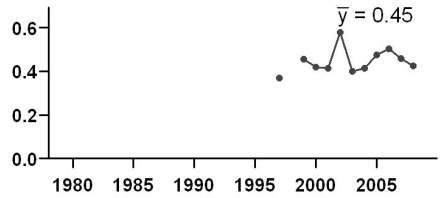
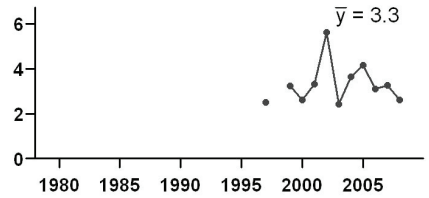
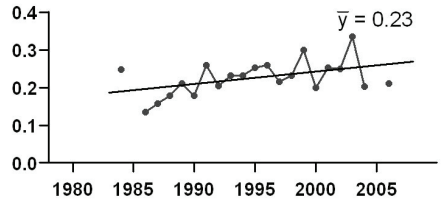
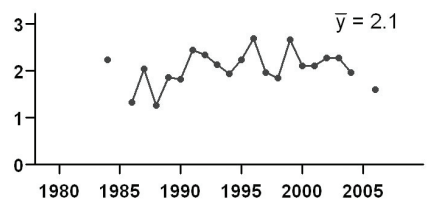
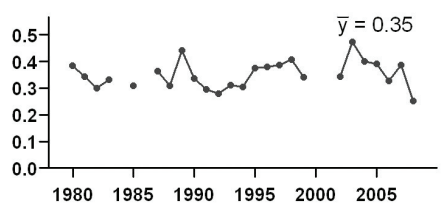
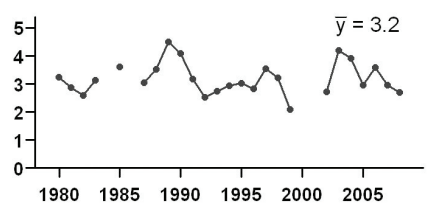
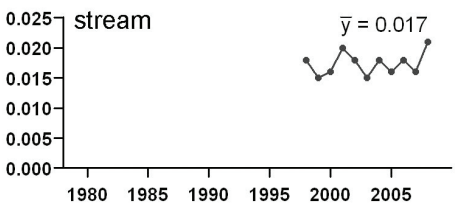
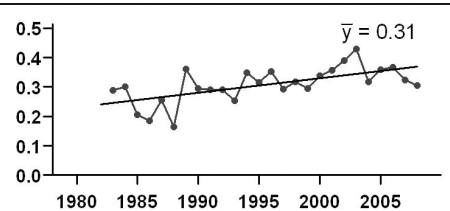
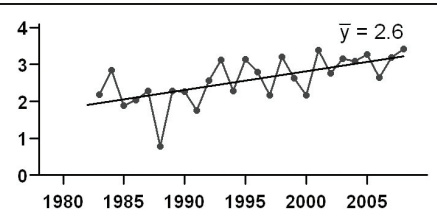
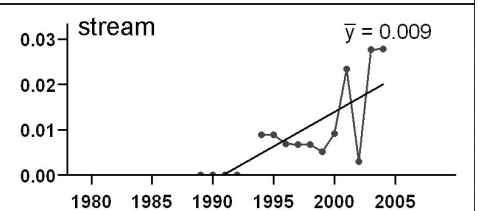
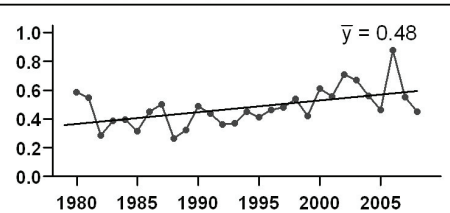
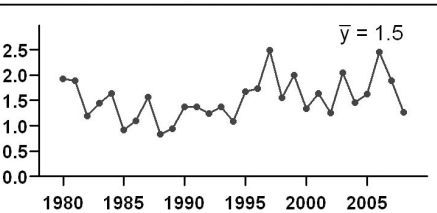
Site	Concentration of ammonium in precipitation (mg N/L)	Deposition of ammonium from precipitation (kg N/ha-yr)	Concentration of ammonium in surface water (mg N/L)
Cedar Creek Ecosystem Science Reserve (CDR)			NA
Grazinglands Research Laboratory (GRL)			NA
Kellogg Biological Station (KBS)			
Konza Prairie Biological Station (KNZ)			
Shortgrass Steppe (SGS)			NA

Figure 12-14. Trends for each temperate grassland and savanna site: ammonium concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Cedar Creek Ecosystem Science Reserve (CDR): NS, NS, NA; Grazinglands Research Laboratory (GRL): 0.0033, NS, NA; Kellogg Biological Station (KBS): NS, NS, NS; Kona Prairie Biological Station (KNZ): 0.0049, 0.0511, 0.0015; and Shortgrass Steppe (SGS): 0.0081, NS, NA. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

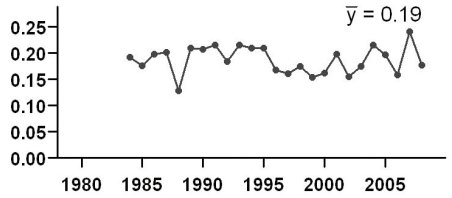
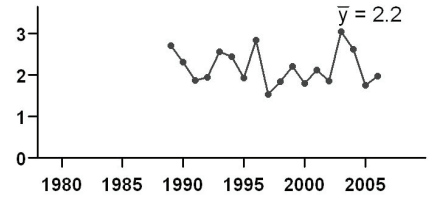
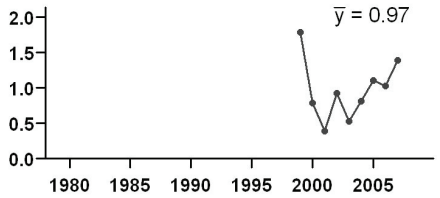
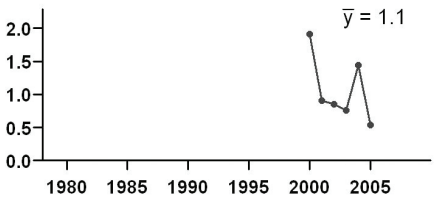
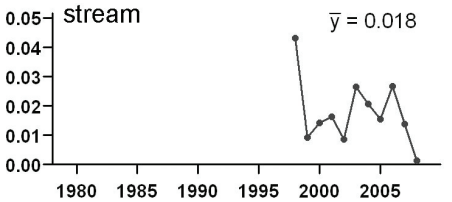
Site	Concentration of ammonium in precipitation (mg N/L)	Deposition of ammonium from precipitation (kg N/ha-yr)	Concentration of ammonium in surface water (mg N/L)
Baltimore Ecosystem Study (BES)			NA
Central Arizona-Phoenix (CAP)			

Figure 12-15. Trends for each urban site: ammonium concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Baltimore Ecosystem Study (BES): NS, NS, NA and Caspar Creek Experimental Watershed (CAP): NS, NS, NS. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

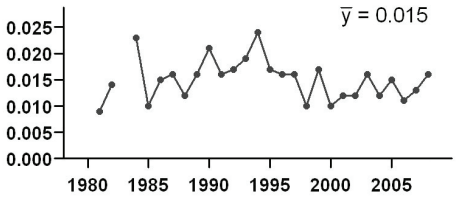
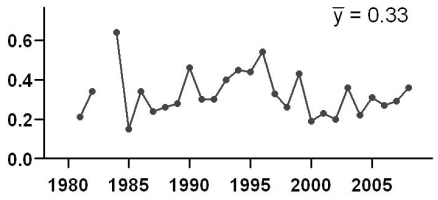
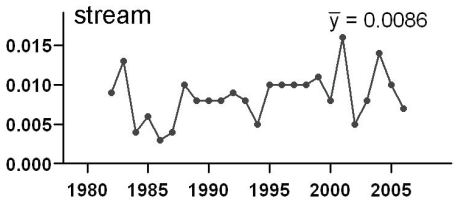
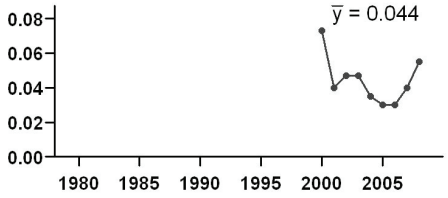
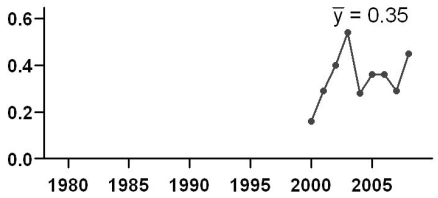
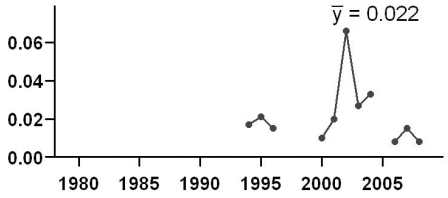
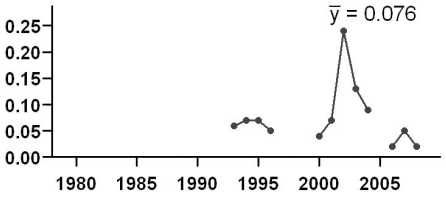
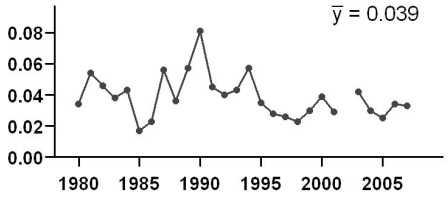
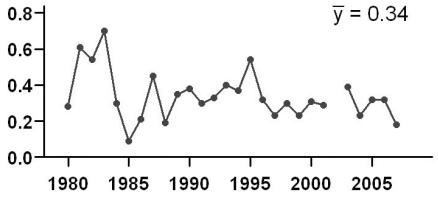
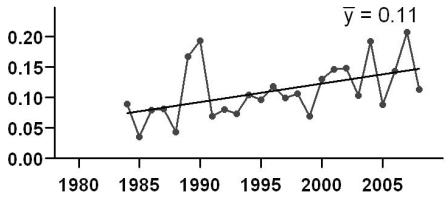
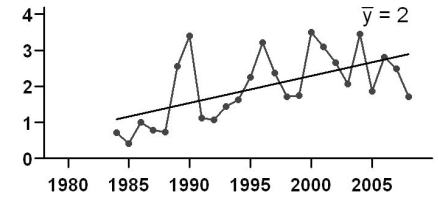
Site	Concentration of ammonium in precipitation (mg N/L)	Deposition of ammonium from precipitation (kg N/ha-yr)	Concentration of ammonium in surface water (mg N/L)
Andrews Experimental Forest (AND)			
Blacks Mountain Experimental Forest (BLA)			NA
Bonanza Creek Experimental Forest (BNZ)			NA
Caspar Creek Experimental Watershed (CSP)			NA
Fraser Experimental Forest (FRA)			NA

Figure 12-16 (western forest sites) continued next page.

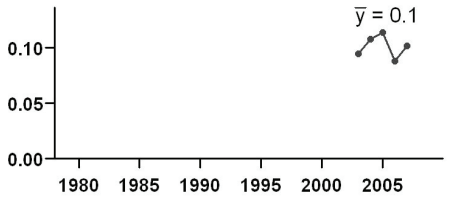
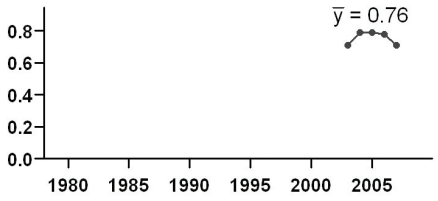
Site	Concentration of ammonium in precipitation (mg N/L)	Deposition of ammonium from precipitation (kg N/ha-yr)	Concentration of ammonium in surface water (mg N/L)
Priest River Experimental Forest (PRI)			NA

Figure 12-16. Trends for each western forest site: ammonium concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) H.J. Andrews Experimental Forest (AND): NS, NS, NS; Blacks Mountain Experimental Forest (BLA): NS, NS, NA; Bonanza Creek Experimental Forest (BNZ): NS, NS, NA; Caspar Creek Experimental Watershed (CSP): NS, NS, NA; Fraser Experimental Forest (FRA): 0.0030, 0.0748, NA; and Priest River Experimental Forest (PRI): NS, NS, NA. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

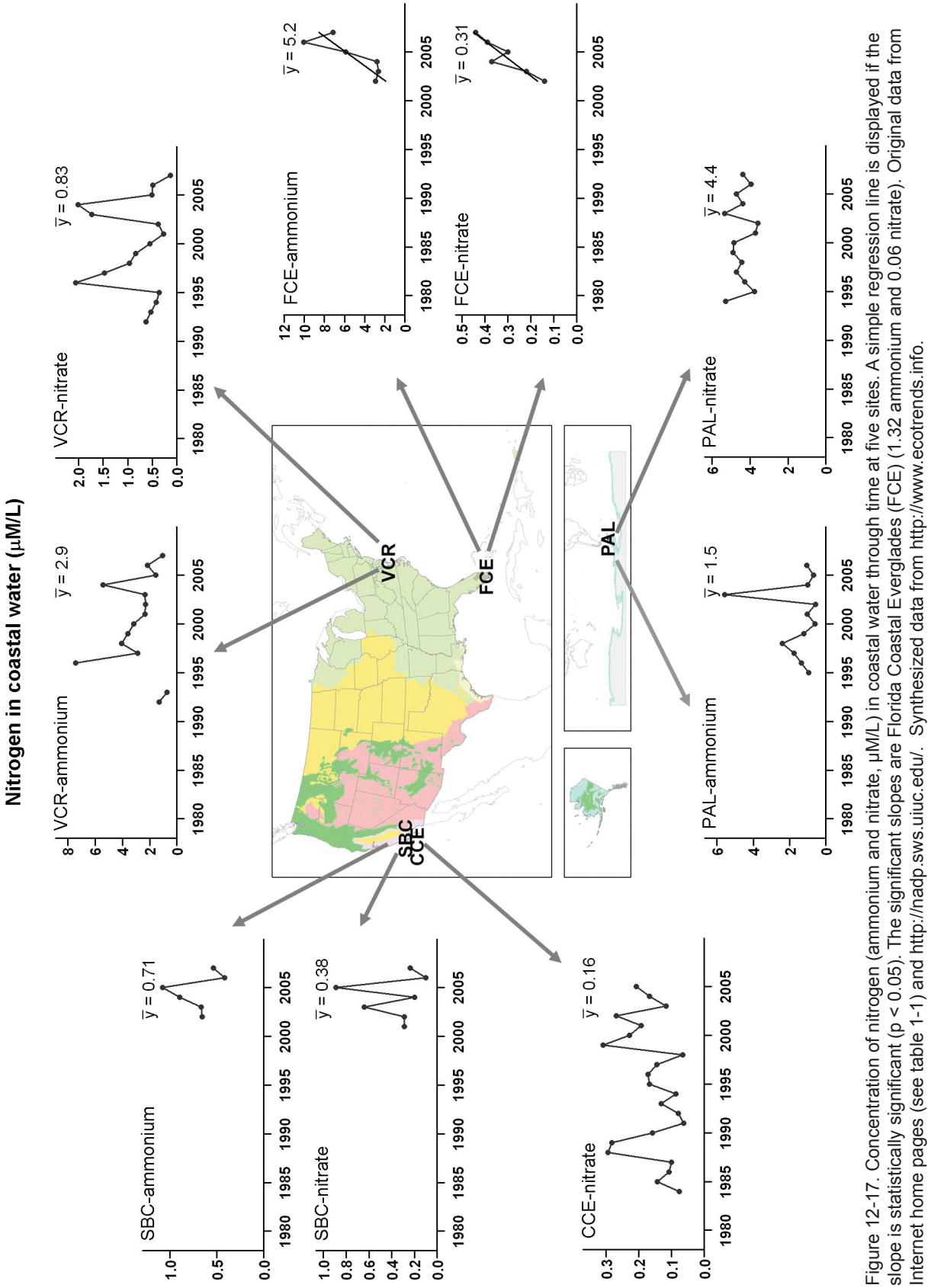


Figure 12-17. Concentration of nitrogen (ammonium and nitrate, µM/L) in coastal water through time at five sites. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The significant slopes are Florida Coastal Everglades (FCE) (1.32 ammonium and 0.06 nitrate). Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

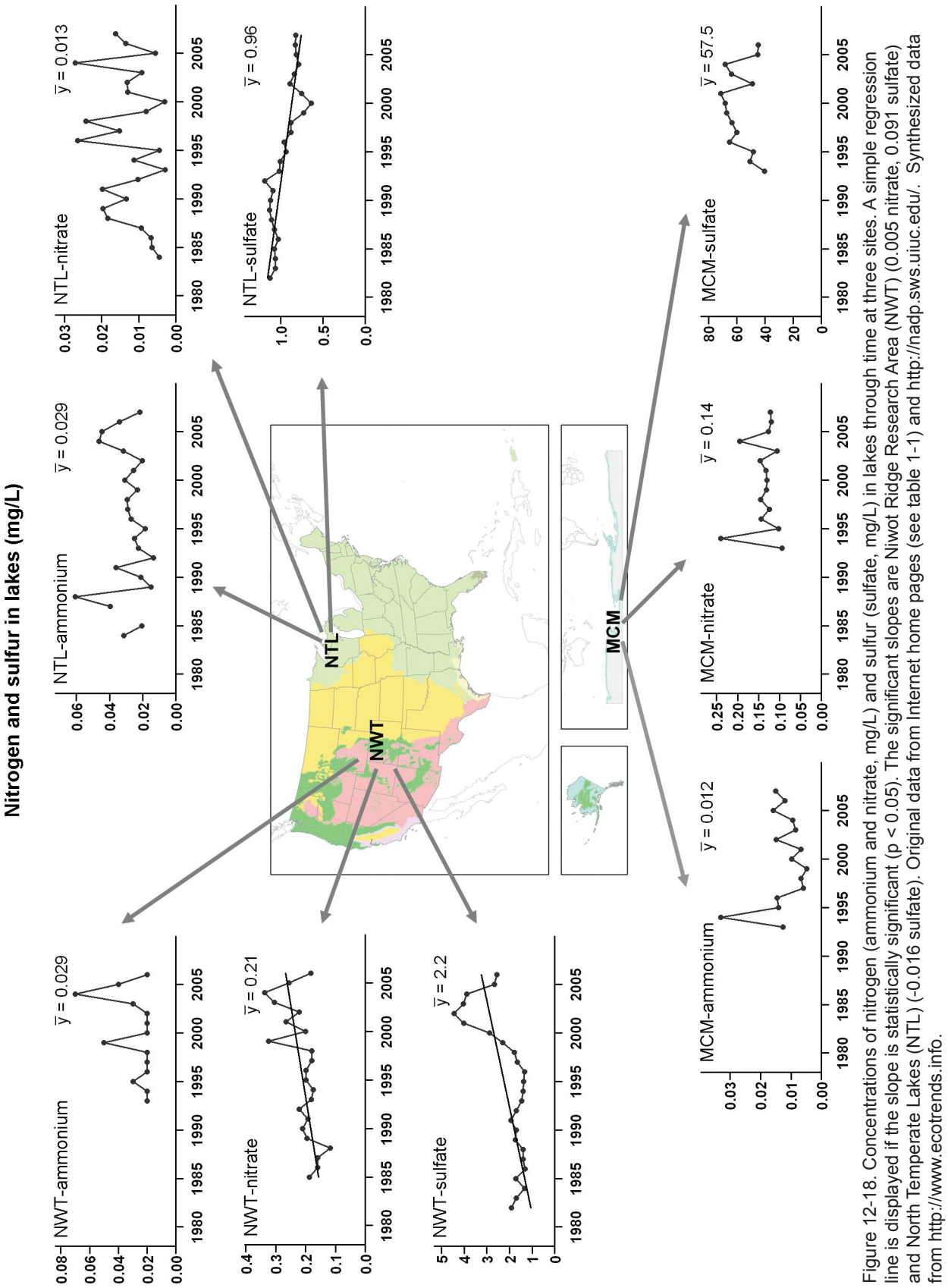


Figure 12-18. Concentrations of nitrogen (ammonium and nitrate, mg/L) and sulfur (sulfate, mg/L) in lakes through time at three sites. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The significant slopes are Niwot Ridge Research Area (NWT) (0.005 nitrate, 0.091 sulfate) and North Temperate Lakes (NTL) (-0.016 sulfate). Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

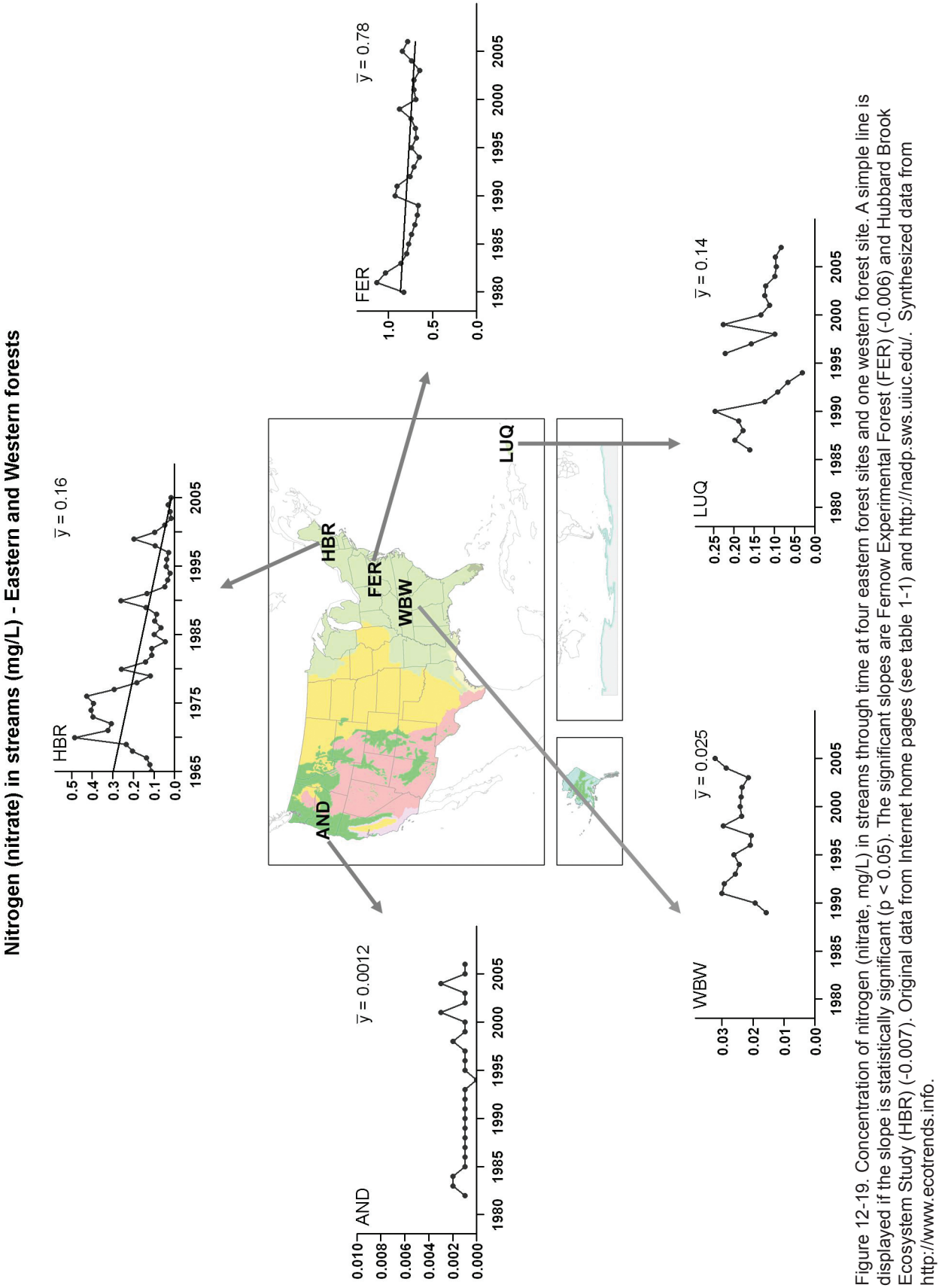


Figure 12-19. Concentration of nitrogen (nitrate, mg/L) in streams through time at four eastern forest sites and one western forest site. A simple line is displayed if the slope is statistically significant ($p < 0.05$). The significant slopes are Fernow Experimental Forest (FER) (-0.006) and Hubbard Brook Ecosystem Study (HBR) (-0.007). Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

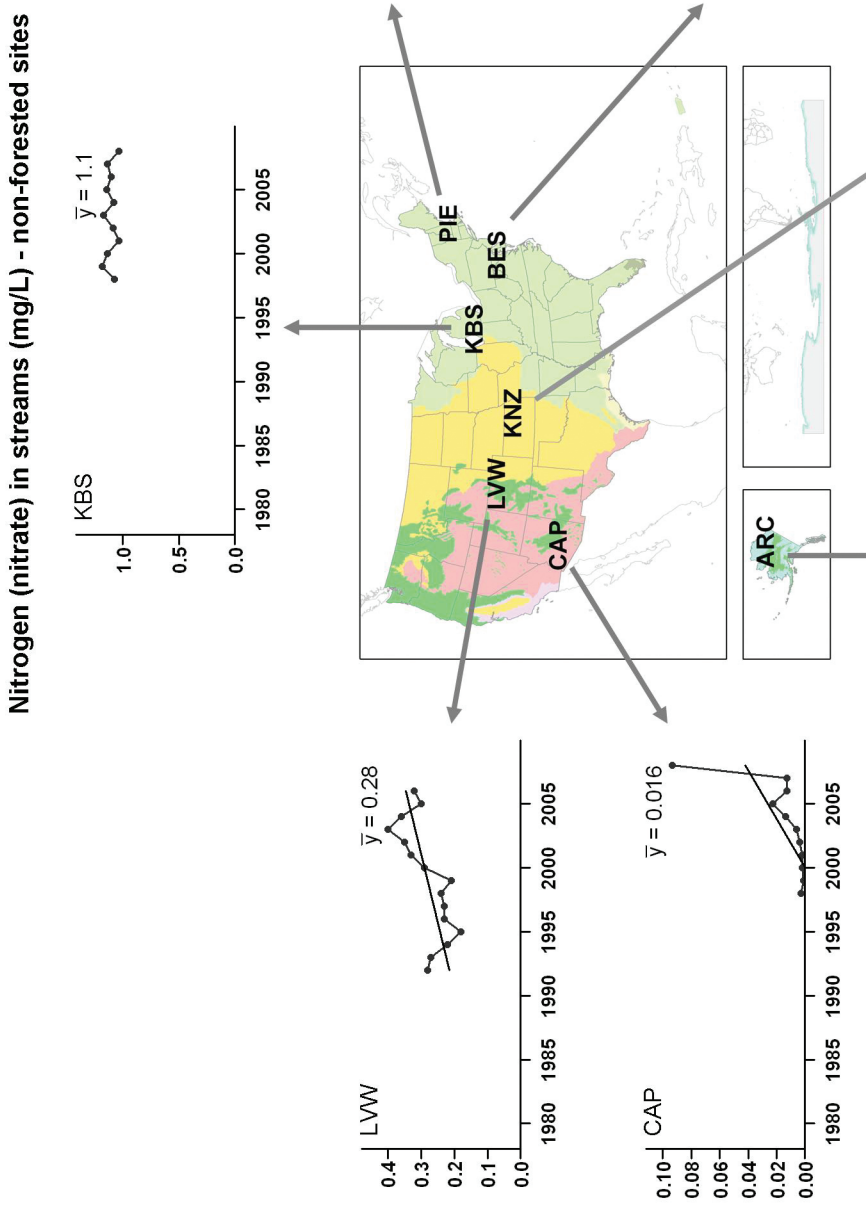


Figure 12-20. Concentration of nitrogen (nitrate, mg/L) in streams through time at seven nonforested sites. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The significant slopes are Arctic (ARC) (0.0030), Baltimore Ecosystem Study (BES) (-0.0733), Central Arizona-Phoenix (CAP) (0.0053), Konza Prairie Biological Station (KNZ) (0.0001), and Loch Vale Watershed (LVW) (0.0095). Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

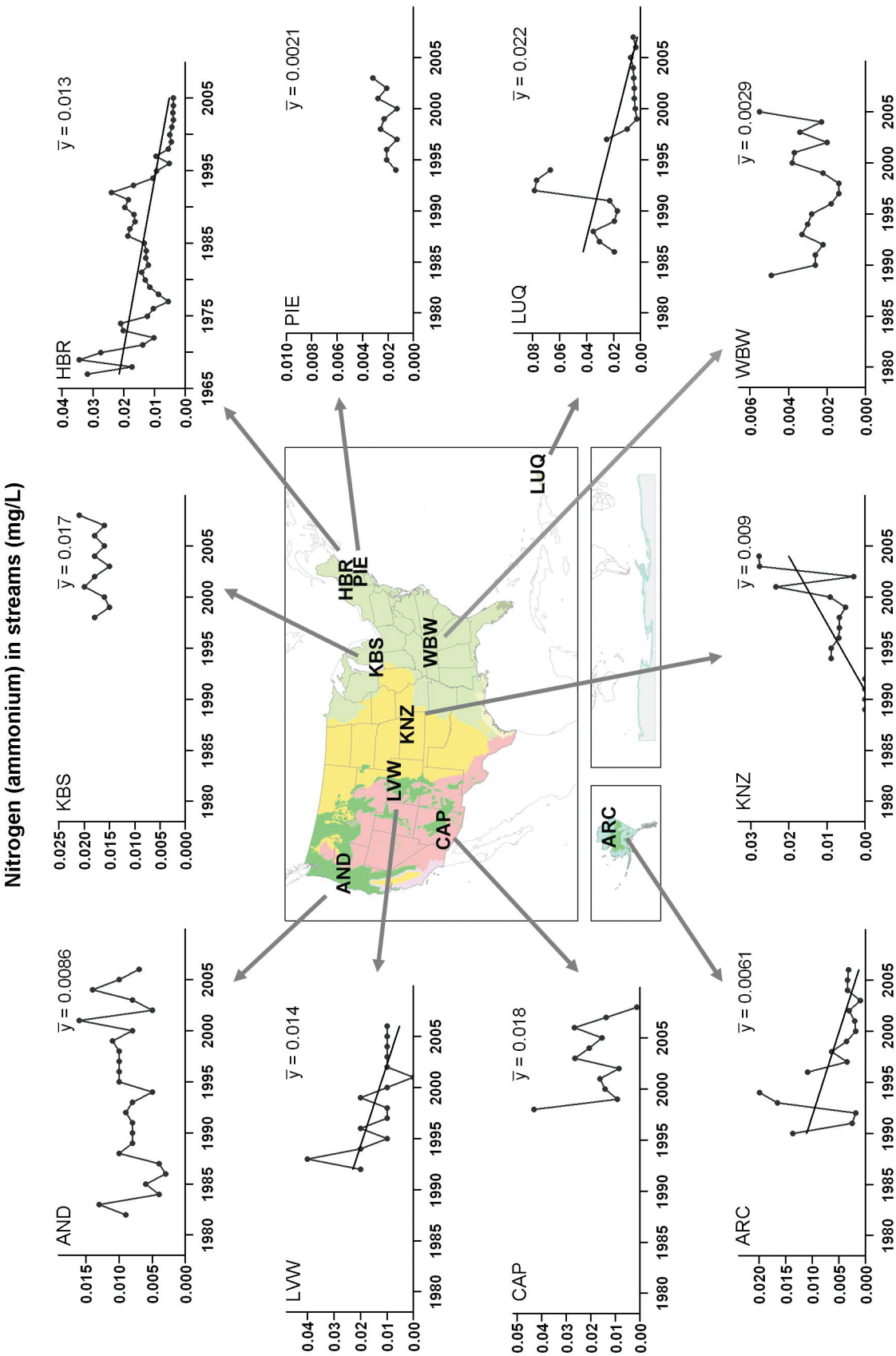


Figure 12-21. Concentration of nitrogen (ammonium, mg/L) in streams through time at ten sites. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The significant slopes are Arctic (ARC) (-0.0006), Hubbard Brook Ecosystem Study (HBR) (-0.0004), Konza Prairie Biological Station (KNZ) (0.0015), Luquillo Experimental Forest (LUQ) (-0.0019), and Loch Vale Watershed (LVW) (-0.0013). Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

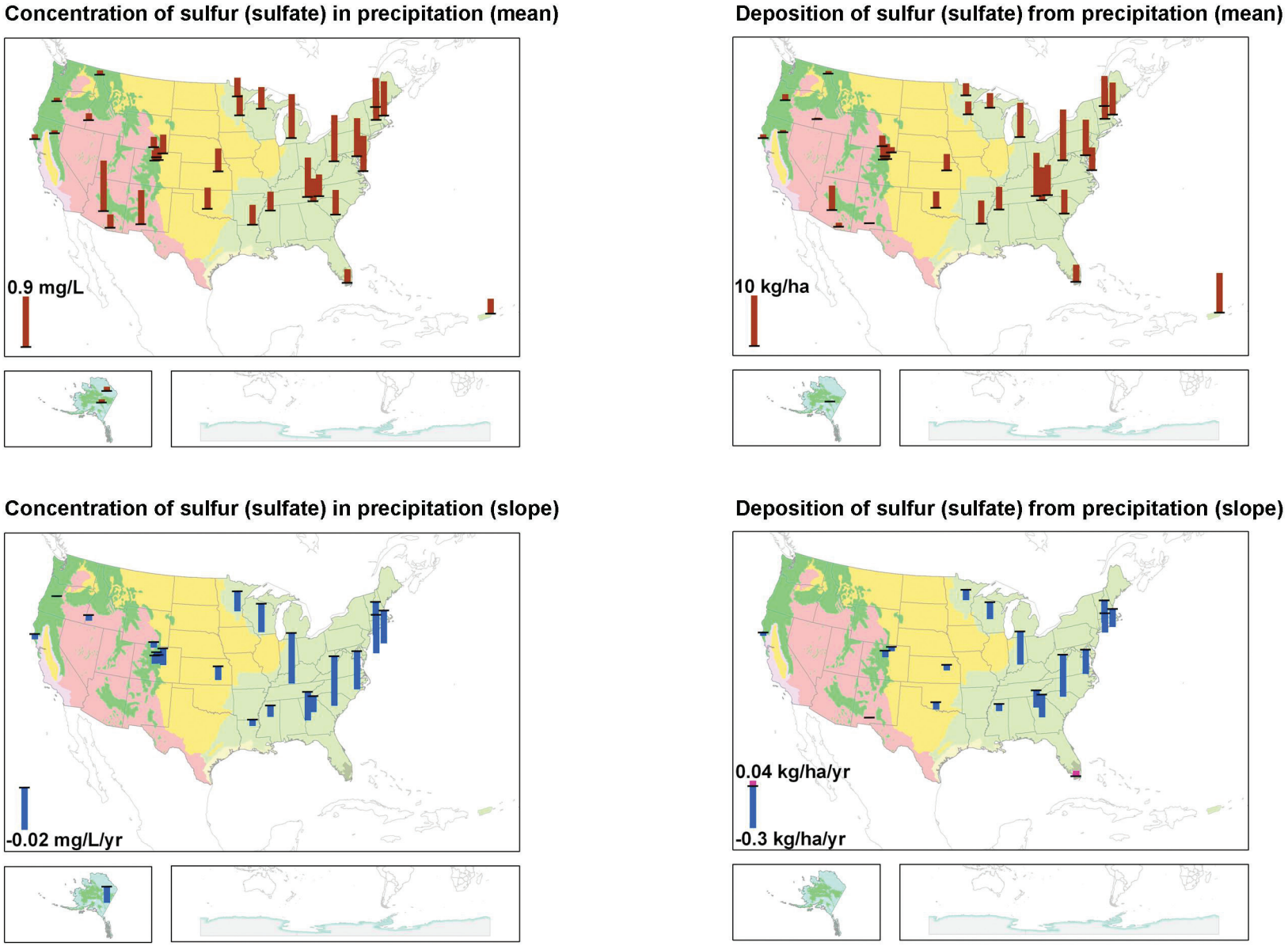


Figure 12-22. Continental patterns in sulfur (sulfate) from precipitation: concentration (volume-weighted concentration, mg/L) and wet deposition (kg/ha). Top panels: long-term averages; positive values are red and negative values are green. Bottom panels: slopes of significant regression lines ($p < 0.05$); positive values are pink and negative values are blue. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

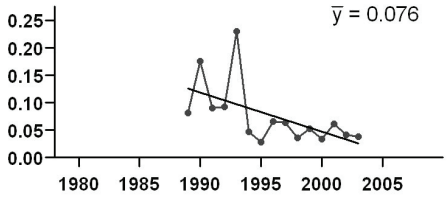
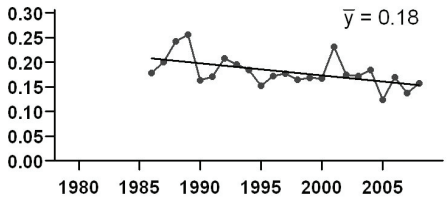
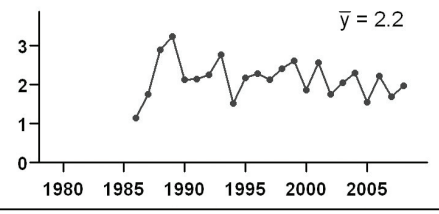
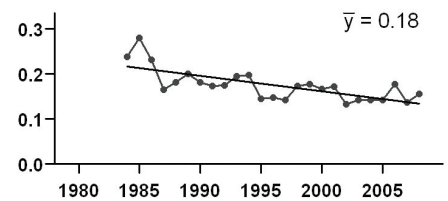
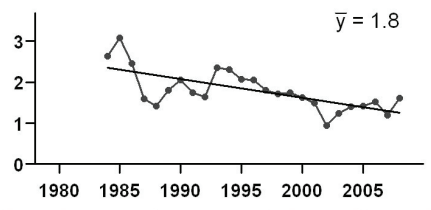
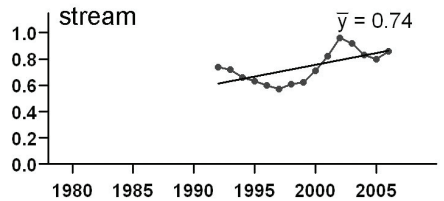
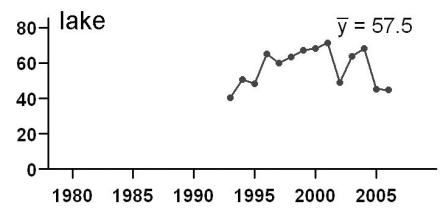
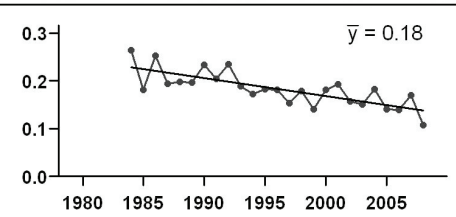
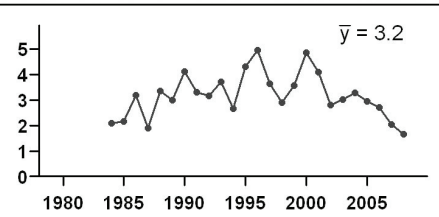
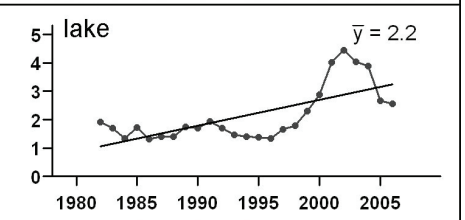
Site	Concentration of sulfate in precipitation (mg S/L)	Deposition of sulfate from precipitation (kg S/ha-yr)	Concentration of sulfate in surface water (mg S/L)
Arctic (ARC)		NA	NA
Glacier Lakes (GLA)			NA
Loch Vale Watershed (LVW)			
McMurdo Dry Valleys (MCM)	NA	NA	
Niwot Ridge Research Area (NWT)			

Figure 12-23. Trends for each alpine and arctic site: sulfate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Arctic (ARC): -0.007, NA, NA; Glacier Lakes (GLA): -0.002, NS, NA; Loch Vale Watershed (LVW): -0.003, -0.046, 0.018); McMurdo Dry Valleys (MCM): NA, NA, NS; and Niwot Ridge Research Area (NWT): -0.004, NS, 0.091. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

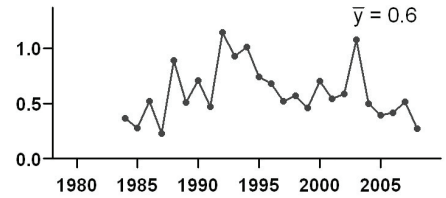
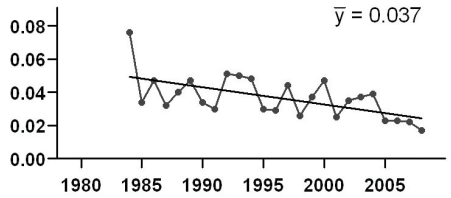
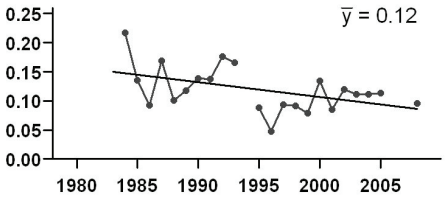
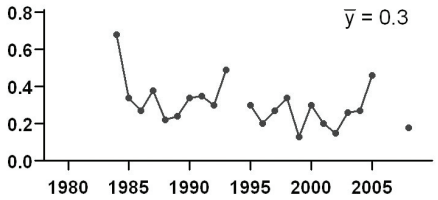
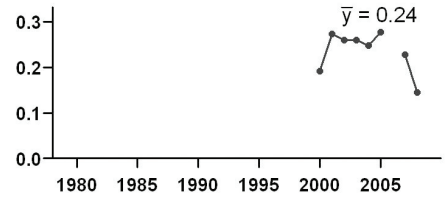
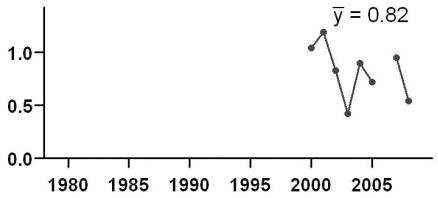
Site	Concentration of sulfate in precipitation (mg S/L)	Deposition of sulfate from precipitation (kg S/ha-yr)	Concentration of sulfate in surface water (mg S/L)
Jornada (JRN)			NA
Reynolds Creek Experimental Watershed (RCE)			NA
Walnut Gulch Experimental Watershed (WGE)			NA

Figure 12-24. Trends for each aridland site: sulfate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Jornada (JRN): NS, -0.001, NA; Reynolds Creek Experimental Watershed (RCE): -0.003, NS, NA; and Walnut Gulch Experimental Watershed (WGE): NS, NS, NA. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

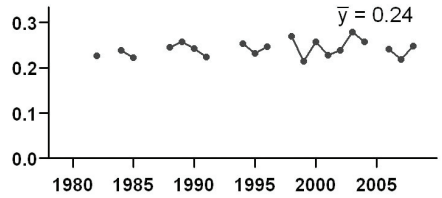
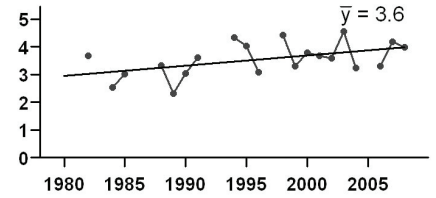
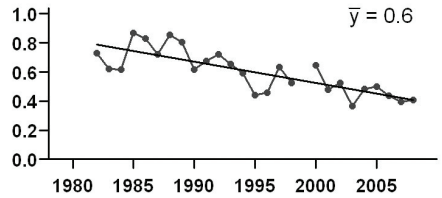
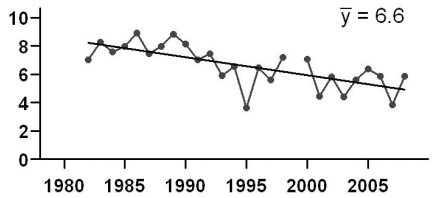
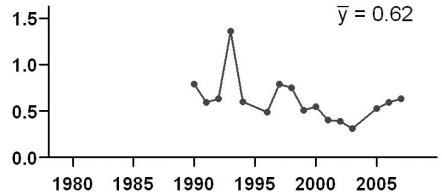
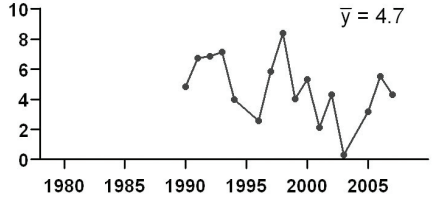
Site	Concentration of sulfate in precipitation (mg S/L)	Deposition of sulfate from precipitation (kg S/ha-yr)	Concentration of sulfate in surface water (mg S/L)
Florida Coastal Everglades (FCE)			NA
Plum Island Ecosystems (PIE)			NA
Virginia Coast Reserve (VCR)			NA

Figure 12-25. Trends for each coastal site: sulfate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Florida Coastal Everglades (FCE): NS, 0.037, NA; Plum Island Ecosystems (PIE): -0.015, -0.127, NA; and Virginia Coastal Reserve (VCR): NS, NS, NA. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

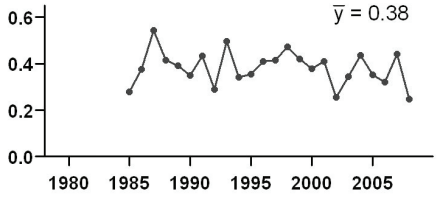
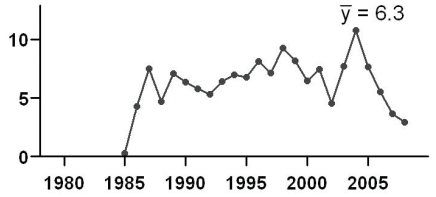
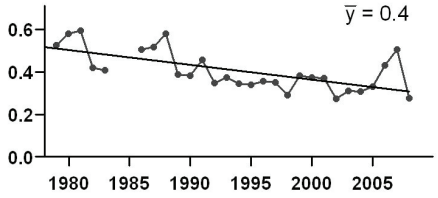
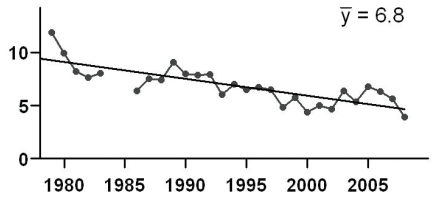
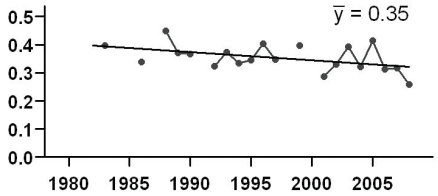
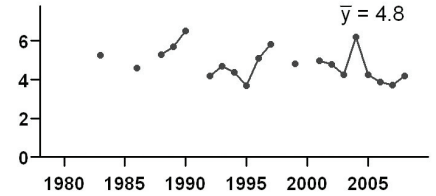
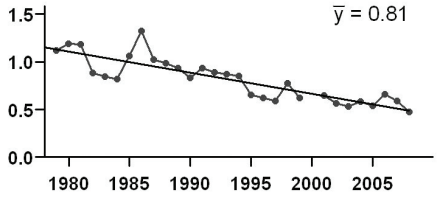
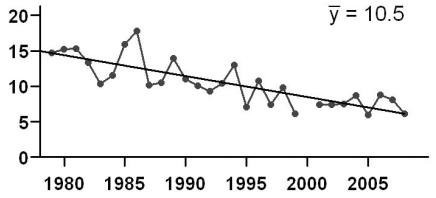
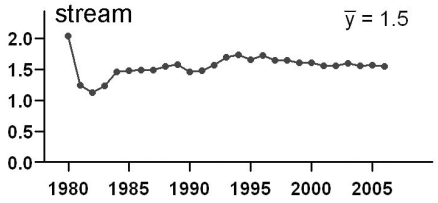
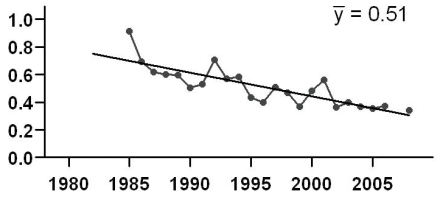
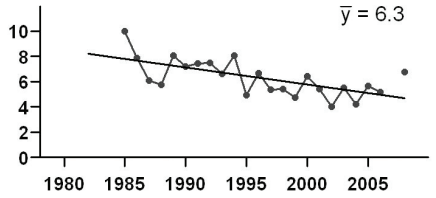
Site	Concentration of sulfate in precipitation (mg S/L)	Deposition of sulfate from precipitation (kg S/ha-yr)	Concentration of sulfate in surface water (mg S/L)
Bent Creek Experimental Forest (BEN)			NA
Coweeta (CWT)			NA
Crossett Experimental Forest (CRO)			NA
Fernow Experimental Forest (FER)			
Harvard Forest (HFR)			NA

Figure 12-26 (eastern forest sites) continued next page.

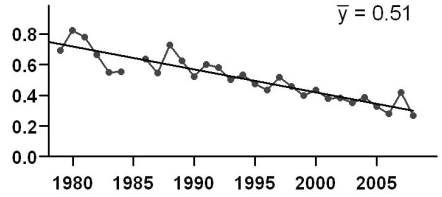
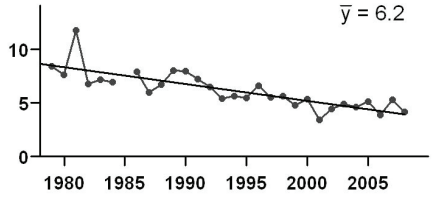
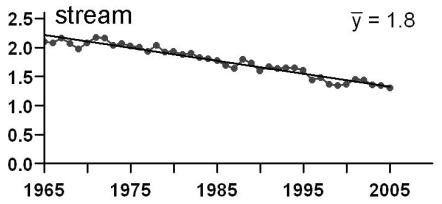
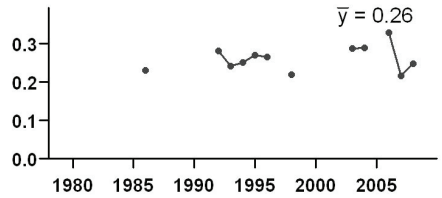
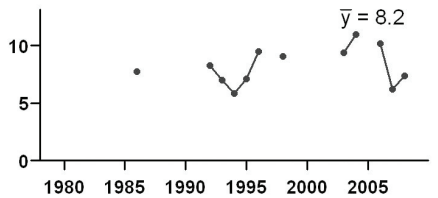
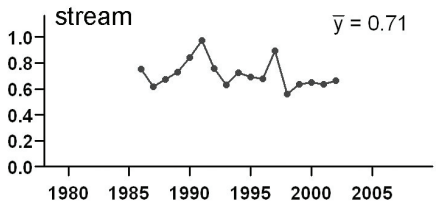
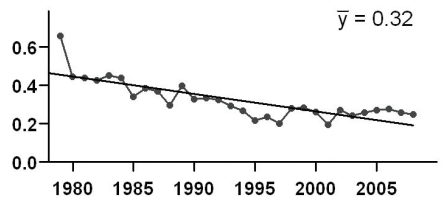
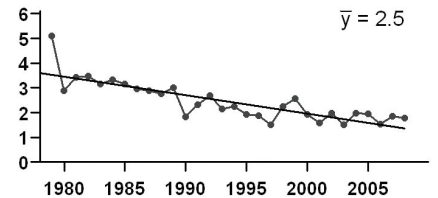
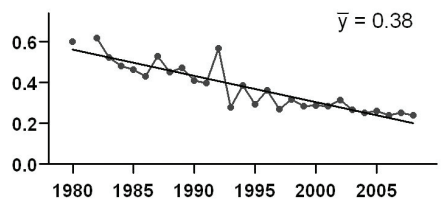
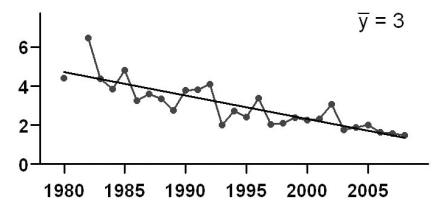
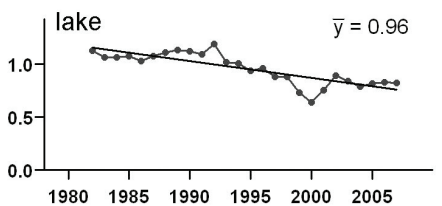
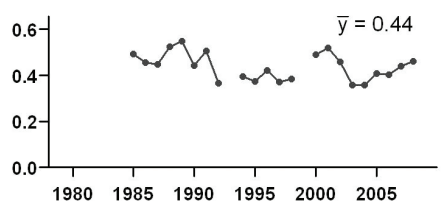
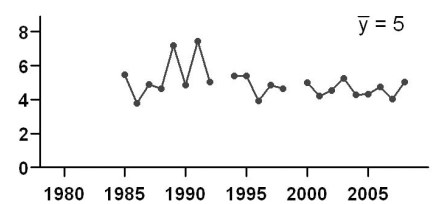
Site	Concentration of sulfate in precipitation (mg S/L)	Deposition of sulfate from precipitation (kg S/ha-yr)	Concentration of sulfate in surface water (mg S/L)
Hubbard Brook Ecosystem Study (HBR)			
Luquillo Experimental Forest (LUQ)			
Marcell Experimental Forest (MAR)			NA
North Temperate Lakes (NTL)			
Santee Experimental Forest (SAN)			NA

Figure 12-26 (eastern forest sites) continued next page.

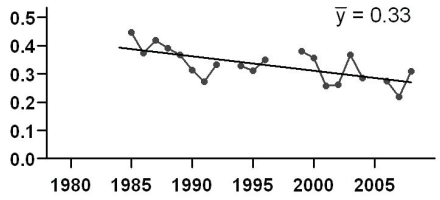
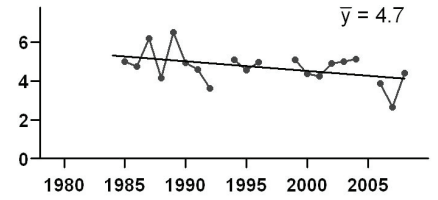
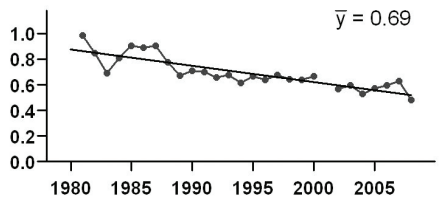
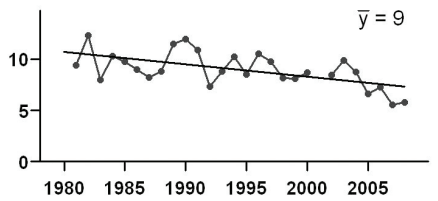
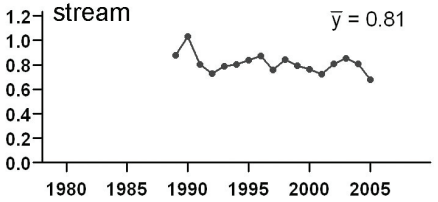
Site	Concentration of sulfate in precipitation (mg S/L)	Deposition of sulfate from precipitation (kg S/ha-yr)	Concentration of sulfate in surface water (mg S/L)
Tallahatchie Experimental Forest (TAL)			NA
Walker Branch Watershed (WBW)			

Figure 12-26. Trends for each eastern forest site: sulfate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Bent Creek Experimental Forest (BEN): NS, NS, NA; Crossett Experimental Forest (CRO): -0.003, NS, NA; Coweeta (CWT): -0.007, -0.158, NA; Fernow Experimental Forest (FER): -0.022, -0.293, NS; Hubbard Brook Ecosystem Study (HBR): -0.015, -0.157, -0.022; Harvard Forest (HFR): -0.017, -0.135, NA; Luquillo Experimental Forest (LUQ): NS, NS, NS; Marcell Experimental Forest (MAR): -0.009, -0.075, NA; North Temperate Lakes (NTL): -0.013, -0.120, -0.016; Santee Experimental Forest (SAN): NS, NS, NA; Tallahatchie Experimental Forest (TAL): -0.005, -0.050, NA; and Walker Branch Watershed (WBW): -0.013, -0.120, NS. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

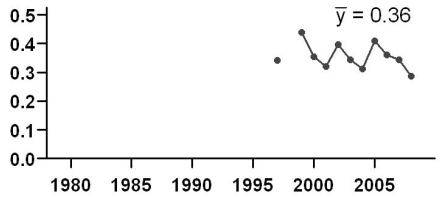
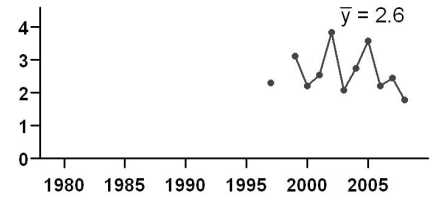
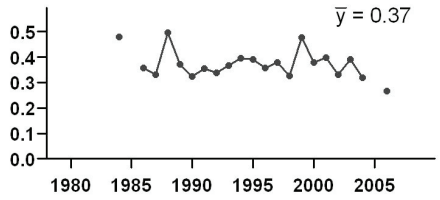
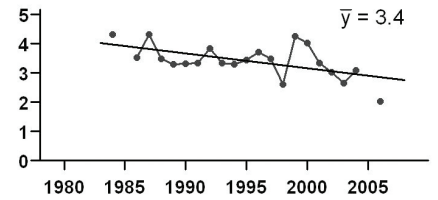
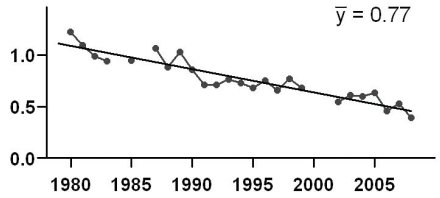
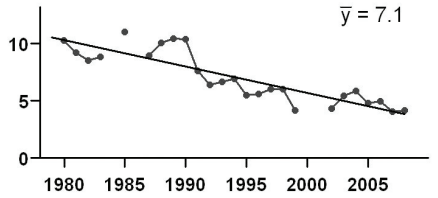
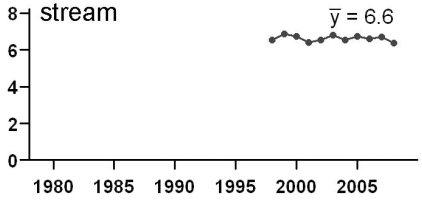
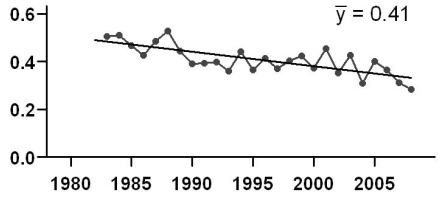
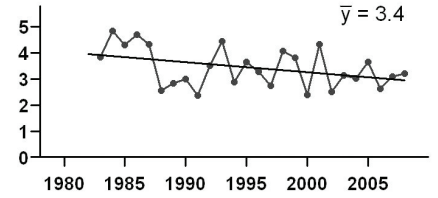
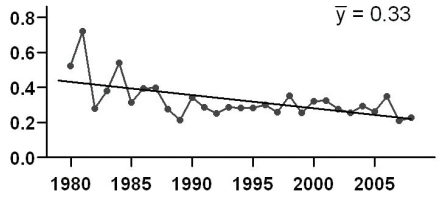
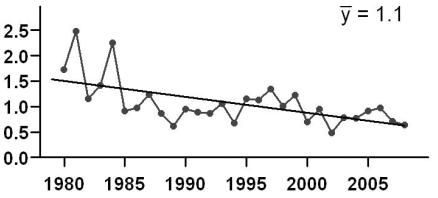
Site	Concentration of sulfate in precipitation (mg S/L)	Deposition of sulfate from precipitation (kg S/ha-yr)	Concentration of sulfate in surface water (mg S/L)
Cedar Creek Ecosystem Science Reserve (CDR)			NA
Grazinglands Research Laboratory (GRL)			NA
Kellogg Biological Station (KBS)			
Konza Prairie Biological Station (KNZ)			NA
Shortgrass Steppe (SGS)			NA

Figure 12-27. Trends for each temperate grassland and savanna site: sulfate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) Cedar Creek Ecosystem Science Reserve (CDR): NS, NS, NA; Grazinglands Research Laboratory (GRL): NS, -0.051, NA; Kellogg Biological Station (KBS): -0.023, -0.231, NS; Konza Prairie Biological Station (KNZ): -0.006, -0.039, NA; and Shortgrass Steppe (SGS): -0.007, -0.031, NA. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

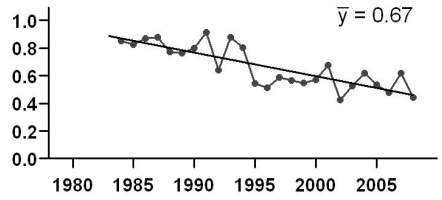
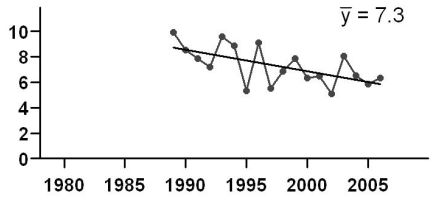
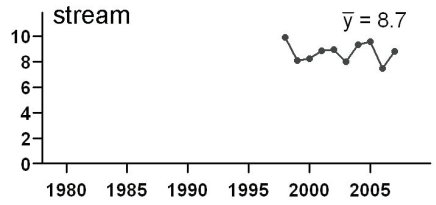
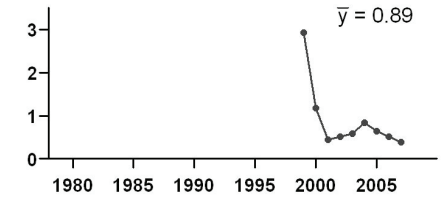
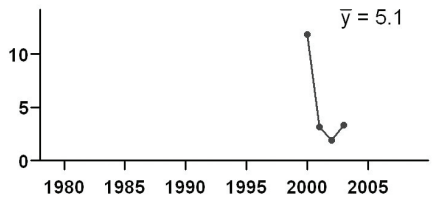
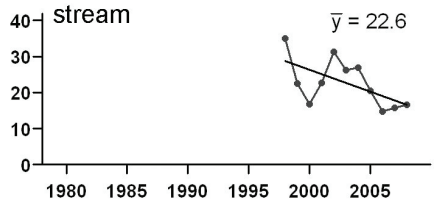
Site	Concentration of sulfate in precipitation (mg S/L)	Deposition of sulfate from precipitation (kg S/ha-yr)	Concentration of sulfate in surface water (mg S/L)
Baltimore Ecosystem Study (BES)			
Central Arizona-Phoenix (CAP)			

Figure 12-28. Trends for each urban site: sulfate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NS = not significant) Baltimore Ecosystem Study (BES): -0.017, -0.170, NS and Central Arizona-Phoenix (CAP): NS, NS, -1.215. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

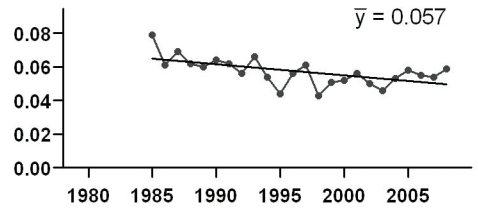
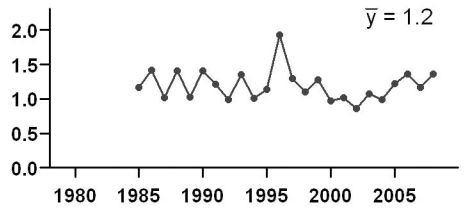
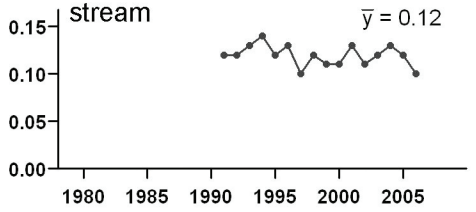
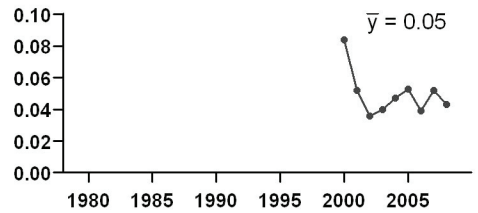
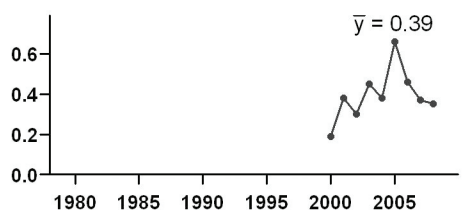
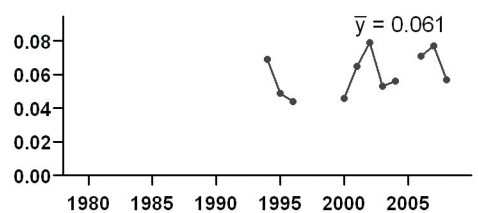
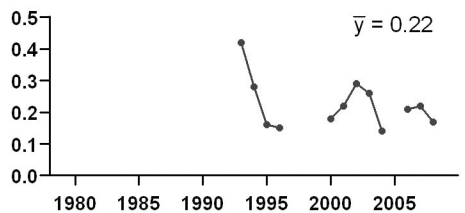
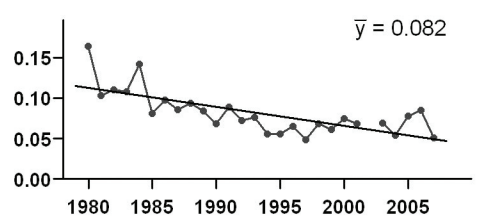
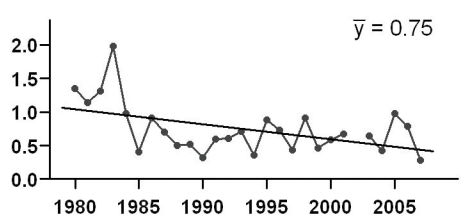
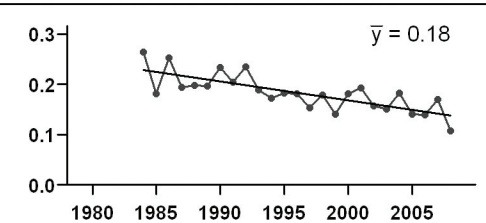
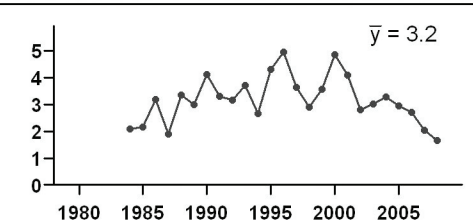
Site	Concentration of sulfate in precipitation (mg S/L)	Deposition of sulfate from precipitation (kg S/ha-yr)	Concentration of sulfate in surface water (mg S/L)
Andrews Experimental Forest (AND)			
Blacks Mountain Experimental Forest (BLA)			NA
Bonanza Creek Experimental Forest (BNZ)			NA
Caspar Creek Experimental Watershed (CSP)			NA
Fraser Experimental Forest (FRA)			NA

Figure 12-29 (western forest sites) continued next page.

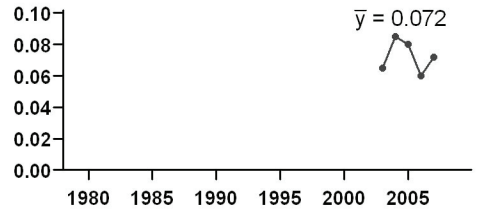
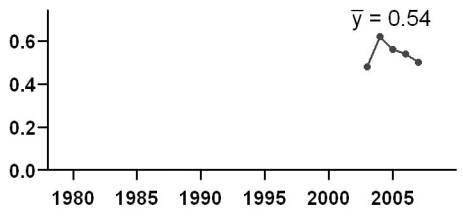
Site	Concentration of sulfate in precipitation (mg S/L)	Deposition of sulfate from precipitation (kg S/ha-yr)	Concentration of sulfate in surface water (mg S/L)
Priest River Experimental Forest (PRI)			NA

Figure 12-29. Trends for each western forest site: sulfate concentration in precipitation, wet deposition, and surface water. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The slopes for concentration in precipitation, wet deposition, and surface water, respectively, are (NA = not available, NS = not significant) H.J. Andrews Experimental Forest (AND): -0.001, NS, NS; Blacks Mountain Experimental Forest (BLA): NS, NS, NA; Bonanza Creek Experimental Forest (BNZ): NS, NS, NA; Caspar Creek Experimental Watershed (CSP): -0.002, -0.022, NA; Fraser Experimental Forest (FRA): -0.004, NS, NA; and Priest River Experimental Forest (PRI): NS, NS, NA. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

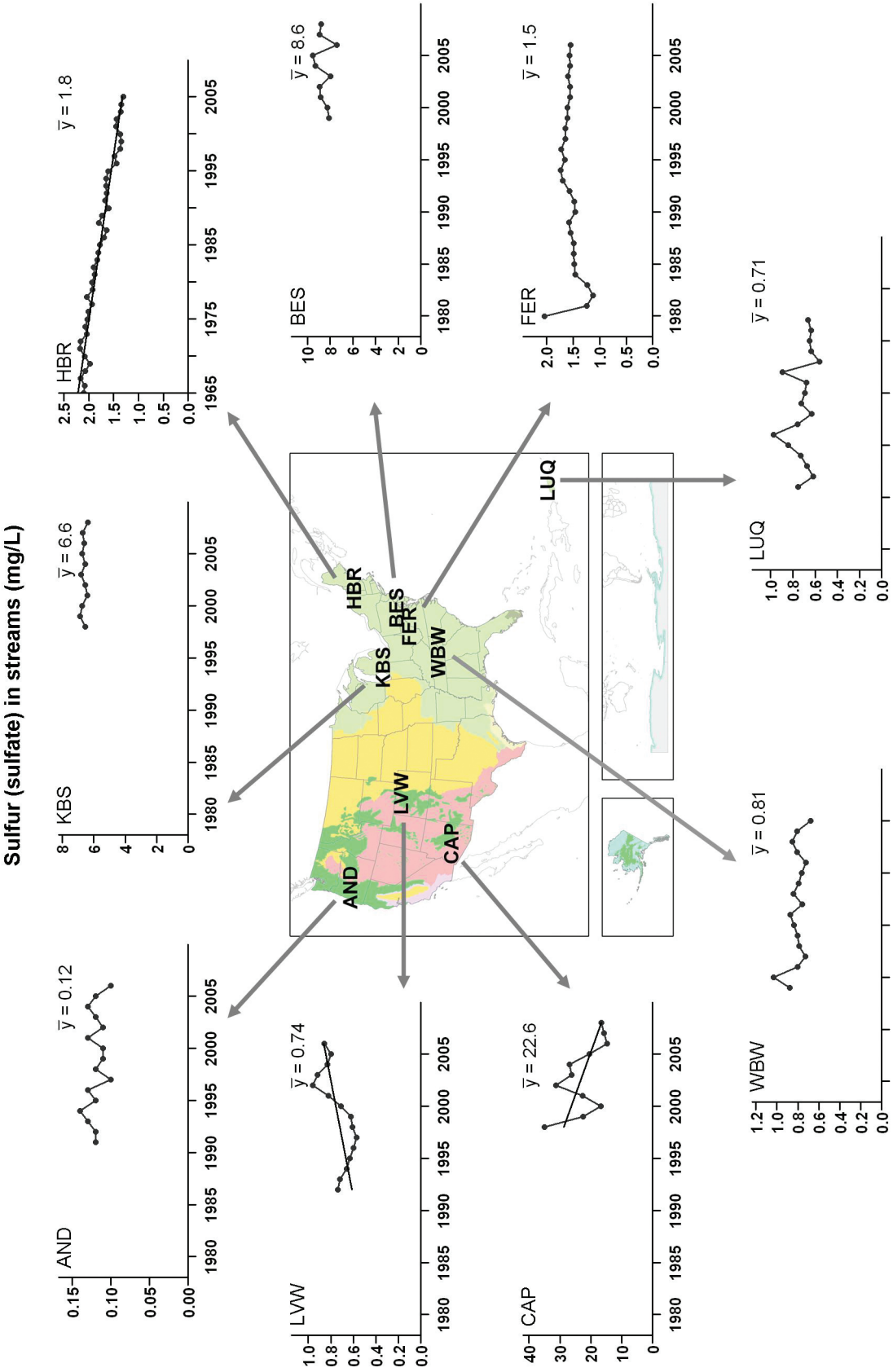


Figure 12-30. Concentration of sulfur (sulfate, mg/L) in streams through time at nine sites. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The significant slopes are Central Arizona-Phoenix (CAP) (-1.22), Hubbard Brook Ecosystem Study (HBR) (-0.02), and Loch Vale Watershed (LVW) (0.02). Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.eco-trends.info.

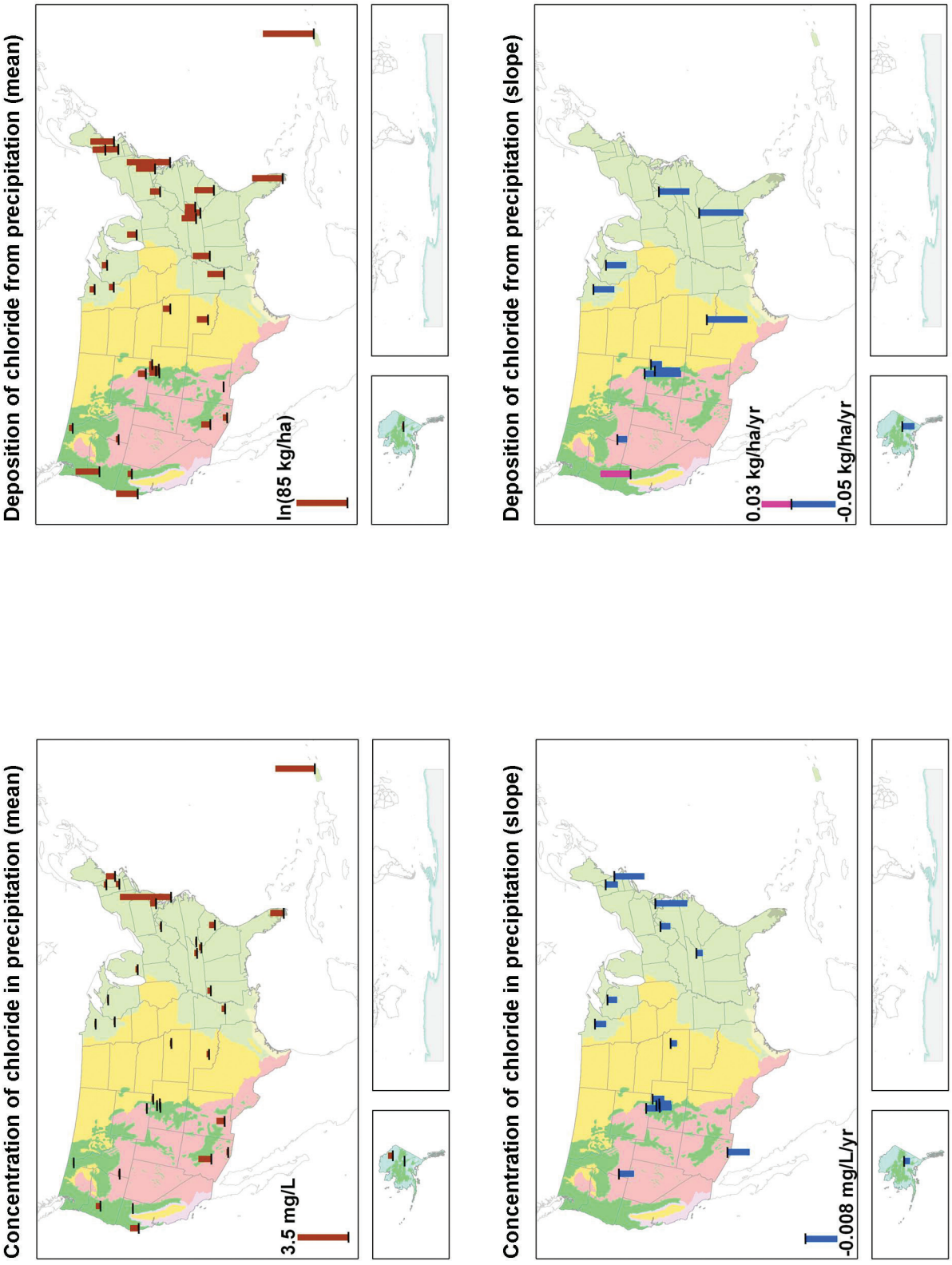


Figure 12-31. Continental patterns in chloride from precipitation: concentration (volume-weighted concentration, mg/L) and wet deposition (kg/ha). Top panels: long-term averages; positive values are red and negative values are green. Bottom panels: slopes of significant regression lines ($p < 0.05$); positive values are pink and negative values are blue. For the means of deposition from precipitation, the bar height is the ln-transformed value [ln(1+mean)]. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

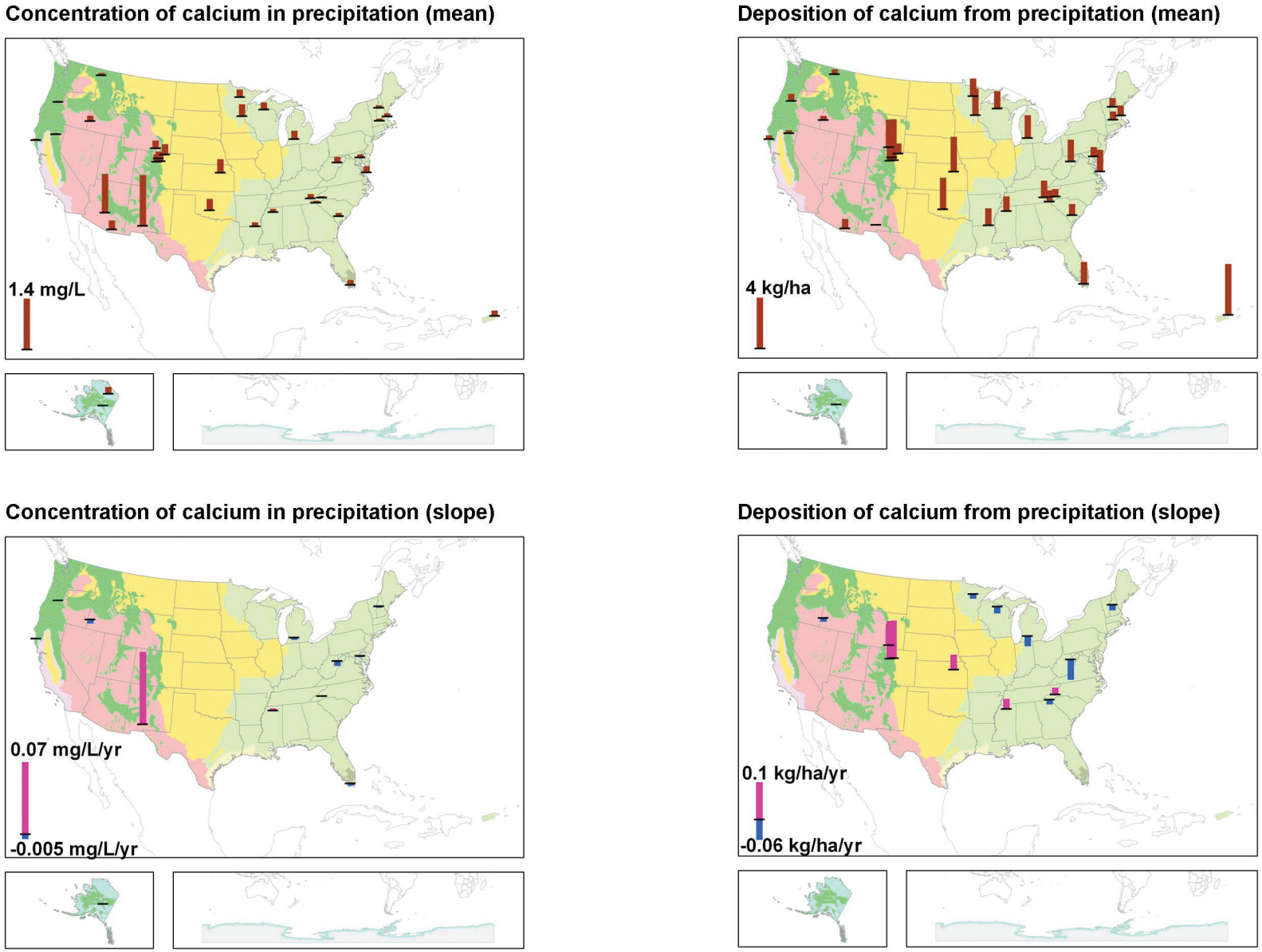


Figure 12-32. Continental patterns in calcium from precipitation: concentration (volume-weighted concentration, mg/L) and wet deposition (kg/ha). Top panels: long-term averages; positive values are red and negative values are green. Bottom panels: slopes of significant regression lines ($p < 0.05$); positive values are pink and negative values are blue. Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

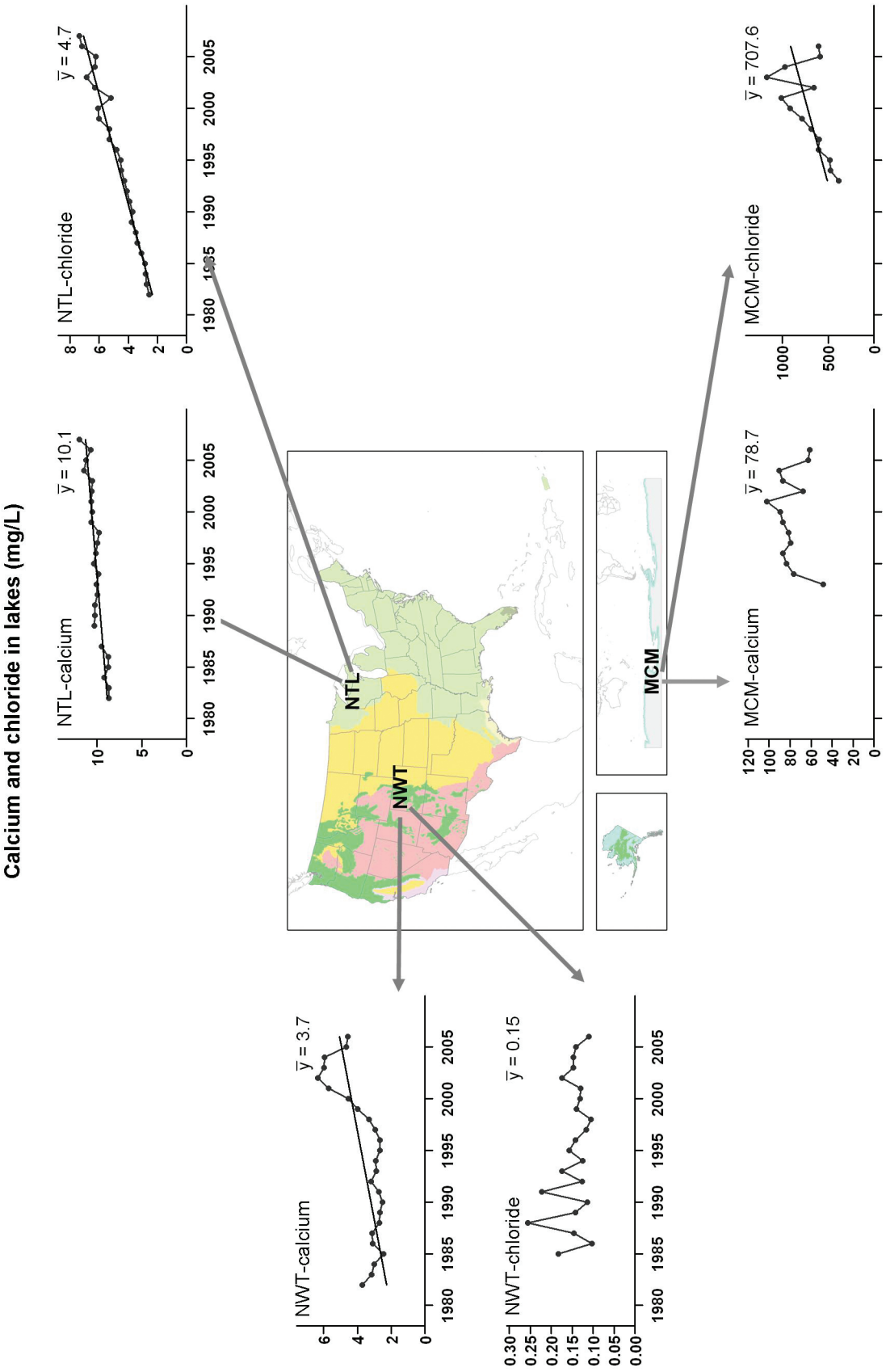


Figure 12-33. Concentrations of calcium and chloride (mg/L) in lakes through time at three sites. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The significant slopes are McMurdo Dry Valleys (MCM) (30.38 chloride), North Temperate Lakes (NTL) (0.10 calcium, 0.19 chloride), and Niwot Ridge Research Area (NWT) (0.12 calcium). Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

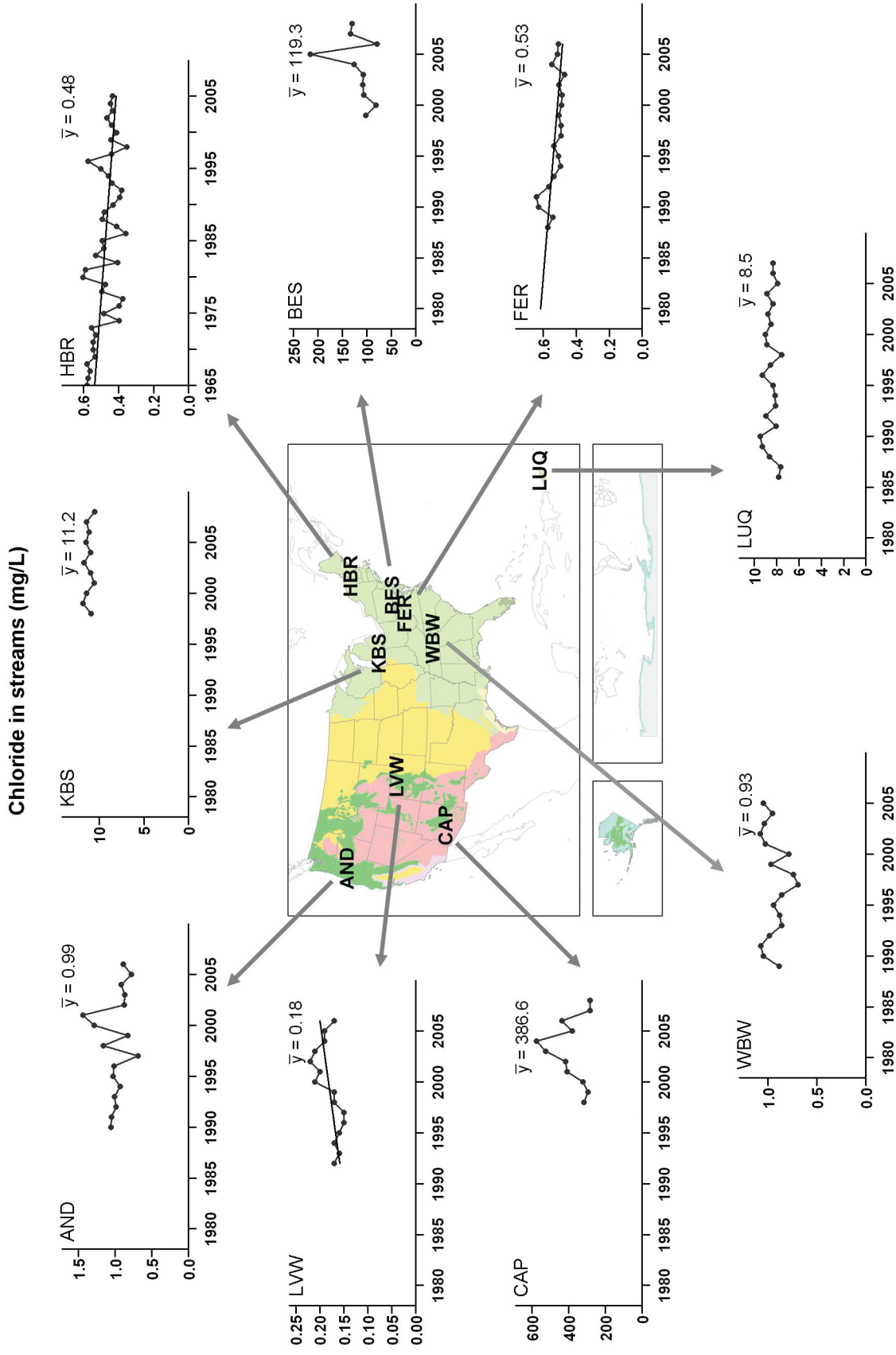


Figure 12-34. Concentration of chloride (mg/L) in streams through time at nine sites. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The significant slopes are Fernow Experimental Forest (FER) (-0.005), Hubbard Brook Ecosystem Study (HBR) (-0.003), and Loch Vale Watershed (LVW) (0.003). Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.

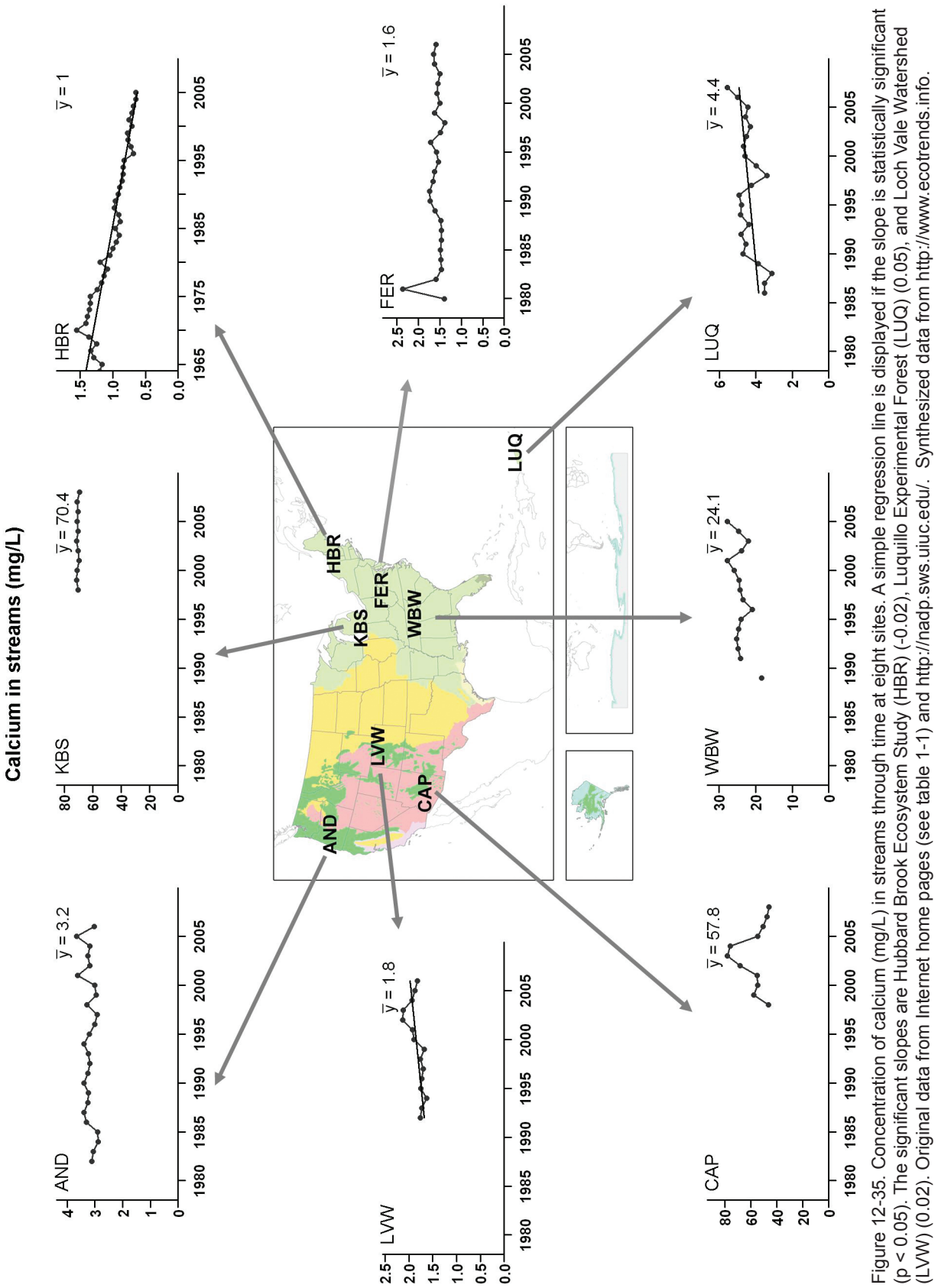


Figure 12-35. Concentration of calcium (mg/L) in streams through time at eight sites. A simple regression line is displayed if the slope is statistically significant ($p < 0.05$). The significant slopes are Hubbard Brook Ecosystem Study (HBR) (-0.02), Luquillo Experimental Forest (LUQ) (0.05), and Loch Vale Watershed (LVW) (0.02). Original data from Internet home pages (see table 1-1) and http://nadp.sws.uiuc.edu/. Synthesized data from http://www.ecotrends.info.