



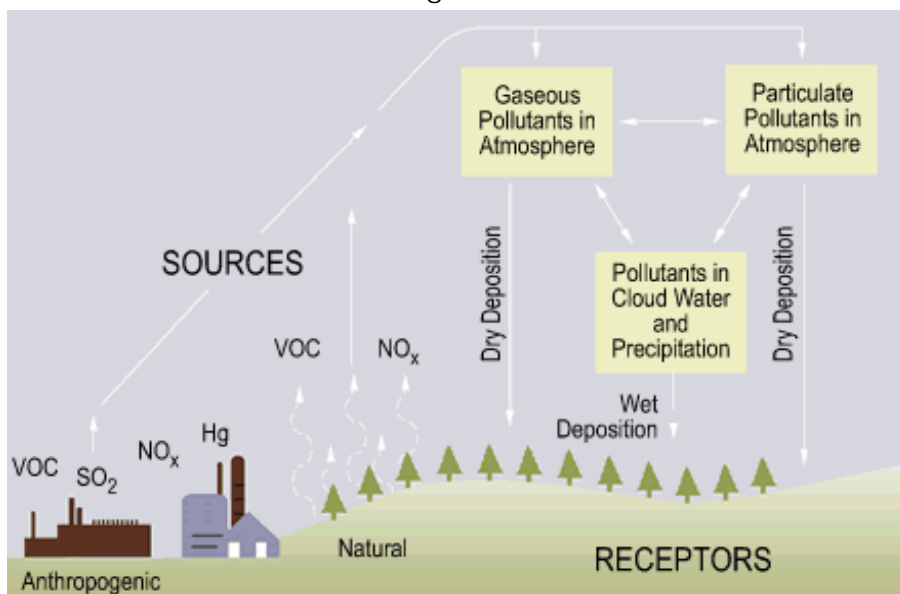
2013 Acid Deposition Summary

New Jersey Department of Environmental Protection

NATURE AND SOURCES

Atmospheric deposition is a process in which pollutants are deposited on land or water from the air. Deposition is usually the result of pollutants being removed from the atmosphere and deposited by precipitation (wet deposition) or by the settling out of particulates (dry deposition). Dry deposition also includes gaseous pollutants that are absorbed by land or water bodies. Figure 1 shows the basic mechanisms of deposition and the major pollutants of concern. These include sulfur dioxide (SO_2), nitrogen oxides (NO_x), mercury (Hg), and volatile organic compounds (VOCs). SO_2 is a major contributor to acid deposition, which can reduce the ability of water bodies to support certain types of fish and other aquatic organisms. NO_x also contributes to the acid deposition problem and can contribute to eutrophication of water bodies as well. Hg will accumulate in fish by a process known as bio-magnification. Small amounts of Hg in water are concentrated in smaller organisms. These smaller organisms are in turn consumed by larger ones. As the Hg moves up the food chain, it becomes more concentrated. Fish in Hg contaminated water can become contaminated to the point where they are no longer safe for people to eat. For more information on Hg in fish see “A Guide to Health Advisories for Eating Fish and Crabs Caught in New Jersey Waters” which is available at <http://www.state.nj.us/dep/dsr/njmainfish.htm>. VOCs are a very diverse group of compounds, some of which are toxic, including known carcinogens.

Figure 1



Source: USEPA Clean Air Markets

Web Site: <http://www.epa.gov/acidrain/what/index.html>

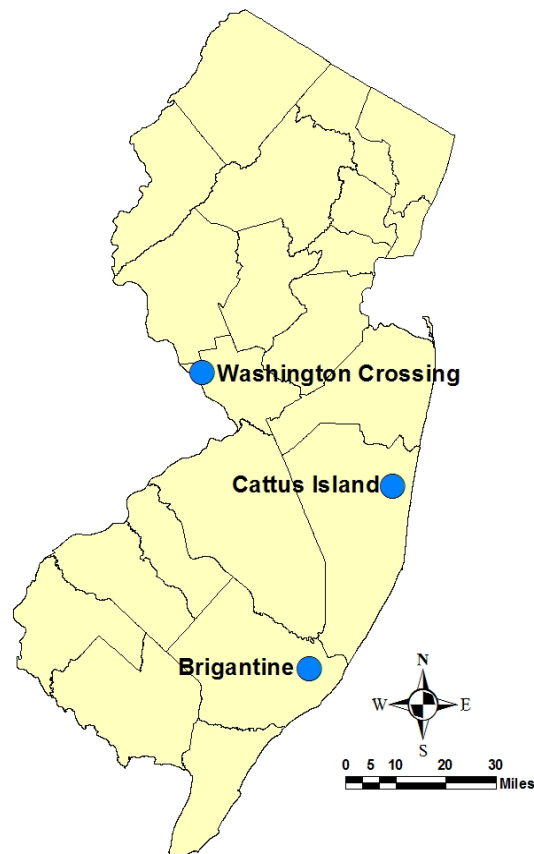
Atmospheric deposition is the result of pollution from a wide variety of sources and in some cases the pollution can travel great distances before being deposited on the land or water. Some known sources of atmospheric deposition are power plants, motor vehicles, incinerators, and certain industries.

MONITORING LOCATIONS

Figure 2 shows the three active deposition monitoring sites in New Jersey for 2013: Washington Crossing State Park, Cattus Island, and the Edwin B. Forsythe National Wildlife Refuge (NWR), also known as Brigantine. Each of the sites has a sampler for collecting wet deposition (rain and snow) and a rain gauge for determining precipitation amounts. The Ancora State Hospital monitoring site was shut down at the end of 2011 and the Cattus Island monitoring site began operation in September 2012.

Washington Crossing State Park, Cattus Island, and the Edwin B. Forsythe (NWR) are part of the National Atmospheric Deposition Program's (NADP) National Trends Network (NTN). A sample is collected every week from each site. The New Jersey Department of Environmental Protection (NJDEP) collects all samples from Washington Crossing and Cattus Island. The United States Fish and Wildlife Service – Air Quality Branch (USFWS-AQB) is responsible for sample collection at the Edwin B. Forsythe NWR or Brigantine. All collected samples are shipped to the Central Analytical Laboratory (CAL) at the Illinois State Water Survey (ISWS) for analysis. The CAL analyzes each sample with the goal of providing data on amounts, trends, and geographic distributions of acids, nutrients, and base cations in precipitation. The resulting data is then used by the U.S. Environmental Protection Agency (USEPA) to assess national deposition patterns and trends. (NADP, 2011)

Figure 2
Acid Precipitation Monitoring Network - 2013



SUMMARY OF 2013 DATA

A summary of the 2013 wet deposition data is provided in Table 1. Raw data was obtained from the NADP website (NADP, 2014). The table shows total deposition, pH, conductivity and concentrations of several important ions. When acidity is reported on the pH scale, neutral is considered a 7 with decreasing pH values corresponding to increasing acidity. Normal rainfall has a pH of approximately 5.6 due to the natural presence of carbonic acid in the air. The mean pH values recorded at the Washington Crossing State Park and Cattus Island weekly samplers was 5.13 and 5.04 respectively. The Edwin B. Forsythe NWR sampler recorded a mean pH of 5.00.

Conductivity is a measure of the total density of ions in the water collected. It is used as an indicator of the total amount of pollution in the sample. Conductivity is the ability of the water to conduct electricity and generally increases as the concentration of ions in water increases.

Concentrations of specific ions considered important because they can affect the chemistry of lakes, streams and other water bodies, are also reported for each site. Summaries are provided for each season of the year along with annual averages in Table 1.

Table 1
Acid Precipitation Monitoring Network - 2013
Annual and Seasonal Averages
 Weighted by Precipitation Amount

Ca ²⁺	- Calcium	Cond.	- Specific conductance
Mg ²⁺	- Magnesium	cm	- Centimeter
K ⁺	- Potassium	uS/cm	- MicroSiemens per centimeter
Na ⁺	- Sodium	mg/L	- Milligrams per liter
NH ₄ ⁺	- Ammonium	<MDL	- Below minimum detection limit
NO ₃ ⁻	- Nitrate	Winter	- December – February
Cl ⁻	- Chloride	Spring	- March – May
SO ₄ ²⁻	- Sulfate	Summer	- June – August
-	- No Data	Fall	- September – November

Edwin B. Forsythe National Wildlife Refuge – Weekly

	Precip. cm	pH	Cond. uS/cm	Ca ²⁺ mg/L	Mg ²⁺ mg/L	K ⁺ mg/L	Na ⁺ mg/L	NH ₄ ⁺ mg/L	NO ₃ ⁻ mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L
Winter	24.25	4.91	19.89	0.109	0.225	0.076	1.825	0.095	0.576	3.308	0.871
Spring	30.43	5.20	12.18	0.106	0.110	0.053	0.875	0.265	0.603	1.585	0.777
Summer	31.60	4.99	8.82	0.053	0.041	0.028	0.291	0.203	0.641	0.578	0.560
Fall	18.39	4.94	13.09	0.063	0.093	0.045	0.785	0.202	0.619	1.365	0.749
Annual	110.10	5.00	11.11	0.069	0.078	0.039	0.624	0.189	0.603	1.143	0.647

Washington Crossing State Park – Weekly

	Precip. cm	pH	Cond. uS/cm	Ca ²⁺ mg/L	Mg ²⁺ mg/L	K ⁺ mg/L	Na ⁺ mg/L	NH ₄ ⁺ mg/L	NO ₃ ⁻ mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L
Winter	23.75	4.95	9.77	0.075	0.043	0.021	0.364	0.186	0.804	0.642	0.597
Spring	20.49	5.28	7.00	0.117	0.035	0.029	0.186	0.274	0.755	0.332	0.600
Summer	51.70	5.09	7.11	0.048	0.015	0.033	0.073	0.275	0.692	0.133	0.499
Fall	16.13	5.30	4.99	0.052	0.020	0.023	0.122	0.148	0.390	0.215	0.350
Annual	109.70	5.13	6.88	0.061	0.021	0.027	0.122	0.231	0.649	0.219	0.488

Cattus Island – Weekly

	Precip. cm	pH	Cond. uS/cm	Ca ²⁺ mg/L	Mg ²⁺ mg/L	K ⁺ mg/L	Na ⁺ mg/L	NH ₄ ⁺ mg/L	NO ₃ ⁻ mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L
Winter	33.37	5.06	28.32	0.149	0.390	0.121	3.272	0.089	0.533	5.933	1.141
Spring	21.18	5.14	22.01	0.154	0.285	0.096	2.273	0.204	0.653	4.246	1.119
Summer	40.68	4.95	10.92	0.058	0.061	0.036	0.470	0.228	0.727	0.872	0.724
Fall	11.92	5.18	19.42	0.102	0.258	0.081	2.140	0.090	0.385	3.776	0.834
Annual	101.58	5.04	15.22	0.089	0.158	0.058	1.273	0.167	0.604	2.330	0.797

WET DEPOSITION

Acid deposition is primarily the result of sulfuric and nitric acids and ammonium derived from atmospheric emissions of sulfur dioxide, nitrogen oxides, and ammonia. Excessive deposition of these materials can have significant environmental impacts on both terrestrial and freshwater ecosystems through acidification of soil and water bodies, reducing the diversity of aquatic organisms and stressing native vegetation. (Driscoll et al, 2003)

Sulfate, for example, can alter soil and water chemistry, and a deposition level of 20 kilograms per hectare per year has been generally accepted as the limit above which damage to sensitive natural resources is likely to occur (i.e. Aquatic Effect Level). Deposition in rain and snow is often expressed as mass per unit land area over time (NJCRP, 2003).

Figures 3 and 4 show the change in the amount of sulfate ion deposited over the last several years at the sites in Washington Crossing State Park and the Edwin B. Forsythe NWR, respectively. Figures 5 and 6 show the change in the amount of ammonium ion deposited at these sites, and Figures 7 and 8 shows the change in the amount of nitrate ion deposited. All figures below show “wet deposition” only. They do not include dry particulate deposited when no precipitation was occurring. Therefore, the total deposition is higher than what is shown here.

The year to year variations in the charts below are a function of both the concentrations of sulfate, nitrate, and ammonium in air and cloud droplets, and the total amount of precipitation that occurs each year. For example, in 1991 and 1992, both the sulfate concentrations and the total precipitation were below normal, while they were high in 1993 and 1994. Since the data is in the form of annual totals, it is also sensitive to loss of samples due to contamination or other factors.

According to the New Jersey Comparative Risk Project Ecological Technical Work Group, streams and lakes with significant buffering capacity are somewhat protected from the effects of acid deposition. It is for this reason that actual risk assessments are primarily based on the direct observation of pH in streams and lakes, and on actual observed effects on aquatic species, rather than on deposition measurements alone (NJCRP, 2003).

To convert the values shown in Figure 3 through Figure 8 to pounds per acre per year, multiply by 0.89 (since one kilogram equals 2.21 pounds and one hectare equals 2.47 acres).

Note that the Cattus Island site is not included in the trend charts below because there is only one complete year of valid data available.

Figure 3 through 8 Data Legend	
•	Met Criteria
▲	Did Not Meet Criteria
All Raw Data for Figure 3 through Figure 8 were obtained from the NADP website. NADP criteria requirements can also be found at http://nadp.isws.illinois.edu/ .	

Figure 3
 Sulfate (SO₄) NADP/NTN Site NJ99 (Washington Crossing State Park)
 Annual Wet Deposition (1981-2013)
 Kilograms Per Hectare (kg/ha)

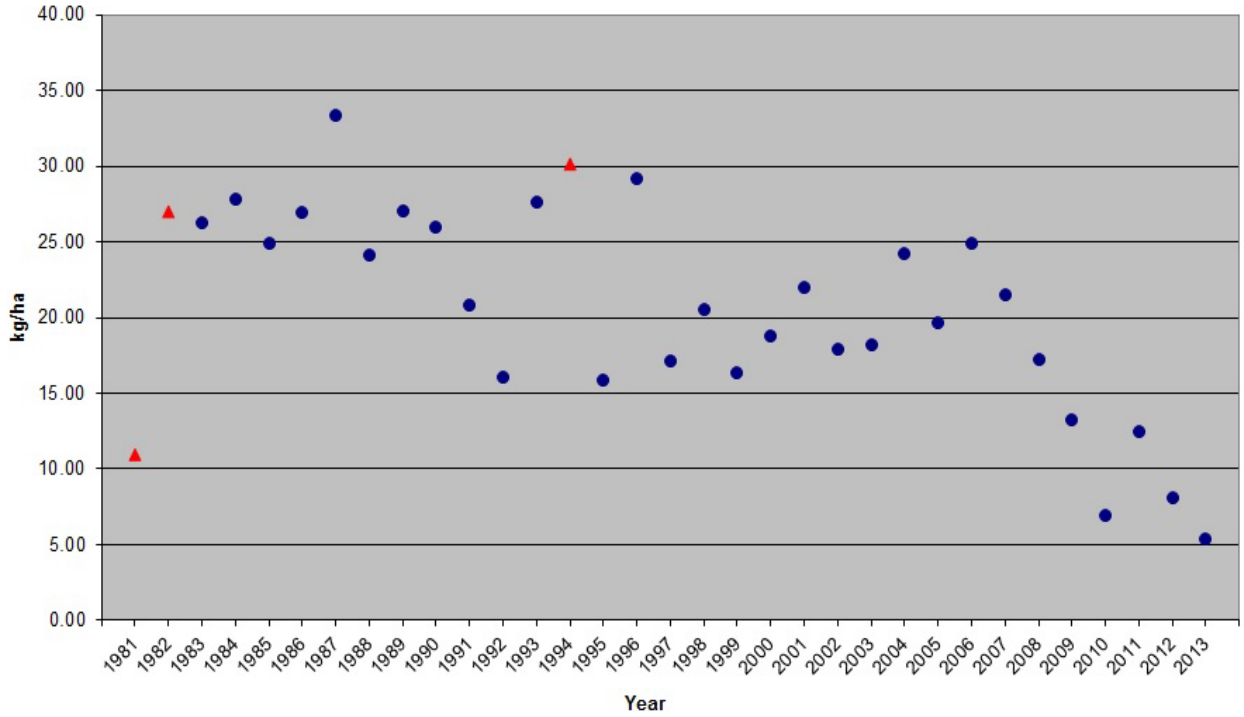


Figure 4
 Sulfate (SO₄) NADP/NTN Site NJ00 (Edwin B. Forsythe National Wildlife Refuge)
 Annual Wet Deposition (1998-2013)
 Kilograms Per Hectare (kg/ha)

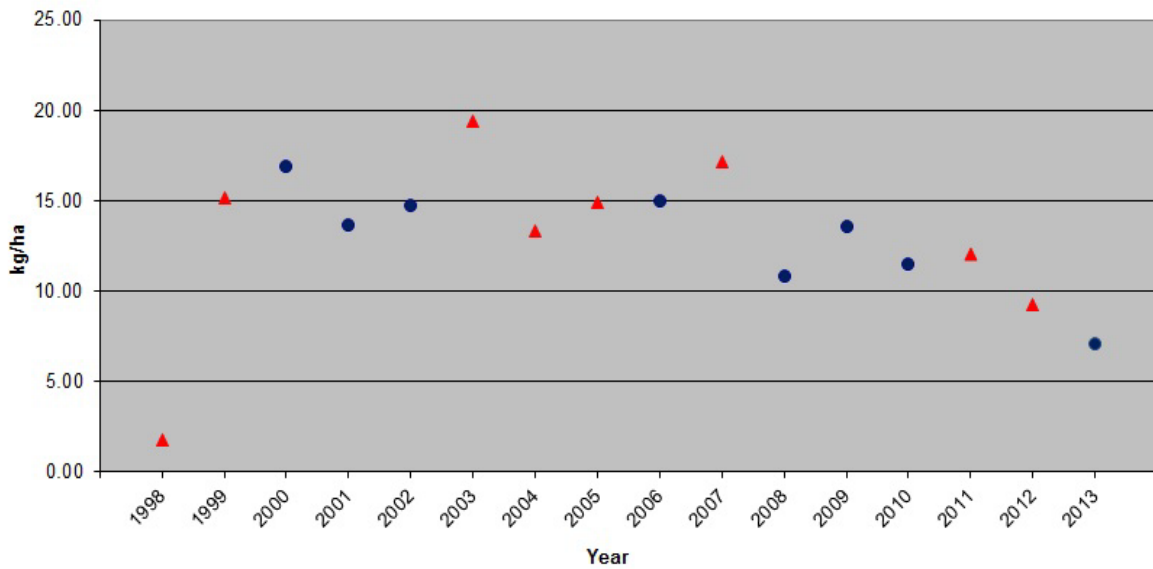


Figure 5
 Ammonium (NH₄) NADP/NTN Site NJ99 (Washington Crossing State Park)
 Annual Wet Deposition (1981-2013)
 Kilograms Per Hectare (kg/ha)

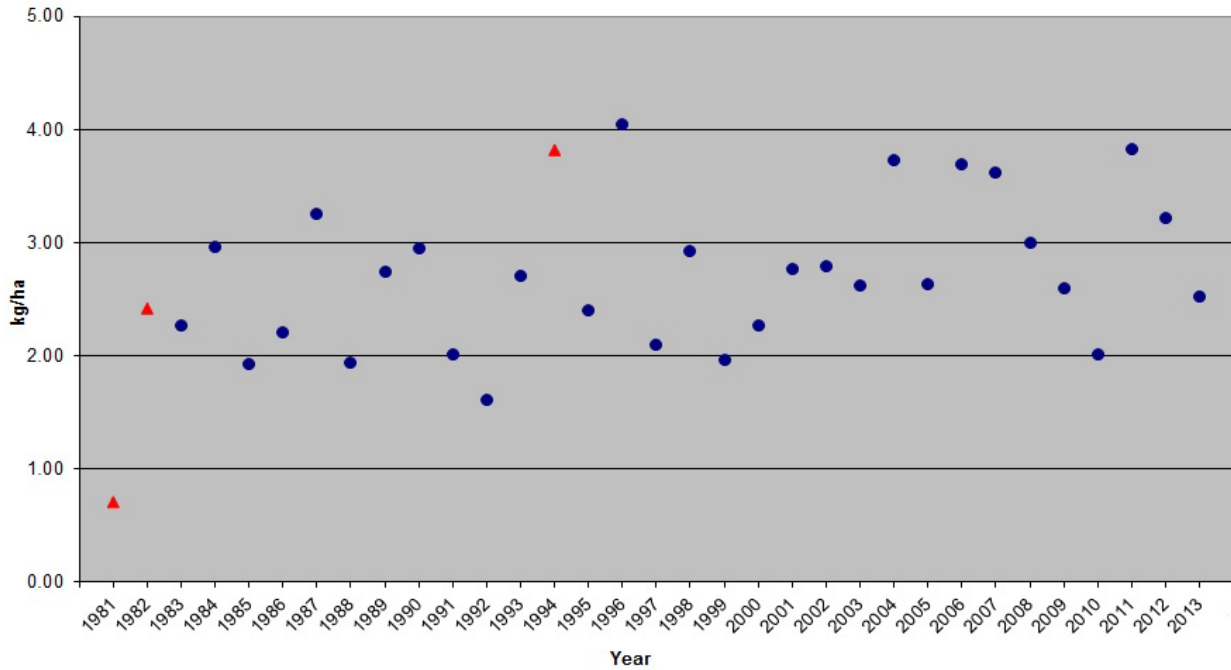


Figure 6
 Ammonium (NH₄) NADP/NTN Site NJ00 (Edwin B. Forsythe National Wildlife Refuge)
 Annual Wet Deposition (1998-2013)
 Kilograms Per Hectare (kg/ha)

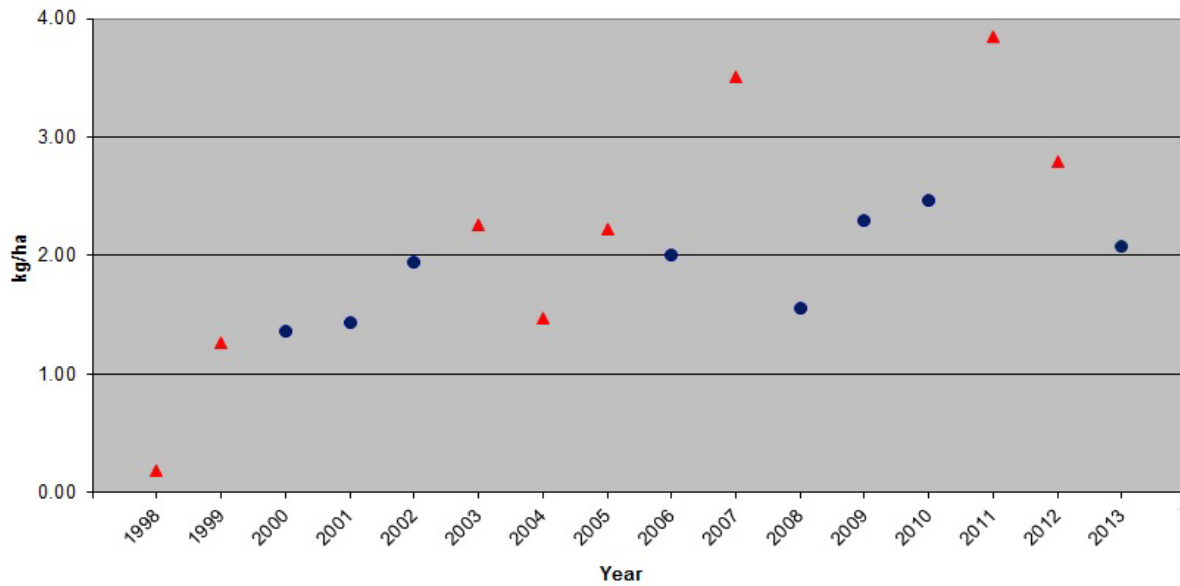


Figure 7
 Nitrate (NO₃) NADP/NTN Site NJ99 (Washington Crossing State Park)
 Annual Wet Deposition (1981-2012)
 Kilograms Per Hectare (kg/ha)

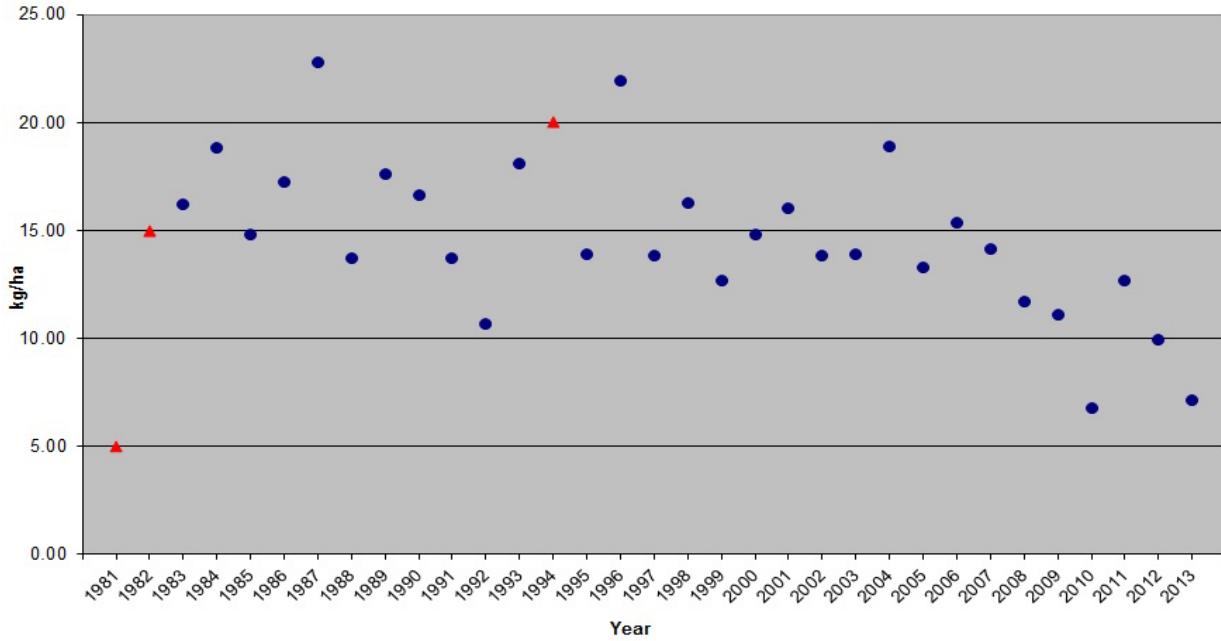
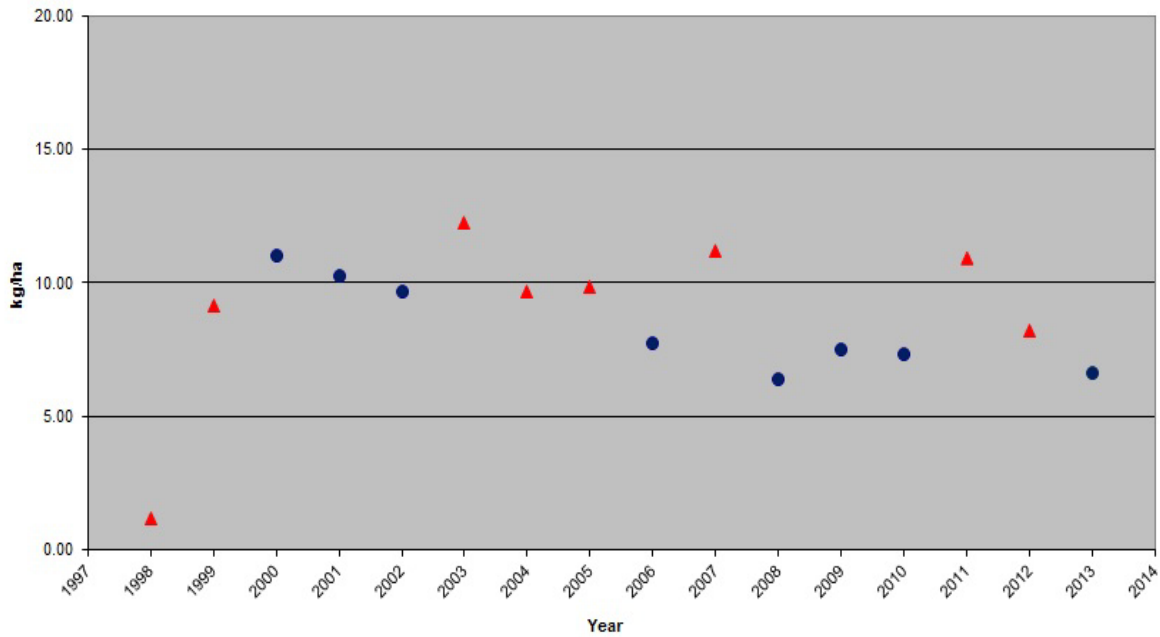


Figure 8
 Nitrate (NO₃) NADP/NTN Site NJ00 (Edwin B. Forsythe National Wildlife Refuge)
 Annual Wet Deposition (1998-2012)
 Kilograms Per Hectare (kg/ha)



REFERENCES

Driscoll, C.T., Driscoll, K.M., Mitchell, M.J. and D.J. Raynal. 2003. Effects of acidic deposition on forest and aquatic ecosystems in New York State. *Environmental Pollution*, 123(3):327-336. <http://www.esf.edu/hss/HF%20Ref%20PDF/EvnPol.123.327.336.pdf>.

FISH SMART, EAT SMART: A Guide to Health Advisories for Eating Fish & Crabs Caught in New Jersey Waters -2006, New Jersey Department of Environmental Protection (NJDEP), Division of Science, Research and Technology, 2006, URL. www.state.nj.us/dep/dsr/njmainfish.htm.

National Atmospheric Deposition Program (NRSP-3). 2010. NADP Program Office, Illinois State Water Survey, 2204 Griffith Dr., Champaign, IL 61820. <http://nadp.isws.illinois.edu/>

New Jersey Comparative Risk Project, Ecological Technical Work Group, NJDEP, Division of Science, Research and Technology, July 2003, URL: <http://www.state.nj.us/dep/dsr/njcrp/>.

United States Environmental Protection Agency (USEPA) Clean Air Markets, 2007, URL: <http://www.epa.gov/acidrain/what/index.html>.