



2009 Atmospheric Deposition Summary

New Jersey Department of Environmental Protection

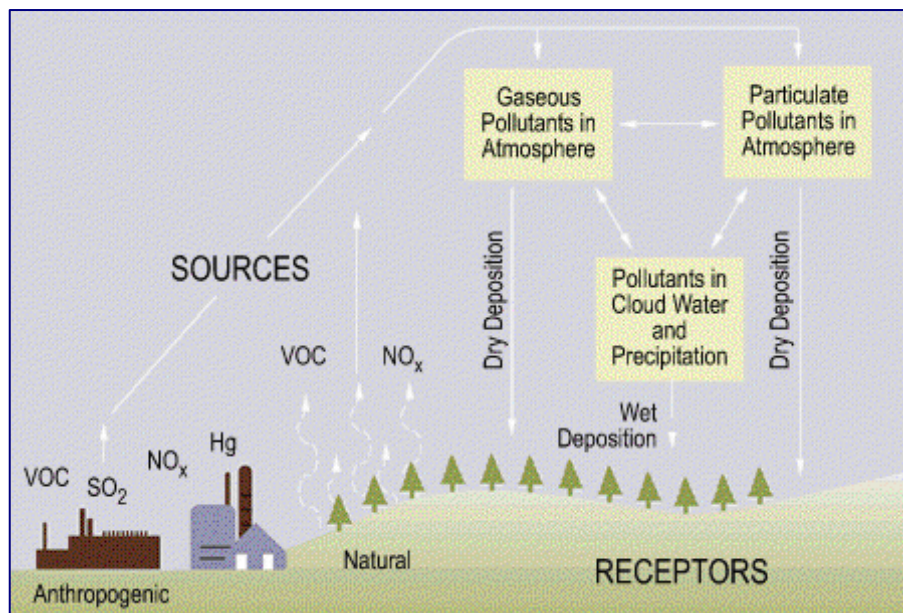
NATURE AND SOURCES

Atmospheric deposition refers to pollutants that 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 (SO₂), nitrogen oxides (NO_x), mercury (Hg), and volatile organic compounds (VOCs). SO₂ 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 www.state.nj.us/dep/dsr/njmainfish.htm. VOCs are a very diverse group of compounds, some of which are toxic, including known carcinogens.

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.

Figure 1



Source: USEPA Clean Air Markets

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

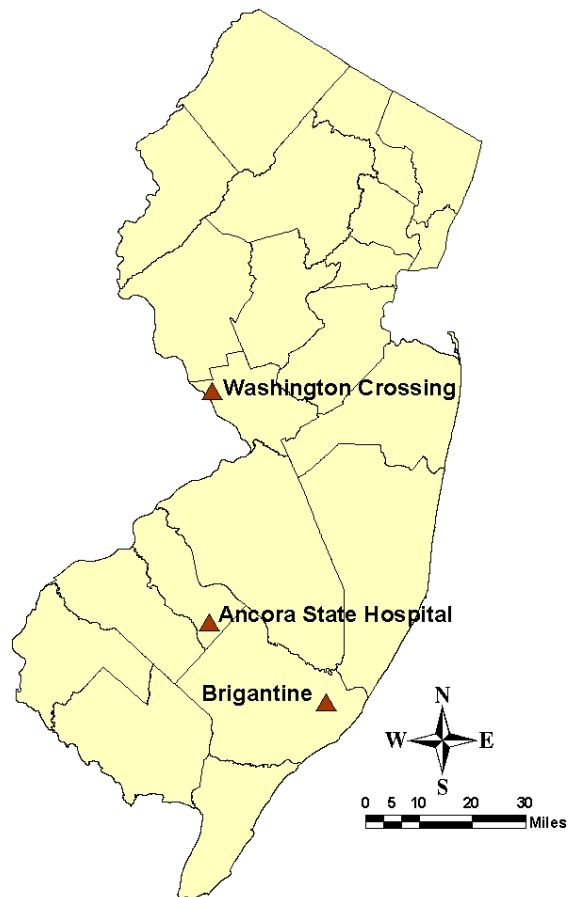
MONITORING LOCATIONS

Figure 2 shows the three active deposition monitoring sites in New Jersey for 2009: Washington Crossing State Park, Ancora State Hospital, 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.

Washington Crossing State Park 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. 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 samples are then 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, 2010)

In addition to the NADP sites, the State also collects samples from an event sampler at Washington Crossing next to the weekly sampler, and at the Ancora State Hospital site in Camden County. These samples are normally analyzed at the Department's own laboratory. Because of ongoing equipment issues, these additional samples are not being analyzed by the State.

Figure 2
Acid Precipitation Monitoring
Network - 2009



SUMMARY OF 2009 DATA

A summary of the 2009 wet deposition data is provided in Table 1. Raw data was obtained from the NADP website (NADP, 2010). 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 value recorded at the Washington Crossing State Park weekly sampler was 4.73 and the Edwin B.

Forsythe NWR sampler recorded a mean pH of 4.94.

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 - 2009
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 | 26.72 | 4.75 | 14.43 | 0.105 | 0.083 | 0.039 | 0.707 | 0.172 | 0.781 | 1.285 | 0.950 |
| Spring | 21.29 | 4.97 | 11.95 | 0.079 | 0.083 | 0.050 | 0.718 | 0.181 | 0.569 | 1.277 | 0.856 |
| Summer | 42.26 | 4.78 | 12.63 | 0.088 | 0.041 | 0.033 | 0.288 | 0.239 | 0.691 | 0.555 | 1.150 |
| Fall | 47.80 | 5.25 | 19.87 | 0.122 | 0.279 | 0.110 | 2.340 | 0.072 | 0.264 | 4.168 | 0.831 |
| Annual | 140.54 | 4.94 | 15.67 | 0.106 | 0.144 | 0.065 | 1.200 | 0.164 | 0.536 | 2.145 | 0.969 |

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 | 22.66 | 4.64 | 13.58 | 0.070 | 0.026 | 0.014 | 0.238 | 0.119 | 0.954 | 0.416 | 0.927 |
| Spring | 22.63 | 4.80 | 12.21 | 0.114 | 0.034 | 0.035 | 0.185 | 0.308 | 1.056 | 0.327 | 1.147 |
| Summer | 60.41 | 4.61 | 14.47 | 0.072 | 0.015 | 0.011 | 0.051 | 0.243 | 0.947 | 0.129 | 1.300 |
| Fall | 24.66 | 4.97 | 9.62 | 0.070 | 0.056 | 0.094 | 0.436 | 0.094 | 0.520 | 0.764 | 0.607 |
| Annual | 131.86 | 4.73 | 12.24 | 0.077 | 0.027 | 0.031 | 0.171 | 0.197 | 0.841 | 0.319 | 1.006 |

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).

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

Figure 3
 Sulfate (SO₄) NADP/NTN Site NJ99 (Washington Crossing State Park)
 Annual Wet Depositions (1981 - 2009)
 Kilograms Per Hectare (kg/ha)

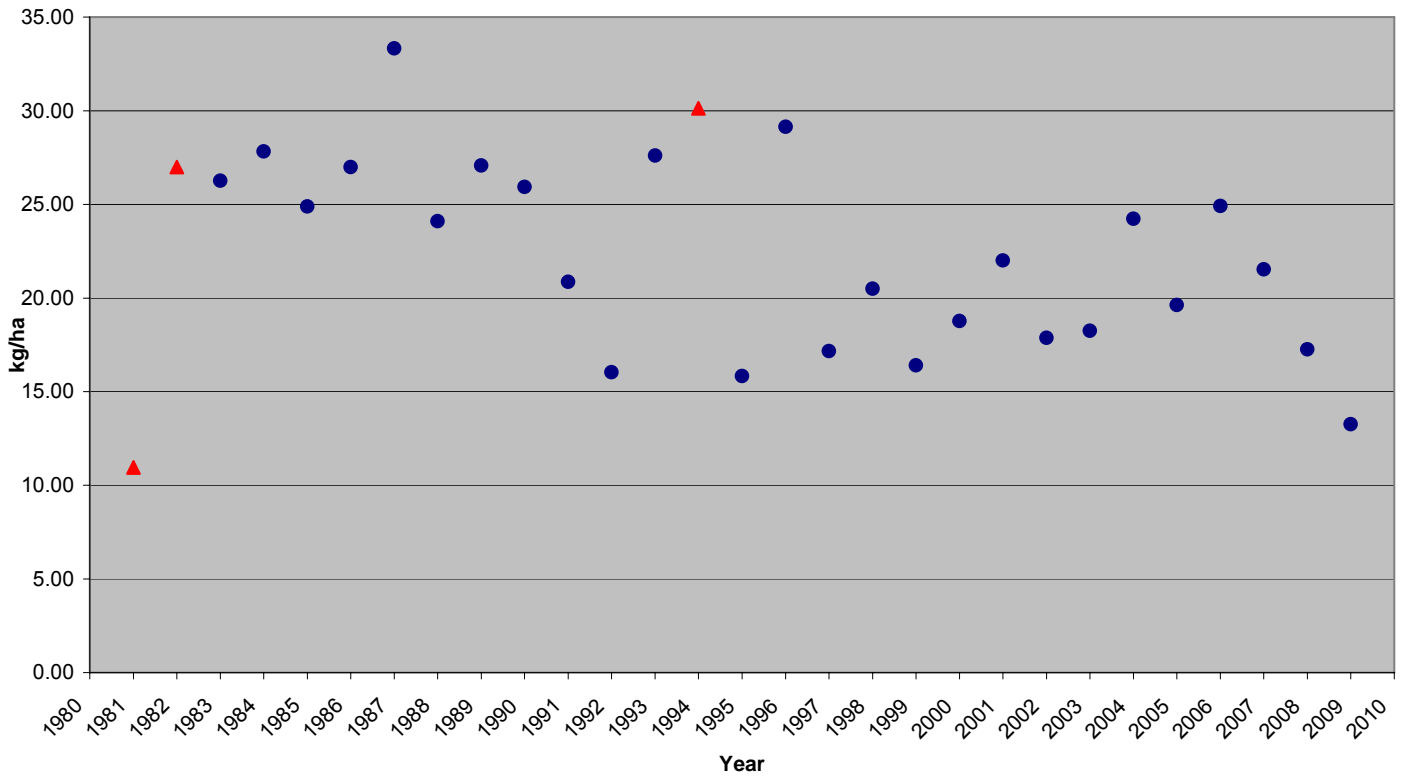


Figure 4
 Sulfate (SO₄) NADP/NTN Site NJ00 (Edwin B. Forsythe National Wildlife Refuge)
 Annual Wet Depositions (1998 - 2009)
 Kilograms Per Hectare (kg/ha)

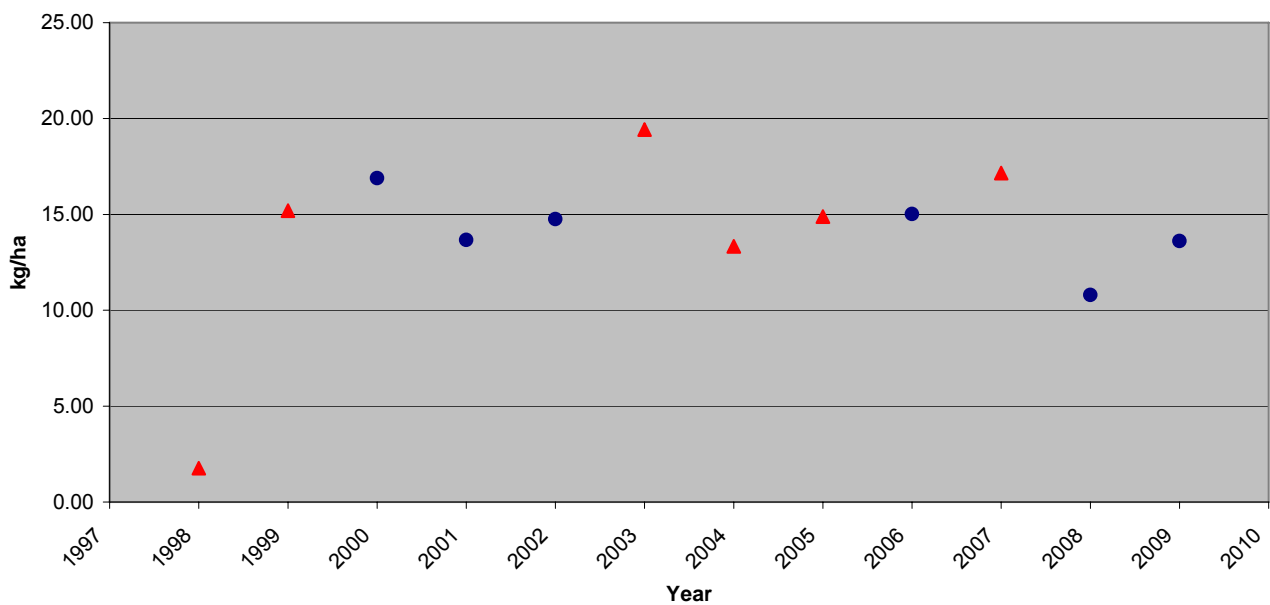


Figure 5
Ammonium (NH₄) NADP/NTN Site NJ99 (Washington Crossing State Park)
Annual Wet Depositions (1981 - 2009)
Kilograms Per Hectare (kg/ha)

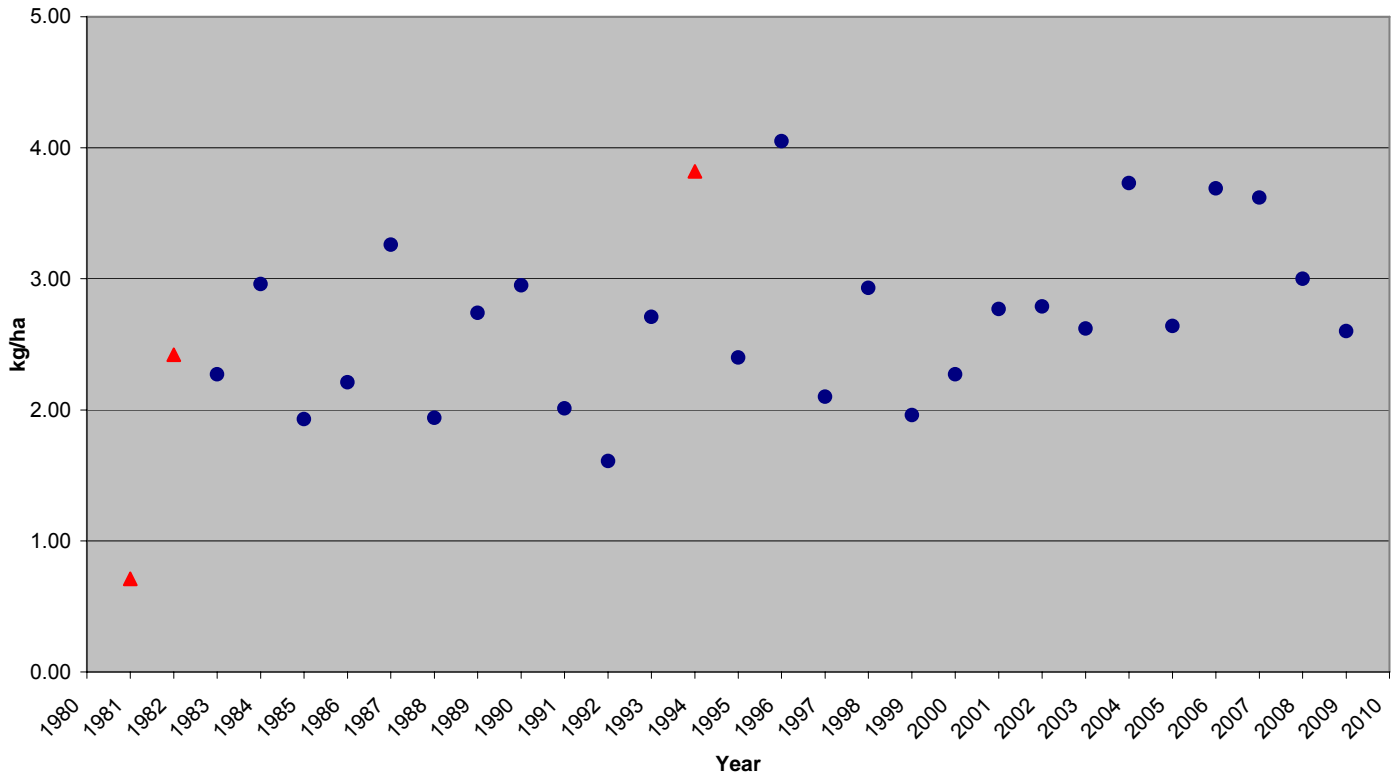


Figure 6
Ammonium (NH₄) NADP/NTN Site NJ00 (Edwin B. Forsythe National Wildlife Refuge)
Annual Wet Depositions (1998 - 2009)
Kilograms Per Hectare (kg/ha)

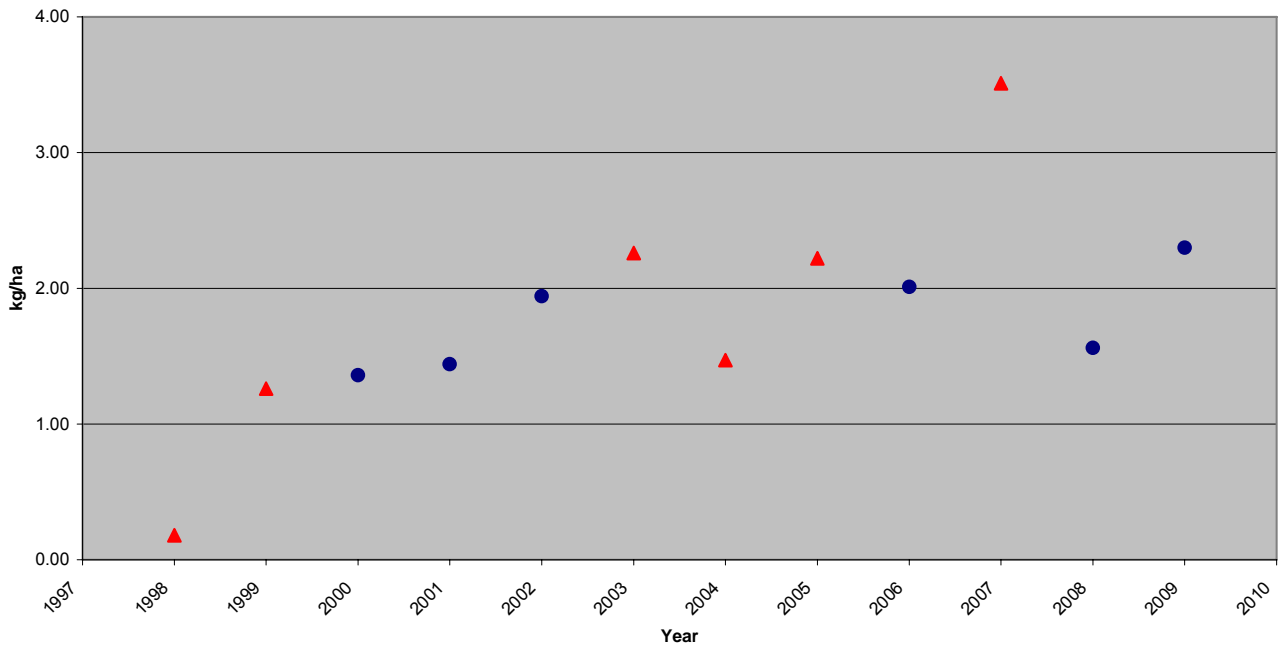


Figure 7
Nitrate (NO₃) NADP/NTN Site NJ99 (Washington Crossing State Park)
Annual Wet Depositions (1981 - 2009)
Kilograms Per Hectare (kg/ha)

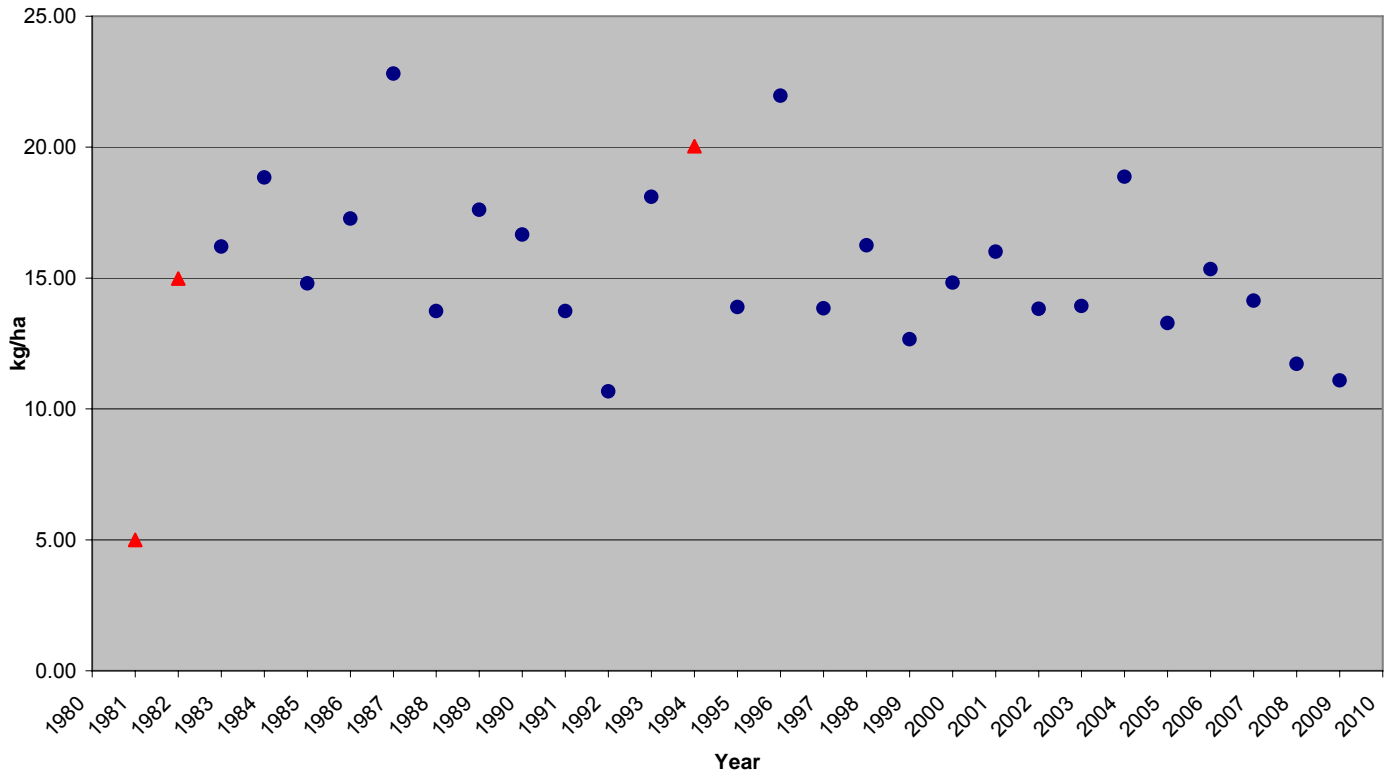
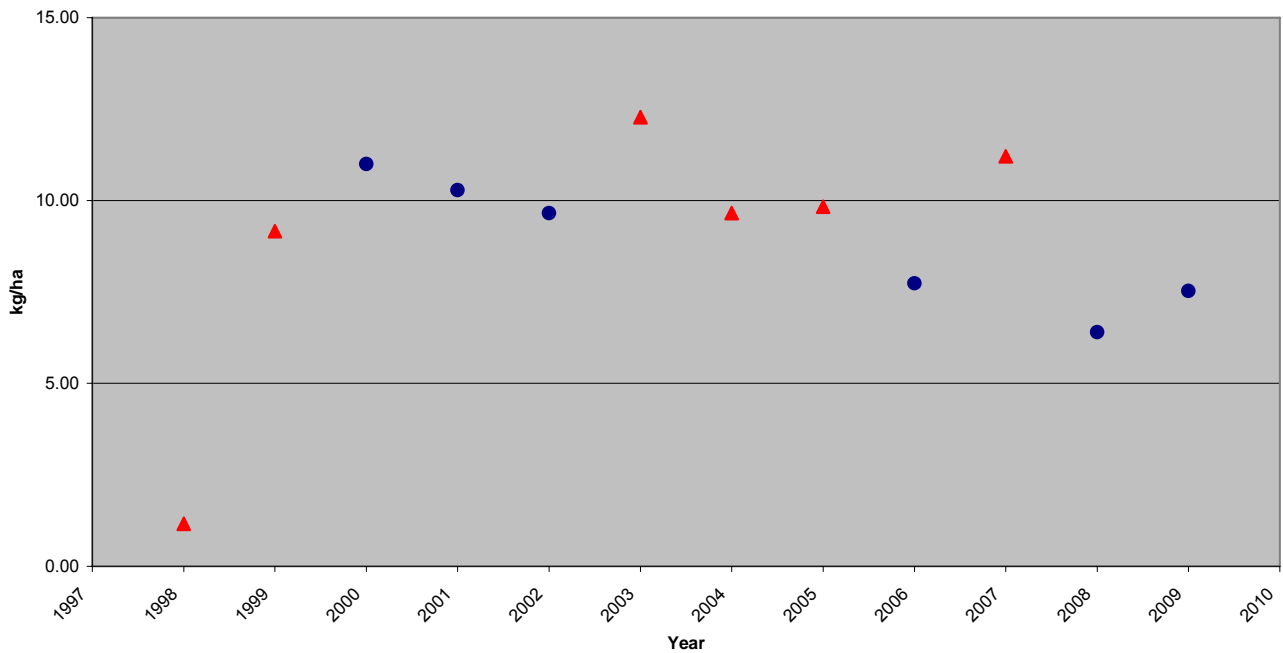


Figure 8
Nitrate (NO₃) NADP/NTN Site NJ00 (Edwin B. Forsythe National Wildlife Refuge)
Annual Wet Depositions (1998 - 2009)
Kilograms Per Hectare (kg/ha)



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