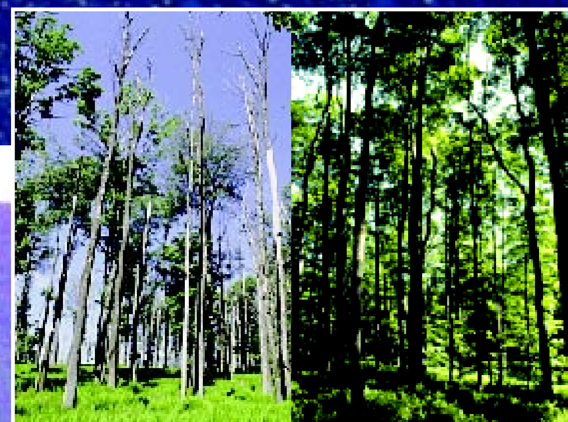
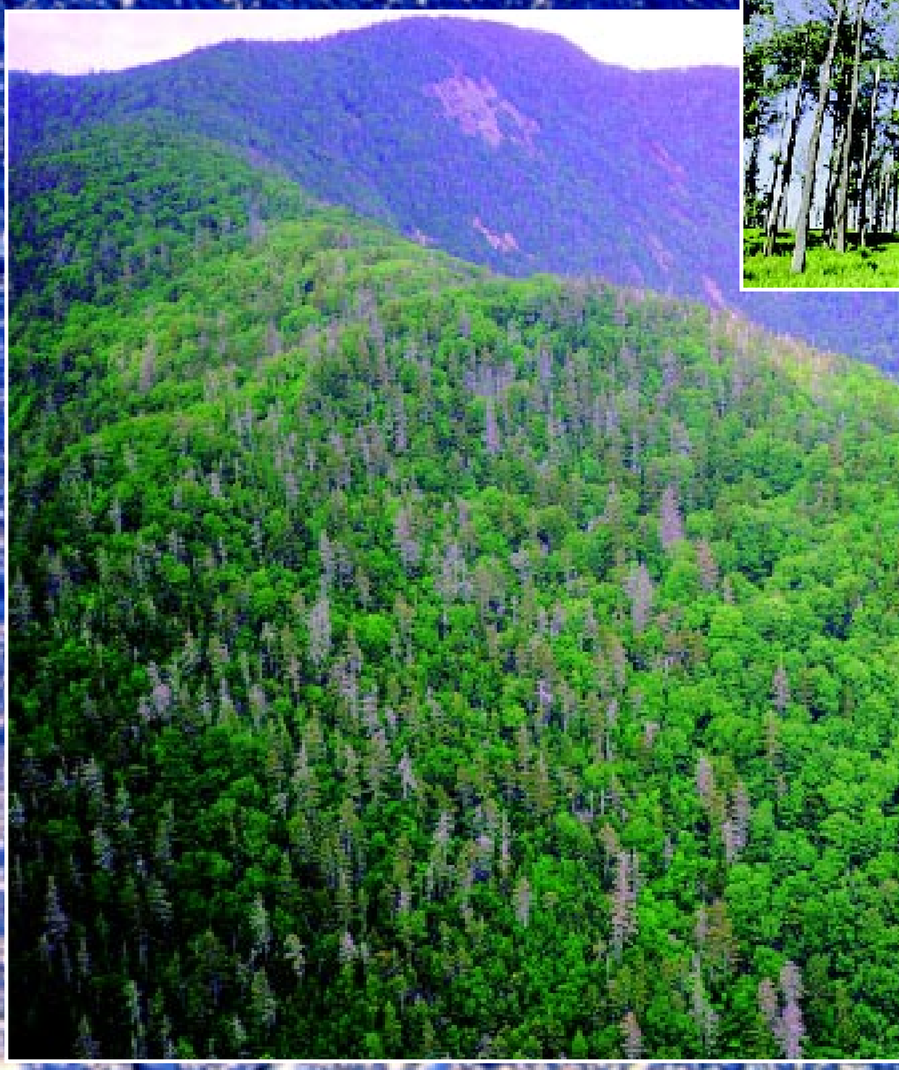
A CLEAR THE AIR REPORT

Unfinished Business: *Why the Acid Rain Problem Is Not Solved*





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Executive Summary

Over a decade ago, widespread damage from acid rain to forests and waters prompted government action to reduce the threat. In North America, the US Clean Air Act, the Eastern Acid Rain Program in Canada and cooperative agreements between the US and Canada led to significant declines in emissions of sulfur dioxide across large regions of North America. With the passage of the 1990 Clean Air Act Amendments, many hoped that its 50 percent reduction in sulfur dioxide (SO_2) emissions – a cut of 10 million tons – and a reduction of two million tons of oxides of nitrogen (NO_x) from the utility industry would be enough to support swift recovery of ecosystems damaged by acid rain.

What is acid rain?

Acid rain is the common term used to describe wet, dry and fog deposition of sulfates and nitrates. When sulfur dioxide and nitrogen oxides are emitted through the burning of fossil fuels into the atmosphere, they come into contact with water where they are converted to sulfur and nitrogen based acids, which can be as acidic as lemon juice.

There is no question that legislation to date has made a positive difference. Reductions in emissions of acidic compounds have been followed by reductions in deposition, and chemical improvements in some soils and waters have been documented.[1] But despite the emissions reductions, the problem of devastated forests, lakes, streams and ecosystems due to acid rain has not been solved. A growing body of evidence shows that without significant additional cuts in acid rain-forming emissions many of the problems associated with acid rain will persist for many, many decades.

The reason for this is that even with current and anticipated reductions, emissions are still much higher than pre-industrial levels. Over the past 150 years, millions and millions of tons of acidic compounds have fallen to the earth's surface. This long history of acid burden means that ecosystems throughout North America remain damaged and at risk.

Since passage of the Clean Air Act Amendments of 1990, scientists better understand ways in which acid rain alters ecosystems. We now know that if we are to reverse the chemical effects of acid rain accrued over a century and a half, we must further reduce emissions of acidic compounds.

This report documents that:

Acid rain is still a major problem

Even after the cuts required by the current Acid Rain law have taken place:

- Atlantic salmon populations will continue to decline in Nova Scotia.[2]
- Nearly 100,000 Canadian lakes will be damaged.[3]
- Acid-sensitive streams in New York's Catskill and Adirondack Mountains will be too acidic to support a diversity of aquatic life.[4]
- Thirty percent of brook trout streams in Virginia will not be able to support brook trout.[5]
- Reductions in fish diversity will persist in northwest Pennsylvania.[6]
- Declining vigor of red spruce and sugar maple will likely occur in other tree species as well.[7]

Greater emission reductions will be needed to support recovery

Analyses conducted at sites in New Hampshire, New York and Virginia indicate that only with deeper cuts in emissions of acid compounds – up to 80 percent beyond Clean Air Act Amendments of 1990 – will biological recovery be able to begin by mid century in acid-sensitive areas of North America.[8,9,10]

WILLIAM SHARPE, PENN STATE UNIVERSITY

Acid rain contributing to crown death in this Pennsylvania sugar maple stand.

Economical technology is available to achieve the level of deep reductions needed

The needed reductions can come today from a mixture of energy options including expansion of the nation's use of energy efficiency, clean renewables, cleaner fuels and pollution control equipment.

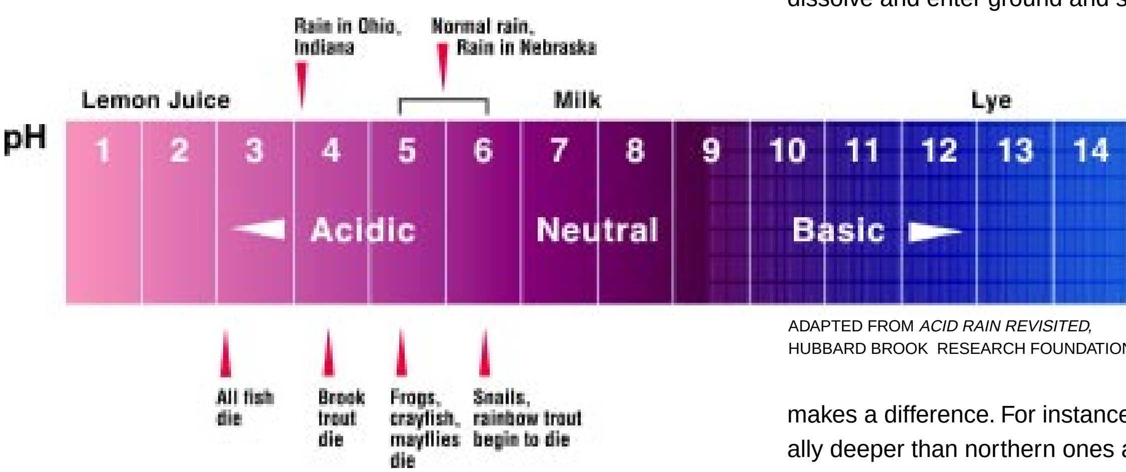
Acid Rain Means Strong Acids Hit the Earth's Surface

When sulfur dioxide and nitrogen oxides are emitted into the atmosphere, they come into contact with water where they are chemically converted to acidic compounds of sulfates and nitrates. These strong acids are deposited onto the earth's surface as rain, snow and fog and through dry deposition. While acidic deposition is the more accurate term, acid rain is used more commonly.

Acid rain comes from the burning of fossil fuels

Sulfur, an impurity found in coal and oil (and in trace amounts in natural gas), is released when fossil fuels are burned, largely for electricity production and industrial processes. Oxides of nitrogen are released during burning of all fossil fuels, including gasoline and diesel fuel, when the nitrogen in the fuel and atmosphere reacts with oxygen.

Figure 1 –
pH Scale and Wildlife Tolerance



ADAPTED FROM *ACID RAIN REVISITED,* HUBBARD BROOK RESEARCH FOUNDATION

pH scale measures acidity

The pH scale, which goes from 0 to 14, is used to measure acidity. A pH of 7 is neutral. The lower the number, the more acidic, and the higher the number the more basic (alkaline). The pH scale is logarithmic which means that the difference between each number is not linear. Instead, a pH of 5 is 10 times more acidic than a pH of 6, and a pH of 4 is 100 times more acidic than a pH of 6.

The pH of normal precipitation is slightly acidic, about pH 5.5. The fact that normal rain is slightly acidic is due to the presence of carbon dioxide in the atmosphere.[11] The map, Figure 2, the most recent annual data from the National Atmospheric Deposition Program (NADP) shows that in 1999 there were many parts of the US where the annual, average pH of wet precipitation was below 4.5, ten times more acidic than normal precipitation.[12] For the average pH to be in the low fours, some rain events have to be even more acidic than that. Since 1999, NADP data show weekly pH values of wet deposition (rain or snow) have fallen below four – the acidity of tomato and orange juice – in many states, including Ohio, Indiana, Illinois, Pennsylvania, Maryland, Virginia, West Virginia, Kentucky, North Carolina, Tennessee, Georgia, South Carolina, New York, Vermont, Maine, Connecticut, New Hampshire, Massachusetts, New Jersey.[13]

Acid rain affects soil chemistry

Soils contain many substances including aluminum, calcium and magnesium. When acid compounds enter soils, there is some plant uptake, and some of the compounds move into ground and surface waters. Still others stick to soil particles and, in doing so, replace calcium and magnesium, which dissolve and enter ground and surface waters during rains and snowmelt. Acids also mobilize aluminum – which is abundant in soils in a harmless, organic form. Once released, however, the organic form is converted to inorganic aluminum, which is toxic to living organisms.

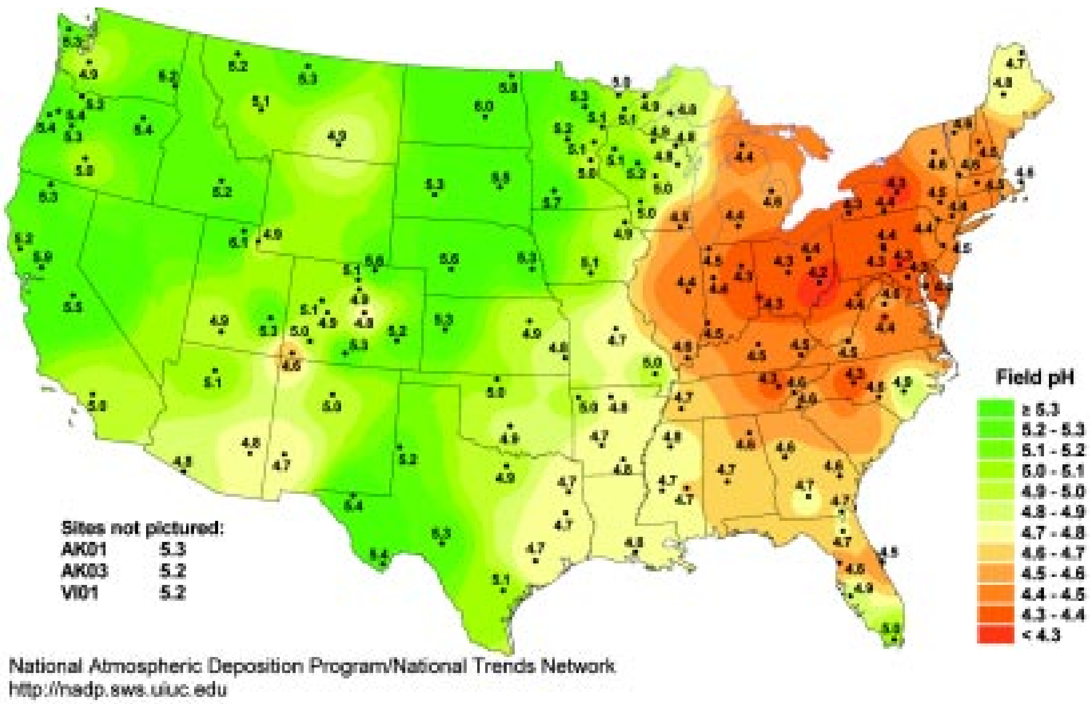
Soil depth also makes a difference. For instance, southern soils are generally deeper than northern ones and create a more effective buffer against acid damage. Some southern soils are just now becoming acid saturated and are no longer able to retain acids. As a result, acid levels in waters in the southeast US are now increasing.[14]

Site sensitivity depends on deposition and geology

How a site is affected by acid rain depends on the levels and history of acid deposition, combined with its "sensitivity" or ability to neutralize acidic inputs. The most sensitive sites lack soils that are able to neutralize the acidic inputs. Soils with good neutralizing capacity are rich in base cations, mostly calcium and magnesium.

Figure 2 –

pH of Wet Deposition 1999



Most sensitive sites receive deposition that exceeds the soils' ability to neutralize acids. Many of these occur downwind of emission sources, often in mountains where soils are thin as well as poorly buffered, i.e. low in basic compounds. These high elevation sites are also more vulnerable because mountain fog is frequently more acidic than rain.[15]

In the US, the areas that combine acid rain and little neutralizing capacity are located at high elevations east of the Mississippi. These are: the southern Blue Ridge Mountains of eastern Tennessee, western North Carolina and northern Georgia; the mid Appalachian Region of eastern West Virginia, western Virginia and central Pennsylvania; New York's Catskill and Adirondack Mountains; the Green Mountains of Vermont; and the White Mountains of New Hampshire.

In some cases, extremely poor buffering capacity means that the site cannot even neutralize small increases in acidity. This condition exists along the coast of Nova Scotia.

Many sites also display moderate sensitivity, such as cation-poor sandstone soils in southern Indiana and Ohio[16] and calcium-depleted soils in Georgia, South Carolina and North Carolina.[17]

Some of the least acid sensitive sites in the country are located in parts of the Great Plains where acidic deposition is relatively low, and there are deep, calcium-rich soils. In these well-buffered soils, large stores of calcium and magnesium can handle acid inputs with little apparent impact for decades or sometimes even centuries. However, even in these cases, 150 years of acidic deposition means retention of acidic compounds well above historic backgrounds.[18]

Chronic acidification, episodic acidification and Acid Neutralizing Capacity (ANC)

Acid Neutralizing Capacity (ANC) is the term used to describe the ability of a water body to counteract or neutralize acid deposition. ANC is measured in microequivalents per liter (µeq/L). When lakes and streams have an ANC that is always below 0 µeq/L, there is no ability to neutralize acidic inputs, and the waterbody is considered chronically acidic. More commonly, there are short bursts of high acidity that come after snowmelt or heavy rains when the ANC falls below 0 for hours or even weeks. These surface waters are described as being episodically acidic. This "acid shock" usually occurs in the spring often before the growing season but can occur in the fall as well. Surface waters with ANC values greater than 50 are considered insensitive to inputs of acidic deposition. Although ANC values above 50 are common in North America, acid-sensitive sites often have ANC values below 0.

Chemical Changes to Soil and Water Can Be Toxic to Aquatic and Terrestrial Systems

Aquatic systems

Aquatic species are affected both by episodic and chronic acidification. The more acidic a lake or stream becomes, the fewer species it can support. Plankton and invertebrates are among the first to die from acidification, and when the pH of a lake drops below 5, more than 75 percent of its fish species disappear.

Acid rain gives fish heart attacks.

In fish, the toxic aluminum released from soils due to acid rain disrupts the salt and water balance in the blood. As a result, water moves from blood plasma to the red blood cells, causing the red blood cells to swell and burst. This doubles the thickness of the blood, turning it into the consistency of peanut butter. The fish's heart cannot pump such thick blood, and the fish is deprived of oxygen. If the acid waters don't kill the fish, the toxic aluminum will.

Some aquatic species can handle acidic conditions. Many others, though – mayflies, some crayfish, lake trout – decline as pH decreases. The result is that biological communities in acidified lakes have fewer species (less biodiversity) than water bodies that are not acidic. This reduction in biodiversity matters. As diversity is diminished, ecosystems become less stable and productive. When diversity is lost, the quality of life for all is diminished, and there is a greater risk that critical parts of the cycle of life will fail.[19]

While brook trout are often the species referred to when studying damage to fisheries from acidic deposition, Figure 1 illustrates that by the time brook trout are impacted, waters have already become unsuitable for many other aquatic species.

Major problems to aquatic life from acidic rain include:

Loss of Atlantic salmon in Nova Scotia and Maine. Salmon spend their early years in fresh water and mature years in the ocean. Atlantic salmon habitat in Nova Scotia rivers has been devastated by increased acidity. A study of 49 rivers that historically supported salmon found populations to be extinct in 14 rivers and severely impacted in 20. Loss of salmon is correlated with increased acidity.[20] Preliminary work suggests that episodic acid deposition has also contributed to the decline of Atlantic salmon in Maine, with the greatest impact occurring in smolts and fry.[21]

Damaged Canadian watersheds, located primarily in southern Ontario and Quebec, have not responded to reductions in sulfate deposition as well or as rapidly as those in less-sensitive regions. At the current sulfur deposition levels, roughly 95,000 Canadian lakes will continue to be damaged by acid deposition.[22] Acid rain has resulted in large losses of fish and aquatic communities in over 30,000 sensitive lakes in Ontario and Quebec.[23]

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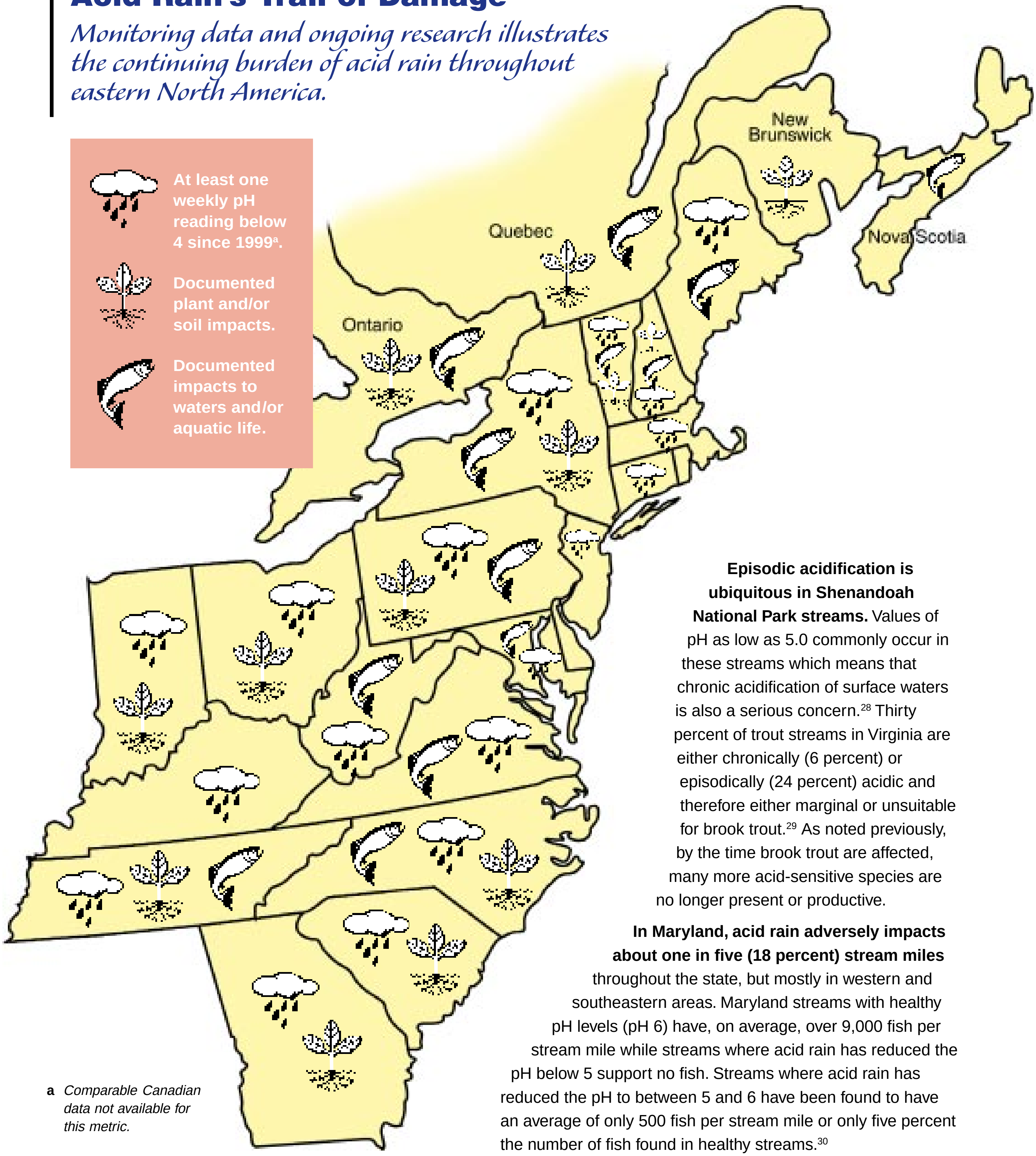
In Vermont, 35 lakes have been identified as sensitive and impaired by acidification and declines in base cations in soils.[24]

Forty one percent of lakes in the Adirondack region of New York are either chronically or episodically acidic. The same holds for 15 percent of lakes in New England. Nearly 25 percent of surveyed lakes in the Adirondacks (representative of the range of lakes in the region) do not support any fish, and many others have less aquatic life and species diversity than less acidic lakes.[25] The Catskill Mountains contain many streams with low ANC. Ten years of sampling at four streams indicates a lack of any recovery despite decreases in sulfate deposition and less acid rain.[26]

Reduction in fish diversity in northwest Pennsylvania is linked to aluminum leaching from soils due to acid rain. A comparison of fish data collected in the Allegheny Plateau and Ridge and Valley region 40 years ago to data collected in the mid 1990s found an overall decrease in species diversity, with the most dramatic declines occurring in five species of non-game, acid-sensitive fish. Streams experiencing a loss of species had greater increases in acidity and more episodic acidification than streams that either gained or had no change in species.[27]

Acid Rain's Trail of Damage

Monitoring data and ongoing research illustrates the continuing burden of acid rain throughout eastern North America.



Episodic acidification is ubiquitous in Shenandoah National Park streams. Values of pH as low as 5.0 commonly occur in these streams which means that chronic acidification of surface waters is also a serious concern.[28] Thirty percent of trout streams in Virginia are either chronically (6 percent) or episodically (24 percent) acidic and therefore either marginal or unsuitable for brook trout.[29] As noted previously, by the time brook trout are affected, many more acid-sensitive species are no longer present or productive.

In Maryland, acid rain adversely impacts about one in five (18 percent) stream miles throughout the state, but mostly in western and southeastern areas. Maryland streams with healthy pH levels (pH 6) have, on average, over 9,000 fish per stream mile while streams where acid rain has reduced the pH below 5 support no fish. Streams where acid rain has reduced the pH to between 5 and 6 have been found to have an average of only 500 fish per stream mile or only five percent the number of fish found in healthy streams.[30]

a *Comparable Canadian data not available for this metric.*

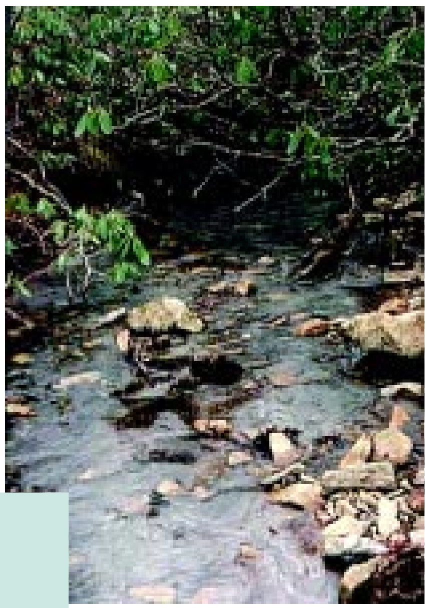
West Virginia streams are experiencing fish kills and changes to their insect populations as a result of chronic and episodic acidity. Roughly 10 percent of the total stream miles are affected by acid rain.[31]

Some of the highest deposition of sulfates and nitrates in the country fall in the Great Smoky Mountains National Park, and it is one of the few places where sulfate deposition has remained largely unchanged over the past decade.[32] As a result, streams there are very sensitive to acidic deposition. Many high elevation streams currently are acidic, with ANC values falling below 0.[33]

Paine Run: An Endangered River

In April 2001, American Rivers listed Virginia's Paine Run River, located in the Shenandoah National Park, as one of the nation's most endangered rivers. The stream made the Most Endangered list because, without further cuts in nitrogen and sulfur, Paine Run will become too acidic to sustain populations of brook trout and other aquatic organisms. This listing came eight years after American Rivers identified the St. Mary's River in the nearby George Washington National Forest as one of the most threatened rivers in the country because of damage it had suffered from acid rain.[34] When a river loses fish, communities lose tourism dollars as people go elsewhere for better fishing opportunities.

MIKE O'NEILL, JAMES MADISON UNIVERSITY



MIKE O'NEILL, JAMES MADISON UNIVERSITY

Liming on St. Mary's River in Virginia (l & r).

Can liming help?

One way to reverse the acidity of streams and lakes badly damaged by acid deposition is to add buffering agents. At selected sites in northern Europe and the United States, lime (a calcium-based material) is added directly to streams and lakes to lower the acidity and make waters more habitable for fish and other aquatic life. As an example, the US Forest Service has resorted to depositing limestone in the St. Mary's River in an effort to reduce the acidity of the stream enough to restore the native fish populations. The West Virginia Department of Natural Resources is liming streams to offset the damage from acidic deposition. However, as long as acid rain continues, the limestone-induced reduction in acidity can only be an expensive and temporary solution.

A long history of acid burden means ecosystems throughout North America remain damaged and at risk.

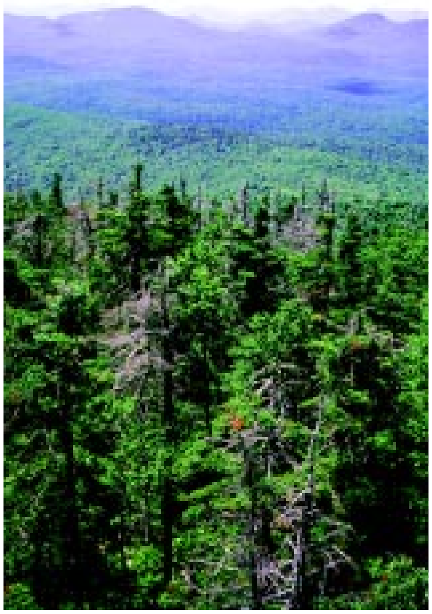
Acid Rain Injures Forests and Trees

Because trees are exposed to many stresses over the course of their long lives, it is not always easy to isolate the role acid rain plays in forest health. However, there is evidence the stress from acid rain makes trees less hearty and less able to resist other stresses, such as insects, disease and drought.

Red spruce have declined throughout the Appalachians.

Acid rain is the major cause of red spruce mortality at high elevation sites in the Northeast.[35] Since the 1960s, more than half of the large canopy red spruce have died in the Adirondack mountains of New York and Green Mountains of Vermont, and roughly 25 percent have died in the White Mountains.[36] There is evidence of damage and mortality in the southern Appalachians as well.[37,38] Acid rain affects red spruce both indirectly via changes in soil nutrients and directly when acidic fogs and rain leach calcium directly from needles, leaving the membranes of the needles unable to handle freezing temperatures.[39] Red spruce is an important commercial tree species found from the Canadian Maritimes south through the southern Appalachians. These trees also form an integral part of certain high elevation forest communities in the eastern US.

MIKE STOREY, ADIRONDACK PARK AGENCY



Dead red spruce in Adirondack Park.

Sugar maple stressed through much of its range.

Sugar maple, known from the mid Atlantic states through Canada for its colorful foliage, maple syrup and lumber value, is experiencing deteriorating health in many parts of its range. The dollar value of the sugar maple is huge. In Vermont alone, the economic value of sugar maple trees and products is estimated at over $110 million annually.[40]

In Pennsylvania's Allegheny Plateau and Ridge and Valley regions, sugar maples are suffering from poor regeneration, loss of tree vigor, and excessive mortality.[41] Acid rain plays a role in this decline.[42] Acid rain induced leaching of calcium and magnesium from soils has meant that sugar maples growing in already nutrient-poor sites have less calcium and magnesium in their leaves. As a result they have been less able to recover from insect infestations and drought.

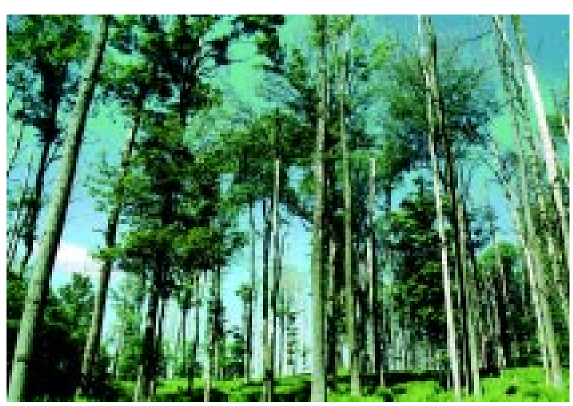
In Ontario and Quebec, a decline in soil nutrients due to acidic deposition is occurring in sugar maple-dominated hardwood forests. This nutrient loss has already contributed to the decline in sugar maple seedlings. Continued soil nutrient loss from current levels of deposition will result in a decline of forest ecosystem productivity.[43]

Poor sugar maple health that is likely associated with acid rain has also been observed and is currently being studied at other sites in New England and in New York.[44]

Birch, Tulip Poplar, White Ash, and Basswood also impacted.

Although most of the work associated with tree decline has focused on sugar maple and red spruce, acid rain injures other tree species as well.

There is indication that the nutrient imbalances associated with sugar maple decline may be causing similar disturbances to white ash and basswood.[45] White birch and mountain paper birch are in decline in the Bay of Fundy on Canada's east coast. Acid fog – which is common in the area – is believed to be the primary stressor causing this decline.[46] Experimental work has found that tulip poplar seedlings have a low threshold for aluminum toxicity. Tulip poplar is a major tree species in southern Appalachian forests and is located in a region that receives considerable inputs of acid rain.



SCOTT BAILEY, UNIVERSITY OF NEW HAMPSHIRE

Premature dieback of sugar maples.

Impacts to Wildlife Could Be Widespread

In places where soils, forests and waters are affected by acidic deposition, the same combination of increased acidity, low alkalinity and more available aluminum can place wildlife at risk both directly and as a result of alterations to food sources and habitats.

Amphibians

Because amphibians require both aquatic and terrestrial environments, they can be particularly susceptible to acid rain induced alterations to habitat and food sources. During the larval stages (just after hatching), aquatic amphibians are most affected by acidic water. Unfortunately, this stage often follows the period of highest water acidity that occurs following snowmelt in the spring. Limited surveys conducted in the eastern United States found lethal levels of pH in waters in 10 to 15 percent of the temporary ponds where sensitive species of amphibians lay their eggs.[47] An additional 10 to 14 percent had pH levels low enough to have other effects such as delayed growth in tadpoles and immune system suppression.[48]

There is also evidence that soil acidification influences the many species of salamander that breed and spend their entire lives in the soil. Not only are eggs affected, but also the distribution and abundance of adults are decreased. A study in New York showed that soil pH influenced the distribution of 11 out of 16 local amphibian species.[49] In the acid-sensitive areas of eastern Canada, more than half of the habitats of 16 of the 17 of the amphibian species there have been affected by acid rain.[50]

Birds

Acidification of the terrestrial and aquatic environments can affect bird populations via a number of pathways, including alterations in diet and food availability, changes to habitat and subsequent impacts on reproduction. For aquatic birds, there is evidence of adverse impacts from acidity to common loons, common merganser, belted kingfisher, osprey, American black duck, common golden-eye, ring-necked duck, eastern kingbird and tree swallow.[51] Diminished fish stocks from acidic deposition are believed to be playing a role in the impacts occurring to fish-eating birds.[52]

For other terrestrial birds, research undertaken in southern Quebec explored the relationship between changes in forests due to increased acidification and birds. The researchers found that where there was a reduction in canopy cover, the number of canopy birds declined as well.[53] The Birdhouse Network (TBN), a citizen-science project at Cornell University studying cavity-nesting birds, is undertaking a study to determine whether acid rain is a contributor to the high number of unhatched eggs found in 1999 and in particular to eggs that did not hatch as a result of weak shells.[54] Earlier research demonstrated a relationship between acid rain, loss of dietary sources of calcium and poor reproduction in birds in the Netherlands.[55] The work suggests that calcium-deficiency, as a result of acidification, may be widespread.[56]

Acid Deposition Damages Buildings

Limestone and marble, the stones used in many buildings and monuments around the world, are especially vulnerable to acid rain. In these stones, strong acids easily dissolve calcium carbonate – the dominant mineral. Many exposed areas on buildings and statues show roughened surfaces, loss of detail in carving and dark streaks.[57] When a sculpture or building is damaged by acid rain, there is no recovery; it is permanently altered.

The marble balustrade on the west side of the Capitol building shows damage from acid rain dissolving the mineral calcite.[58]

Clean Air Act Amendments of 1990 Will Not Support Recovery

As Figure 3 shows, the Clean Air Act of 1970 and the amendments of 1990 (CAAA) have already been responsible for significant reductions in sulfur dioxide emissions. These reductions have resulted in declines in acidic deposition and some chemical improvements to soils and waters in certain areas of the northeastern US.[59] Surveys show that acidified lakes in the Adirondacks are showing signs of chemical improvement in, what appears to be, response to decreases in acidic inputs.[60] But Figure 3 also shows that even with these cuts, emissions remain high when compared to emissions a century ago. Given an accumulation of over 150 years worth of sulfur and nitrogen compounds, it is no surprise that soil build up and subsequent release into waters will continue to damage ecosystems for decades to come.[61]

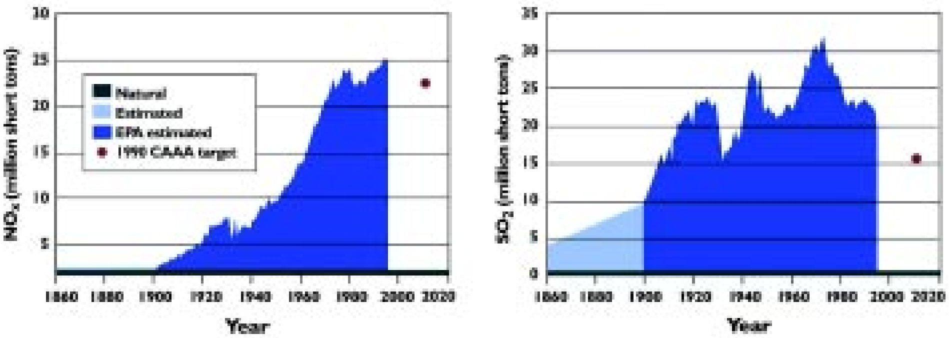
A number of scientists in North America have grappled with the question of what level of emission reductions will support recovery of ecosystems that have been damaged by acidic deposition. Modeling, combined with long-term monitoring, have yielded the following results:

- The Science Links project of the Hubbard Brook Research Foundation found that an additional 80 percent reduction by 2010 of power sector sulfur dioxide from the level required by the CAAA of 1990 would allow biological recovery to begin mid century in the Northeastern US.[63]
- A modeling analysis conducted for sensitive waterbodies in New York's Adirondacks found that substantial and timely improvements in soil and stream chemistry would occur if acid rain-forming emissions were reduced 80 percent beyond full implementation of CAAA of 1990. Aggressive controls would speed up the chemical recovery in these waters,[64] thus setting the stage for biological recovery.
- Model simulations for Shenandoah National Park project that greater than 70 percent reduction in sulfate deposition (from 1991 levels) would be needed to change stream chemistry such that the number of streams suitable for brook trout viability would increase. A 70 percent reduction would simply prevent further increase in Virginia stream acidification.[65]

Figure 3 –

Reductions Called for in the CAAA Compared to Historical Levels[62]

Total U.S. Emissions



- In the Great Smoky Mountains National Park, application of two separate ecosystem models demonstrated that sulfate reductions of 70 percent are necessary to prevent acidification impacts from increasing at sensitive sites. Deposition reductions above and beyond these amounts are necessary to improve currently degraded aquatic and terrestrial ecosystems.[66,67]
- At current levels of deposition, analyses at forest sites in the southeastern US suggest that within 80 to 150 years, soil calcium reserves will not be adequate to supply the nutrients needed to support the growth of merchantable timber.[68,69]
- To reverse and recover from acidic deposition impacts, Canadians in the Acidifying Emissions Task Group have recommended a 75 percent reduction in US power plant sulfur emissions, post CAAA of 1990.[70] Without such a reduction, 76,000 lakes in southeastern Canada will remain damaged.[71]

Chemical improvement versus achieving biological recovery

The good news that some ecosystems are beginning to show signs of improvement from acid rain damage indicates that reductions in acid inputs make a difference. There is, however, a large gap and time lag between chemical improvement and restoration of water bodies and forests to biological health. Biological recovery will come much faster and completely only after deeper cuts in emissions.

Deep Emissions Reductions Are Available and Affordable

The problem of acid rain can be solved through affordable technology available today. The optimal way of reducing acid rain causing emissions will be to expand the nation's reliance on energy efficiency, clean renewable, gas-fired energy sources and potentially the use of advanced coal technologies – sources that produce little or no acid-forming emissions. Emission control technologies are also available today that can achieve the needed reductions at the power plants themselves. For example, power sector reductions in sulfur dioxide of 75 percent beyond those required under current law are readily achievable today through a combination of flue gas desulfurization (scrubbing) and use of lower sulfur coal. Comparable nitrogen oxide reductions can be achieved through use of selective catalytic and non-catalytic reduction technology, low-NO_x burners and overfire air.

In the case of sulfur, the most common and oldest removal technology is Flue Gas Desulfurization (FGD), often referred to as scrubbers. They operate by adding lime slurry to the flue gas to capture the sulfur dioxide. The resulting by-product is a sludge that, depending on its chemical composition, either requires disposal or is reused in other products. Scrubbers have been in use for three decades and are able to remove up to 95 percent of the sulfur from the stack.[72] The capital cost of the scrubbers has fallen; cost of operation is dependent on the sulfur content of the fuel and ranges from .07 to 2.5 cents per kWh.[73] New sulfur control technologies are emerging as well.

NREL

Selective Non-Catalytic Reduction (SNCR) and Selective Catalytic Reduction (SCR) are post-combustion technologies used to control nitrogen oxides. Both use an ammonia-containing reagent to react with the nitrogen oxides produced in the boiler and convert them to harmless nitrogen and water. SNCR accomplishes this at high temperatures, while SCR operates at lower temperatures and hence needs a boost – the catalyst – to produce the reaction between ammonia and nitrogen oxides. SCR controls achieve up to 90 percent reduction while SNCR typically achieves between 30 to 40 percent removal.

Technologies to reduce nitrate and sulfate deposition remove air toxics as well. Scrubbers can cut mercury emissions an average of 50 to 55 percent,[74] hydrochloric acid emissions by 80 percent and hydrofluoric acid emissions by 30 percent.[75] Because hydrochloric acid enhances the acidity of cloud water, it contributes to acidic deposition. These acid gases also contribute to the formation of fine particles and can affect the atmospheric chemistry of mercury. This may be a factor in how long mercury remains in the atmosphere before being deposited to earth. SCRs and SNCRs, in combination with scrubbers, potentially can remove more than 90 percent of the mercury in the flue gas.[76] With each technology, co-benefits of multi-pollutant reductions are achieved at essentially zero cost.[77]

What Needs to Be Done?

Clean Up Power Plants.

Electric power generation is responsible for two thirds of the sulfur dioxide emissions and over a quarter of the nitrogen oxides in the United States. For over thirty years the oldest, dirtiest power plants have circumvented modern air emissions standards. As a result, these "grandfathered" power plants are allowed to emit as much as 10 times more sulfur dioxide and four times more oxides of nitrogen than modern power plants.

To reduce acid rain significantly, polluting power plants must be made to comply with modern emissions control standards or better, specifically, a 75 percent reduction in sulfur dioxide and nitrogen oxide emissions. Only a comprehensive approach that reduces toxic mercury and climate-warming carbon dioxide as well as nitrogen oxide and sulfur dioxide emissions will truly clear the air of the host of air pollution ills caused by power plants.

Support Long-term Monitoring.

A long-term, scientific record of air and water quality trends is essential to understand the impacts of acidic compounds and to continue to inform policy and decision makers on environmental and public health legislation.

UNIVERSITY OF GEORGIA

Call on EPA to:

Set protective air quality stantards.

Reductions in oxides of nitrogen and sulfur dioxides, accompanied by ecosystems benefits will occur if EPA applies standards that do a much better job of protecting human and ecological health.

Finalize the BART (Best Available Retrofit Technology) rule.

As a part of the Regional Haze Rule, EPA has developed guidelines requiring states to identify and clean up grandfathered power plants that cause or contribute to visibility impairment in national parks and wilderness areas. Since the pollutants that degrade visibility are the same ones that harm ecosystems, there will be a rippling beneficial effect resulting from the BART rule.

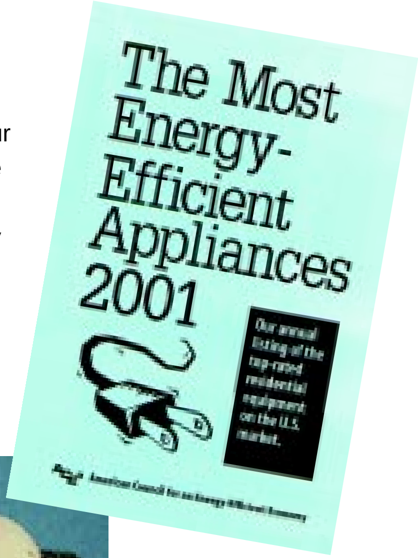
Work with the Department of Justice to pursue enforcement actions against power plants that illegally upgrade their facilities.

Numerous companies have illegally upgraded the capacities of their coal plants while evading the permitting process required to prevent deterioration of air quality in their regions. The US Department of Justice and EPA have brought enforcement actions against a number of these plants. However, these polluters are fighting the actions in court and have hired highly-paid lobbyists to seek pardons from the White House for their illegal behavior.

You can:

Use less energy.

Energy production is the primary contributor of sulfur and nitrogen in our air. The United States uses more energy per capita than any other country. Using less energy by conserving or using energy more efficiently will reduce the amount of acid rain.



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Demand energy sources with lower sulfur and nitrogen emissions.

Natural gas emits virtually no sulfur and less nitrogen than coal and oil. Increased reliance on renewable resources would, over time, result in reduced sulfur and nitrogen emissions.

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