

Conserving Biodiversity in the Northeast:

Atmospheric Deposition and Invasive Species

Prepared for:
The Nature Conservancy
Northeast Freshwaters Division
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Section 1:

INTRODUCTION

Preface

The Nature Conservancy



The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life by protecting the lands and water they need to survive. The Nature Conservancy has worked to fulfill this mission primarily by focusing on providing permanent protection to lands and waters through direct acquisition of land and facilitating the protection and management of land and water by federal, state and local government agencies. However, certain threats to natural biodiversity cannot be mitigated solely through the local protection of land and water. As part of its new Northeast Freshwater Program, The Nature Conservancy is seeking to address two such issues and develop policy and program options to mitigate these threats.

Field Projects

The core course titled *Field Projects: Planning and Practice* is required for students in the M.A. program. Students are exposed to the realities of urban and environmental planning practice by working in teams for clients from a variety of organizations, including government, community, non-government organizations, and academia, to address a unique planning and/or policy problem. The course provides practical planning and research experience and focuses on the interplay of expertise, social and political values, and professional relationships. Each student team prepares and presents a final planning and policy report called the *Field Project Report*.

Project Goal

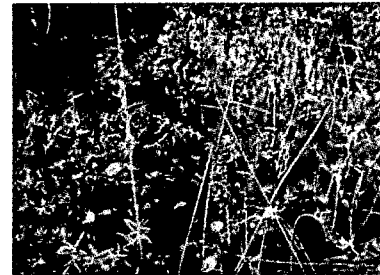
This project analyzes the extent to which atmospheric deposition and invasive/non-native species threaten the biodiversity of freshwater ecosystems in the Northeast. It also recommends specific actions regarding both issues to assist The Nature Conservancy in making decisions regarding potential priority conservation actions and provide options for how The Nature Conservancy can effectively address these issues.

In regards to these issues, the project addresses four main questions, including:

1. What information has been documented and what are the areas of scientific consensus related to the threat to freshwater biodiversity from these sources?
2. What is the current political and legal framework surrounding these issues on a state, regional, and national level? What are the current legislative, regulatory or other policy decisions being contemplated at the state, regional and federal levels related to these issues?
3. What other organizations are addressing these issues from the freshwater biodiversity standpoint and what actions are they taking?
4. For each issue, how could TNC take action?

Using the information accumulated to answer the above questions, the Tufts Team summarized the current state of understanding regarding the scientific literature and policy framework affecting these issues, postulated the severity of each issue, and recommended action that could be used to address the threats posed by invasive/non-native species and atmospheric deposition.

The Tufts Team provided a draft and this final report that accomplishes the stated goals of this project. This final report also recommends specific actions for the client to take in addressing both issues. The Tufts Team will present its findings and recommendations to the Nature Conservancy through a public lecture at the Conservancy's Boston headquarters. All researched literature, final report, and presentation will be archived on CD-R exclusively for the use of the client.



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Executive Summary

The freshwater resources of the Northeastern United States are under threat in numerous ways. The Nature Conservancy (TNC) has indicated that atmospheric deposition and invasive/non-native species are two threats to biodiversity that it wishes to address. This report investigates the two issues from both a scientific and a policy standpoint and offers recommendations for action on TNC's part.

Invasive and non-native species are a major threat to biodiversity in the Northeast. Invasive and non-native species are species of plants and animals that enter regions where they do not occur naturally and compete with the natural flora and fauna. Many invasive species were introduced into the Northeast region accidentally, but some were brought purposefully as pets or decorative plants. Non-native species are species of fish that are purposefully released in fish stocking programs to provide catch for fishermen. Both invasive and non-native species threaten biodiversity in many ways, including: displacing native species, changing water conditions, and spreading disease. Understanding the scope of this problem can be challenging because there are so many nuisance species and routes of introduction. However, many experts suggest that invasive species are the second greatest threat to biodiversity globally after habitat destruction. The current rate of species loss is 150 times higher than the natural background rate of extinction. These two facts together give a sense of the scope of this problem.

There are many regionally-based actions TNC can undertake directly to counter this growing threat. TNC can support state and federal policy that would thwart the introduction and spread of these species. It could also educate lawmakers and the public as to what can be done.

1. *Address the problem of invasive and non-native species on a regional level by creating analysis tools, designating pristine areas, influencing policy, and educating the public.*
2. *Counter the introduction and spread of invasive species on a national level through supporting new federal law and developing a public awareness campaign.*
3. *Partner with the Northeast Aquatic Nuisance Species (NEANS) panel.*
4. *Support NAISA legislation.*

5. *Promote cross-pollination of state best management practices.*
6. *Manage fish stocking programs on a national level by enacting cautionary measures and partnering with fishermen.*
7. *Battle invasive species in the global arena by addressing trade issues, improving goods inspection, and focusing on prevention.*

The three air pollutants emitted in large quantities and most harmful to the biodiversity of the Northeast are Nitrogen Oxides, Sulfur Dioxide, and Mercury. The chemicals are released into the atmosphere from various sources and fall into freshwater ecosystems as atmospheric deposition. This process threatens biodiversity by altering water conditions, making them uninhabitable by many native species. Atmospheric pollution was originally addressed by the Clean Air Act of 1963. This piece of legislation has gone through many revisions in the years since. The Clean Air Act Amendments of 1990 mandated the protection of ecosystems affected by air pollution as a vital component of preservation of the public welfare in addition to the public health. TNC now has an opportunity to shape the national debate on the future air quality of this country. Recommended actions for The Nature Conservancy include:

1. *Advocate for new legislation regulating point sources using a cap and trade framework based on critical loads.*
2. *Advocate for new legislation regulating non-point sources using a cap and trade framework based on critical loads.*
3. *Push for further international engagement on the issue of atmospheric deposition.*
4. *Concentrate data collection at TNC properties on Mercury deposition.*
5. *Educate the public about their role in the natural world with the goal of instilling a sense of the intrinsic value of biodiversity.*

The findings of this research team indicate that invasive and non-native species, as well as atmospheric deposition pose a substantial threat to Northeast freshwater biodiversity. TNC can best use its resources by addressing both of these problems simultaneously.

General Introduction

History is fraught with problems stemming from the crossing of boundaries. If unwelcome invaders moved into foreign territory, the defensive response was deliberate, forceful, and obvious. Unfortunately, cooperation between unrelated groups in the face of these invaders was a luxury in these times as poor communications, transportation, and a lack of trade between distant groups resulted in a separation of problems across artificial boundaries. It could be said that typical issues between New England states were “your problems- yours alone, not mine, and definitely not ours.”

In the present day we understand that weather systems, groundwater flow, animal migrations, trade routes, and communications are ignorant of the often arbitrary boundaries that humans have established. Cooperative efforts could aid us in preserving our natural ecosystems, but we respond too late to prevent the invading hordes of air-borne and water-borne pollutants, invasive species, undervalued trade goods, and other “cross-boundary” problems. In this era of easy transport and communication it makes sense to step back from the limiting artificial boundaries and approach the problems of the modern world with a larger scale. This strategy of regionalism has perhaps no better application than in New England, an area known for its collection of individualistic states.

Preventative action on environmental issues is the most effective land management strategy available to conservationists. The Nature Conservancy (TNC) can use preventative actions to avoid damage to its properties from invasive and non-native species and atmospheric deposition. This report outlines the threats to biodiversity presented by these invading organisms and chemicals and offers an analysis of the policy options available to TNC in its efforts to protect the biodiversity of the special places of the Northeast.

Section 2:

Science of Invasive and Non-Native

Species

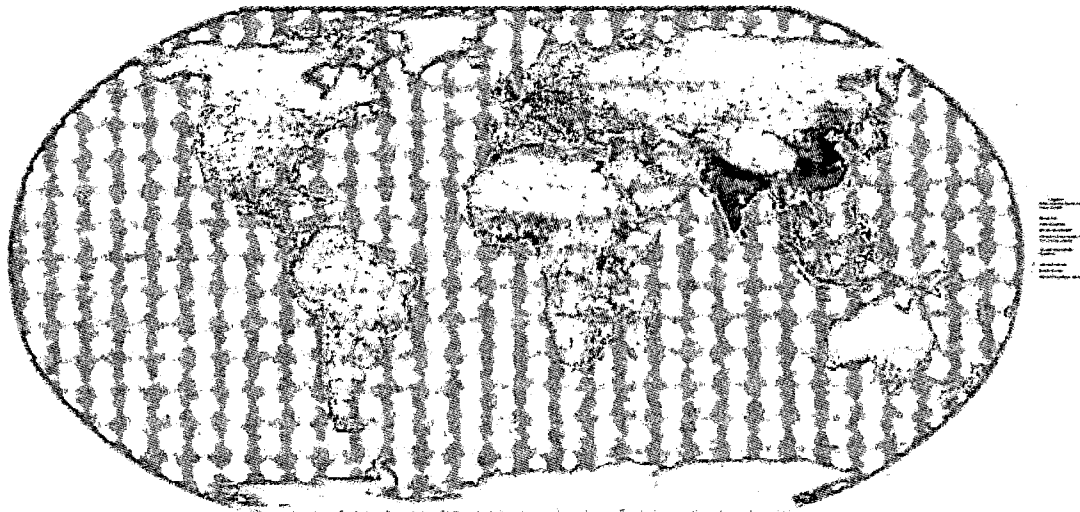
Invasive and Non-Native Species

The Scope of the Problem

Invasive and non-native species are species of plants and animals that enter regions where they do not occur naturally and compete with the natural flora and fauna. Many invasive species were introduced into this region accidentally, but some were brought purposefully as pets or decorative plants. Non-native species are species of fish that are purposefully released in fish stocking programs to provide catch for fishermen. Both invasive and non-native species threaten biodiversity in many ways, including: displacing native species, changing water conditions, and spreading disease. Understanding the scope of this problem can be challenging because there are so many nuisance species and routes of introduction. However, many experts suggest that invasive species are the second greatest threat to biodiversity globally after habitat destruction. The current rate of species loss is 150 times higher than the natural background rate of extinction. These two facts together give a sense of the scope of this problem.

There are many data bases being compiled on invasive species in the Northeast and around the globe. (See Appendix) Some of the worst aquatic invasive plants and animals in the Northeast include: Zebra Mussels, New Zealand Mudsnails, Spiny Water Flea, Rusty Crayfish, Round Gobies, Whirling Disease, Pond Water-Starwort, Hydrilla, European Watercress, Watermilfoil, Common Water-Hyacinth, Yellow Floating Heart, Flowering Rush, Water Chestnut, European Water Chestnut, Brazilian Water-Weed, and Purple Loosestrife.

To understand how the Northeast compares to the rest of the globe in terms of biodiversity lost through invasive species introduction, the UN Environmental program map below can be used as a rough guide. The map shows human population density, and protected natural areas. The human population density is shaded in red. Nature conservation areas appear as blue and green dots. (See Appendix for larger version of this map)



Global Map of Human Density and Protected Areas

Source: World Atlas of Biodiversity

<http://www.unep->

[wcmc.org/information_services/publications/biodiversityatlas/presspack/maps.htm](http://www.unep-wcmc.org/information_services/publications/biodiversityatlas/presspack/maps.htm)

In areas with the highest population density and the least amount of protected areas, biodiversity lost to invasive species tends to be a very large problem. By this approximation, the Northeastern United States has a greater problem than the Western states. However, globally, this problem is largest in India and Eastern China¹

Invasive Plants:

Strategies of Reproductive Success

Invasive plant species tend to be hardy and aggressive. Their strategies of reproductive success include:

- clonal spread (plant fragmentation)
- highly adaptive production of seeds, turions, sporocarps, rhizomes, or stolons
- longevity of seeds
- self-pollination
- bird dispersal
- vehicular dispersal
- tolerance for extreme environmental conditions such as wide variance of light, temperature, pH levels, eutrophy, and salinity
- domestic/decorative plant escape

Threats to Biodiversity

Invasive plant species may threaten native biodiversity in a number of ways, including:

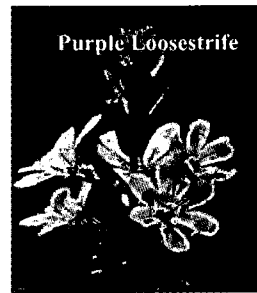
- locally dense mats of vegetation choke or shade out native vegetation
- plant alters water conditions in terms of dissolved oxygen level, pH, flow, or temperature
- monotypic stands exclude native plants
- plant completely congests waterways, or completely fills water column
- plant harbors mosquitoes²

Purple Loosestrife

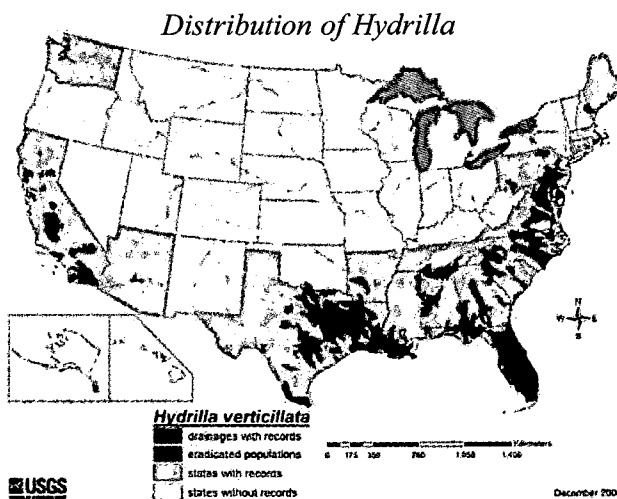
Purple loosestrife colonized the Northeast in the early 19th Century. Brought from Europe for medicinal purposes, it spread across most of the continent, aided by industrial canals and road traffic. This perennial reproduces through prolific seed production, and is managed by cutting, burning, and herbicide. Since it regenerates from the rootstock, all vegetative material must be removed by hand for its control. Purple loosestrife threatens native wildlife through taking space from resident plants, altering the water properties, forming monotypic stands, and disrupting the food chain.³

Strategies of Mitigation

Currently, invasive plant species are controlled in a variety of ways. These include large-scale mechanical removal, small-scale removal of all plant parts by hand, and herbicides. Biological controls have also been used, which may involve importing the invasive's native predatory insect species and releasing them into the wild. These insect may keep the plant from raging out of control. Other mitigation methods involve creating stringent legal policy for handling foreign plants, or for carefully cleaning boats and equipment that travel between various water bodies.⁴



Source:
InvasivePlants.net :
Purple
Loosestrife
<http://www.invasiveplants.net/plant/purpleloosestrife.htm>



Source : USGS: Non-Indigenous Aquatic Species
http://nas.er.usgs.gov/plants/docs/hy_verti.html

Hydrilla

The *Hydrilla verticillata*, originally from the Indian sub-continent, was brought to the U.S. in the 1950s as an aquarium plant. It has plagued the southern states for many decades and has more recently been found in southern Connecticut and Cape Cod. The submerged, aquatic perennial reproduces both through seeds and fragmentation. It threatens biodiversity through its dense mats, which choke out other plants, and through altering the water conditions of pH and dissolved oxygen. Because it grows rapidly, and can survive wide ranges of light, pH conditions, and salinity, it is very difficult and expensive to control.⁵

Invasive Animals:

Strategies for Reproductive Success

Invasive animals often out-compete native species as reproducers. Their strategies include:

- rapid reproduction
- ability to mass in high density
- small size enables hitchhiking (shellfish, fish eggs)
- ability to rapidly attach to introduced surfaces, and native mussel populations (shellfish)
- hardiness (able to survive desiccation, parasites, disease, and variance temperature, pH levels, eutrophy, and salinity)
- asexual reproduction

Threats to Biodiversity

These animals can sometimes devastate native biodiversity through a variety of behaviors. Many of these species can:

- aggressively compete for food/resources
- change physical characteristics of water body
- disrupt the traditional aquatic food chains
- clean/filter water
- increase wildlife exposure to organic pollutants
- are difficult for fish to digest when eaten
- are less nutritional than replaced native species
- consume or displace plant bodies that make up breeding grounds for other creatures
- act as fish parasites or diseases
- cause populations of large predators to dwindle – prey populations grow out of control⁶

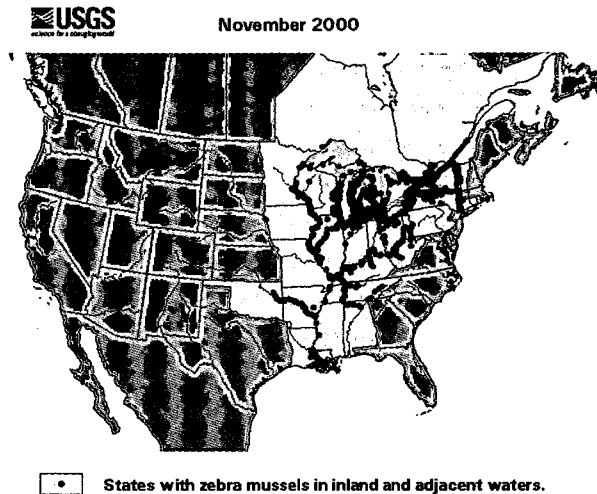
Zebra mussel

Zebra mussel has long been recognized as one of the most destructive invasives in the Northeast and Great Lakes region. This freshwater mollusk can rapidly colonize a water body through its ability to attach to almost any hard underwater surface, including other native mussels. Being covered by zebra mussels weakens native mussels and makes them more vulnerable to stressors such as parasites, environmental variance, and disease.

Through their filter feeding of algae, they take food away from larval and juvenile fishes. Colonies of the marble-sized creatures can have densities up to hundreds of thousands per square yard.

7, 8

Distribution of Zebra Mussel



Source : ProtectYourWaters.Net
http://www.protectyourwaters.net/hitchhikers/mollusks_zebra_mussel.ph

Strategies of Mitigation

Methods of controlling for freshwater animal invasive include stringent cleaning policy for all boats/equipment that travel between water bodies. Also, fisherman can be encouraged to only use native or biologically inert bait on their fishing lines. Sterile male releases may help control the number of invasives at large, and these animals can also be controlled through chemical and biological controls. As with all invasives, preventing a creature from entering a water body is much more cost effective than managing it once it is there.⁹

Bighead Carp

The bighead carp was introduced to an Arkansas fishery in 1973 in order to improve water quality. Although regulations were quickly put in place to end the release of the carp into native rivers, this eastern Chinese fish has made its way upstream into the Mississippi and Missouri rivers. The carp is an aggressive feeder that eats a range of both fish and plants and can alter the food chain of any water body it enters. Soon the carp may enter the Great Lake system, and greatly alter the biodiversity of that ecosystem.⁶



Bighead Carp

Source: USGS, Florida Integrated Science Center – Gainesville
http://cars.er.usgs.gov/pics/nonindig_fish/nonindig_fish/nonindig_fish_22.html

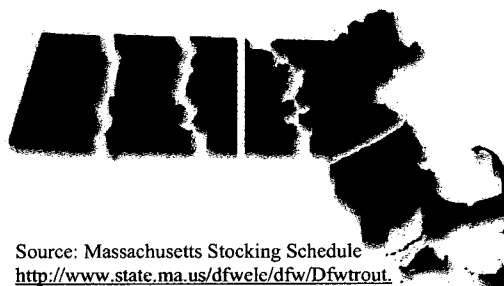
Non-Native Species

Fish Stocking is an enormous undertaking in the Northeast. Each year, the New York Department of Environmental Conservation stocks over one million pounds of fish into more than 1,200 public streams, rivers, lakes and ponds. The species they stock include brook trout, brown trout, rainbow trout, lake trout, steelhead, chinook salmon, coho salmon, landlocked salmon, walleye, muskellunge and tiger muskellunge.¹⁰

Massachusetts maintains an extensive trout stocking schedule for five state districts: The Western District, the Valley District, the Central District, the Northeast District, and the Southeast District and maintains a publicly accessible list of all streams and ponds stocked (<http://www.state.ma.us/dfwele/dfw/Dfwtrout.htm>). In 2004, these districts were supplied with 505,000 brook, brown, rainbow and tiger trout.¹¹

Illegal fish stocking is also a problem. In a 2001 press release the Maine Department of Inland Fisheries Freshwater Fishing Report described finding a wide variety of illegally introduced fish species, including: largemouth bass, smallmouth bass, black crappie, blue gills, northern pike, white catfish, cusk, golden shiner, smelt, and white perch.

The Five Massachusetts Fish Stocking Districts



Source: Massachusetts Stocking Schedule
<http://www.state.ma.us/dfwele/dfw/Dfwtrout.htm>

The press release described the rate of new illegal introductions as “astonishing.”¹²

Threats to Biodiversity

Non-native fish threaten biodiversity directly in the same way that invasive species do. They may also breed with fish that occur

- Depletion of natural genetic diversity
 - Decreased natural population size
 - Decreased genotype diversity
- Accelerated genetic drift due to decreased population size and increased fragmentation
- Creation of mixed-stock fisheries⁹
- Disease and parasite transfer
- Disruption of local landscape
 - Division of resources away from natural populations
 - Decrease in natural population fitness
- Hybridization
- Competition for food¹³

Western Toads

In the western United States, toad populations have decreased drastically since the 1980s, and the evidence suggests that one reason is fish stocking. Joseph Kiesecker at Pennsylvania State University in State College and his colleagues found that lakes that were stocked with fish had high concentrations of *Saprolegnia ferax*, a fungus the plagues fish in fisheries worldwide. Kiesecker found that 90 percent of toad embryos may die at sites with high concentrations of *Saprolegnia ferax*.¹⁴

Methods of Mitigation

- Clearly evaluating management model (what are the goals of fish stocking)
- Stocking sterile fish
- Keeping species within their natural boundaries
- Recognizing that fish stocking always alters the gene pool to some degree
- Tailoring fish stocking to each unique situation.¹⁵

The New England Brook Trout

In the last century, the native New England brook trout has been greatly displaced by millions of hatchery-bred rainbow and brown trout. The genetic uniqueness of a wide-variety of subspecies has been “watered-down” by the introduction of hundred of thousands of farm bred generic New England brook trout. Some of this country’s last remaining strains of pure native brook trout live in the in Maine’s North Woods:

The Rangeley ponds, along the Maine/New Hampshire border contain some of the best native trout fisheries in New England. Many of them have never been stocked with state-sanctioned fish, and harbor a unique genetic strain of squaretail trout. These trout are protected by strict harvesting policies. However, smallmouth bass and northern pike have begun moving into the lower ponds. Their forage base overlaps the squaretail trout. These aggressive feeders may soon threaten the existence of the fragile squaretail population populations.¹⁶

Section 3:

Invasive and Non-Native Species Policy

Global Policy

Global trade has been identified by the U.N. as a major cause of the introduction of invasive species. Since 1990, international trade has increased by 50%.¹⁸

In July of 2002, the Commission for Environmental Cooperation (CEC) published a report on diminishing biodiversity in North America. The CEC is an organization between Canada, Mexico and the United States created under the North American Agreement on Environmental Cooperation (NAAEC). The NAAEC is the environmental complement to the North American Free Trade Agreement (NAFTA). The CEC's report showed that a significant proportion of the plant and animal species of North America is threatened.¹⁹

In March of 2003, the CEC published a report describing the role of trade in dispersing invasive species and the severity of the invasives problem. The report states that, "invasions by plants, animals, and pathogens into non-native environments pose one of the most significant, but least addressed, international threats to biodiversity, both within natural ecosystems and agricultural settings." The CEC divides invasive species threats into six categories: crop losses, rangeland value decline, water resource depletion, livestock disease, genetic contamination, and management and eradication costs. Non-indigenous species can be blamed for more than 40 percent of all insect damage to crops in the US. This report claimed that the spread of invasive species is driven by global trade, transport and tourism. Global trade has increased since the start of NAFTA, however, inspection of transported goods has remained constant with approximately two percent of all shipments undergoing inspection.²⁰

The United Nations Conference on Biodiversity, Decision VI/23 recognizes invasive species as one of the primary threats to biodiversity as a result of global trade, transport, tourism, and climate change. Decision VI/23 also asks that the various governing bodies of the world

acknowledge dangers posed by invasive species and incorporate invasive species controls into their legislation. It also urges that further research be done on invasive species pathways of introduction and means of controlling them.²¹

The UN recommends focusing on prevention, because it is far more cost-effective and environmentally desirable than controlling established invasive species. However, after invasive species have been introduced the best option is early detection and rapid action, including eradication or containing the organism. The UN also proposes that states should suppress actions of deliberate and accidental introduction of invasive species, and should identify species that could pose a threat. States should conduct research on invasive species, educate the public, and enact boarder control and quarantine measures.²¹

NAFTA's recommendations include: developing global strategies, assessing the financial cost of invasive species remediation programs, finding alternatives to inspection for guarding against invasive species, protecting against introduction of new species, and incorporating invasive species controls into new trade agreements.²⁰

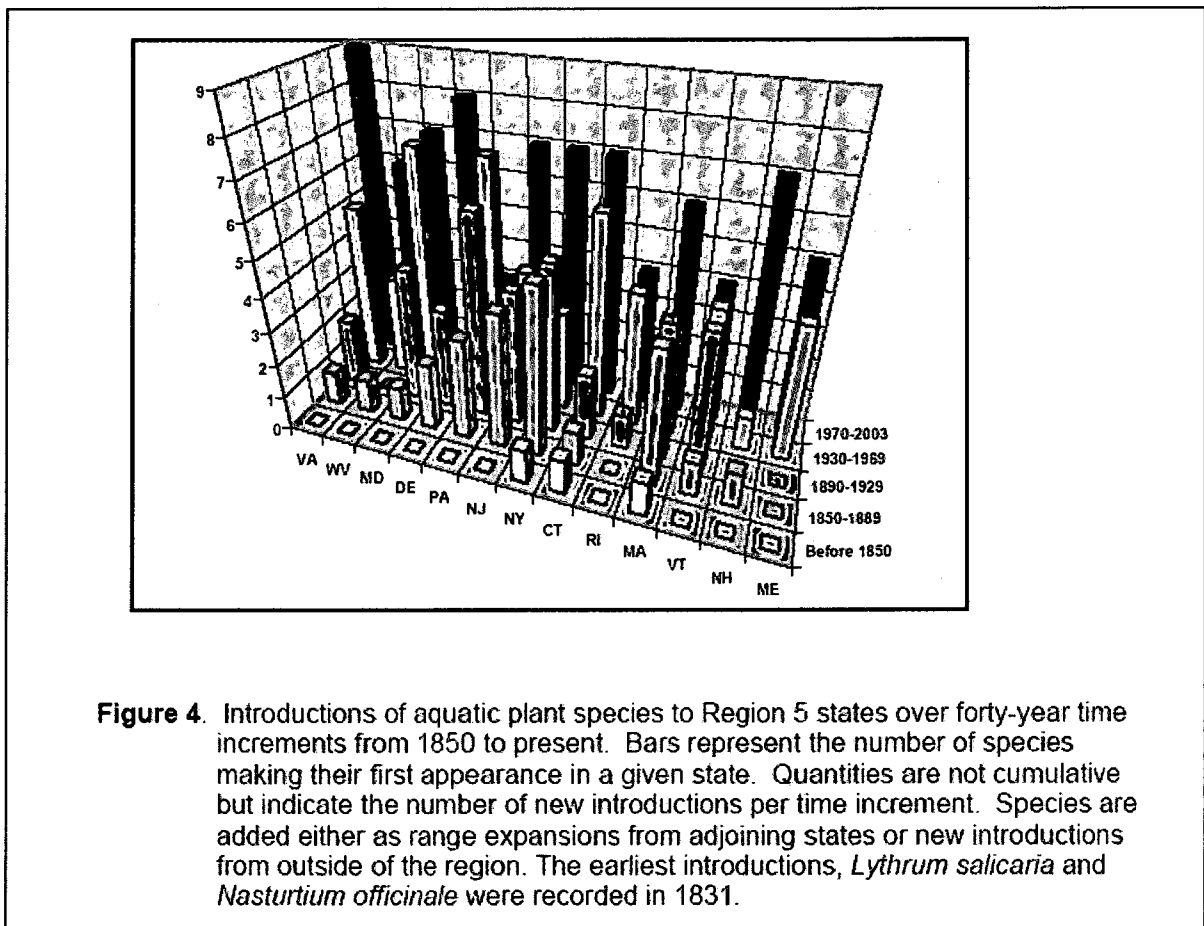
The Aquatic Nuisance Species (ANS) Task Force developed a protocol for researchers who need to use live exotic specimens in laboratory settings. If it is determined that a species could survive if released into surrounding waters, or that its diseases or parasites could be a nuisance, major preventative measures must be taken to ensure its containment. The ANS Task Force suggests that physical, biological, environmental, or chemical barriers be used contain or confine all life stages of the organism.²²

National Policy

National Aquatic Invasive Species Act Reauthorization

The first legislation to address invasive species was the Non-indigenous Aquatic Nuisance Species Prevention and Control Act of 1990. It was later amended as the National Invasive Species Act (NISA) of 1996. In 2004, the reauthorization of the original National Aquatic Invasive Species Act (NAISA) is moving forward. This effort to strengthen the national aquatic invasive species laws and funding comes at a critical time as regions are faced with more incoming species than ever before²³.

Figure 7



The text below is a one-page summary of the NAISA created by the Northeast-Midwest Institute:²⁴

The National Aquatic Invasive Species Act (NAISA) of 2003

U.S. waters face increasing threats from aquatic invasive species. The National Aquatic Invasive Species Act (NAISA) will prevent these harmful invasive species from damaging the United States' aquatic ecosystems and natural resources by:

- **Reducing invasive species introductions from ships by:**
 - Establishing a national mandatory ballast water management program
 - Requiring ships to have an Invasive Species Management Plan that outlines ways to minimize transfers on a "whole ship" basis
 - Creating a ballast water treatment technology certification program
 - Including incentives for ship owners to install experimental ballast treatment technology
- **Preventing invasive species introductions from other pathways by:**
 - Identifying and managing pathways that pose the highest risk of introducing invasive species
 - Creating a screening process for planned importations of live aquatic organisms
- **Supporting development and implementation of State Aquatic Invasive Species Management Plans, including early detection, screening and rapid response activities at state and regional levels**
- **Conducting ecological surveys for early detection of invasive species and analysis of invasion rates and patterns**
- **Making available federal funding and resources for rapid response to introductions of invasive species**
- **Preventing interbasin transfer of organisms by increasing funding and resources for dispersal barrier projects and research**
- **Establishing environmental soundness criteria to ensure all prevention and control measures enacted do not further harm the environment**
- **Creating education and outreach programs to inform the public on preventing transfers of invasive species by proper cleaning of recreational boats, and proper disposal of non-native organisms for home aquaria.**
- **Conducting research on high-risk invasion pathways and alternative prevention and control technologies**
- **Making available \$170 million in federal funds for aquatic invasive species prevention, control, and research.**

Regional Policy

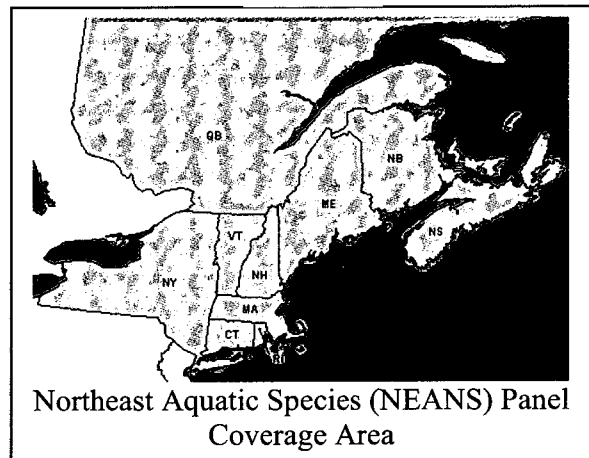
Northeast Aquatic Species Panel Summary

The Northeast Aquatic Species (NEANS) Panel mission is to “protect the marine and freshwater resources of the Northeast from invasive aquatic nuisance species through commitment and cohesive coordinated action.” It operates throughout the seven Northeast region states and Canada (see Figure 8). This panel formed in summer 2001 under the Federal Aquatic Nuisance Species Task Force to assist the implementation of the Non-indigenous Aquatic Nuisance Species Prevention and Control Act of 1990 (amended as the National Invasive Species Act of 1996). This Panel is the Northeastern regional arm of the Federal Aquatic Nuisance Species Task Force and channels funding and expertise to local agencies involved with invasive species.

The regional panels serve to:

- Identify priorities for the region with respect to ANS;
- Coordinate, where possible, ANS program activities in each region;
- Develop an emergency response strategy for Federal, State, and local entities for stemming new invasions of ANS in each region; and
- Provide advice to public and private individuals and entities concerning methods of preventing and controlling ANS infestations.

Figure 8



Northeast Aquatic Species (NEANS) Panel Coverage Area

NEANS Panel Membership

The Panel is currently made up of 41 members representing state and federal agencies, academic institutions, non-profits, and industry. The current composition of the NEANS Panel is weighted heavily towards the state agencies of the seven participating states. There is a recognition that this young panel needs to attract non-profits and industry from all states and regions in order to be more representative of all the stakeholders in invasive species. The NEANS Panel also maintains an email listserv, which communicates current invasive species policy information to members and non-members alike.²⁵

The Panel also works through four committees that have funding for research, interns, and events²⁶. These four committees are:

- Ballast Water Committee
- Science and Technology Committee
- Communication, Education, and Outreach Committee
- Policy and Legislation Committee

Each committee is active between larger Panel meetings to achieve the goals set forth by the panel. Current activities include:

- Completing comprehensive invasive species list for the Northeast
- Creating a Top Ten Invasive Species list for the Northeast
- Drafting Rapid Response Team Action Guidelines
- Analyzing all seven state invasive species agency action plans
- Monitoring state legislation and creating a guidebook of the legislative process
- Performing research on invasive species removal methods
- Listing all potential invasive species organizations in the Northeast
- Drafting a management plan for ballast water
- Outreach to other groups and communicating information to stakeholders
- Analyzing future invasive species threats and vectors of dispersion

NEANS-Funded Research

The Federal ANS Task Force awards funds to regional groups that have submitted their invasive species management plans. Massachusetts and other Northeastern states have all been quick to submit plans and position themselves for funding support. As a result, there is a steady stream of funds available to the Northeastern states through the NEANS Panel. The Science and Technology Committee is always looking for new research projects and grant topics. Current studies are directed towards the comprehensive invasive species list to be released in the near future. Funds are also directed towards identifying the Top Ten Invasive Species based upon each individual state's Top Ten list. Another project being completed in the short-term (summer 2004) is an assessment of future invasive species distribution methods.

The Science and Technology Committee typically funds research on new remediation and extirpation techniques for invasive species, such as phragmites and milfoil. However, there is an emphasis on creating new project areas that can be funded in future cycles. None of these past research studies has dealt specifically with biodiversity issues in the Northeast, but that lack of past research may indicate an opportunity to pursue it as a new topic.

The Policy and Legislation Committee previously worked on several research outlines: Legislation, regulation, and agencies/organizations. These brief outlines were completed in spring 2003 as a first attempt to compile all Northeast invasive species data in one central location. By having the state regulations and legislation side by side, it is easier to identify the best state models to follow as well as identifying states that need more invasive protection. For example: the State of Maine has some of the most aggressive state regulations that deal with invasive species.²⁷ This Committee will investigate their status and effectiveness this summer with a new legal intern. This intern will also assess all of the prior year's legislation in the

Northeast to determine which bills became law and which failed. There will be a comparison of best legislation to promote among other states and a small handbook for organizations to learn about enacting legislation that protects against invasive species. The NEANS Panel is clearly interested in ensuring that BMPs extend beyond one state's boundaries and spread throughout the entire Northeast.

In agreement with Anne Monnelly, Policy and Legislation Committee co-chair, elements of this report will be shared with NEANS and the committee will likewise share their preliminary legislation research. By initiating these discussions early, it avoided the potential for doubling efforts and wasting valuable resources on identical research. The Tufts team worked to update the list of organizations in the Northeast that are involved with invasive species. In the meantime, the Panel's legal intern will focus on collecting information on invasive species legislation, regulation, and state management plans. Both the Tufts team and members of the NEANS Panel were in close communication through a series of meetings in the spring and hopefully, this relationship will enable further cooperation with TNC.

NEANS Rapid Response Draft Methods

The number of invasive species in New England is increasing with every passing year and it is difficult to create individual management plans for every species in every state. By sharing collective resources, the NEANS Panel will create guidelines for Rapid Response teams to address new invasive species once they are identified. This sharing of research allows different states to know that they will be prepared with an action plan when a neighboring state's invasive species manages to cross borders. This added readiness is also intended to slow down the spread of invasive species by allowing specialized teams to neutralize such species in a quick and efficient manner. These guidelines are still being drafted after an original meeting in May

2003 about potential Rapid Response Team formats. The guidelines will be sent around to other Panel members for comment in the near future.

NEANS Spring Panel Meeting

Although there will not be an opportunity for TNC representatives to present this report to an upcoming NEANS meeting group, there will be several important workshops on research, member updates, and state/national legislation .²⁸ Recent research by committees and outside organizations will be presented during the proceedings. Funding may be available for conference costs. (See Appendix for Spring Panel Agenda)

Meeting details:

May 17 – 18, 2004
The Inn at Newport Beach
Newport, RI • 401-846-0310

Northeast Invasive Species State Policies

Individual state policies on invasive and non-native species demonstrate the point at which scientific evidence and state legislation meet to become one comprehensive set of strategies. This is where the “rubber meets the road” and the true fight against invasive species begins. There can be an overwhelming supply of scientific data signifying the economic and environmental, but this alone will not prevent the spread of invasive species through the Northeast. In a similar vein, the most progressive legislation

“Invasive aquatic plants and illegal fish introductions are cited by lake biologists as today’s leading threats to the environmental quality of New England’s inland surface waters.”
(Aquatic Invasive Species Review, 2003)

will be ineffective if implemented slowly, haphazardly, or at ineffective locations. The arguments for controlling invasive species may take place in the state house or university setting,

but the “on the ground” struggle is being directed and waged by individual state agencies. These state implementers consist of agencies such as the Massachusetts Department of Conservation and Recreation, Maine Department of Environmental Protection, New York State Department of Environmental Conservation, Connecticut Department of Environmental Protection, Vermont Department of Environmental Conservation, New Hampshire Department of Environmental Services, and Rhode Island Department of Environmental Management [Natural Heritage Program].

The State of Maine recognizes that invasive plants and animals are creating havoc with neighboring state’s freshwater habitats and places a high level of attention on preventative techniques and policies.²⁹ This level of support is evident in the 2003 Invasive Aquatic Species Review:

“Invasive aquatic plants and illegal fish introductions are cited by lake biologists as today’s leading threats to the environmental quality of New England’s inland surface waters. Plant invasions translate into social and economic burdens associated with lost recreation, degraded real estate values and escalating vegetation control costs. These costs amount to millions of dollars spent each year in Maine’s neighboring states that face at least five already established aggressive nuisance plant species. Illegal fish introductions pose similar threats to both the diversity of Maine’s inland fishery as well as to the vigor of Maine’s outdoor sports industry.”³⁰

The State of Maine has been very proactive in issuing a four-year strategy for dealing with the issue of invasive species.³¹ The ideas promoted in Maine can certainly be applied to any other state or land agency. Since the problem with invasive species does not stop at the state borders, it is essential that policies do not simply end at the border either.

Some examples of the preventative policies implemented in 2003 by the Maine Department of Environmental Protection include:³²

- DEP distributed 40,000 “Your Boat Sticker and Maine... Together We’re Fighting Aquatic Invaders” brochures statewide to lake associations, at courtesy boat inspections and to municipal officials.
- A pre-season mailing of 60,000 postcards sent by DIFW, and co-written by DEP, invited last year’s out-of-state inland anglers to return to Maine but leave the aquatic weeds back home.
- Maine Turnpike Authority (MTA) continued to distribute the “Clean Your Boat Before You Float” brochure to motorists towing boats through the York tollbooth.
- DEP distributed 86 of its general boat ramp/Remove All Plants signs statewide. Infested lakes were posted with special “this lake is infested” signs at boat ramps.
- Courtesy Boat Inspection has increased from 2,500 in 2001 to 6,500 in 2002 to greater than 10,000 in 2003.
- Maine Department of Inland Fisheries and Wildlife announced it would move from warnings to the next level of compliance, enforcing Maine law with summonses upon finding evidence of boat ramp drive-offs with plants still attached to motor props, trailers, etc.
- The third season of Voluntary Lake Monitoring Program’s Plant Patroller Monitoring program has now created a cadre of greater than 800 trained volunteers (350 trained in 2003) able to identify invasive plants statewide.
- DEP requested and received a U.S. Fish and Wildlife grant of \$60,000 to support development of rapid response capacities of both DEP and IFW.

“Historically, fish stocking 50 to 100 years ago was done with little knowledge of the habitat requirements for a given species or the dynamics of a particular ecosystem. In the early 1950’s fishery managers began to study these ecosystems to gain an understanding of how they operated in order to make informed decisions for future management of these waters. As more information was gathered, management recommendations resulted in a variety of stocking changes. In many situations the species to be stocked was changed. Perhaps many didn’t realize that at one time Maine stocked four species of Pacific salmon. In other instances changes were made in the size of fish stocked. Years ago millions of tiny fry were planted in waters with large populations of predatory fish, resulting in few returns to the angler.”⁴⁵

- Game Wardens attended a number of lake association meetings as guest speakers, and included key points of the invasive species program as part of their presentations.

Organizations Committed to Biodiversity

TNC already plays a large role in the realm of invasive species management, education, and outreach. It is currently one of the five core issues that TNC works to improve.³⁴ In evaluating the decision to branch out in the Northeast to address invasive species and biodiversity, it is important to determine other organizations already playing a role in the invasive species and biodiversity field. Identifying active organizations will provide information about the field itself as well as determining if this subject has received enough attention already through established channels.

For the purpose of this study, an internet search of organization websites was determined to be the most time-effective method of gathering information about other organizations involved with invasive species. The NEANS Panel provided a compilation of government and non-governmental organizations involved with invasive species in the Northeast, which provided focus for this website survey. After adding several organizations to the list, a website review was completed to verify that these invasive species organizations had programs specifically aimed at invasive species *and* biodiversity issues. This survey was aimed at programs dedicated to biodiversity issues that consisted of more than passing mention of biodiversity as one issue of many others. Groups that maintain extensive research report collections, such as Sea Grant may have some biodiversity initiative, but the vastness of reports prohibited examining each report for its content.

Although many groups listed biodiversity as one more reason to support invasive species work, there were only three groups that appeared to have significant programs directed at invasive species *and* biodiversity: The Northeast-Midwest Institute, Natural Heritage Network, and the UNH Cooperative Extension Services Ecological Reserve System. A summary of each group, its geography, and focus is listed below:

The Northeast-Midwest Institute

“Northeast-Midwest Institute (Washington, D.C.) - A private, non-profit, and non-partisan research organization dedicated to the economic vitality, environmental quality, and regional equity for Northeast and Midwest states. Formed in the mid-1970's, it fulfills its mission by conducting research and analysis, developing and advancing innovative policy, providing evaluation of key federal programs, disseminating information, and highlighting sound economic and environmental technologies and practices.”³⁵

The Northeast-Midwest Institute primarily focuses on ballast water issues in the Great Lakes and Northeast as well as Great Lakes ecosystem health issues. They are very active in the proposed legislation, NAISA, and provide congressional testimony on technical issues. They highlight biodiversity issues as one reason to support the NAISA legislation in 2003.³⁶ There appears to be some collaboration between TNC and the Northeast-Midwest Institute since portions of the report were given by John A. Anderson, Jr, Director of TNC's Great Lakes program in Chicago.

Natural Heritage Program

The Natural Heritage Program describes its work on invasive species and biodiversity as:

“Invasive species constitute the second-leading threat to imperiled native species. Mounting an effective response to this threat, however, depends on an ability to focus resources on those plants and animals that pose the greatest risk to our natural ecosystems.

With support from the Turner Foundation and the National Fish and Wildlife Foundation, NatureServe is collaborating with TNC to develop a method for assessing the invasiveness of non-native plants. Much as NatureServe currently ranks native species for their rarity and extinction risk, this project will lead to the ability to rank invasive species based on their potential to cause ecological problems.”³⁷

The Natural Heritage Program works through a series of partners, which in the Northeast are composed of the following groups:

- *Massachusetts Natural Heritage & Endangered Species Program*, Massachusetts Division of Fisheries and Wildlife³⁸
- *Connecticut Natural Heritage Program*, Connecticut Department of Environmental Protection³⁹
- *New Hampshire Natural Heritage*, Division of Forests & Lands⁴⁰
- *Maine Natural Areas Program*, Maine Department of Conservation Bureau of Geology and Natural Areas⁴¹
- *Vermont Nongame and Natural Heritage Program*, Fish and Wildlife⁴²
- *Rhode Island Natural History Survey*⁴³
- *New York Natural Heritage Program*, New York State Department of Environmental Conservation⁴⁴ (<http://www.dec.state.ny.us/website/dfwmr/heritage/>)

University of New Hampshire Cooperative Extension Services Ecological Reserve System

The organization’s mission is:

“To establish and support a well-coordinated, comprehensive system of public and private lands voluntarily dedicated to protecting the full spectrum of biological diversity in New Hampshire.”⁴⁵

Core Partners

- [Audubon Society of New Hampshire](#)
- [New Hampshire Division of Forests and Lands](#)
- [New Hampshire Fish and Game Department](#)

- Society for the Protection of New Hampshire Forests
- The Nature Conservancy

University of New Hampshire Cooperative Extension

Non-Native Fish Stocking

Fish stocking may not be necessarily for healthy fisheries management. According to the theory of surplus production, natural fish populations produce more fish than a water body can carry. The total weight of fish in an ecosystem will approach the carrying capacity of that area. Once fishing begins in these areas, many of the large older fish are removed, which reduces biomass and increased the likelihood that the young fish will survive. The extra production of young fish may lead to a steady-state surplus production situation. Although a portion of the mature adult population must be allowed to survive in order to reproduce, the remaining surplus is available for fishermen.¹⁵

There is some concern that when making decisions about fish stocking, anglers have more influence over policy than more disenfranchised populations. In Lake Huron, alien salmon are stocked for fishermen. But many worry that these foreign fish are threatening native trout. The native people of this area, the Nawash of Chippewa, prefer to fish trout than salmon, but they are also worried that the salmon are threatening the lake trout population. In 1999, Eric Johnston of the Nawash people told Alternatives Journal, "the decisions are being made for the anglers...Not everybody has got a boat trailing behind their car, some people just want to go out to these natural areas to see what's there."⁴⁶

Section 4:
Invasive and Non-Native Species
Recommendations

Invasive and non-native species are a major threat to biodiversity in the Northeast. There are many regionally-based actions The Nature Conservancy can undertake directly to counter this growing threat. The Nature Conservancy can support state and federal policy that would thwart the introduction and spread of these species. It could also educate lawmakers and the public as to what can be done.

1-Address the problem of invasive and non-native species on a regional level through creating analysis tools, designating pristine areas, influencing policy, and educating the public.

Regionally, The Nature Conservancy should create maps of invasive species spread, and the reduction of biodiversity in various areas due to invasive species. It should identify top invasive species, and windows of opportunity for containing and preventing them, as well as top threatened species. Furthermore, The Nature Conservancy should continue to designate pristine natural areas with much of their original biodiversity intact. It should protect these areas through ending the construction of new roads and controlling the use of private non-local boats. Make these pristine areas available to the public through footpaths and allow boats to be rented on site for use in protected waters. On a regional level, The Nature Conservancy should identify areas that have never been stocked with the goal of enacting fish protection measures.

2-Counter the introduction and spread of invasive species on a national level through supporting new federal law and developing a public awareness campaign.

Nationally legislation should be enacted making it illegal to import dangerous invasive plant or animal species without a license. It should be illegal for pet stores and plant nurseries to distribute nuisance species without a permit. All states should be required to created measures for proper containment of foreign species kept in regions where they may become a nuisance.

The Nature Conservancy should launch a national education campaign promoting the awareness that invasive species do more than clog boat motors, they also threaten biodiversity. The public should be informed that every invasive species threatens global biodiversity and that biodiversity in an important natural resource.

3-Partner with the Northeast Aquatic Nuisance Species Panel.

NEANS Panel Membership-The Northeast Division of the Nature Conservancy could join the Panel as an official member to help bridge the gap between state agencies and non-profits. This membership may allow for an increasingly large forum for voicing concerns about biodiversity. By partnering with the Policy and Science Committees on this project, there remains a link to continue working closely with this group and their research. The Panel also functions by non-confrontational methods such as research, education, and outreach. Although legislative and regulatory models are analyzed, this information is passed along to states and organizations for individual actions.

NEANS-Funded Research-The funding that flows through the NEANS Panel to other states could fund potential TNC studies on biodiversity and invasive species. This is one way in which the NEANS Panel could be a strong ally for TNC. As part of the decision-making process, TNC could direct funding towards issues such as biodiversity that have been previously ignored.

NEANS Rapid Response Draft Methods- These draft guidelines present the opportunity for TNC to act as an editor to state guidelines in addressing invasive species. Since TNC has experience dealing with invasive species on its own lands, it is already familiar with mechanisms for removal. By acting as an editor, TNC can direct and critique the rapid response policy of state agencies and possibly learn new techniques about invasive species management.

4-Support NAISA legislation.

The Nature Conservancy can support this legislation by submitting letters of support for specific amendments in the following bills:⁴⁷

- Homeland Security Fiscal year 2005 Appropriations Bill
- Commerce, Justice, State and Judiciary Fiscal year 2005 Appropriations Bill
- Interior (U. S. Fish and Wildlife Service) Fiscal year 2005 Appropriations Bill
- Energy and Water Fiscal year 2005 Appropriations Bill

5- Promote Cross-Pollination of State Best Management Practices.

In order to provide continuous defense of invasive species throughout all Northeastern states, there should be a compilation of Best Management Practices (BMPs) between state agencies. It is important that all state agencies understand what actions are being undertaken by abutting states. This will help to not only identify BMPs for implementation among states, but identify individual state's policies that need improvement.

The Nature Conservancy should stress the need among the Northeastern states to compile this BMP resource. Once established, it will be important that each state compare its policies against the BMP standard to identify areas for improvement. The Nature Conservancy can participate in this BMP work on its own or through the NEANS Panel. The NEANS Panel is currently reviewing all state agency policies and creating a list of BMPs for the Northeast region. The Nature Conservancy can also use these BMPs to manage its own lands to protect and remediate lands at risk of invasive species.

6-Manage fish stocking programs on a national level by enacting cautionary measures and partnering with fishermen.

In regards to fish stocking on a national level, this country should make it illegal for fishermen to use live bait, plant parts, or fish eggs that could lead to nuisance species being

introduced to an ecosystem. An education campaign for fishermen should be launched which both promotes the natural fishing experience and advertises the costs of fish stocking on biodiversity. It would be very useful to have a national fishing license survey, asking fishermen about their priorities for the fishing experience, as well as a 10% tax on all fishing licenses. Funds collected through this tax would be spent on protecting threatened species and native ecosystems.

7-Battle invasive species in the global arena by addressing trade issues, improving goods inspection, and focusing on prevention.

International organizations should focus on the prevention of invasive species over the mitigation of existing nuisance species. Prevention is much cheaper than mitigation. Law makers around the globe need to be educated about the importance of biodiversity and the problems associated with global trade. All new international trade agreements should include invasive control measures. And globally, new technologies should be incorporated for goods inspections across borders since only a very small fraction of traded goods are currently inspected.

Section 5:
Science of Atmospheric Deposition

Atmospheric Deposition – Introduction

This study will discuss the impacts to biodiversity of three of the most widely emitted air pollutants with negative impacts in the northeast: Nitrogen Oxides (NO_x), Sulfur Dioxide (SO₂), and Mercury (Hg). It will also identify key legislative opportunities and partnerships for TNC in order to maximize the effectiveness of any actions undertaken by the organization.

Biodiversity is a word that is rarely used in the public debate over air quality. Instead, forest deterioration, fish kills, lake sterility, and other scientific findings are used to advocate for further emissions cuts to promote improvement and conservation of the public welfare. Public health-based arguments for more stringent air quality standards often get more traction during policy debates. Decision makers are more often concerned about voters than they are about biodiversity. However, the Clean Air Act Amendments of 1990 (CAAA 1990) mandated the protection of ecosystems affected by air pollution as a vital component of preservation of the public welfare in addition to the public health.

Little action has been taken to protect the ecosystems in question since 1990. The National Research Council's Committee on Air Quality Management in the United States recommends that progress be made toward "enhancing the protection of ecosystems and other aspects of the public welfare."⁴⁸ "Within the framework of the CAA, 'welfare' refers to the viability of agriculture and ecosystems (such as forest and wildlands), the protection of materials (such as monuments and buildings), and the maintenance of visibility."⁴⁹ TNC, as part of its mission to protect biodiversity, should play a role in researching, supporting, and monitoring this public welfare enhancement process.

Identifying Sources of Contamination

When NO_x , SO_2 , and Mercury travel through the atmosphere, descend, and are deposited on the Earth's surface they become known as atmospheric deposition. The mobile nature of these pollutants upon emission in gaseous or particulate form makes regional, national, and international regulation the most effective management strategy. Regulations targeted at reducing the quantity of pollutants emitted throughout the nation over time will reduce the quantity of pollutants deposited. Just as water resources and their quality cannot be separated from actions within their associated watershed, air quality issues require study and action on a similar scale. The EPA defines an airshed as "... the geographic area responsible for emitting 75% of the air pollution reaching a body of water."⁵⁰

TNC's science-based approach to

property management dovetails nicely with an airshed-based approach to managing atmospheric deposition pollutants.⁵¹

Controlling the emissions from within the airsheds of vulnerable freshwater resources in the northeast will require regulations and enforcement that crosses state and national boundaries. Figure 9 illustrates the approximate geographic extent of the

Figure 9 - Nitrogen Oxide Airshed Extents

PRINCIPAL OXIDIZED NITROGEN AIRSHEDS FOR:
NARRAGANSETT BAY, CHESAPEAKE BAY,
PAMLICO SOUND, TAMPA BAY, MOBILE BAY,
LAKE PONTCHARTRAIN



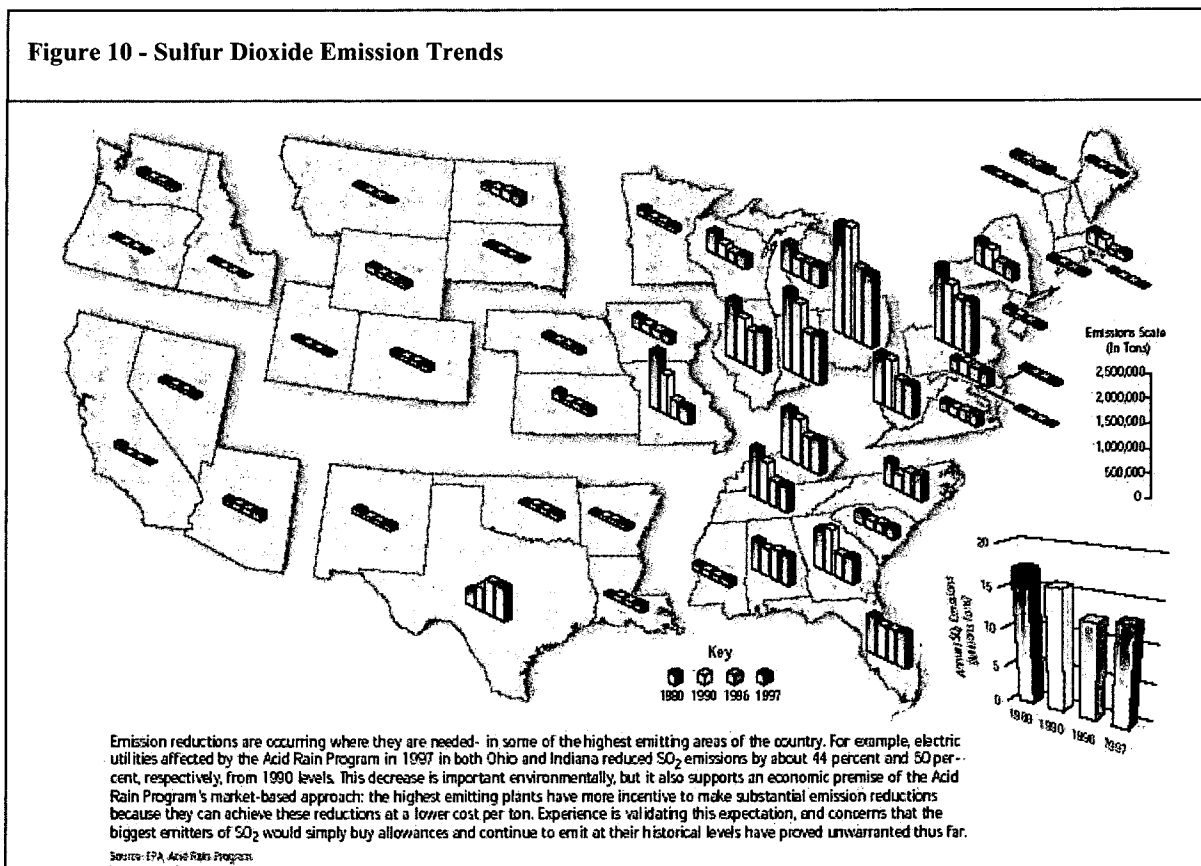
DEVELOPED BY R. DENNIS, ATMOSPHERIC SCIENCES MODELING DIVISION:
AAL, NOAA, and MERL USEPA



NO_x-based airsheds for several major estuaries on the East Coast of the United States. It should be noted that these airsheds extend well beyond the borders of the states containing the water resources in question, necessitating regional action to address water quality concerns in the estuaries. Similar pollutant-specific airsheds can be delineated for freshwater resources in the Northeast in order to more accurately target the bulk sources of the contamination through regional regulatory means.

Sulfur Dioxide & Nitrogen Oxides

The bulk of SO₂ and NO_x pollutants originating in the United States are emitted from power plants in the mid-western United States. Figure 10 indicates state-wide SO₂ emission



reduction trends from 1980-1997, as well as confirming the geographic location of the larger SO₂ emitters in the Midwestern states.

Overall emissions reductions in many states have resulted in reduced NO_x and SO₂ deposition in the northeast. Recent studies from the Hubbard Brook Research Forest in New Hampshire have shown that SO₂ deposition has decreased since 1990, largely due to reductions in emissions from power plants. These reductions are attributed to the more stringent caps on sulfur emission included in the Clean Air Act Amendments of 1990, along with the market-based management structure allowing trading of SO₂ pollution permits. These same research studies also note that Nitrogen Oxide deposition in the study region has not appreciably changed in the same time period.⁵²

Passenger automobiles and truck transport make up a large portion of the total nitrogen emissions, as can be seen in Figure 11.⁵³ Regulation of these sources has been more difficult to implement due to their distributed nature, their mobility, and their relatively short life span.⁵⁴ It is important to note that the bulk of SO₂ is emitted from power plants, which can be regulated and monitored fairly easily due to their stationary nature and relatively long lifetimes. Nitrogen Oxides are emitted in large volumes from light duty gasoline engines as well as from power

Figure 11 - Nitrogen Oxide Emissions

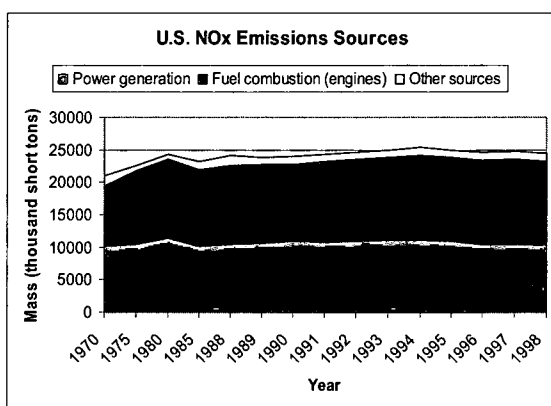
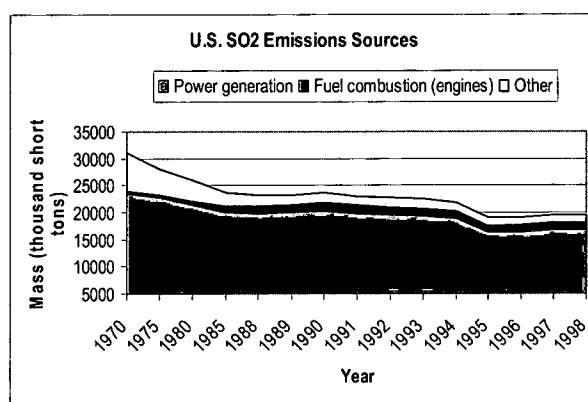


Figure 12 - Sulfur Dioxide Emissions



plants.

Figure 12 illustrates the overall decline in emissions of SO₂ over time. The figure also illustrates the relative contributions of emissions sources to the total emission of these pollutants. From these data it can be determined that actions targeting NO_x emissions should address both power generation and fuel combustion sources, while actions targeting SO₂ emissions should be targeted largely at power generation facilities. It is also important to note that total NO_x emissions have not decreased in a manner similar to SO₂ emissions during the time period 1970 to 1998 (the last year for which data were available).

Mercury

Coal-fired electric power plants are now the major source of Mercury emissions in the United States, comprising 32.6% of the total estimated national emissions of Mercury in the 1994-1995 study period.⁵⁵ Legislation reducing emissions from municipal and medical waste incinerators have had large positive impacts on Mercury emissions. These regulations have also elevated commercial power generation to the top of the list of Mercury emitters. Possible legislative actions to combat this emission source will be discussed later in this report.

What are the chemical mechanisms involved?

Freshwater populations of fish, macroinvertebrates, and plants are part of an ecosystem's food web. As chemical changes in water and soil deprive prey species of nutrients within this web, a food shortage results. Higher predators die off or move to areas with higher concentrations of food and lower concentrations of toxins. Unfortunately, not all species are mobile enough and not all ecosystems are interconnected enough, to enable access to these pristine refugia. Species more susceptible to the lower pH and higher toxic concentrations begin

to experience a local population decline. Species with a higher tolerance for the contaminants remain - often able to reproduce more effectively with the result of an eventual population imbalance and a reduction in overall local biodiversity. Remediation of freshwater ecosystems can allow acid and Mercury-sensitive populations to recover and can protect native biodiversity.

Mercury and Biodiversity

Mercury deposition in freshwater ecosystems has been found to cause biodiversity reductions. Mercury causes muscular and neurological problems in various wildlife species. Atmospheric Mercury from anthropogenic and natural sources becomes Methyl Mercury when deposited into freshwater. This form of mercury is easily absorbed by many species throughout the freshwater food web. Mercury is retained in the bodies of contaminated individuals and can bio-accumulate, causing major health problems for higher predators like humans and birds. In addition to the health of wild species and human consumers of these wildlife products, Mercury is persistent in the environment. This means that Mercury remains in the environment and may be re-emitted in the future after animals die or after it is taken up by plants. There is scientific uncertainty about some of the sources of Mercury.⁵⁶

Nitrogen, Sulfur, and Biodiversity

Nitrogen and Sulfur Oxide aerosols from various pollution sources can combine with atmospheric moisture to form dilute acids. These acids are deposited on plant surfaces, on the soil, and directly into freshwater in a number of natural precipitation forms such as rain, snow, and fog. Actual particulates, or “dry deposition”, and acid rain, or “wet deposition”, contribute the nitrogen and sulfur compounds to the Northeast freshwater environment.

The interaction between dilute acid rain and Northeast soils is a particular impediment to biodiversity. As this water travels through the soil, it removes nutrients and metals by

chemically reacting with these compounds. Two principle chemical species related to freshwater ecosystem health and diversity are Calcium (Ca) and Aluminum (Al). Some terrestrial macroinvertebrates, essential to the local food web, obtain Calcium from soil. When the Calcium is transported through this leaching process, lower levels of the local food web are impacted with negative consequences for higher predator species.⁵⁷

Aluminum metal is found naturally in the soils of the northeast. Acidic runoff and soil water movement transports this Aluminum metal from the soil to the aquatic environment, where it can accumulate to toxic concentrations. The combination of lowered pH (high acidity) and increased Aluminum concentrations has been found to be toxic to several Northeast fish species.⁵⁸

Critical Load - Introduction

Naturally occurring chemical processes responsible for Calcium and Aluminum transport have been slow in the past. Rates of nutrient transport have increased over the past 150 years due largely to increased combustion of fossil fuels for electric power generation, transportation, and industrial purposes. This increase has pushed the rate of atmospheric deposition of these materials in many locations above a point known as the critical load.

The critical load concept is based upon two rates: the first is the rate at which chemical species become available for chemical reactions through the natural soil weathering process. The second is the rate at which chemical species that react with soil chemicals are added through the process of atmospheric deposition. If the rate at which calcium is naturally weathered from soils and becomes available for reaction is less than the rate at which the atmosphere deposits chemicals that can react, the total amount of calcium in the soil will decrease.

The critical load concept can be illustrated with a simple analogy. If a bathtub with a slowly dripping faucet and a leaking drain plug is left for a long period of time, the leaking rates are important in determining whether or not the tub will overflow. If the faucet leaks faster than the drain, then water fills the tub slowly and it eventually fills. This situation is analogous to the natural soil-building process without the addition of weak acids through atmospheric deposition. The soil builds up even though natural processes are slowly taking some soil nutrients away.

The alternate analogy is when the drain plug in our imaginary bathtub leaks at a rate greater than that at which the faucet does. Water will NOT eventually fill the tub; rather the tub will be emptied at some time in the future. The same analogous relationship between water in the tub and soil in the environment is appropriate. The addition of weak acids to the soils surrounding a freshwater resource allows the increase in the rate of removal of soil nutrients, eventually leading to a "tub" empty of soil nutrients.

Prior to rapidly increasing anthropogenic inputs after the beginning of the industrial revolution to this process, the rate of nutrient generation in Northeast soils was greater than the transport of nutrients out of the soil. This resulted in the development of a reservoir of nutrients in the soil. Anthropogenic processes since the industrial revolution in Europe and North America have resulted in a reversal of this natural soil-building process.

The rate at which chemical and physical weathering processes produce soil nutrients is defined as the critical load of that soil. Deposition rates above that load will deplete soil nutrients ("empty tub"), with the previously noted impacts to the surrounding ecosystem. Atmospheric deposition below this level will allow soil nutrients to accumulate ("full tub"). Identification of critical loads for soils and ecosystems in New England will allow policy makers

to identify target atmospheric deposition concentrations of specific pollutants and then work towards emissions reductions in order to meet those targets.

Is rehabilitation possible?

Years of deposition above the critical load of the ecosystems in the Northeast have depleted nutrients from the soil, left surface waters highly acidic, and reduced the biodiversity of the ecosystems. Action at the regional level can help to reverse the trends in freshwater ecology. Immediate reductions in deposition below the critical load levels for deposition regions will allow freshwater ecosystems to recover. Soil nutrients will accumulate and water pH will return to more natural levels.⁵⁹

Returning to our bathtub analogy, it becomes clear that we must prevent leakage at the drain plug if we hope to fill the tub. If we are losing water from the tub and we reduce leakage until that leakage rate is equal to the rate at the faucet, the water level will remain at a constant level, never filling and never emptying. If we wish to fill the tub, we must further reduce the drain plug leakage until it is lower than the faucet's filling rate.⁶⁰

Reducing the amount of pollutants deposited on the ecosystems to a level below the critical load is the most sustainable answer. It is insufficient to reduce the level of pollution to the actual critical load level. The freshwater ecosystems of the Northeast have been damaged by atmospheric deposition. Any action that is implemented will not be a conservation effort, but a remediation effort. By reducing deposition levels exactly to the critical load level, the problem will not improve. Soil weathering will exactly balance the deposition of contaminants from the atmosphere. In order to remediate the problem the levels must be reduced below the critical load and kept there for a period of time. Scientific studies have estimated recovery times for

Northeast freshwater ecosystems from 20-50 years.⁶¹ This long-term recovery will not be possible if deposition levels are not reduced to a level below the critical load.

It is important to note that reductions of deposition rates are the most effective remedy for these freshwater ecosystems. Chemical treatments of surface waters, such as the application of chemical bases (high pH) to counteract the lowered pH levels of contaminated waters have met with mixed success. Errant calculations or mis-application of chemicals can cause large local fish kills due to excess treatment chemicals. The chemical by-products of the buffering reactions in surface waters may cause unexpected negative results. Furthermore, the process is not sustainable since new applications of chemicals will be required in the future because the root cause of the contamination has not been removed.

Section 6:
Policy of Atmospheric Deposition

Atmospheric Deposition Policy – Introduction

The scientific findings previously detailed show that atmospheric deposition has and continues to have a negative impact on Northeast freshwater biodiversity. Over the past decades, legislative and regulatory action has been taken at various levels of government to mitigate these impacts though often not in the name of public welfare. The following section will discuss in detail these actions and current developments regarding this issue as it pertains to the Northeast, while providing examples of actions taken in other parts of the world.

National Policy

Due to the fact that most northeast atmospheric deposition pollution originates downwind especially in the Midwest, the national policy arena contains the most significant policies and regulations exist. The single most important atmospheric deposition statute is the federal Clean Air Act (CAA). Originally passed in 1963, the CAA has been transformed through amendments several times in the passed four decades. Despite these changes, the primary purpose of the act is to “promote the public health and welfare” of the nation’s population by preventing and reducing air pollution.

Though the language of the CAA does recognize the harmful effects of atmospheric deposition on environmental quality, biodiversity and ecosystem health are not mentioned. This lack of recognition is reflected in the level of standards that the 1990 amendments established to curb SO₂ and NO_x emissions. Before this is explored in depth it is necessary to review the CAA’s history.

The Clean Air Act of 1963 was the first significant federal attempt to address the issue of air pollution. This legislation relied on the states to issue and enforce environmental regulations. It soon became apparent that most states were not making progress on curbing emissions of important pollutants. The interstate nature of air pollution and the lack of substantial state action caused congress to amend the CAA.

The Clean Air Act of 1970 required the newly created EPA to set National Ambient Air Quality Standards (NAAQS) for several pollutants including SO₂ and NO_x. These standards applied to existing stationary emissions sources. All new sources were to comply with New Source Performance Standards (NSPS) that were determined by the EPA and left to the states to implement and enforce. For mobile emissions sources, tail-pipe emission goals were set for specific pollutants including NO_x.

In response to industry pressure standards were relaxed. For mobile sources, the EPA granted extensions and eventually targets were reduced. In the 1977 Clean Air Act Amendments mobile source NO_x allowable emissions standards were increased from .4 g/mi. to 1.0 g/mi. The EPA's mandate for all cars to be equipped with catalytic converters successfully cut emissions by about 5%; however, automobiles are presently the largest source of atmospheric NO_x. This is due to the fact that there are significantly more cars being driven longer distances on today's roads despite per mile gains in emission abatement.

Though emission regulations are under the jurisdiction of the EPA, the federal Corporate Average Fuel Economy (CAFE) standards also have a bearing on non-point source pollution. Specifically, CAFE standards mandate fuel economy standards for automobiles in the US. Current standards call for cars to maintain an average fuel economy of 27.5 mpg and light trucks (minivans, pickup trucks and SUVs) to maintain an average 20.5 mpg. Given that pollution

(especially NO_x) is release in proportion to gallons of fuel combusted, higher fuel economy standards could achieve a substantial reduction in non-point source emissions. The Department of Transportation recently issued revised CAFÉ standards increasing the light truck requirement to 22.5 mpg by 2007. However, more substantial increases are necessary to adequately address atmospheric deposition. The increasing popularity of light trucks makes the need for stricter CAFÉ standards even more pressing.

Though the CAA of 1970 mandated lofty goals for stationary emissions sources, most of these mandates were not met. Instead many power companies increased the height of plant smoke stacks to reduce local air pollution. This had the deleterious effect of promoting long-range transport of SO₂ and NO_x exacerbating the acid rain problem. Other companies switched fuels to either low-sulfur coal or natural gas. This action did achieve negligible reductions in SO₂ emissions but did little to reduce NO_x.

The Clean Air Act Amendments of 1990

Through the 1980s, atmospheric deposition came to the forefront as a major environmental issue in the United States. Though acid rain had been identified as a problem as early as the 1960s, it was not until the effects of acid deposition were observed in eastern parts of the country that public awareness was sufficient to spur national action. Given that the CAA of 1970 and its subsequent amendments did not achieve significant reductions in emissions of several pollutants, the Clean Air Act Amendments (CAAA) of 1990 were enacted.

The CAAA represents a major departure from traditional command and control environmental legislation. Instead of blanket mandates for emissions, different pollutants are treated in different ways. Six principal air pollutants CO, SO₂, NO_x, ozone, particulate matter

and lead are regulated through a series of differing standards and approaches including a market based cap-and-trade system for SO₂. These pollutants are separated from others due to their ubiquity in the atmosphere and the fact that they are not poisonous in low doses. Hazardous air pollutants (HAPs) of which Hg, dioxin and Cadmium are a few examples are more strictly regulated by EPA mandated maximum available control technology (MACT) due to the serious health effects of these compounds.

The goal of Title IV of the CAA is to reduce point source annual SO₂ emissions by 10 million tons below 1980 levels by 2010 and to reduce point source annual NO_x emissions by 2 million tons by 2000. At present the targets have not been met for NO_x; however, there has been 100% compliance for SO₂.

Title II of the CAAA addresses mobile sources and set a NO_x standard prohibiting any vehicle to exceed 4.0 grams per brake horsepower hour (gbh). Though the EPA was entrusted with the power to set more stringent standards than this, this approach is reminiscent of previous unsuccessful attempts to reduce tail-pipe emissions.

Hg Regulations

Title I of the CAAA pertains to HAPs and calls on the EPA to create MACT standards for these compounds. The Hg standard was developed during the 1990s and was due to be implemented by the turn of the century. Presently the EPA's Hg MACT rule is pending approval and if implemented would significantly reduce point source Hg emissions from coal-fired power plants, industrial plants and waste incinerators by 2009. The Bush administration has claimed that the Hg MACT is too burdensome on industry and has stalled its implementation. This development will be discussed in detail in a subsequent section.

The Cap and Trade Acid Rain Program and NO_x Regulations

Title IV of the CAAA calls for the creation of the Acid Rain Program, which initiates a national cap-and-trade program for SO₂. The EPA set a national cap of approximately 30% of total emissions that was not to be exceeded and then allowed the regulated utilities to pursue the most cost effective actions to achieve compliance. In Phase I over 260 of the largest electric utility SO₂ sources were given emissions allowances, each representing one ton of SO₂. Through the cap-and-trade program a utility could either reduce emissions to coincide with the number allowances it holds, achieve reductions below their allowance level and sell surplus allowances to utilities that do not meet their own targets or buy allowances and increase emissions to the new allowance level. The total number of allowances is equal to the national emissions cap.

Phase I of this program began in 1995 and resulted in a 50% SO₂ reduction from the 263 sources regulated under the program. This resulted in a national SO₂ reduction of approximately 30%.

Title IV of the CAAA addresses point source NO_x emissions differently. Instead of implementing a similar cap-and-trade scheme, the EPA implemented power generation based limits (lbs. NO_x/mmBtu of heat generated). These limits applied to the same 263 sources as the SO₂ rules. From 1990 to 1999 the average NO_x emission rate for Phase I sources fell from 0.70 to 0.40 lb/mmBtu or 43%. Unfortunately, there is no national cap on point source NO_x emissions as there is with SO₂. This allows for the possibility of increases in total national NO_x emissions under full compliance as the total number of sources increases with time.

Phase II of the Acid Rain program began in 2000. The same SO₂ cap-and-trade structure was applied to over 2,000 large and small electric utilities and industrial sources plus all new sources. By 2010, the EPA expects national SO₂ emissions to be 50% below 1980 levels primarily due to the reductions anticipated from Phase 2 of the Acid Rain Program.

NO_x emission rates will apply to the same 2,000-plus sources as the SO₂ regulations. Although slight NO_x emissions reductions were achieved nationally through Phase 1, total emissions are expected to be slightly higher in 2010 than in 2000 due to increased power generation and increases from mobile sources. To supplement the Title IV NO_x regulations the EPA constructed the NO_x State Implementation Plan (SIP) call to provide extra controls in the summertime to alleviate ground-level ozone problems. Between these two programs, the EPA expects NO_x emissions in 2010 to be 2.5 million tons less than in 1990.⁶²

Results of the CAAA and CAFE emission regulations

The progress made in the past decade due to the CAAA of 1990 on curbing atmospheric deposition is notable considering the lack of progress in the 20 years previous to its passage. Public health has certainly benefited from decreases in acid air pollution. Unfortunately these gains appear to put only a small dent in the atmospheric deposition problem from the perspective of Northeast freshwater biodiversity. Though many freshwater bodies have experienced a detectable increase in pH, they are still more acidic than they were before acid rain became a problem. It is clear that much deeper cuts in emissions are needed to achieve rehabilitation and preservation of biodiversity.

CAFE standards have partially fulfilled their primary purpose of increasing the fuel economy of the national automobile fleet; however, the increasing popularity of light trucks has undermined this purpose to some extent. Though CAFÉ standards have an indirect effect on NO_x emissions and atmospheric deposition, an increase in the standards would have a significant impact.

To date, Congress and the EPA have set emissions reductions targets based partially on what is politically feasible and partially on what benefits the public health and welfare.

Unfortunately this process has not adequately taken biodiversity into account. This lack of attention to such a critical component of public welfare provides an opportunity for TNC to play a leading role in advocating for emission reduction targets that ensure the long-term preservation of freshwater biodiversity in the Northeast.

Atmospheric Deposition in other parts of the world

The US is not the only country where atmospheric deposition is a serious problem.

Figure 13 shows which areas of the globe are most affected by acid rain as well as where there

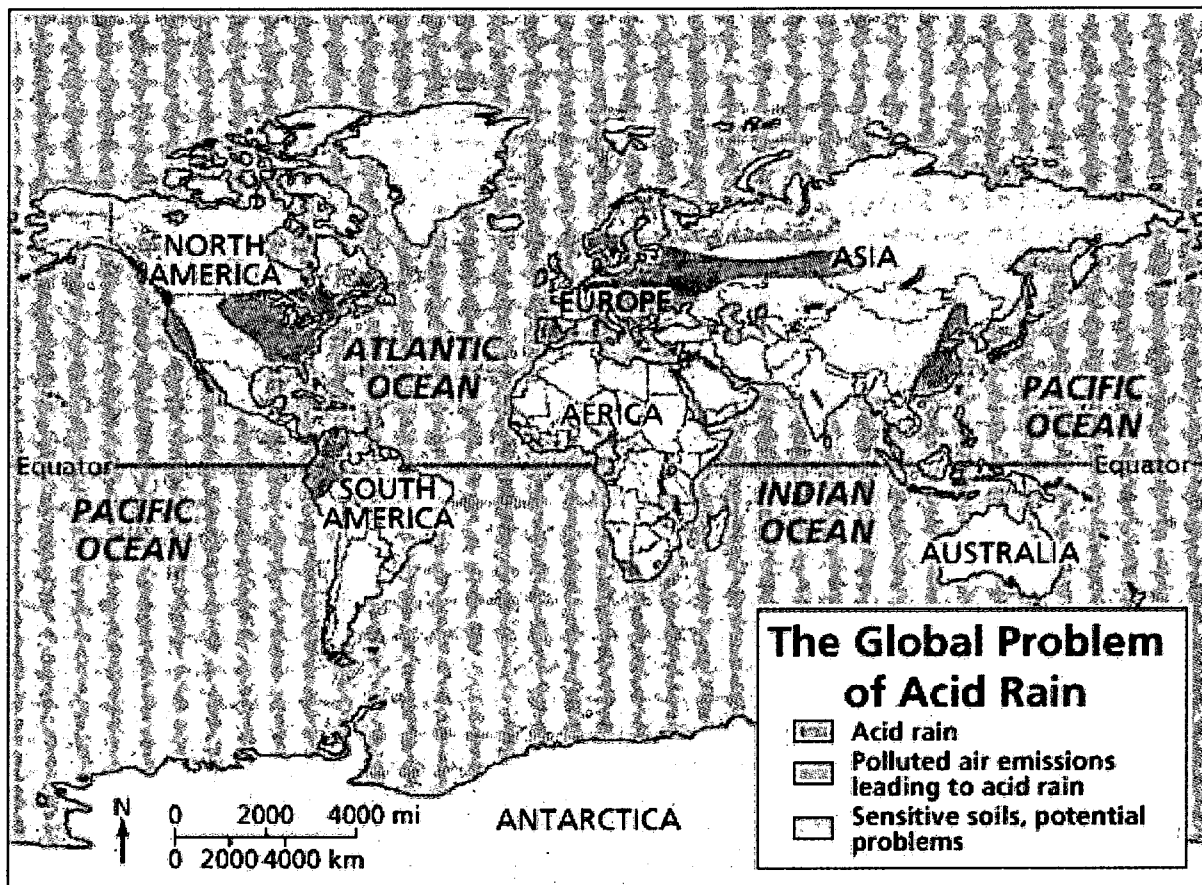


Fig. 13 source: Holt, Rinehart and Winston Publishers⁶²

is potential for atmospheric deposition damage. Along with eastern North America, Europe, China and parts of Colombia and Venezuela also experience significant amounts of acid rain.

China's measures to curb atmospheric deposition have been overwhelmed by its unprecedented economic growth. Most of China's electricity is supplied by coal, as is home heating in some parts of the country. This coupled with the government's reluctance to draft regulations that might slow its economy have resulted in a deposition problem that is not likely to be fixed soon. Latin American countries have faced similar problems in dealing with atmospheric deposition.

Europe has experienced a severe problem with atmospheric deposition similar to what has been seen in the US. However, through international cooperation the continent has made exceptional progress in addressing this issue. Below these measures are discussed in depth and key differences with the CAAA are identified.

The Convention on Long Range Trans-boundary Air Pollution (LRTAP) - Helsinki, Sofia, Oslo, Aarhus and Gothenberg Protocols

To meet these challenges, the United Nations Economic Commission for Europe (UNECE), has facilitated the negotiation of numerous multi-lateral environmental agreements addressing several pollutants. One of these is the Convention on Long Range Trans-boundary Air Pollution (LRTAP), which has produced several protocols that address atmospheric deposition. Below is summary chart of these protocols:

Conserving Biodiversity in the Northeast

Protocol	Helsinki	Sofia	Oslo	Aarhus	Gothenberg
Entered into Force	September 1987	February 1991	August 1998	December 2003	Not yet in force
Number of Parties	22	28 (including US)	25	21 (including US)	31 signatories (including the US) – 8 ratifications (not yet including the US)
Pollutants covered	SO ₂	NO _x	SO ₂	Cd, Pb, Hg	SO ₂ , NO _x , VOCs, NH ₃
Required Reductions	All Parties, 30% from 1980 levels	Cap emissions at 1987 levels (US at 1978 levels). Long-term below critical loads.	Differentiated among parties depending on where greatest effects can be achieved. EU goal of 67% from 1980 levels. Long-term goal below critical loads.	Reduce emissions below 1990 levels (or a chosen year between 1985 and 1995)	Overall emissions ceiling of 63% of 1990 levels for SO ₂ and 41% of 1990 levels for NO _x by 2010. Differentiated among parties depending on where greatest effects can be achieved. Long-term goal below critical loads.
Achieved Reductions	Overall 50% reduction as of 1993	Overall 9% reduction as of 1994	All parties achieved goals either early or by 2000 deadline	N/A	N/A
Requires establishment of critical loads	No	Yes	Yes	No	Yes

Figure 14. Summaries of Relevant Protocols to LRTAP Source: United Nations Economic Commission for Europe, 2004⁶⁴

There are several notable aspects of these environmental agreements. First, they have been successful in achieving significant emissions reductions especially of sulfur. Second, despite their success the parties to the convention have sought for even deeper reductions. Thirdly, the latter protocols call for the establishment of critical loads for all areas under the protocol's jurisdiction, allowing for the identification and understanding how stringent emission

regulations must be in the long-term. Though the reduction goals do not directly correlate with these critical loads, the language of the agreements state that the long-term goal is for emissions to be reduced below these points to allow ecosystems to recuperate from the decades of damage done by atmospheric deposition.

Through the LRTAP protocols the parties have implemented several measures to achieve significant emission reductions. Such as:

- 1 Party specific reduction goals based on which parties can afford to make the most cuts balanced with the consideration of which parties are doing the most harm to the environment.
- 2 Mandating Best Available Techniques for emission reductions at point and non-point sources.
- 3 Implementation of pollutant specific emission limits for mobile sources.
- 4 Development of a neutral, region wide monitoring entity.
- 5 Creation of a scientific panel that facilitates the establishment of critical loads to guide further emission reduction decisions.

One distinguishing difference between these agreements and the US CAA is the language with respect to the environment. While the CAA has the intent of promoting the public health and welfare, the Gothenberg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone justifies its purpose by recognizing the adverse effects on human health and the environment. Also, by setting long-term goals below critical loads, the LRTAP protocols clearly institute the preservation of ecosystems and biodiversity as a top priority.

Overall, LRTAP provides many excellent examples of what strategies are available to achieve meaningful short-term and long-term cuts in

atmospheric pollutants. Given the fact that the US is a signatory to the most recent and most stringent Gothenberg Protocol, and the Aarhus Heavy Metals Protocol, there are opportunities for implementing many of these beneficial concepts in the near future. However, first the Senate must ratify these agreements and pass implementation legislation. Nevertheless, the fact that the US has signed these agreements provides opportunities for the adoption of LRTAP's cutting edge regulations.

Recent Developments in Atmospheric Deposition

State Level Developments

Despite the fact that current CAAA amendments do not expire until 2010, there have been several developments at the state, regional and national level regarding atmospheric deposition pollutants. Several states have implemented regulations on SO₂, NO_x and Hg that are more stringent than CAA standards. Below are some recent state level developments:

- 1 Connecticut became the first state to regulate Hg emissions from electric utilities. By mandating Best Available Control Technology (BACT) standards (similar to the EPA's MACT standards), Connecticut plans to achieve a 90% reduction in emissions by 2008.
- 2 Massachusetts is expected to implement Hg regulations this fall that would require electric utilities to reduce emissions by 85% of 2001 levels by 2006 and 95% of 2001 levels by 2012. These reductions would be achieved by mandating a cap of 0.0075lbs. of Hg emitted per Gigawatt hour of electricity generated by 2006 and a cap of 0.0025lbs. of Hg emitted per Gigawatt hour of electricity generated by 2012. This regulation does provide a possible loophole that allows utilities to offset some emissions by conducting off-site Hg collection programs (thermometer and battery collection). This is a point of

contention due to the fact that the bioavailability of the offsets is significantly lower than that of power plant emissions.

- 3 Several Midwestern states are currently developing their own Hg electric utility regulations.
- 4 New Jersey passed legislation adopting California's low-emission vehicle program in the state beginning in 2009. The legislation mandates that a certain number of low-emission and zero-emission vehicles be made available for sale in the state.
- 5 In 2001 Massachusetts issued regulations requiring the state's five dirtiest power plants to reduce SO₂ and NO_x emissions by 50-75% by 2007. These regulations were also the first in the nation to regulate CO₂.

Regional Developments

Regionally, significant developments have taken place in the recent past. Below are several that concern the Northeast:

- 1 The New England Governors Conference and Eastern Canadian Premiers (NEGC/ECP) completed two major policy agreements. The Mercury Action Plan instructs member states and provinces to implement policies that will result in at least a 75% reduction in Hg emissions by 2010. The Acid Rain Action Plan calls for the Canadian and US federal governments to implement regulations that would result in a 50% reduction in SO₂ beyond current regulations by 2010 and a 20-30% reduction in NO_x beyond current regulations by 2007 in each country. It also calls for reductions in trans-boundary fluxes of both pollutants between the US and Canada. Finally, it calls for the establishment of realistic critical loads for the northeast US and Eastern Canada in order to guide further

policy. The NEGCECP have also been extremely vocal in opposing recent US efforts to undermine certain environmental regulations.

- 2 The EPA has issued two proposed rules regarding NO_x, SO₂ and Hg. The Interstate Air Quality Rule (IAQR) would apply to 29 Eastern states and the District of Columbia. It would construct a new cap-and-trade framework for SO₂ and NO_x that would raise overall caps and extend targets to 2015 effectively weakening the current CAA regulations. The proposed Mercury Rule would create a similar cap-and-trade scheme for Hg and would apply to the same 29 states plus DC. This rule would not strike down the MACT regulations of the CAA it would likely increase the amount of Hg deposition experienced in the Northeast due to the fact that most regulated utilities are downwind from this region.

National Developments

At the national level, several bills have been filed in recent years regarding air pollution as a whole and specifically SO₂, NO_x and Hg. The most prominent of these is the Bush Administration's proposed Clear Skies Act (CSA). This bill represents the most dramatic changes in U.S. air pollution laws in over a decade. This initiative revises nearly all of Title IV of the 1990 CAAA as well as parts of Title I and Title VIII and implements a two-phase emission target program and could be thought of as a national version of the IAQR. Through these revisions, new cap-and-trade programs are proposed for NO_x and Hg emissions as well as revised caps and targets for SO₂ for stationary sources.

The Bush Administration's self-proclaimed motivation for this initiative is that the CAA has not done enough to protect public health and the environment. They claim that greater reductions in Hg, NO_x and SO₂ can be achieved at a lower cost to industry and the economy

while simultaneously increasing environmental quality. This is done by extending the successful SO₂ cap-and-trade program to cover Hg and NO_x.

The EPA's recent reclassification of Hg as a non-hazardous pollutant allows the CSA to implement a cap-and-trade program for reductions in Hg emissions. Given that point sources are the primary emitters of Hg (particularly coal-fired power plants), it is likely that if the CSA is enacted, the Northeast could experience increased levels of Hg deposition. This phenomenon could be magnified by the large concentration of coal-fired power plants downwind of the Northeast and the possibility that such plants would buy credits to comply with the CSA instead of actually reducing their emissions. Due to the extended targets of the CSA any reductions in deposition from current levels would not be experienced for at least another decade if not longer. Many states are concerned about the CSA as it also strips much of the states' authority to regulate electric utility emissions. It is likely that if the CSA ever passes, much of the reduction gains made at the state level could be rolled back. Table X illustrates the possible impacts of the CSA.

Pollutant	NO _x	SO ₂	Hg
CAA existing regulations	1.25 million ton cap by 2010	2 million ton cap by 2012	5 tons per year by 2008 (using MACT)
CSA	2.1 million ton cap by 2008	4.5 million ton cap by 2010	26 tons per year by 2010
	1.7 million ton cap by 2018	3 million ton cap by 2018	15 tons per year by 2018
Increase allowed by CSA over CAA existing programs (by 2018)	450,000 tons	1 million tons	9.5 tons
% Increase allowed by CSA over Clean Air Act (by 2018)	36%	50%	190%
Delay allowed by CSA over CAA	8 years	6 years	10 years

Figure 15 Comparison of the CAAA and the proposed CSA. Source: The Sierra Club⁶⁵

When President Bush first proposed the CSA in February 2002, he mentioned protecting the environment twice in the eleven paragraphs he devoted specifically to the CSA. He praised the power of the market in lowering the cost of reducing emissions and protecting public health, biodiversity was not addressed. Representative Barton of Texas introduced the CSA in both 2002 and 2003. In both instances, it failed to pass. The Bush Administration has pledged to push for passage again in 2004; however, it has not been submitted to date.

Non-governmental Advocacy Groups, Quasi-governmental Agencies and the Atmospheric Deposition Debate

Several national and regional non-profit groups have various positions and programs to address the problem of atmospheric deposition. Very few are tackling the issue from the perspective of preserving biodiversity, let alone the freshwater biodiversity of the Northeast. This provides TNC with an opportunity to provide a unique voice in the national debate. Public health is most often cited as the reason for preserving and/or strengthening the CAA and passing complementary state legislation. Protecting the environment is secondary. This reflects advocacy groups' desires to motivate their membership on these important issues. More often than not, Americans are concerned more about public health than environmental protection through promoting the public welfare. Below is a summary chart of key national and regional environmental groups and their current campaigns and positions with regard to atmospheric deposition and biodiversity.

Conserving Biodiversity in the Northeast

	Acidic Deposition	Hg reduction	Specific campaigns	Framing argument with respect to biodiversity
Sierra Club ^{66,67}	Advocates protecting and enhancing the current CAA. Strongly opposes the CSA. Also advocates developing cleaner sources of energy.	Against any deviation from the CAA-MACT regulations. Advocates either heavy upgrading or closing old coal-fired power plants.	Has been active on several fronts to stop passage of the CSA as well as the Mercury Rule and the IAQR. Advocates for higher CAF... standards to ensure cleaner air and energy security.	Often uses fact such as lakes to acidic to support fish in its arguments. But frames the debate more around public health.
National Resources Defense Council ⁶⁸	Advocates protecting and enhancing the current CAA. Strongly opposes CSA. Also advocates developing cleaner sources of energy.	Using the recent mercury/fish concerns to advocate for more stringent regulations.	Strong advocate of clean vehicles end energy conservation both of which would reduce atmospheric deposition.	Often uses facts such as lakes to acidic to support fish in its arguments. But frames the debate more around public health.
National Wildlife Federation ⁶⁹	Not as much of a priority does advocate for stricter power plant regulations.	A major priority. Identifies Hg as a major threat to wildlife in the Midwest and the northeast.	Member of the Clean the Rain Campaign a coalition of groups advocating for strong local and national Hg regulations.	Advocates for cleaner freshwater bodies to protect biodiversity especially with respect to Hg.
Clean Water Action ⁷⁰	Fought to clean up the Filthy five and other dirty power plant in New England.	Has fought for mercury products ban throughout New England.	Also, a member of clean the rain, has been active in the Northeast and nationally on banning mercury products and cleaning up regional power plants.	Public health is the primary angle used especially with respect to Hg in fish.
Conservation Law Foundation ⁷¹	Has initiated lawsuits against specific Midwestern utilities to force emission reductions to protect New England forests.	Supports new CT and MA regulations fighting to close loophole in MA regulations that allow offsite collection of Hg products to offset emissions.	Part of the "Filthy Five" coalition campaign to clean up the five dirtiest power plants in MA.	Advocates that New England's forests are losing their economic and natural vitality sue to acid rain.
American Rivers ⁷²	Associates acid rain with the energy production cycle, sees mining practices as a more direct threat. Recognizes the threat to rivers but focuses more on conservation and dam removal.	Associates Hg deposition with the energy production cycle. Sees other aspects of that cycle as more important threats.	Works with several prominent scientists in conducting research on river restoration.	Rivers are at risk from increasing energy consumption. Fish and plant species are being lost due to many aspects of the energy production cycle of which deposition is an important part.
Northeast	Has been extremely vocal	Has been equally	Ongoing publications	Treats all aspects of

States for Coordinated Air Use Management (NESCAUM) <small>73</small>	against current attempts to weaken the CAA through the IAQR and CSA. Has been publicizing the CSA provisions that take regulatory jurisdiction away from states.	vocal regarding the Mercury Rule. Advocates for multi-pollutant bills similar to CAA as best way to achieve significant reductions.	and testimony regarding atmospheric deposition.	environmental quality equally
NEGC/ECP <small>74</small>	Has issued an Acid Rain Action Plan to advocate for far deeper cuts in emissions than nearly any other group. Also, has worked to establish critical loads for the region to help guide policy making.	Has issued an Hg action plan that calls for all members to eventually eliminate anthropogenic Hg emissions.	Given that the Northeast and Eastern Canada have the highest incidence of atmospheric deposition, the NEGC/ECP have been extremely active in addressing these issues.	Frame the debate in several ways including public health and economics but also recognizes the damage done to the environment and reductions in biodiversity.

Figure 16 Various groups working on the problem of atmospheric deposition.

Different groups frame the debate in many ways, but all agree that further emission cuts are needed and stricter regulations must be implemented. It is important to note that though these groups all are on the same page as to what should be done, none of them have a structure or perspective similar to TNC. This provides a substantial opportunity for TNC to provide a new and different voice to the debate. One that is focused solely on the preservation biodiversity and the protection of extraordinary places from the threat of atmospheric deposition.

Section 7:
Atmospheric Deposition
Recommendations

Recommendations for Action and Conclusions

Clearly, atmospheric deposition remains a prominent threat to Northeast freshwater biodiversity. Though substantial action has been taken to combat this threat significant, reduction in emissions are still required. The distributed nature of TNC's Northeast properties, its science based conservation approach and its reputation as a leader in protecting biodiversity puts the organization in a unique and potentially influential position. To this end, the following recommendations are presented.

1-Advocate for new legislation regulating point sources using a cap and trade framework based on critical loads.

Though the CAAA has resulted in a decrease in total SO₂ emissions, deeper cuts are necessary in order to protect Northeast freshwater biodiversity. New national legislation is needed to achieve such cuts. Point sources should be addressed using a system similar to the SO₂ cap and trade program. Though the potential for emission hotspots is present when utilizing this approach, its past success makes it the most politically feasible option.

NO_x and SO₂ should both be covered by under any new cap and trade legislation though separate markets should be constructed or expanded for permit trading. Separate markets are important to prevent trading between pollutants (a ton of SO₂ for a ton of NO_x). If cross pollutant trading were allowed and abatement cost for one compound were cheaper than another excessive emissions of the more expensive would result, this is not desirable.

Emissions caps should be based on critical loads. This information would guide the determination national caps with the long-term goal of reducing emissions below critical loads. Airshed data and deposition transport modeling should supplement this information in order to

identify which areas of the country are producing the most harmful emissions. With this in mind, geographic weights could be superimposed on the trading scheme to insure that substantial emission reductions are achieved where they can do the most good. For example, currently emissions from the Midwest are inflicting the most harm on the Northeast. In an even trading system with no weights, the status quo can be preserved if it is less expensive for midwestern sources to buy permits from elsewhere as opposed to cutting emissions. However, if weights were imposed so that it costs a Midwestern source twice the market price to purchase a permit from elsewhere and its' permits are worth twice as much on the market, the more damaging source has an incentive to reduce emissions and sell permits instead of the other way around.

It would be impossible and politically impractical to pursue emission caps that reduce emissions below critical loads in a short time frame. Gradual cuts will be necessary over decades to avoid undue costs to the economy and to insure legislative traction.

With respect to Hg, due to its hazardous nature a cap and trade system for this pollutant is not appropriate. MACT regulations should be implemented and periodically reviewed to tighten standards as technology improves. As with the CAAA, this legislation should also permit states to develop regulations that are stricter than national standards. Federal preemption is unnecessary and politically unattractive.

There are several groups advocating for legislation similar to what is described above; however, only the NEGC/ECP has advocated and is working on establishing critical loads. This influential group could be a natural ally on this issue. TNC should develop a line of communication with this organization to share data and identify common ground. From there the relationship could evolve into a potent alliance that could be very effective in achieving this goal.

2- Advocate for new legislation regulating non-point sources using a cap and trade framework based on critical loads.

Though the CAAA sets emission limits from mobile sources and CAFÉ standards mandate fuel efficiency standards, these regulations are relatively inflexible as compared to the SO₂ cap and trade program. Adding flexibility to these standards could make it politically feasible to achieve greater overall emission reductions. The concept is as follows; set a fleet-wide average standard based on critical loads for automobile NO_x and SO₂ emissions. Then allow manufacturers to receive credits for exceeding the standard (averaged over all of that manufacturer's automobiles for a given model year) that they can then sell to those that do not meet the standard. The standard should be stricter than current regulations to spur action by manufacturers. Every year, manufacturers will be required to meet the standard through emission reductions or by acquiring the necessary amount of credits. Over time the national standard should tighten with the goal of reducing emissions below critical loads, this will increase the cost of compliance providing an incentive for more manufacturers to implement emission control equipment rather than buying credits.

This concept is similar to the EPA's program in the 1980's that successfully phased lead out of gasoline.⁷⁵ However, it has not been applied in such an enormous setting. Much of the data collection infrastructure needed for accurate compliance monitoring is already in place as it is used to enforce current regulations. Questions arise over the diffuse nature of mobile emissions and how to link them to regional critical loads. Complex calculations will be needed to determine standards and to track compliance. This option is more difficult as it does not yet exist in the national policy debate. However, TNC could lead on this issue while also partnering with other advocates of stricter mobile emissions standards such as NRDC and the Sierra Club.

3- Push for further international engagement on the issue of atmospheric deposition.

Pressuring the Senate to ratify the Gothenberg Protocol to LRTAP could add momentum to any efforts for stronger emissions standards. A public education campaign should be initiated to familiarize people with the US's international obligations; this could provide the necessary political pressure to achieve ratification. From there, the protocol calls for emission reductions based on critical loads that could be followed allowing for a streamlined legislation drafting process. However, the usual political hurdles will need to be overcome, as regulated industries will likely be opposed to stricter standards.

4- Concentrate data collection at TNC properties on Mercury deposition.

The uncertainty surrounding Mercury transport and deposition, coupled with the questions concerning natural mercury emissions sources provides TNC with a powerful research opportunity. By collecting mercury data at all TNC properties, aiding or possibly funding additional mercury deposition research studies, and assisting in the modeling of mercury transport by acting as a data collection and distribution center, TNC can provide the science-based underpinnings that will drive future mercury emissions and control policies on a regional level.

An issue in current Mercury transport studies is the role of "background" sources, or sources that have not been identified in the research program being implemented. The studies will often identify Mercury sources that are located in states, nations, and even continents that are outside of the study region. By providing a distributed network of Mercury deposition data throughout all TNC properties, a greater understanding of the transport mechanisms and the relative role of Mercury sources on a large scale can be provided. From this greater

understanding it may be possible to act in a regulatory manner to control these previously difficult to identify sources.⁷⁶

5- Educate the public about their role in the natural world with the goal of instilling a sense of the intrinsic value of biodiversity.

It is possible that TNC could partner with corporations with an environmental focus or interest in order to gain further funding or an ally in the advocacy sphere for its conservation efforts. This partnering raises troubling questions about corporate motives for environmental protection and the economic valuation process that provides justification for such conservation efforts. It is more likely that public education and outreach efforts will lend greater weight to future conservation efforts than will corporate partnerships.

Pharmaceutical companies have spent large amounts of research funding in efforts to screen plants for new chemical compounds with medicinal properties. It is possible that TNC could partner with these companies in an effort to preserve biodiversity as a resource for the protection of human health.⁷⁷ This “conservation as human health” argument has weak points. First, TNC’s position that biodiversity is a resource valuable in and of itself is undermined by linking the resource to human health. If biodiversity is so important with or without humans in the picture, why use human health as a marketing tactic? Second, linking these biodiversity resources to a possible future product leaves them susceptible to exploitation when new (and suddenly profitable) compounds are identified. Does this argument save resources today only to auction them off in the future?

Partnerships with pharmaceutical companies are also questionable as the future cost-effectiveness of plant screening as a drug discovery method is questioned. Advanced computer models and rapidly increasing understanding of biology and chemistry in pharmaceutical

research may preclude the need for biodiversity as a resource. It may be cheaper to allow a computer to design the next anti-cancer agent than to search for it in the freshwater ecosystems of the Northeast.

One of the most difficult arguments to make for conservation of biodiversity is the “value” of biodiversity as a resource. Budgets and cost-benefit analysis are often the tools used to manage large projects and programs with environmental and social impacts, but quantifying these impacts with a dollar-based metric may be an unsound solution. The “value” of biodiversity varies throughout time, throughout space, across cultures, and across boundaries of all types. Providing a “price” that identifies the “value” of an endangered species in order to insert this effected species into a mechanistic decision-making scheme will inevitably result in conflict over that valuation and its use. Human-kind did not buy biodiversity. What right does human-kind have to sell it?

Financial valuation of biodiversity resources is fraught with the potential for these errors. It may be argued that the ecosystem containing the California condor will not be irrevocably altered in the event that the condor is driven to extinction. Should policy makers assign a low “value” to the condor and its survival? David Ehrenfeld reminds us that “it is certain that if we persist in this crusade to determine value where value ought to be evident, we will be left with nothing but our greed when the dust settles.”⁷⁸ Ehrenfeld goes on to say that “[I]f conservation is to succeed, the public must come to understand the inherent wrongness of the destruction of biological diversity.”

TNC can better conserve biodiversity in the Northeast by educating people about the intrinsic value of diversity. By providing a sense of the scope and the scale of the natural communities that surround and permeate human existence, it may be possible to change the human perception

that our ability to destroy indicates ownership, that our ability to preserve indicates power, and that the low values we place on the last remaining special places indicate our lack of understanding of the world.

Section 8:
Conclusions

Conclusion

By acting at a regional, national, and international level on both of these issues, The Nature Conservancy can provide protection to freshwater biodiversity. Though these recommendations may include different approaches than have been utilized in the past, they are within The Nature Conservancy's mandate in helping to save the last great places. Invasive/non-native species and atmospheric deposition are unique problems that can not be adequately addressed from within a property's boundaries. Therefore, through education, scientific research, partnerships with relevant organizations, and advocacy, The Nature Conservancy can take steps to mitigate these threats. The benefits of such actions will not only be experienced on Conservancy lands but throughout the Northeast resulting in the preservation and remediation of whole ecosystems.

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- 1- “Strengthen the scientific and technical capacity of the AQM system to assess risk and track progress.”
- 2- “Expand national and multistate performance-oriented control strategies to support local, state, and tribal efforts.”

- 3- "Transform the SIP (State Implementation Plan) process into a more dynamic and collaborative performance-oriented, multipollutant air quality management plan (AQMP) process."
- 4- "Develop an integrated program for criteria pollutants and hazardous air pollutants (HAPs)."
- 5- "Enhance protections of ecosystems and other aspects of the public welfare."

It is this final recommendation that The Nature Conservancy should seek to support and for which data relating to HAPs and their impacts on freshwater ecosystems should be collected and distributed in support of recommendations 1 and 4 above. This is further discussed in the Recommendations sections of this report.

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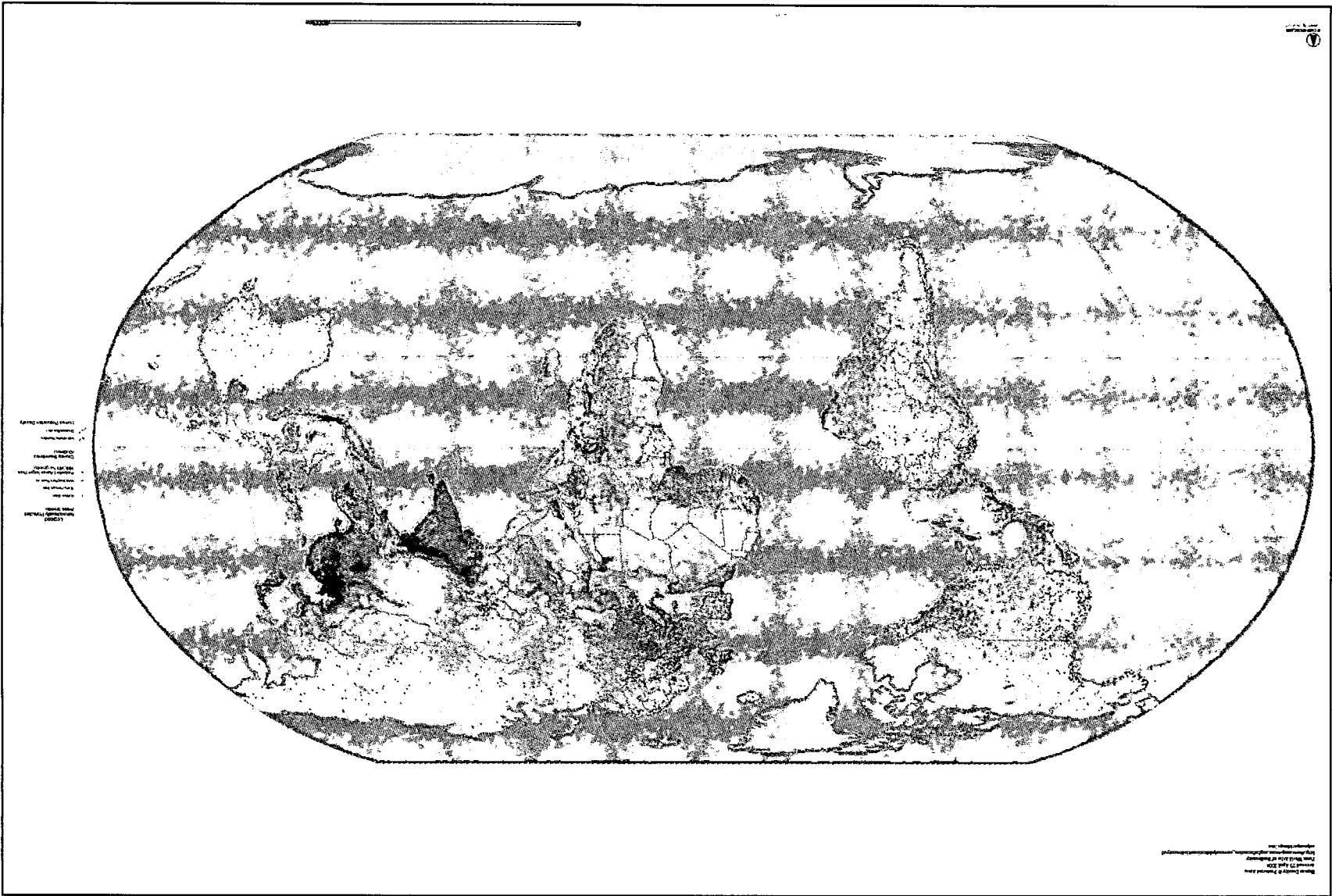
Section 8:

Appendix

(See CDR for list documents)

Appendix A: Invasive and Non-Native Species

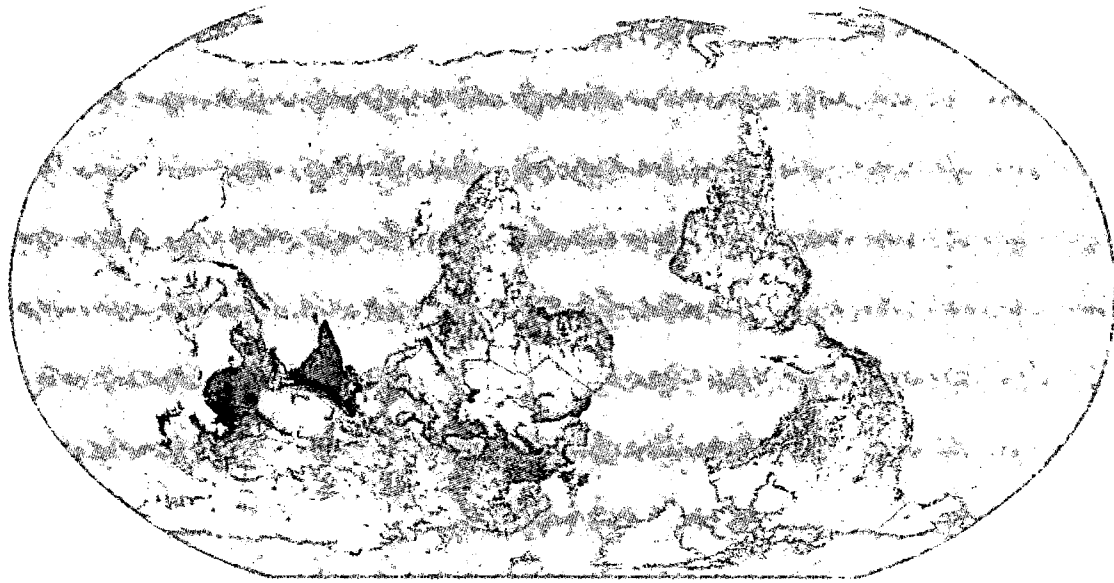
Nuisance Species Databases Available Online		
Data Base	Available from:	Available at:
Aquatic Animal Databases	InvasiveSpecies.gov	http://www.invasivespecies.gov/databases/aadb.shtml
Aquatic Plant Databases	InvasiveSpecies.gov	http://www.invasivespecies.gov/databases/apdb.shtml
Canadian National Alien and Invasive Species Database	The Atlantic Forestry Centre	http://www.atl.cfs.nrcan.gc.ca:8080/cfsnet/naisd-e.html
Catalog of Species	Invasive Plant Atlas of New England	http://webapps.lib.uconn.edu/ipane/search.cfm
The database of aquatic, wetland and invasive plants	Center for Aquatic and Invasive Plants The University of Florida, IFAS	http://plants.ifas.ufl.edu/search80/NetAns2/
Fisheries Global Information System	DIAS - Database on Introductions of Aquatic Species	http://www.fao.org/figis/servlet/static?dom=collection&xml=dias_collection12.xml&xp_detail=med
General Databases	InvasiveSpecies.gov	http://www.invasivespecies.gov/databases/genadb.shtml
The Global Invasive Species Database	Invasive Species Specialist Group and Global Invasive Species Programme	http://issg.appfa.auckland.ac.nz/database/welcome/
Great Lakes Aquatic Nonindigenous Species Database Project	National Oceanic and Administrative Program	http://www.glerl.noaa.gov/res/Task_rpts/nsreid10-3.html
The Great Lakes Fish Stocking Database	Great Lakes Fishery Commission	http://www.glfc.org/fishstocking/
NISbase	USGS: Nonindigenous Aquatic Species	http://www.nisbase.org/nisbase/index.jsp
Noxious Weeds and Non-native Invasive Plants	National Forest Service: Eastern Region	http://www.fs.fed.us/r9/wildlife/range/weed/index.php
Noxious Weeds Lists	INVADERS Database System, University of Missoula Montana	http://invader.dbs.umt.edu/Noxious_Weeds/
Regional Databases	InvasiveSpecies.gov	http://www.invasivespecies.gov/databases/reqdb.shtml
World Biodiversity Database	Expert Center for Taxonomic Identification	http://www.eti.uva.nl/Database/WBD.html
100 of the World's Worst Invasive Alien Species	Global Invasive Species Programme	http://www.issg.org/booklet.pdf



Legend

- Major Highway
- Interstate
- State Route
- County Road
- Local Road
- Waterway
- Other

Source: U.S. Department of Transportation
Data as of 1992



Low Density

High Density

Human population density

Source: United Nations, World Population Prospects, 2008

Appendix B: Atmospheric Deposition

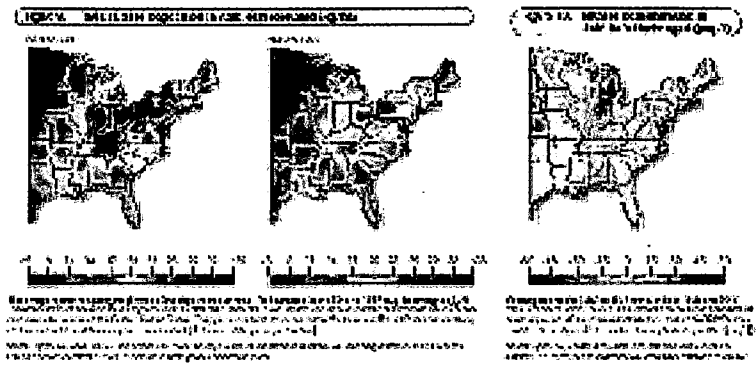
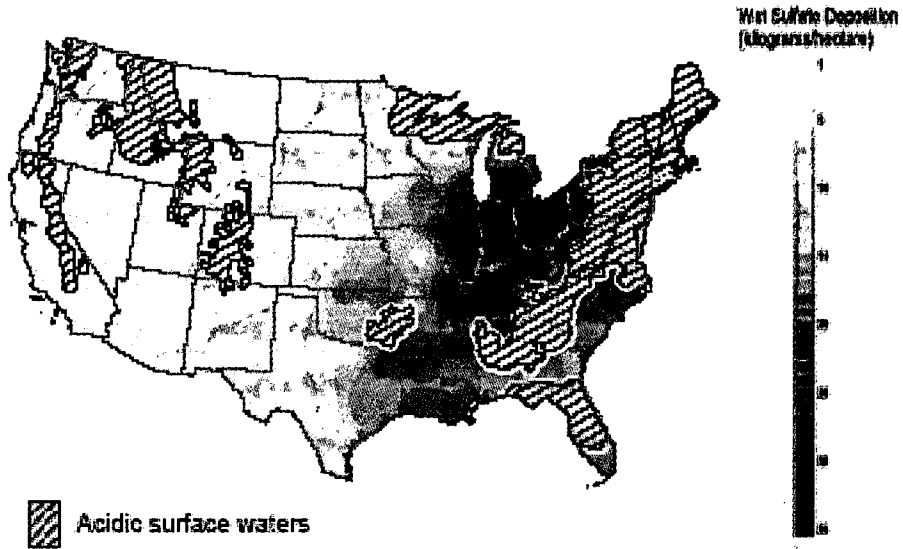


Figure 14. Percentage of Acid Surface Waters in Surveyed Regions



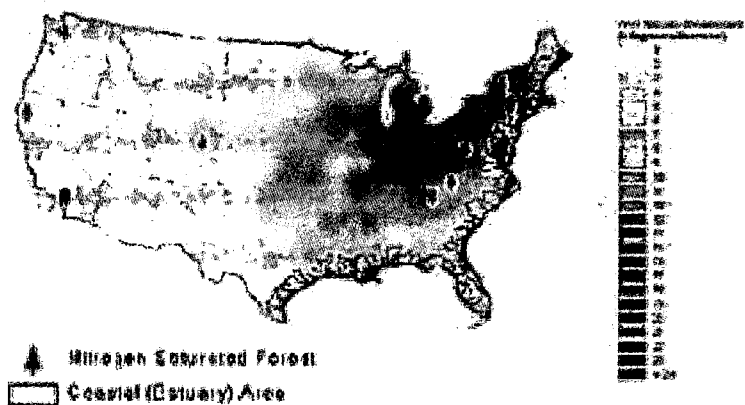
Both maps excerpted from:
Acid Rain Progress Report
 USEPA
 EPA430-R-99-011 November 1999
www.epa.gov/acidrain

Wet Sulfate Deposition (1997-1999) and Acid-Sensitive Surface Waters



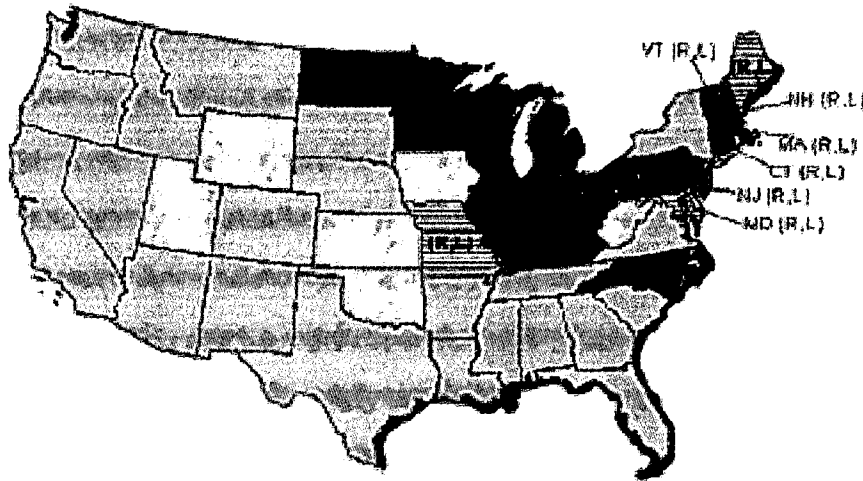
Source: CASTNet/NADP, National Surface Water Survey

Wet Nitrate Deposition to Sensitive Resources








Deposition data measured by CASTNet and NADP, 1997-1999

Mercury currently impairs 5.6 million acres of lakes, estuaries and wetlands and 43,500 miles of streams, rivers and coasts



Mercury advisories by type:

-  Statewide freshwater advisory and additional advisories on specific waterbodies
 -  Statewide freshwater advisory only
 -  Advisories exist for specific waterbodies only
 -  Statewide coastal advisory
 -  No mercury advisories
- R: advisory for all rivers
L: advisory for all lakes

Three maps excerpted from:

Overview of the Human Health and Environmental Effects of Power Generation: Focus on Sulfur Dioxide (SO₂), Nitrogen Oxides (NO_x) and Mercury (Hg)

USEPA June 2002