USA: North Carolina: Atlantic White Cedar Restoration at Pocosin Lakes National Wildlife Refuge

Overview

In the 1980s, the Atlantic white cedar (Chamaecypa risthyoides)-bald cypress (Taxodium distichum) bog at Pocosin Lakes National Wildlife Refuge was cleared and drained as part of a commercial enterprise that was later abandoned. The resultant decomposition of the bog's peat deposits caused a dramatic influx of mercury and nitrogen levels in runoff from the site and adversely affected the entire Albemarle/Palmico estuary system. In response to increasing anoxia and eutrophication in the estuary, the U.S. Environmental Protection Agency funded a non-point-source pollution reduction project in 1994. This project, implemented by the North Carolina Division of Water Quality and North Carolina Division of Forest Resources, was intended to reduce nitrogen and mercury loading of downstream waters by restoring wetland hydrology and native bog vegetation to a 640-acre research area. Practitioners will use the project as a demonstration to guide future restoration efforts over the entire 18,000-acre Pocosin Lakes Atlantic white cedar bog.

Project Details

Lead entity types:

- Governmental Body

Adaptive management

Describe adaptive management processes and mid-course corrections taken to address unforeseen challenges and improve outcomes in each of the following categories:

Other:

Restoration of the Atlantic white cedar ecosystem at Pocosin Lakes National Wildlife Refuge is a long-term effort. Improvements to the site's hydrology and vegetative community have already reduced mercury runoff to levels that are better than the State water quality standard. The ultimate goal is to have water leaving the site with mercury and nitrogen concentrations equal to, or less than, rainfall concentrations. Restoring the hydrology has also encouraged the growth of moss (Spagnum spp) and improved habitat for small mammals and amphibians. In 3 to 4 more years, the trees should be large enough to provide nesting sites for many neo-tropical songbirds.

State of Progress:

- Closed/completed, no further follow-up

Project Start:

1995-04-17

Project End:

1997-01-17

Main source of funds:

- National government and public institution

Global Regions:

- Northern America
- Americas
- World

Countries:

- United States of America

Ecosystem Functional Groups / Biomes:

- Temperate-boreal forests and woodlands biome
- Palustrine wetlands biome

Ecosystems:

- Boreal, temperate and montane peat bogs

Extent of project:

- Other

Extent of restoration:

- Other

Degradations:

- Deforestation
- Urbanization, Transportation & Industry

Description:

In the 1980s, the Atlantic white cedar bog at Pocosin Lakes National Wildlife Refuge was owned by a commercial operation that proposed to mine the area's peat and construct a large peat-to-methanol synthetic fuel plant. The proposal was later abandoned, but the area had already been cleared, ditched, and drained. The site became part of the wildlife refuge in 1990, and although the transfer of property to Federal ownership ended the threat of peat mining in the area, the site remained devoid of a natural community of plants and animals. Moreover, ditching had aerated the peat, causing it to decompose and release mercury. While total concentrations in surface water reported for the site have been variable, the highest total concentrations recorded after ditching ranged from 800 to 1,100 parts per thousand (Environmental Science and Engineering, Inc. 1982), far exceeding North Carolina's water quality standards for mercury at 12 parts per thousand. Subsequent reports have documented lower concentrations (N.C. Division of Environmental Management 1983, Evans and others 1984), but levels still exceed accepted standards and jeopardize the integrity of the entire watershed. In addition to high concentrations of mercury, nitrogen in the runoff has likely contributed to eutrophication downstream.

Planning and Review

Goals and Objectives

Was a baseline assessment conducted:

unsure

Was a reference model used:

RM5

were_goals_identified:

YES

Goals and objectives:

- Other

Goals Description::

To reduce nitrogen and mercury loading of downstream waters by restoring wetland hydrology and vegetation to a 640-acre research area

Stakeholder Engagement

Were Stakeholders engaged?:

unsure

Ecosystem Activities and Approaches

General Activities: --Hydrology Restoration and Monitoring-- A water-control structure was installed downstream from the demonstration area in 1996 so that the wetland hydrology could be restored. This structure controls the water regime on 1,500 acres. --Reforestation-- Approximately 100,000 trees of Atlantic white-cedar (Chamaecyparis thyoides (L.) B.S.P.), pond pine (Pinus serotina Michaux), and bald cypress (Tawodium distichum (L.) Richard) were planted by machine and by hand on Block B6 (0.5 mile x 1.0 mile) in April 1995. The tract had 16 columns (20 acres each) separated by small V-ditches (oriented north-south), spaced about 320 feet apart. Ditches drain to the south toward Clark-Mill Creek and the upper Pungo River. Elevation is approximately 16 feet above sea level, and depth to water table has varied from 7 to 13 inches.

The experimental design is a randomized complete block with five replications and 14 treatments. Four vegetation types (Atlantic white cedar, pond pine, bald cypress, and control), were combined with two tree-to-tree spacings (8 x 8 feet, and 10 x 10 feet) and two site preparation treatments (none vs. heavy disking). Plots are 2.0 acres, with six plots in each column. There are 70 plots, totaling 140 acres. Undisturbed border areas separate experimental plots, and riparian strips are maintained along v-ditches and canals to protect waterways. Block 85 (320 acres) was planted in late February 1996, with no site preparation and no protection from deer. Trees were planted directly into the existing vegetation, primarily broom sedge (Andropogon spp). A commercial crew hand planted 233 acres (28,000 Atlantic white-cedar, 27,000 bald cypress, and 15,000 pond pine), using a target density of 300 trees/acre. An additional 25,000 trees, consisting of eight hardwood species, were machine planted. About 2,000 acres have been planted since 1995, mostly with bald cypress and Atlantic white-cedar. Plots in Block 66 were measured for survival and growth in January 1997. Two circular sub-plots (radius of 30 feet) were installed in each 2-acre plot, yielding a 6 percent sampling intensity. Total number of living trees was noted. Heights and diameters were measured on 5 to 10 trees in each sub-plot. If there were fewer than 10 trees, all were measured. Survival counts were converted to trees per acre, and subjected to analysis of variance to determine treatment effects. Average height of plants was also calculated for each species. --Water Sampling-- Total mercury, nitrite, nitrate, total ammonia, and pH were sampled at fixed surface-water stations and ground-water wells. Nitrogen samples were analyzed in the Department of Biological and Agricultural Engineering at NC State University. Samples for total mercury analysis were shipped on ice overnight to Frontier Geosciences (414 Pontius Ave. North, Seattle, WA 98109) for analysis. Mercury concentration was determined in nanograms/liter (parts per thousand). Surface-water samples for total mercury were run unfiltered but were preserved with 5 percent BrCl, due to the turbidity of the samples, and allowed to oxidize overnight prior to analysis. Aliquots of the samples were analyzed using SnCl, reduction, dual gold amalgamation, and cold vapor atomic fluorescence detection (Bloom 1993). Sample analyses, which included quality-control samples and lab performance on precision (repeatability of results based on relative percent deviation of duplicates) and accuracy (based on percent spike recoveries and analyses of standard reference material and blanks), were acceptable. --Rainfall-- There were two local weather stations from which rainfall data could be compiled for calculations relative to annual rainfall, nutrient inputs, evapo-transpiration, runoff, and nutrient loading. One station was located on the Pungo Unit of the Refuge (approximately 4 miles from the experimental site), the other on Allen Rd (approximately 1 mile from the experimental site). The average of these two stations was used in calculations. Atmospheric inputs of mercury were obtained from data collected as part of the National Atmospheric Deposition Program (NADP) at Pettigrew State Park on the north side of Lake Phelps (approximately 5 miles from the experimental site). Atmospheric inputs of nitrogen were estimated from air deposition data from the National Acid Deposition/National Trends Network at the Lewiston Station in Bedie County (approximately 60 miles northeast of the experimental site).

Project Outcomes

Eliminate existing threats to the ecosystem: --Survival and Growth in Block B6 (Planted in 1995)-- Target stocking levels were 680 trees/acre at an 8 x 8 foot spacing, and 435 trees/acre at 10 x 10 feet. No inventory was conducted immediately after planting to determine actual plant densities. The effect of spacing was significant after 2 years in the field. Bald cypress, Atlantic white-cedar, and pond pine planted at 8 x 8 feet averaged 366, 186, and 265 trees/acre, respectively, which was 11, 68, and 27 percent greater than the stocking at 10 x 10 feet. A target density of 8 x 8 feet initially has 55 percent more trees than 10 x 10 feet. The number of trees surviving after 2 years also varied significantly among species. Cypress performed best, averaging 352 trees/acre. This represented an average survival of 63 percent. Atlantic white-cedar sustained the greatest losses, averaging 148 trees/acre. Only 25 percent of the Atlantic white-cedar seedlings survived the first 2 years. Pond pine averaged 237 trees/acre, indicating that 43 percent of the plants lived through the first 2 years. The result of site preparation varied by species. The difference was primarily with bald cypress; without site preparation, there were 277 trees/acre after 2 years, compared to 427 trees/acre in disked plots. A stocking of 427 trees/acre equates to an average spacing of slightly more than 10 x 10 feet. Stocking levels of Atlantic white-cedar and pond pine were relatively similar between disked and nondisked plots, with Atlantic white-cedar and pond pine averaging 134 to 162 trees/acre, and 224 to 245 trees/acre, respectively. After 2 years in the field, the only variable that significantly influenced tree height was species. Average total height of bald cypress, Atlantic white-cedar, and pond pine was 24.6, 11.6, and 13.1 inches, respectively. Average height at planting was not determined, but bald cypress was initially much taller than the other two species. In addition, most trees were browsed during the first and second year despite the presence of a Gallagher electric fence. No stem diameters were measured in the 1996 inventory. --Nitrogen Analysis-- Total Kjeldahl N (TKN), which includes organic N and ammonia, averaged 1.8 to 3.5 mg/liter in surface water. On occasions when NO,-N was measured, the readings (3 decimal places) were zero mg/liter. In addition, the concentration of NO,-N never exceeded 0.02 milligrams/liter, and was usually â‰¤ 0.01 mg/liter. NO,-N was equivalent to approximately 1 percent of the TKN. Ammonia in surface water ranged from 0.05 to 0.67 mg/liter, but was mostly I 0.2 mg/liter. The ammonia fraction in surface water was 110 percent except in July 1996 (22 percent). TKN in surface water exiting the demonstration plot (1.8 to 3.5 mg/liter) is higher than levels recorded at the State downstream ambient water-quality monitoring station, which ranged from 0.5 to 1 mg/liter in 1996 samples. The current level of TKN is only slightly less than levels reported by Environmental Science and Engineering, Inc. for this area in 1982, of 2 to 4.95 mg/liter. In contrast, nitrate/nitrite levels (< 0.01 mg/liter) in surface water exiting the site were lower than those recorded at the ambient station, which ranged from 0.1 to 1.5 mg/liter. --Mercury Analysis-- Mercury concentrations in unfiltered surface water at the demonstration site ranged from 5.7 to 255 parts per thousand. In both years, the only samples higher than the State standard of 12 parts per thousand were taken in the winter, and all other samples were within the range of values reported for rainfall (National Atmospheric Deposition Program 1997). Factors limiting recovery of the ecosystem: In general, it appeared that bald cypress was less severely browsed than Atlantic white-cedar and will likely outgrow the adverse influence of browsing. Most of the surviving Atlantic white-cedar were heavily browsed, and many plants might eventually succumb or never grow into good trees. On this site, it has been concluded that achieving survival of Atlantic white-cedar commensurate with that of bald cypress will demand additional protection against deer, e.g., plastic or metal netting, sleeves, cages, or different types/configurations of electric fencing. Consequently, experiments are currently being carried out at the site to evaluate various types of deer exclusion. Economic vitality and local livelihoods: The restored area should provide downstream water quality benefits (i.e., reduced erosion and surface-water discharges with

concentrations of total nitrogen and mercury less than or equal to those in rainfall). Other project benefits include wildlife habitat restoration, contributions to the scientific literature on wetland restoration, and the potential for this large demonstration project on restoration of Atlantic white-cedar, bald cypress, and pond pine to serve as a catalyst for the replanting of these wetland trees on private lands with deep organic soils. All these species are valuable for timber and are adapted to grow under wetland hydrologic regimes.

Monitoring and Data Sharing

Does the project have a defined monitoring plan?:

NO

Open Access URL:

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Long Term Management

STAPER