USA: New Jersey: The Restoration of an Urban Floodplain in Rahway

Overview

The highly urbanized Rahway River watershed in New Jersey suffers from frequent flooding due to extensive development and destruction of riparian wetlands and floodplains. A diverse group of stakeholders worked together to restore a 1.8 ha site on the floodplain to riparian wetland with the goals of providing wildlife habitat, filtering pollutants from stormwater runoff, providing stormwater retention to minimize flooding, and providing public access for passive recreation as well as education about wetlands and watershed management. This wetland restoration site has been incorporated into the Union County Parks System as the Michael S. Bezega Wetlands Observation Area. Due to the urban setting (14 houses were removed from the site), the project design and implementation were very complex. Developing the water budgets required analyses of the tidal Rahway River as well as stormwater runoff from local drainage areas. Funding was obtained from six different funding agencies, and the project was constructed largely with city and county public works personnel. Native plants were installed by volunteers who continue to do invasive species management at the site. Key factors contributing to the success of this project include extensive involvement of a diverse partnership of stakeholders, a multi-disciplinary project team, thorough up-front design and engineering analyses, careful selection of vegetation palettes based on analyses of reference wetlands, and extensive on-site supervision of the construction crews by personnel who could make design decisions in the field (Obropta and Kallin 2007).

Quick Facts

Project Location:
Rahway, NJ, USA, 40.60815909999999, -74.27764680000001

Geographic Region:
North America

Country or Territory:
United States of America

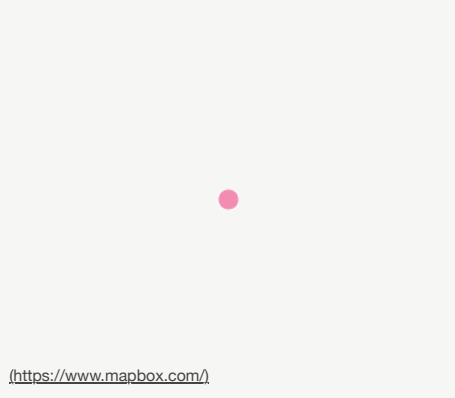
Biome:
Freshwater

Ecosystem:
Freshwater Ponds & Lakes

Area being restored:
1.8 ha hectares

Organization Type:
Other

Location



TIMEFRAME

Project Stage:
Completed

Start Date:
1994-11-21

End Date:
2005-11-21

DEFINING THE PROBLEM

Primary Causes of Degradation

Urbanization, Transportation & Industry, Other

Degradation Description

Since the early 1600's, when the British first colonized the area between the early settlements of Perth Amboy and Rahway, the Rahway River watershed region has supported the longest continuously urbanized communities of New Jersey. The man-made landscape and its impacts to the watershed have been dramatic. During the nineteenth century the project area was a farm, and filling and plowing probably modified the natural geology. At the beginning of the twentieth century, roads and houses were built. As additional houses were built, more fill was probably added to this area.

Comparing data from 1922 to about 1970 and then 1970 to the present, it is clear that the hydrodynamic characteristics of the Rahway River have fundamentally changed. Destruction of wetlands, channelization, and increasing development within the watershed have resulted in the basic hydrology becoming much flashier, with lower average base flows and much higher, more frequent flood events (Obropta and Kallins 2007).

PLANNING AND DESIGN

Reference Ecosystem Description

Rahway City maps dated 1787 show the restored area as a wetland along the Rahway River. Early colonists and seafarers spoke of the abundance of wildlife, a sea of meadows and mature forests that graced the shores of the Rahway River.

Project Goals

The ultimate goal was to restore the floodplain to its predevelopment condition. The restoration goal was to provide wetland mitigation, enhanced and expanded wildlife habitat, and green space in the urban center (Obropta and Kallins).

Monitoring

The project does not have a monitoring plan.

Stakeholders

This restoration effort benefited from a diverse partnership that continued to grow during the project. State, local, and federal agencies joined with local environmental organizations, church groups, and large corporations to help fund the design and construction of this restoration effort. The first and most important step in the project was building a strong partnership of stakeholders. The partnership was built on the collaborative efforts of James Lynch of the City of Rahway's Redevelopment Department, Steven Barnes of the NY/NJ Baykeeper's office, a local non-profit organization that has championed environmental restoration projects, and Christopher Obropta, a consultant from the environmental consulting firm TRC Omni Environmental Corporation. Chris Obropta grew up in the area and was particularly interested in giving back to the community. The three worked together to recruit support from the Union County Parks and Recreation Department, the Mayor of Rahway, and the Union County Freeholders. A landscape architect from an engineering firm, the Reynolds Group, and an engineer from TRC Omni worked together to draft a short report including

PROJECT ACTIVITIES

Description of Project Activities:

During the project's first year of action in 2000, 13 houses were razed and their foundations filled in. Care was taken to preserve any trees during these demolitions, and the areas were reseeded with annual rye grass (Lolium sp.) to control erosion. As a result, the vegetation over most of the site was essentially turf grass and shade trees, with approximately 0.27 ha of woods along the northwest corner of the site, along the river's edge, and in the drainage swale in the southeast corner. During the initial survey, all trees over 25 cm diameter were marked and identified. There were 93 trees, the predominant being red maple (Acer rubrum), silver maple (Acer saccharinum), pin oak (Quercus palustris), green ash (Fraxinus pennsylvanica), and tree-of-heaven (Ailanthus altissima). Soil borings and test pits verified the presence of native soils. The native floodplain soils were located wherever the elevation was less than 2 m and were detected under the fill layers at approximately that elevation. Soil samples were tested for nutrients, pH, and organic matter, and the results indicated that the substrate soil had to be amended to increase organic content. Union County has a leaf composting facility nearby and provided compost as a soil amendment. Two major elements are required for the water budget at this site: runoff from precipitation over an area of approximately 4.7 ha and inundation from the river itself. Two stormwater outfalls discharged directly to the Rahway River, one just upstream and the other in the middle of the site. The original design called for these outfalls, as well as overland flow from streets and parking lots, to be rerouted to forebay areas in the wetlands. Runoff from 1.86 ha was to be discharged to a wet meadow in the northwest quadrant of the site. After flowing through the wet meadow, any water not infiltrating or evaporating would enter the first wet pond. Overflow from there would seep through the center wet meadow and scrub-shrub wetland into a second wet pond or emergent wetland and eventually to the river. Runoff from approximately 2.8 ha to the south and west enters the site via a swale off the end of Allen Street near the center of the site. This runoff flows overland through the lower wet meadow scrub-shrub area. Water budgets were calculated separately for the upper wet meadow and pond and the lower wet meadow and pond using average monthly precipitation from the last ten years obtained from the New Jersey State Climatologist at Rutgers. Seepage rates were based on pre-construction percolation tests performed near the wet pond locations (Obropta and Kallin 2007). Additional details on the water budget calculations can be found in Obropta and Kallin (2003). The water budget for the inundation due to the Rahway River was a bit more complicated. The U.S. Geological Service (USGS) has had a gauging station on the Rahway River approximately 880 m upstream from the site since 1922, and the U.S. Army Corps of Engineers (USACE) has conducted two major hydrological studies of the Rahway. Comparing data from 1922 to about 1970 and then 1970 to the present, it is clear that the hydrodynamic characteristics of the Rahway River have fundamentally changed. Destruction of wetlands, channelization, and increasing development within the watershed have resulted in the basic hydrology becoming much flashier, with lower average base flows and much higher, more frequent flood events. Using channel profiles and stage measurements taken during the previous USACE studies and an estimated inflow elevation (the depth when water from the river would overtop the banks and enter the wetland) of 2 m, Manning's equation was used with a range of reasonable roughness parameters to estimate the flows required to overtop the bank at this level. These calculations indicate that, depending on the roughness parameter used, a flow of 13.5 to 24 cubic meters per second (cms) is required to reach this stage. The daily flow data for the past ten years were analyzed to determine how many days each year's flows exceeded these levels. These data show that at 18 cms, the site would be inundated from one to ten (average 5.3) times during the year. This reflects a minimum number of days when the river would inundate the site, since it would typically take two to three days for the water to recede or infiltrate after each flooding event. Project leaders figured this would be adequate to maintain wetland conditions, supported by the fact that areas on the site and on the floodplain on the other side of the river with elevations below 2 m have wetland vegetation, soils and hydrology. Based on calculations project leaders set the elevation of the inlet swale at 2 m. The invert of the outlet pipe from the lower wet pond was set at 1.7 m so that water would "back in" from the lower wet pond during high flow events. As a result, when the water comes in over the inlet swale in the northwest quadrant of the wetland, the wetland is already full and erosive forces are significantly reduced. As the water recedes, the wetland drains slowly from the discharge pipes at the lower end of the wetland. A wetland seed mix was applied to the wetland areas, and a wildflower/warm season grass seed mix was applied to the transition areas and upland areas. In addition to seeding the entire site, 10,000 herbaceous plants (in 5-cm peat pots) were planted throughout the wetland. The planting plan also specified 5,000 shrubs in the transition areas around the wetlands. These shrubs were purchased in 3.8 L and 7.6 L containers and planted 0.9 to 1.8 m apart, depending on the species. In addition to the herbaceous plants and shrubs, 25 larger-diameter trees were installed. The plant species were chosen to emphasize diverse and flowering plants, using the existing forested floodplain wetlands upstream as a reference site, as well as the Wetlands Floodplain Forest and Red Maple-Hardwood Swamp sections of a local planting guide (see reference in Obropta and Kallin 2007). Most of the species listed in the guide were present on the nearby island and floodplain. The design also included an invasive species control plan. Project designers located the emergent wetlands in heavily shaded areas to discourage purple loosestrife, and established dense colonies of native sedge and rush species to resist invasion. The ongoing monitoring program, to be carried out by the Union County Parks Department, will target the identification and control of invasive species. Owing to the river herring spawning run, the majority of the construction could not begin until July 1, 2002. Over 3,000 cubic yards of anthropogenic fill was taken from the site to a local landfill where it was used as capping material. Approximately 2,300 cubic meters of compost material was brought into the site to amend the soil. A local contractor was

hired to assist in the excavation, hauling, and removal of concrete debris. Apart from a walking path, stone retaining wall, and stormwater routing from the upper outfall, construction was completed by September 2002. Over 350 volunteers contributed four intense days between September 11 and September 14 planting more than 7,000 herbaceous plugs and 3,500 trees and shrubs. The second phase of the construction, in spring 2003, involved the walking path, stone retaining wall, and additional plantings. A mason from the Parks Department provided guidance and quality control. In May 2003, the site was officially incorporated into the Union County Parks Rahway River Greenway and dedicated as the Michael S. Bezega Wetlands Observation Area. The final phase of construction took place in fall 2005. The original design called for routing the discharge from a stormwater catchbasin just upstream to a swale at the northwest corner of the wetland. Unfortunately, an easement could not be obtained from one of the property owners at an affordable price. This meant that instead of 1.9 ha draining to the upper wet meadow, only 1 ha was contributing runoff to the site, which was sufficient to maintain wetland conditions in the wet meadow, but the pond was frequently dry. To increase the amount of water flowing to the upper wet pond, project designers modified the design to include a pipe between the river and the upper wet pond. This pipe included a one-way valve to allow flow from the Rahway River. The invert of the pipe was set at 1.68 m, which means that a flow of approximately 15 cms in the Rahway River will result in water flowing to the pond if there is less than 15 cm of water in the pond. Based on historical flow data, this should occur roughly once a month. This will increase the amount of stormwater treated by the wetland since the river is predominately stormwater when flowing over 15 cms, and will serve to keep water in the upper wet pond virtually all the time. Rutgers University, in conjunction with the volunteer effort of the Rahway River Association, has implemented a post-construction monitoring program. In addition to monitoring the plants as required by the NJDEP wetlands permit, the pollutant removal efficiency of the wetlands will be studied via water quality sampling and soil sampling. With the bulk of the planting effort completed in fall 2002, the vegetation monitoring program began in 2003. At each site project leaders took photographs and recorded the coverage of dominant and invasive plant species.

PROJECT OUTCOMES

Ecological Outcomes Achieved

Eliminate existing threats to the ecosystem:

At the end of the first full growing season, the wetland easily achieved well over 85 percent coverage of target hydrophytes. The wet meadows were dominated by willow-weed, or curlytop knotweed (Polygonum lapathifolium), a native annual forb that was not in any of the seed mixes but may have been included in the compost that augmented the soils in these areas. It is also possible that seed was carried by a flood event. At the upper wet meadow and pond, coverage of willow-weed approached 80 percent, interspersed with a diverse mixture of tussock sedge (Carex stricta), bluejoint grass (Calamagrostis canadensis), fox sedge (Carex vulpinoidea), soft rush (Juncus effusus), smooth bur-marigold or beggartick (Bidens laevis), and nodding bur-marigold (Bidens cernua). The edges of the swales were dominated by boneset (Eupatorium perfoliatum), blue lobelia (Lobelia siphilitica), and New York aster (Symphyotrichum novi-belgii [= Aster novi-belgii]). The wet pond areas were dominated by swamp rosemallow (Hibiscus moscheutos), pickerel weed (Pontederia cordata), and duck potato (Sagittaria latifolia). The shrubs along the sides of the pond include buttonbush (Cephalanthus occidentalis) and redosier dogwood (Cornus stolonifera). A small stand of broad-leaved cattail along the northern edge of the upper pond covered approximately 3 percent of the pond area. At the end of the second growing season in 2004, the major change noted in the vegetation was a significant decrease in willow-weed dominance. Coverage was no more than 10 percent anywhere. The dominant vegetation in the wet meadows was the nodding and smooth bur-marigolds, with nearly 80 percent cover. Boneset and New York ironweed (Vernonia noveboracensis) were common throughout both wet meadows (10 percent cover). Significant new species included sweet flag (Acorus calamus) in the upper wet pond and center wet meadow and spatterdock (Nuphar lutea ssp. variegata) in the lower wet pond. Chufa, or yellow nutsedge (Cyperus esculentus), was noted in both wet meadow areas. The patch of cattails had spread to cover slightly less than 5 percent of the upper wet pond, and scattered plants (over 1 percent) were present in the upper wet meadow. The lower wet pond had been colonized by both common carp (Cyprinus carpio) and mummichogs (Fundulus heteroclitus heteroclitus). Of note, a pair of black-crowned night herons (Nycticorax nycticorax), a threatened species in New Jersey, nested in a tree adjacent to the wetland. By the end of the third growing season in 2005, the wet meadows had developed into a very diverse ecosystem. Spotted Joe-Pye weed (Eupatoriadelphus maculatus), sweet flag, and swamp milkweed (Asclepias incarnata) were common, especially in the upper meadow. The upper portion of the center wetland meadow/swale area was dominated by boneset, tussock sedge, and chufa, while boneset and New York asters dominated the edges of the swale. Coverage by target hydrophytes was 100 percent. There were numerous scattered cardinal flowers (Lobelia cardinalis) and blue lobelia. A few common reed and purple loosestrife plants scattered throughout the center wet meadow were pulled up by the roots and discarded off-site. Mugwort (Artemisia vulgaris) invaded along some of the swale edges, but mostly in the transition area and not in the wetter areas. The patch of cattails in the upper wet pond had spread slightly but still covered less than 5 percent of the pond area. The black-crowned night herons returned to nest a second year (Obropta and Kallins 2007).

Factors limiting recovery of the ecosystem:

The Michael S. Bezega Wetlands Observation Area is surrounded by a highly urbanized setting.

Socio-Economic & Community Outcomes Achieved

Economic vitality and local livelihoods:

The restoration project was preceded with an economic buyout of private property and houses in a troubled floodplain zone. Further restoration activities of the site helped provide flood mitigation, enhanced wildlife habitat, retained and filtered stormwater runoff, and provided opportunities for public recreation and education in an urban setting.

KEY LESSONS LEARNED

Key Lessons Learned

Rutgers University, in conjunction with the volunteer effort of the Rahway River Association, has implemented the post-construction monitoring program. In addition to monitoring the plants as required by the NJDEP wetlands permit, the pollutant removal efficiency of the wetlands will be studied via water quality sampling and soil sampling. With the bulk of the planting effort completed in fall 2002, the vegetation monitoring program began in 2003. At each site Obropta and Kallin (2007) took photographs and recorded the coverage of dominant and invasive plant species. Success criteria for constructed wetlands in New Jersey require 85 percent cover by target hydrophytes and less than 10 percent invasive species. Relevant invasive wetland species listed by NJDEP included Japanese knotweed, purple loosestrife, common reed, and broad-leafed cattail (Typha latifolia).

LONG-TERM MANAGEMENT

Long-Term Management

The restoration site has been incorporated into the Union County Parks System and will be managed by the Union County Parks, Recreation, and Facilities Department.

FUNDING

Sources and Amounts of Funding

$319,000 dollars New Jersey's Wetlands Mitigation Council was very excited about the project and suggested that TRC Omni and the Reynolds Group bring back a preliminary design, and they would consider providing some funding for the project. The City of Rahway then agreed to provide TRC Omni and the Reynolds Group $50,000 to prepare the preliminary design. This money supported the collection of detailed site topography, calculation of the site hydrology and hydraulics, preparation of a preliminary grading plan, and a collection of soil samples. When the preliminary design was completed and presented to the Wetlands Mitigation Council, they agreed to give $50,000 for the final design, permit applications, and construction specifications.

Funding came from many different organizations: the NJDEP; the National Oceanic and Atmospheric Association through their community-based habitat restoration program; the Fish America Foundation provided funds from their program to promote habitat for anadromous fish, in particular the alewife (Alosa pseudoharengus) and blueback (Alosa aestivalis) river herrings. The Union County Freeholders provided support, as did the Merck Corporation, which has a facility within walking distance of the site. Each of the sources of money had restrictions. Some funds could only be used for construction of the wetlands, while others could only be used for purchasing vegetation. Union County, the City of Rahway, the local church, and all the partners in the project provided in-kind service. In addition to managing several of the grant contracts, Union County provided heavy construction equipment and operators. The City of Rahway provided a backhoe, dump trucks, and an operator. TRC Omni's engineering staff provided oversight for the major earth moving and construction. Union County Parks Department and the NY/NJ Baykeeper organized the volunteer planting effort for the site, and the local church provided both volunteers and a staging ground for the volunteer planting efforts. This in-kind support was invaluable.

LEARN MORE

Other Resources

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CONTACTS

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