Strategic Approaches to the Restoration of the Passaic River Watershed: Comparing the Scale of Available Properties to Wetland and Buffer Area Required to Reduce Pollutant Loads

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Abstract

The pollutant load (source) as quantified in available datasets for the Passaic River can be used to determine the scale of wetland and upland buffer restoration required (sink) to address specific pollutants including phosphorus, nitrogen, biochemical oxygen demand, hydrocarbons, and specific metals. Using this method, findings on the mineralization or sequestering of specific pollutants are used to determine the scale of wetlands and/or soil buffers required to remove specific annual loadings. An alternative approach to water quality improvement may be taken whereby the available properties that can be readily acquired along the Passaic River are identified. A comparison of these two approaches may be used as a planning tool to inform acquisition and restoration programs and to assess their potential biogeochemical effects. This poster thus utilizes source-to-sink ratios in the Passaic River Watershed as a general method to evaluate acquisition and/or restoration approaches in terms of ecosystem services required to meet desired water quality improvement.

Introduction

Ecological restoration may be assessed in terms of needs and opportunities in any given watershed. In this poster, restoration needs for the Passaic River are determined by pollutant loads into the rivers receiving waters[1]. The area of wetland and upland buffer systems necessary to remove one hundred percent of these loads was determined from values presented in the literature for terrestrial[2][3] and wetland[4][5] systems. Literature values were used to calculate the area of wetland and upland buffers required to remove all N and P loads to the Passaic River, as described in Crawford et. al.

Opportunities are assessed by two different, potentially complementary methods: landscape area, and biogeochemical capacity. In order to quantify land amenable to near-term acquisition and/or restoration, the area of properties readily available for purchase, modification, and/or enhancement have been identified. The scale of such restoration effort is presented on the right half of the poster. From the biogeochemical capacities of wetlands and upland buffers, given specific loadings of N and P, on can infer the necessary scale of natural systems necessary to remove the nutrient in question.

Methods/Calculations

- The present loads of nitrogen and phosphorus to the Passaic River are on the order of 2.5 X 107 kg per year and 3 X 106 kg per year, respectively (Crawford et al). Wetland and oxidized soil buffer and groundwater systems have substantial but differential capacities to remove these nutrients.
- Wetlands Phosphorus. 1,000 sq. mi. Wetlands have significant but limited capacities to remove phosphorus. Richardson provides an approximation of the quantity of phosphorus that can be removed by wetland systems, ≈ 1 g/square meter/year.
- Wetlands Nitrogen. 140 sq. mi. Compared to phosphorus, higher nitrogen removal capacities exist in wetlands, with an average value of 1.89 kg/hectare/ year reported in Kedlac and Knight.
- Upland Phosphorus. 12 sq. mi. Oxidized soils have high affinities for phosphorus. Richardson reports upland phosphorus removal at approximately 900 lbs P per acre per year for 20 years, with no increase in release rates.
- Upland Nitrogen. 820 sq. mi. While upland soils have limited nitrogen removal capacities based on plant growth, nitrogen removal capacities in groundwater systems has been demonstrated to be quite significant. While measured denitrification rates are modest, approximately 6.0 kg N/ha/yr, total nitrogen removal is much higher, 120 kg N/ha/yr.
- Comparison is made of these approximate measures to the Available Restorable Acres reported in the NOAA Restoration Opportunities Report of July 2004. Relative Scaling is shown in [Figure 2].

Conclusions

- The initial acquisition and restoration approaches are essential to restoring natural resources in urban coastal areas. However, these acquisitions may be seen as steps towards future goals, including watershed restoration, both in terms of habitat expansion and increases in biogeochemical function.
- Wetland creation of approximately 140 square miles, perhaps approximating presettlement wetland area, would be capable one hundred percent of the 2.5 X 107 kg N added nitrogen each year.
- No quantity of wetland restoration would redress the phosphorus problem in the whole watershed, since a wetland area larger than the total watershed system, approximately 1,000 square miles, would be necessary to remove total loads from the river system. However, the method used does not differentiate freshwater from estuarine portions of the river, so modest wetland enhancement work upriver could address more modest loading in the upper reaches of the watershed.
- Upland systems, and surface and subsurface wastewater and stormwater discharge could contribute substantially to the phosphorus problem in the Passaic River. As little as one percent of the land area has the biogeochemical capacity to remove present phosphorus loads.
- Terrestrial buffers, however, could remove only remove a fractions of N, since the nitrogen removal capacity of groundwater systems would require that much of the runoff and wastewater discharge occurred through the ground surface and subsurface. This, however, may be possible with specific point source inputs. The non-point removal would require that the watershed begin to approximate the presettlement infiltration capacities of the soils in the watershed, which would require substantial re-engineering of the stormwater infrastructure.
- While this poster explores the scaling of biogeochemical sinks for pollutants, we are well aware of the fact that there are two means of controlling pollutant loads in watersheds: decreasing sources and increasing sinks. Both approaches are probably essential to achieving water quality and habitat enhancement goals, but little work to date has focused on potential contributions of biogeochemical scaling to increasing water quality at the watershed level.

References

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- [5] Richardson, C.J. & S.S. Qian. 1999. Long-Term Phosphorus Assimilative Capacity in Freshwater Wetlands: A New Paradigm for Sustaining Ecosystem Structure and Function. Environmental Science& Technology: vol 33(10):1645-1661.

Excerpted From: ***NOAA Restoration Center Passaic River Restoration Opportunities Report.*** Date: July 9, 2004

Introduction

This document examines restoration opportunities on the 17-mile stretch of the Lower Passaic River and does so within a narrow set of criteria pertaining to Location, Land Availability, Land Use, Consistency with Regulatory Requirements, and Technical Feasibility (broadly defined).

The Report contains the written and mapped results of an exercise that began with the development a macro-level screening process for determining appropriate sites for natural area restoration and ends with a list of the restoration target sites consistent with the selected criteria of the screening process. The results identify viable project sites for the purpose of identifying and discussing the merits of those sites.

Purpose

1) To create and present a macro-level screening process/adoption of specific criteria for the identification of suitable restoration opportunities. 2) To present the results (text, maps, tables) of the first-run of the screening process. 3) To stimulate discourse among stakeholders. 4) To determine what further level of scrutiny and testing might be needed under a next level round of screening aimed at determining individual site suitability.

5) Begin a process through successive rounds that can ultimately assist Trustees with selection of sites suitable for advanced Phases of Inventory and Feasibility Study. 6) Determine, if necessary, what would be needed to either adjust further this initial set of site-selection criteria in order to broaden the possibilities of site selection or conversely to further narrow it.

Methods

The establishment of criteria was done by means of literature review, site reconnaissance, review of past surveys and maps, and use of remote sensing. We consulted documents relevant to the practice of restoration in the Northeast. Federal NRD case reports were consulted for examples of criteria selection. NJDEP reports were consulted regarding mitigation success for guidance on aspects of technical feasibility. NJDEP GIS aerial mapping and surveys provided the foundation on which to accomplish remote sensing and apply collected data but also assisted in the development of the criteria. State, Federal and local officials were consulted regarding knowledge of restoration practice and local knowledge of the area's waterways.

Screening methodology consisted of applying knowledge of individual sites (information collected through site reconnaissance, review of past surveys and maps, and use of remote sensing) to the selected criteria. Individual Sites were organized by geographic location, political boundary, ownership, usage, and /or outstanding physical feature.

The Criteria for Guidance for Site Selection were determined as follows:

1) Location: Site selection will be inclusive of the lower Passaic and it's tributaries in the 17 mile length including just above the Dundee Dam to below the mouth - including the Second River and Third River tributaries. This is in accordance with the agreements set forth by the Trustees.

2) Land Use: Site selection shall be exclusive of taking of land such as by condemnation or other means of forced buy–out, and largely devoid of structures and buildings or those sites requiring modifications, repairs and/or demolition of existing buildings or infrastructure.

3) Land Availability: Site selection will be inclusive of all open, vacant, or undeveloped lands within close proximity and close functional relationship to the water resource. The sites shall be inclusive but not confined to public or quasi-public land such as parkland, public utilities, lands under water or lands now being considered for parkland development.

4) Regulatory Consistency: Site selection shall be exclusive of habitat exchange such as the taking of subtidal or intertidal waters (existing wetland types) for the purpose of restoring other intertidal habitat types – primarily vegetated marsh.

5) Technical Feasibility: Factors that pose an uncertainty to the success of the restoration. Consideration of physical and biogeochemical conditions which if not corrected are delimiters of certain kinds of biological activity and thus preclude certain types of restoration. Historically, subtidal habitat restoration such as SAV bed or Shellfish restoration have achieved a lesser degree of success than Vegetated Marshes due to the greater physical and biogeochemical constraints presented in urban waterways.

6) Post Remedial Restoration: Consideration of sites where Remediation Work is likely to be rendered, and where habitat disturbance is likely to occur as a result of that work. Post remedial restorative actions may include such activities as capping/fine grading to create specific depths and bottom structure.

7) Habitat Type: Site selection will take into consideration the opportunity for Restoration, Creation, and Enhancement of habitats (structural and/or organismic in nature).

Results:

The Results of the Screening are shown in [Table 1, Table 2] and [Figure 1]. The sites that met the criteria appear marked and numbered on the map as yellow polygons. The outline of the polygons represents the area in which it is likely that restoration could occur in full or part. Green bullets mark areas that are of interest for restoration, but have not been fully screened.

A rough estimation of the total restorable acres of sites included in [Table 1] is 61.9 acres. The largest single contributor being #20 (estimated at 10.0 acres) and #23 (estimated at 10.0 acres). The smallest site contributor is #19 (estimated at .05 acres). Eight of the 27 listed sites contribute less than 0.5 acres each. Site #2 is under consideration for one of four categories of fish passage (dam removal, fish ladder, bypass channel, rock ramp) and contributes an estimated 6.0 stream miles (acreage not determined) of habitat for fish.

An estimation of the total restorable acres of sites included in [Table 2] is less well determined. A ballpark estimate is +100 acres restorable. Sites #1-6 contribute less than 1.0 acre combined. Of these, three sites are Access Projects or Greenways with no habitat acreage value. Site #7 is estimated at +100 acres.

[Figure 1.]

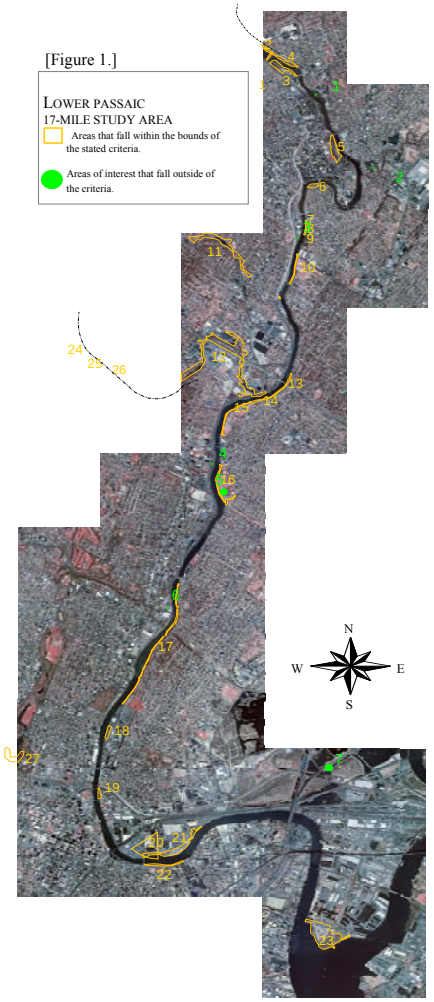


Table 1.

- Sites Identified within the Guidelines of the Set Criteria.

	Site Name	Location	Town	Bank
1	Elmwood Park (camina haun)	Washington & River Rd (Rose dam)	Elmwood Pk.	East
2	Dundee Dam And adjacent parcel Lastoe Ave. River Rd	River Rd & Division St	Clifton-Garfield	East
3	Lower Dam Islands	River Rd & Division St	Clifton	East
4	Green Acres Parcel	Sernel Ave. & River Rd/Ann St.	Garfield	East
5	Dundee Island Prelude Park	Monroe St Bridge and Passaic St. Bridge	Passaic	West
6	Wallington/Nazareth Parcel near boat ramp	Parkway & Hoover Pk Wallington Ave Bridge	Wallington	East
7	Silver Brook Property	South of Gregory Ave Bridge	E.Rutherford	East
8	Joe Sandbrook Park	South of Gregory Ave Bridge	E.Rutherford	East
9	Joe Sandbrook Park, Nature Models & Lot 2	South of Gregory Ave Bridge	E.Rutherford	East
10	Rutherford Memorial Field	Morena Ave.&Morena Ave	Rutherford	East
11	MT.Hesikh Brook Culvert Outfall Kaplan Lake	Houston Ave. Veterans Memorial Park	Passaic	West
12	1st River and Variance Park/Pond	Elaboration	Nutley-Clifton	West
13	Route 3 Bridge (PPR) parcels	Riverside Ave.	Lyndhurst	East
14	Route 3 Bridge - Patty DeLoy Gallagher Park	Riverside Ave.	Lyndhurst	East
15	Riverside Park North Joe Caruso Park	Riverside Ave.	Lyndhurst	East
16	Riverside Park (Hangar Co.South Pk.)	River Rd	Lyndhurst-N Arlington	East
17	Riverbank Park	River Rd	Kearny	East
18	American Strip Steel Parcel	Passaic Ave	Kearny	East
19	Hangar Site	Passaic & Hamilton	Harrison	East
20	PSE&G 4th St. Bridge	West of Jackson St Bridge off Cape May St.	Harrison	East
21	PSE&G Sites	East of Jackson St. Bridge off Cape May St.	Harrison	East
22	Newark Riverbank Park	Off Raymond Blvd (Passaic Ave)	Newark	West
23	Kearny Point	Kearny Point	Kearny	East
24	Clarks Pond	Third River	Bloomfield	West
25	3rd River Steambank	Upper Third River corridor	Bloomfield	West
26	American Scientific	Upper Third River Corridor	Bloomfield	West
27	Lake Hiawatha Lake	Broadbrook Park	Newark	West

Table 2.

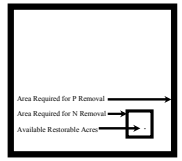
Sites outside of the Guidelines of the Set Criteria/or Requires Further Investigation

	Site Name	Location	Town	Bank
1	Small Delta Island	Mouth of Unnamed Creek below Outwater Lane and River Drive	Garfield	East
2	Saddlebrook River Marshes	Wallington/Garfield Border at Midland Avenue and Nicklin Drive	Wallington	East
3	Waterfront Access in the City of Passaic	Below Gregory Avenue Bridge	Passaic	West
4	River bank Edge Parcels	Adjacent to Rt. 21 on the West bank of River	Belleville/Nutley	West
5	Greenway Link along Power Line Easement	Power Line Easement	Belleville	West
6	Second River Greenway Loop to Joe Minish Park	Intersection of Main and Mill Streets south along Rail Corridor to Joe Minish Park	Belleville/Newark	West
7	Kearny Marsh	Multiple tracts East of Frank Creek and West of the Hackensack River dissected by the NJ Turnpike and I280	Kearny	West

[FIGURE 2]

Relative Scaling of the approximate measure of Acres Required for Nutrient Load Processing (Needs) calculated by GAIA Institute Investigation Report and the Acres Available/Restorable (Opportunities) reported by NOAA Restoration Opportunities Report - July 2004.

PASSAIC RIVER WATERSHED WITH RELATIVE SCALE OF WETLAND AREA REQUIRED FOR:
P REMOVAL: 1,000 SQ. MI. &
N REMOVAL: 140 SQ. MI.
RESTORABLE ACRES: +10² acres in the 17-Mile STUDY AREA



PASSAIC RIVER WATERSHED WITH RELATIVE SCALE OF TERRESTRIAL AREA REQUIRED FOR:
N REMOVAL: 820 SQ. MI. &
P REMOVAL: 12 SQ. MI.
RESTORABLE ACRES: +10² acres in the 17-Mile STUDY AREA