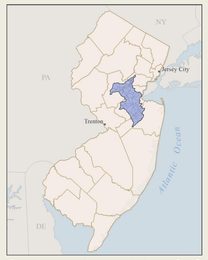
Identifying Open Space Areas for Stream Restoration using a GIS Suitability Analysis

Daryl Krasnuk – Lower Raritan Watershed Partnership

Introduction



The study area is located in the Raritan River Watershed, which is divided into three water management areas: the Upper Raritan, the Lower Raritan, and the Millstone. The focus area for this analysis is the Lower Raritan Watershed (LRW) located in central New Jersey in the counties of Middlesex, Monmouth, Somerset and Union.

River ecosystems provide vital resources for the life of the organisms that depend on them. These critical resources have been subject to increasing anthropogenic pressures as the land is altered to suit human needs. Water quality is often highly responsive to modifications in the landscape as natural land cover is converted to land use suitable for human development. The conversion of natural land cover to altered land use types associated with urban development is especially pronounced in densely populated watersheds such as the LRW.

While there is a strong relationship between increasing urbanization and decreasing water quality, it has been proven that even the most urbanized areas can improve the quality of waters through remediation and restoration. This is promising for watersheds such as the LRW where pockets of protected lands are dispersed in an urban landscape. The overall aim of the prioritization is to identify dedicated open space areas that will produce the biggest return on investment. In this case, the primary goal is to locate open space areas that are most suitable for stream restoration projects that will ultimately lead to an upgraded stream antidegradation designation (category 2 to category 1) using available resources.

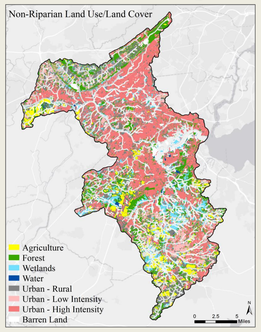
Previous studies prioritized open space stream restoration based on a variety of criteria, but the fundamental objective was similar; with limited resources, areas of open space were identified and prioritized according to the degree of anticipated contribution to the particular conservation, restoration or preservation goal. Although the target criteria can vary considerably due to the location and goals of each study, the underlying mechanism involves spatial conceptualization. The influential components in the prioritization are represented in a spatial context and a Geographic Information System (GIS) is well suited to visualize the study area, evaluate the candidate prioritization criteria and perform a targeted geospatial analysis.

After reviewing prior studies and consulting with subject matter experts, a set of questions were developed to aid in the identification of the requisite data for performing the stream restoration prioritization analysis of dedicated open space in the LRW. The questions that were developed are as follows:

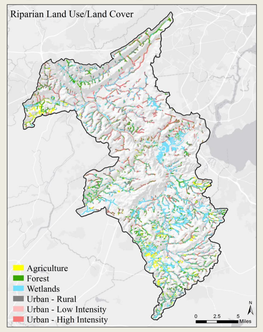
- What antidegradation designations are applied to streams in the study area and where are they located?
- Where are protected areas located, what type of protection is offered and who owns the parcels?
- Where are the biotic water quality sampling sites located?
- Where are the known contaminated sites & ground water recharge areas?
- Where are the sensitive HUC-14 areas located?
- How much impervious surface cover is there in each sub-watershed?

Acknowledgements: Hudson County Division of Planning. Dr. Fenyk, Lower Raritan Watershed Partnership. Dr. Hartman and Dr. Tulloch, Rutgers University.

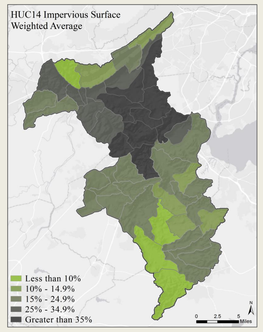
1. Suitability Analysis Layers



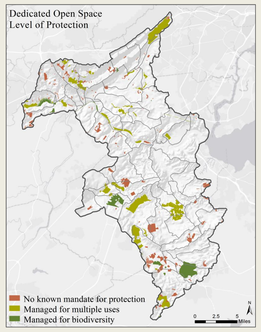
A reclassified land use/land cover dataset offers an overview of the spatial distribution of developed and undeveloped areas as well as habitat connectivity and fragmentation patterns.



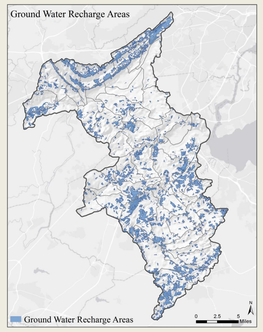
To evaluate the health of riparian areas, all surface water streams were given a bidirectional linear buffer of 300 feet. This zone was then intersected with the reclassified LULC dataset.



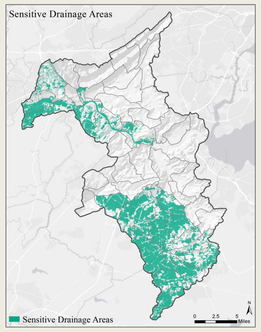
To gauge the potential for stream degradation the impervious surface weighted average for each HUC-14 sub-watershed was estimated using data from the 2012 NJDEP LULC dataset.



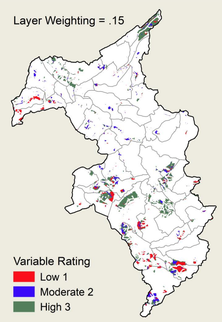
Protected Areas Database of the US and NJDEP Open Space layers were merged to define several categories of open space and rate the level of habitat protection for each area.

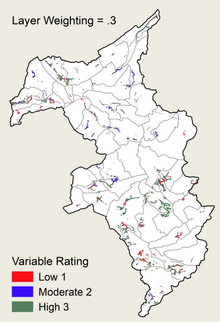


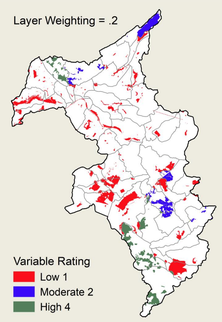
The NJDEP Ground Water Recharge layer identifies undeveloped areas of land that contribute the highest one-third of the recharge volume in the Lower Raritan Watershed.

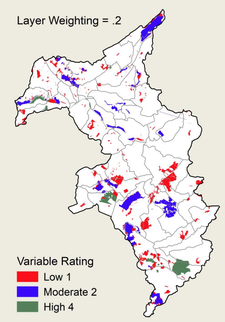


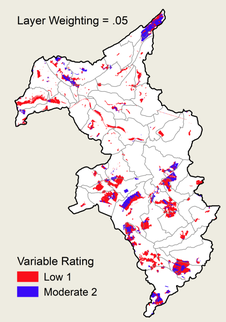
Areas that drain to water supply intake points, contain existing category 1 water features or those that were identified as providing natural drainage to NJDEP selected water supply reservoirs.

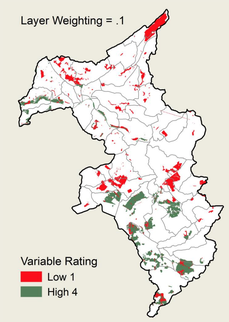












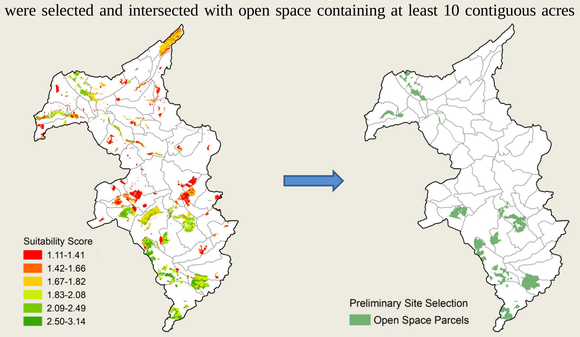
2. Rates and Weights

The unique values of individual raster cells in each layer were rated from 1 to 4 based on the importance of each attribute in completing the prioritization analysis and summarily identifying geographic areas where the highest impact could be felt. The ratings describe the difference in relative importance among each attribute within a raster layer. A rating of 1 meant that the particular attribute did not contribute any positive value to stream restoration potential while a value of 4 indicated very high stream restoration potential. Next, the relative importance of each raster layer was given a weight. The weights were given as a decimal summing to one. The weighting explains the level of importance that the entirety of the layer contributes toward finding areas that have the highest potential for stream restoration. For example, LULC that is not located in a riparian area was given a weight of .15 while LULC located in a riparian area was given a weight of .30. This means that the input for the LULC in the riparian raster is twice as important as the input for the LULC not in riparian raster. The output was calculated by multiplying the integer value assigned to each raster cell (rating) by each raster dataset (weighting) where the lowest possible score is 1 and the highest possible score is 3.45.

Variable	Rate	Layer	Weight	Total
Agriculture	1	LULC not riparian	0.15	0.15
Wetlands	3			0.45
Upland Forest	3			0.45
Water	1			0.15
Barren Land	1			0.15
Rural	2			0.3
Low/Medium Density	1			0.15
High Density	1			0.15
Riparian Agriculture	1	LULC in riparian	0.3	0.3
Riparian Wetlands	3			0.9
Riparian Upland Forest	3			0.9
Riparian Water	1			0.3
Riparian Barren Land	1			0.3
Riparian Rural	2			0.6
Riparian Low/Medium Density	1			0.3
Riparian High Density	1			0.3
No Protection	1	Protection Type	0.2	0.2
Some Protection	2			0.4
Full Protection	4			0.8
Sensitive HUC14 Yes	4	Sensitive HUC-14	0.1	0.4
Sensitive HUC14 No	1			0.1
GWR Yes	2	GWR Area	0.05	0.1
GWR No	1			0.05
IS < 10	4	HUC-14 IS %	0.2	0.8
IS 10 - 14.9	2			0.4
IS 15 - 19.9	1			0.2
IS 20 - 24.9	1			0.2
IS >25	1			0.2

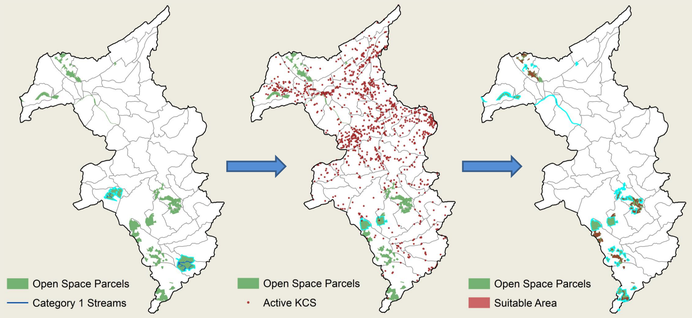
3. Suitability Analysis Output

The suitability analysis produced scores ranging from a minimum value of 1.1 and a maximum value of 3.14. To narrow down the site selection for the next step, the raster cells with a score in the highest quartile were selected and intersected with open space containing at least 10 contiguous acres of land.



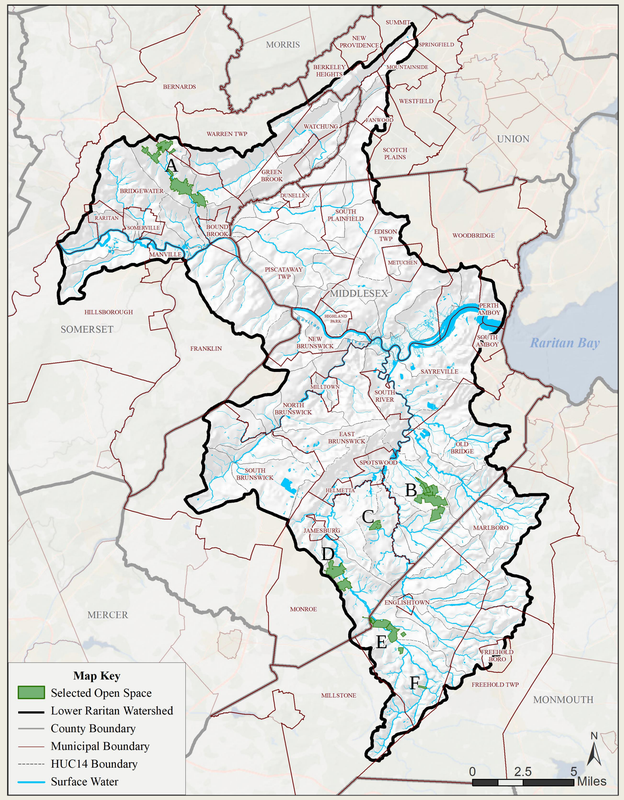
4. Suitability Analysis Refinement

Open Space areas already containing C1 streams were removed from the output. Next, the Known Contaminated Sites (KCS) layer was used to remove areas of open space that contained an active KCS. Finally, open space areas that contained less than 50% of suitable conditions by area were eliminated.



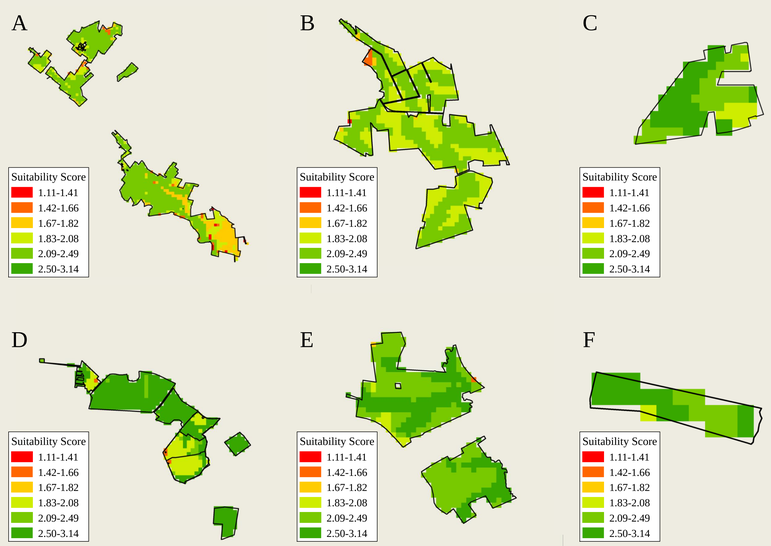
The highlighted open space areas were removed from contention

5. Final Output



Discussion

The contiguous open space areas identified in the analysis ranged in size from 20.5 acres to 599.2 acres. An examination of parcel ownership revealed that 94.7% of the lands are held publicly while only 5.3% are privately owned. The majority of the selected open space area is core habitat and contained natural land cover, primarily upland forest and/or forested wetlands. The immediate area bordering the parcels included a significant area of natural buffering on at least three sides, but generally some part of each area shared an edge with altered habitat. The majority of these areas were part of the Green Acres program. While this study looked at existing sites, and considered the factors within not only the focus area but the impact of other factors within each sub-watershed, additional consideration through the examination of conditions occurring upstream from the potential stream restoration site may provide valuable input. For example, integrating a SWAT analysis to quantify high sediment and pollutant loads that would make stream restoration projects downstream futile.



GIS Data Sources:
"14 Digit Hydrologic Unit Code Delineations for New Jersey (Version 20110225)." Department of Environmental Protection (NJDEP), New Jersey Geological Survey (NJGS)
"Ambient Biomonitoring Network (AMNET), New Jersey, Edition 201404." New Jersey Department of Environmental Protection (NJDEP), Office of Information Resources (OIRM), Bureau of Geographic Information Systems (BGIS).
"Critical Sub-Watersheds, Cross Acceptance." New Jersey Department of Environmental Protection (NJDEP), Office of Information Resources (OIRM), Bureau of Geographic Information Systems (BGIS).
"Dedicated Open Space, Cross Acceptance ." New Jersey Department of Environmental Protection (NJDEP), Office of Information Resources (OIRM), Bureau of Geographic Information Systems (BGIS).
"Ground Water Recharge Areas, Cross Acceptance." New Jersey Department of Environmental Protection (NJDEP), Office of Information Resources Management (OIRM), Bureau of Geographic Information Systems (BGIS)
"Impervious Surface from Land Use/Land Cover 2012 Update." New Jersey Department of Environmental Protection (NJDEP), Office of Information Resources Management (OIRM), Bureau of Geographic Information Systems (BGIS)
"Known Contaminated Sites List (KCSNJ) for New Jersey." New Jersey Department of Environmental Protection (NJDEP), Office of Information Resources Management (OIRM), Bureau of Geographic Information Systems (BGIS)
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"NJ Composite of Parcels Data with Joined MOD-IV Attributes 2016, New Jersey State Plane NAD83, Middlesex and Monmouth County." NJ Office of Information Technology (NJOIT), Office of Geographic Information Systems (OGIS)
"NJDEP 10-meter Digital Elevation Grid." New Jersey Department of Environmental Protection (NJDEP), Office of Information Resources Management (OIRM), Bureau of Geographic Information Systems (BGIS).
U.S. Geological Survey, Gap Analysis Program (GAP), May 2016. Protected Areas Database of the United States (PAD-US), version 1.4 Combined Feature Class.