North Jersey Resource Conservation & Development

Riparian Zones in the Upper Delaware Watershed

A Technical Report for the Upper Delaware Watershed Management Project

April 2002

A healthy Riparian Zone along the Paulins Kill

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Introduction

The Upper Delaware Watershed includes almost 1300 miles of streams and rivers ranging in size from many small, first order, unnamed brooks to larger streams such as the Musconetcong River. Over three hundred miles of these streams are classified as "trout production" water by the NJ Department of Environmental Protection (DEP). This classification means that local trout populations are actively spawning in these waters, an indicator of excellent quality water. The streams of the watershed play an important role in industry, agriculture, recreation and fish and wildlife habitat of the watershed. Many changes to the characteristics of the streams have occurred in the last 400 years, since European settlement of the area. Most streams in the Upper Delaware Watershed receive greatly increased runoff, compared to pre-European settlement days, due to changes in the watershed. Commercial and residential development, clearing of forests, agriculture activities, and transportation has caused increased runoff volumes in streams and increased frequency of flooding events in the watershed.

The term riparian comes from the Latin *riparius*, meaning bank of the stream. The riparian area of streams is the zone located immediately adjacent to the stream and the area affected by the stream. Lowrance, *et al*. (1985) define riparian ecosystem as "a complex assemblage of plants and other organisms in an environment adjacent to and near flowing water". The boundary of the riparian area and the adjoining uplands is gradual and not always well defined. However, riparian areas differ from the uplands because of high levels of soil moisture, frequent flooding, and the unique plant and animal communities found there. Through the interaction of their soils, hydrology, and biotic communities, riparian zones maintain many important ecological functions.

When analyzing riparian zones of particular importance are the "headwater" areas. The New Jersey Department of Environmental Protection has proposed defining headwaters as "all first order streams that are delineated as a blue line on a 1:24,000, 7.5 minute USGS quadrangle map; up to and including their point of origin, such as seeps and springs along their adjoining riparian corridors" (NJ Clean Water Council, 2000). Headwater areas are often small and inconspicuous in the landscape and are therefore vulnerable to disturbance from agriculture or development activities. Although individually small, headwater streams, also referred to as 1st order streams, constitute more than one half of all of the stream miles in the Upper Delaware Watershed. The union of two 1st order streams creates a 2nd order stream. The union of two 2nd order streams becomes a 3rd order stream and so on. When the amount of first, second and third order streams are added this accounts for 84% of all streams in the Upper Delaware Watershed (figure 1.) Despite their relatively small size (width, length and discharge) these

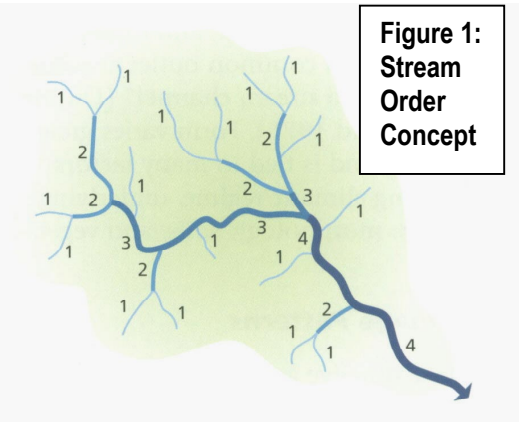


Figure 1: Stream Order Concept

small streams, and the condition of their riparian zones, are critically important to the ecological function of the downstream waters. Historically many of these smaller streams have been channelized, piped, diverted or even filled by human activities. Since these streams account for such a large percentage of the stream miles in the watershed, special emphasis should be paid to riparian zones along these smaller streams.

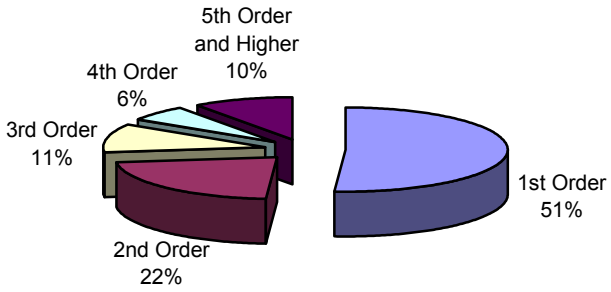


Figure 2: Percentage of Various Stream Orders in Upper Delaware Watershed

Riparian zones can protect water quality, provide wildlife habitat, reduce impacts from flooding and provide recreational and educational opportunities. The land use adjacent to a riparian zone can effect the values and functions that the riparian zones provide. Water quality of streams is also largely shaped by the amount of impervious cover in a watershed. Blaha, *et al*. (2000) concluded that the percentage of impervious cover was the single best predictor of stream condition in the Maryland piedmont. Impervious cover creates increased runoff and evaporation, reducing the amount of water available for groundwater recharge. Impervious cover in riparian zones can increase pollutant transfer to streams. In suburban and urbanized areas hydrocarbons, metals, bacteria, salts and pesticides may be included in runoff from impervious surfaces. In agricultural areas pesticides, pathogens and excess nutrients can pollute runoff from barnyards and farmsteads that are highly impervious. Streams and rivers without healthy riparian zones provide little protection to surface waters from overland flow of pollutants such as sediment, nutrients and pathogens. The condition of vegetation near streams and rivers is a primary component of the integrity of riparian ecosystems. In this report we will describe various riparian zone functions in the Upper Delaware Watershed, examine existing data sources to identify the watersheds riparian zones, characterize riparian zone health in the watershed and discuss strategies to protect and restore riparian zones.

Figure 3: Ecological Functions of a Healthy Forested Riparian Zone
(After Palone and Todd, 1997)

Functions of Riparian Zones

Healthy riparian zones provide numerous ecological functions that are expressed as some important societal values. Figure 3 depicts location of the various important ecological functions in a typical healthy riparian zone in the Upper Delaware Watershed. The photograph is of a healthy functioning riparian area on the Big Flatbrook in Sandyston Township, Sussex County. Diverse woody and herbaceous vegetation, varying flow regimes and substrates and the complex horizontal and vertical structure of this ecosystem create varied niches, different energy flow pathways, nutrient cycling systems and complex food webs. Some specific functions are discussed in greater detail below.

Fisheries

Riparian forests provide many functions that enhance fisheries resources in streams in the Upper Delaware Watershed. Mature trees shading a stream protect the water surface from radiant heating and provide a microclimate that is cooler during the warm summer months. Evapotranspiration of soil water and shallow ground water adds to the cooling process. The cooler, more stable stream temperatures provide high quality habitat for trout as well as a number of other aquatic organisms that occur in trout streams. Even in warm water fisheries streams with no trout reproduction, the stabilized temperatures provided by dense shade are important.

Trees immediately adjacent to streams provide large woody debris (from falling limbs and trees) that form instream cover, create pools, stabilize the streambed and provide habitat for many stream organisms in the aquatic food webs. Streams without large woody debris are usually streams without healthy fish populations. As trees mature along a streambank, undercut banks may occur that are held together by roots of woody vegetation. These areas are very important for fish habitat.

Figure 4: In-stream large woody debris is integral to a fully-functioning riparian zone

Leaves that fall into streams from streamside forests provide organic material that is the base of the complex food webs in streams. Leaves, twigs and branches which makeup “coarse particulate organic matter” (particles > 1 mm in size) and organic detritus from broken down leaves that makeup “fine particulate organic matter” (particles < 1 mm in size) serve as food and cover for bacteria, fungi and invertebrates that form the bottom of the food web. In small well-shaded upland streams as much as 75% of the organic food base of streams may be supplied by dissolved organic compounds that fall from the forest canopy (Welsh, 1991). This is a major fuel that runs stream ecosystems. Without these inputs fish resources may be severely limited in streams.

Trees also provide habitat for terrestrial insects that fall into streams and at times can be a major food source for fish and other aquatic organisms. Mature trees also dissipate energy from flood events and provide refuge for fish during out of bank flows. Herbaceous plant communities along streams can also provide important fish habitat. A well-developed turf has a dense root system that can be very effective at controlling streambank erosion. Use of native grasses with deep root systems is more beneficial than introduced grasses.

Wildlife

Rich soils, regular inputs of nutrients, and availability of water contribute to high productivity and diversity of vegetation within the riparian area. The diversity and productivity of the riparian plant community and its proximity to water make these areas especially attractive for many species of wildlife. The diverse habitat structure provided by a mature streamside forest provides food, cover and nesting sites for many species of terrestrial wildlife. Most of the Upper Delaware Watershed's amphibians and many reptiles are dependent upon water for at least part of their life cycle and streams provide this important habitat. Many bird species use riparian zones as migratory routes due to the presence of abundant food and cover required during migration. Rewa (2000) reports that 75%-90% of all wildlife species use riparian areas during some part of their life cycle. Finch and Marshall (1993) report that most western US neotropical migrant birds breed in riparian habitats. Non-migratory wildlife also use riparian areas as travel corridors so they can safely move between important habitats.

The Delaware River and its tributaries are important migratory corridors for many neotropical species such as warblers, vireos, and flycatchers due the abundance of insect activity along streams. Many bird species in the Upper Delaware Watershed also nest and rear young in riparian areas due to plentiful food and nesting sites. Species such as the three-inch tall, blue-gray gnatcatcher create inconspicuous nests 15-25 feet high in the fork of a deciduous tree along first and second order streams and wetlands. In contrast the three-foot tall great blue heron is a colonial nester, with as many as twenty large nests in one large sycamore tree along the Pequest River. Some local mammals depend upon streams and riparian areas for at least part of their life cycle. Secretive species like the river otter and mink are common in streamside forests in less disturbed areas of the Upper Delaware Watershed such as the Flat Brook subwatershed.

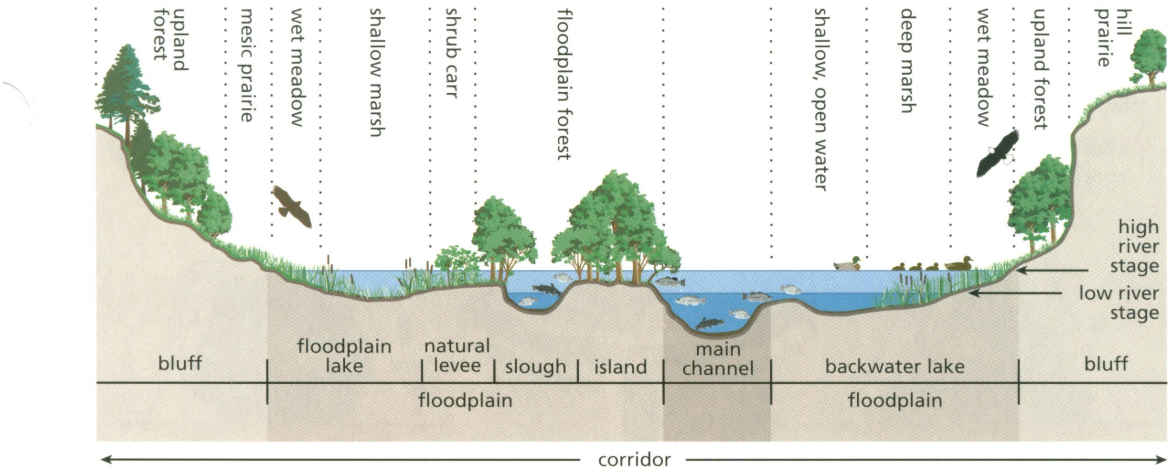


Figure 5: Cross-section of a River Corridor.
Source: Stream Corridor Restoration: Principals, Processes, and Practices. Federal Interagency Stream Restoration Working Group.

The interface between aquatic and terrestrial ecosystems that is present in riparian zones makes these areas especially diverse and critical to wildlife populations. The interface creates a great biological diversity and attracts many species. A healthy, mature streamside forest usually includes large trees, sub-

canopy trees, shrubs and herbaceous vegetation that create diverse horizontal and vertical structure for wildlife. A natural herbaceous streamside border can provide unique habitat for some species that prefer early successional habitats.

Providing fish and wildlife habitat was the most often stated objective of riparian ecosystem habitat restoration in a comprehensive literature review of riparian ecosystem restoration by the Northern Prairie Wildlife Research Center (Manci, 1989).

Pollution Abatement

The water quality functions that healthy riparian areas provide are perhaps the most important functions in the Upper Delaware Watershed. The steep slopes, erosive soils and intensive land uses that occur in the watershed can create many potential nonpoint source pollution problems for surface waters. Healthy vegetation helps control soil erosion in riparian zones. Manci (1989) categorizes five ways in which vegetation influences soil erosion:

(1) foliage and leaf residues intercept rainfall and dissipate energy
(2) root systems physically bind or restrain soil particles
(3) residues increase surface roughness and slow velocity of runoff
(4) roots and residues increase infiltration by maintaining soil porosity and permeability
(5) plants deplete soil moisture through transpiration, giving the ground a "sponge effect" to allow it to absorb water

Streamside forests filter runoff and remove sediment and other suspended solids from water. Phosphorus can also be reduced by filtering action of forests since much of the available phosphorus is bonded to soil particles. Welsh (1991) reports that about 80% of available phosphorus can be removed by a riparian forest filter. Some ammonium may be bound to sediment and also filtered out.

Most of the nitrogen in runoff is not attached to soil particles and is dissolved in water. In a healthy riparian buffer these sources of dissolved nitrogen are converted into other forms that are either used by plants or bacteria or volatilized into the atmosphere. Studies have shown that the amount of nitrogen in runoff and shallow ground water can be reduced by as much as 80% after passing through a streamside forest (Welsh 1991). Gold, *et al*. (2000) reported in the Northeast that groundwater nitrate removal is a function of soil drainage class and hydrology of the riparian zone. Specifically, riparian zones on hydric soils had groundwater nitrate removal rates of greater than 80% while riparian zones on steeper slopes and non-hydric soils had removal rates of less than 30%.

Another critically important function that riparian buffers provide is storing nutrients. As plants grow in a healthy riparian buffer they take up available nutrients and store the nutrients in plant tissue. These nutrients can be stored for many years in the form of woody tissue in trees. Nutrients are passed to food webs as animals consume plant tissue or process leaves and woody debris that fall into streams. Some nutrients are also stored in leaf litter on the forest floor or in forest soils. Some of these nutrients are released periodically to the stream ecosystem during floods and provide essential nutrients for stream food webs.

Few studies have examined the effectiveness of riparian buffers in trapping pesticides and other toxins. Those that have examined this function have reported a riparian buffer can be effective in removal of herbicides such as atrazine, alachlor and 2,4-D from cropland discharges (Correll, 1997). Moorman *et al*. (2000) reported that atrazine sorption and total atrazine retention was greater in riparian buffer strip soils than in cropped soils in Iowa, however atrazine degraded more slowly in riparian buffer strip soils than in cropped soils due to the greater populations of atrazine-degrading microorganisms in cropped soils. Converting a cropland edge to a filter strip of native herbaceous vegetation is a very beneficial start towards creating a healthy riparian zone.

Flood Water Retention

Healthy, natural riparian zones are critically important during flood events. Mature trees slow floodwater velocities reducing flood damage downstream. The slower velocity also creates deposition of sediments in the flood plain. Sediment deposition in downstream reaches can degrade water quality, cause increased erosion, damage bridges and create other economic and ecologic havoc. Sediments deposited in forests may include nutrients that can be processed or stored in the forested flood plain and slowly released later to the stream ecosystem. The forested flood plain acts as a natural sponge, holding large volumes of floodwater for slow release as stream water levels recede. This again protects downstream areas from flood damage. Emergent wetlands or scrub/shrub wetlands present along some streams serve a similar function.

Recreation and Aesthetics

Riparian zones provide many important benefits to humans. Riparian areas attract people. They are cool and relaxing and offer a pleasing combination of land, water, vegetation, and wildlife that provides an escape from urban and suburban hustle and bustle. Millions of people live within 75 miles of the Upper Delaware Watershed and the riparian areas provide recreational opportunities including swimming, picnicking, fishing, hunting, birding, hiking and simply relaxing. Riparian areas invite a diversity of users in different age groups, different ethnicities and varying degrees of physical mobility.

With the demands upon our limited riparian recreational areas some problems are bound to result. Soil erosion, soil compaction and litter are all obvious at heavily used riparian recreation sites. Careful planning and management schemes are needed to protect these fragile areas so as to keep important ecological functions in tact.

Riparian Model

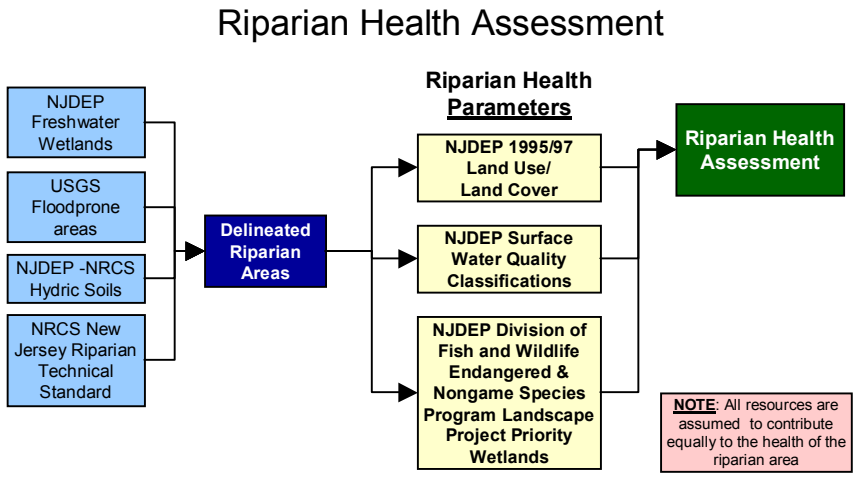
A model to define riparian areas and characterize the relative health of riparian areas was recently developed by Hughes and Lathrop (2001) for two sub-watersheds within the Upper Delaware Watershed. This project attempted to develop an accurate, simple methodology for riparian health in Northwestern New Jersey using readily available data from state and federal governmental agencies. The model has been modified and run for the entire Upper Delaware Watershed (McGinnis, 2001) and is described in detail in Appendix 1 .The model is described briefly below.

The model first defines riparian areas based upon hydrology factors. A riparian area in this model is either: defined as a wetland by NJ Department of Environmental Protection (DEP) Freshwater Wetlands maps; has hydric soils as defined by USDA Natural Resources Conservation Service (NRCS) soils maps; or is floodprone as defined by US Geologic Survey (USGS) 100 year floodplain maps. An area is defined as riparian under the model if any one of the three criteria above is found immediately adjacent to a stream. In the original model developed by Hughes and Lathrop, in some areas along streams (steep slopes near first and second order streams for example) there are no flood plains, no hydric soils and no wetlands adjacent to streams in the watershed. The health and condition of the streamside vegetation is still very important in these areas. The McGinnis version of the model created a 40-foot wide strip (the width of one pixel in the database) on each side of any stream without one of the three defining hydrology factors. Every stream will then have at least an 80-foot riparian zone (40 feet on each side of the stream) in which the relative health was characterized. This results in a continuous area that will have all of the streamside vegetation characterized.

The second part of the model assesses the relative health of the defined riparian areas. The health was characterized by examining surface water quality designations from NJ DEP, land use/land cover data

from NJ DEP and threatened and endangered species data from the NJ Division of Fish & Wildlife's "Landscape Project".

Figure 6: Riparian Health Assessment Scoring Flow Diagram



Surface Water Quality
The New Jersey DEP, Bureau of Watershed Management provided the ranking of the streams based on the surface water quality classification. The following scores were given to the various water quality classifications.

FW1	5
Trout Production, Trout Maintenance, Non Trout C1 waters	4
Trout Production Waters	4
Trout Maintenance Waters	3

Land Use/Land Cover
Over fifty (50) 1995/97 land use/land cover types from NJ DEP data were examined and ranked based upon desirable ecological functions provided. Types were scored on a scale of 1, being the lowest, to 5, being the highest, based on its contribution or detriment to the waterway, this scoring was developed by the Natural Resources Conservation Service. Generally the less disturbed land use/land cover categories have higher rankings (deciduous forest > 50%crown closure = 5) than human influenced areas (single unit residential, medium density = 1). A full list of the land use/land cover types and scoring used is presented in Appendix 1.

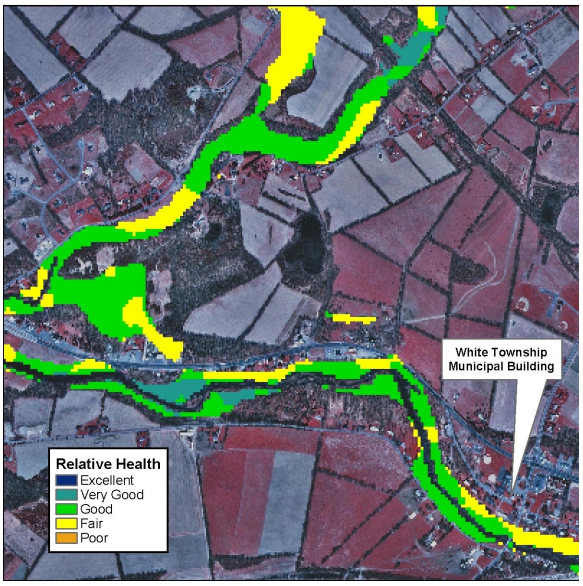
Landscape Project
Using the New Jersey DEP Endangered and Nongame Species Program's (ENSP) "Landscape Project" dataset presents the possibility for threatened or endangered species based on a grouping of identified natural resources. This data has been compiled for Threatened or Endangered (T&E) species that occur in grasslands, forests, wetlands and forested wetlands. For this project, we are only focusing on the wetland threatened or endangered species dataset, which includes forested wetlands. The Landscape Project scored habitats from a 1 (the lowest priority) to a 5 (the highest priority) based upon the potential of and T&E species being present. That scoring system was used in assigning a quantitative value to the T&E Potential. The model was run with Landscape Project data from ENSP in December of 2001. Newer Landscape Project data was released by ENSP in January of 2002.

The overall health of the riparian areas is then assessed by summing the three quantifying files together (surface water quality, land use/land cover and T&E species). The sum of this calculation will be the assessed health. The ranks can range from 1 (having the lowest riparian health) to a 15 (having the highest riparian health). The final ranking created five categories of riparian health:

Excellent	13-15 points
Very Good	10-12 points
Good	7-9 points
Fair	4-6 points
Poor	1-3 points

A representation of the final product of the model appears in figure 7. A small portion of the Pequest subwatershed, at the confluence of Beaver Brook and the Pequest River, in White Township, Warren County is shown. A color infrared aerial photograph is the background and the riparian health categories are shown in colors. An Internet Mapping Service will be part of the Upper Delaware Watershed Management Project in the future, which will allow users such as local municipalities, watershed groups, concerned citizens and others to view and download maps such as the one shown in figure 7.

Figure 7: Riparian Health Model Results for a Portion of the Pequest subwatershed in White Township, Warren County.



The model does have limitations, which reflect the limitations of the data sources used. For example some areas with perennial flows are inadvertently left off of USGS topo maps and therefore do not appear in the USGS floodprone areas database. Some areas delineated as wetlands on the NJ DEP freshwater wetland maps do not have wetland hydrology, hydric soils and hydrophytic vegetation that are required for an area to be defined as a wetland. In any project of this scope some areas will be overlooked and some areas may be misrepresented depending on the scale that is used to examine the data. It is important to understand these limitations when using this information.

Maps of the streams, riparian areas and riparian health of the Upper Delaware Watershed are included at the end of this report. Riparian health maps of the 5 main sub-watersheds are presented. Each map includes a table of the amount of each of four general categories of stream health (Excellent, Very Good, Good, Fair). No riparian zones defined as “poor” health by this model were identified.

Results

The Upper Delaware Watershed includes almost 83,000 acres (or 130 square miles) of riparian zones along the 1265 miles of streams identified by the riparian model used. The amount of acreage in riparian zones varies from a low of 9% in the Pohatcong/Lopatcong watershed to a high of 21% in the Flat Brook and the Pequest watersheds.

The relative health of these riparian zones includes almost 3400 acres, or 4% of all riparian zones that are categorized as “excellent” health. Most of the riparian zones are categorized as either “very good” (27,840 acres – 34%) or “good” (34,778 acres – 42%) health. About 16,500 acres, or 20% of all riparian zones, are only categorized as “fair’ health. Maps of the relative health of riparian zones in the five major Upper Delaware sub-watersheds are shown as Maps 1-5 at the end of this report. Results of the riparian health model are presented in Table 1 and Figures 8 and 9.

Figure 8. Relative Health of Riparian Zones in the Upper Delaware Watershed

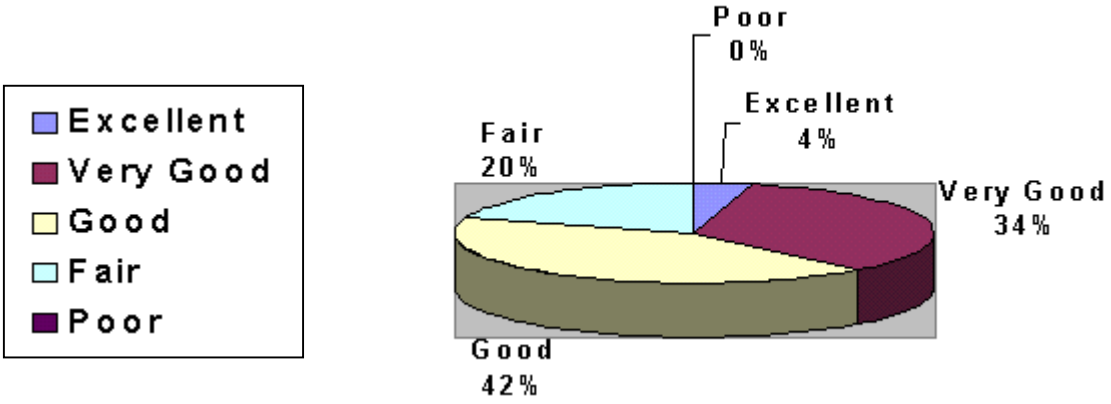
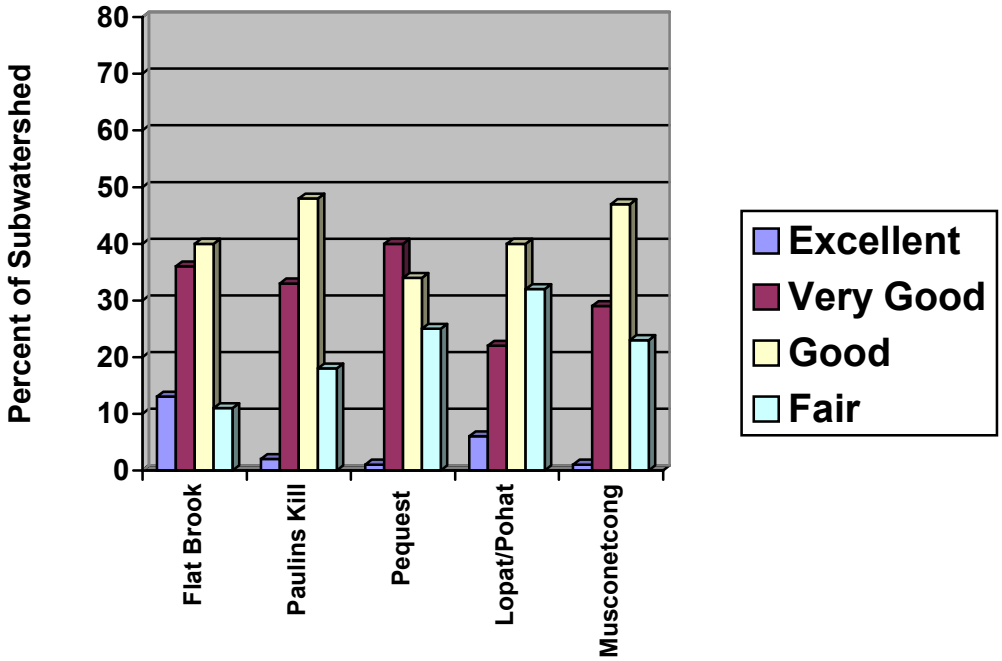


Table 1: Five Major Sub-watershed Groups and Riparian Health Model Results

Sub-Watershed Group	Total Area of Basin (acres)	Total Riparian Area (acres)	Acreage (%) in “Excellent” Health	Acreage (%) in “Very Good” Health	Acreage (%) in “Good” Health	Acreage (%) in “Fair” Health	Acreage (%) in “Poor” Health
Flat Brook	83,384	17,324 21% of basin	2,270 (13.1%)	6,220 (35.9%)	6,934 (40%)	1,900 (11%)	0
Paulins Kill	125,845	24,995 20% of basin	377 (1.5%)	8,150 (32.6%)	12,005 (48%)	4,463 (17.9%)	0
Pequest	100,542	21,394 21% of basin	291 (1.4%)	8,458 (39.5%)	7,328 (34.3%)	5,317 (24.9%)	0
Pohat/Lopat	67,925	6,429 9% of basin	400 (6.2%)	1,409 (21.9%)	2,594 (40.3%)	2,026 (31.5%)	0
Musconetcong	99,555	12,434 12% of basin	56 (.5%)	3,603 (30%)	5,918 (47.6%)	2,857 (23%)	0

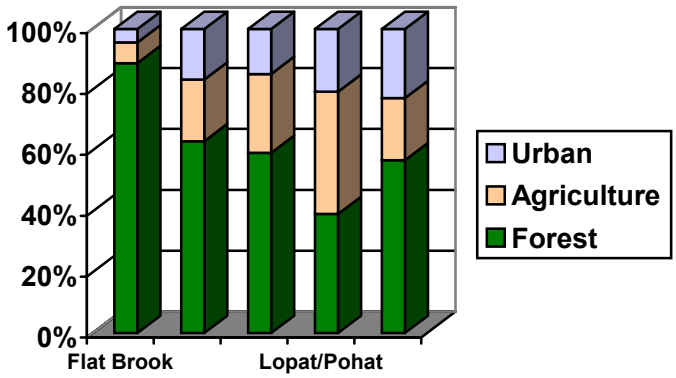
The Flat Brook sub-watershed group has the healthiest riparian zones with 90% of it's riparian zones categorized as either "good", "very good" or "excellent" and only 10% of it's riparian zones categorized as "fair" (Map 1). By contrast the Lopatcong/Pohatcong watershed group has the least healthy riparian zones in the Upper Delaware Watershed with only 68% of it's riparian zones categorized as either "good", "very good" or "excellent" and 32% of it's riparian zones in the "fair" category. Maps showing the results of the riparian health model for the five major sub-watershed groups are presented after the text as Maps 1-5.

Figure 9: Relative Health of Riparian Zones in Five Major Sub-Watershed Groups



The relative health of the riparian zones in the Upper Delaware Watershed is no doubt directly related to the intensity of land use in the sub-watersheds. The Flat Brook sub-watershed is the least developed of the five sub-watersheds. The Flat Brook watershed includes the most forest land cover (78.5% of the watershed) and includes substantial acreage in state forests, state wildlife management areas and the federal national recreation area. These government-owned lands are all managed to protect water quality and wildlife habitat, two major factors in determining relative riparian health. In addition the less intensive land use creates more suitable habitat for threatened and endangered species, another data layer used to define riparian zone health. The higher amounts of woody vegetation along streams and less intense land use near streams create healthier riparian zones. Figure 10 shows the land use throughout the entire basin depicted by the five subwatersheds.

Figure 10: Land Use in Five Major Sub-Watershed Groups



The Lopatcong/Pohatcong sub-watershed is characterized by more urban land use, more agricultural land use, less forest land cover (only 35.7% of the watershed) and it is no surprise that the riparian zones are relatively lower in health than the Flat Brook sub-watershed. The lack of streamside woody vegetation and more intensive land use adjacent to streams accounts for lower relative riparian zone health. Interestingly this watershed does include 6% of its riparian zones in the "excellent" category and this is the second highest amount of "excellent" of the five sub-watersheds examined. These healthy riparian zones are clustered around the upper reaches of Merrill Creek, Lopatcong Creek, Buckhorn Creek, Mill Brook and Brass Castle Creek – five trout production streams - in the Scotts Mountain area of Warren County. Another area with excellent riparian zone health is the upper reaches of Pohatcong Creek in Independence and Mansfield Townships, Warren County. These areas are mostly forested areas with less intense land use than the rest of the watershed (Map 4).

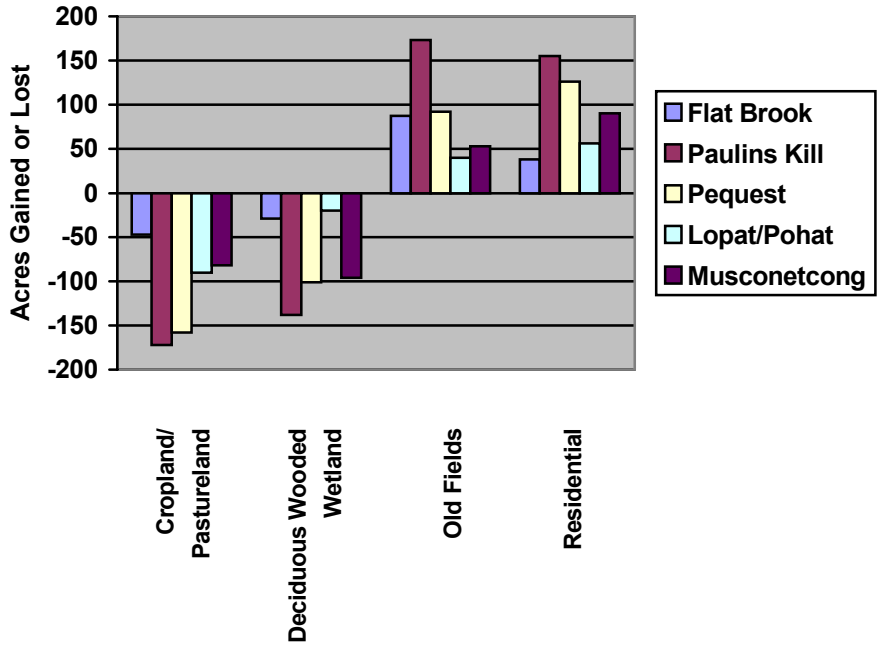
In the middle of these two extremes are the Paulinskill, Musconetcong and Pequest sub-watersheds. These three watersheds do not have as high a percentage of their riparian zones in either the "excellent" category or the "fair" category as the Flat Brook and Lopatcong/Pohatcong watersheds do. A complex mixture of land uses including forests, agricultural land, some urban land, rural-residential land and wetlands covers these watersheds. These three sub-watersheds have the lowest amount of acreage in the "excellent" riparian health category with the Musconetcong having only .5% of it's riparian zones in the excellent category (Map 5) the Pequest with only 1.4% (Map 3) and the Paulins Kill with only 1.5% (Map 2).

An interesting example of some important data derived from this riparian model is shown on Maps 6 and 7. These maps show the land use and riparian health of Buckhorn Creek and several first and second order tributaries in Harmony and White Townships in Warren County. These streams are classified as trout production water in the NJ Surface Water Quality database. The headwaters of this small watershed are located in mature forested areas. There is little disturbance in the upper reaches of the watershed and water quality and riparian health is excellent. As the streams near the Delaware River, they change. Much of the riparian zone in this area is only in the "fair" category. This is due to the intensive land use in this active agricultural community. There is little woody vegetation near the streams in this area, only a narrow band if any at all. The water quality is still good, due to the excellent conditions in the headwater areas of this drainage, and the streams are still classified as trout production waters. The area is also experiencing development pressure from residential developments. As impervious cover increases, with development pressure, runoff can be expected to increase. Nonpoint source pollutants such as sediment, fertilizer, road salt, and other contaminants normally increase as development increases. The narrow band of natural vegetation along the streams in the lower reaches of the basin cannot be expected to filter increased pollution loads. Areas such as these could be targeted to try to improve the riparian zone health by expanding existing buffers or installing new buffers.

The 1986 LandUse/Land Cover data for the Upper Delaware Watershed's riparian zones was compared to the 1995/97 data and several trends were observed, as can be seen in Figure 11. The single largest land use category lost in riparian zones between 1986 and 1995/97 was the "cropland and pastureland" category. This probably reflects loss of agricultural land throughout the Upper Delaware Watershed and New Jersey as a whole in that time period. The effect on the riparian zone health by this loss is determined by how specific land use changed in a specific riparian zone. For example if a riparian zone was coded as cropland/pastureland in 1986 and it is coded as old field in the 1995/97 dataset the riparian health has improved. There would no longer be livestock grazing, tillage, fertilization, or pesticide application in the riparian zone. If that same riparian zone became high density residential in 1995/97 the riparian health declined since there would be significant disturbance during construction and many features of a natural riparian zone would disappear with residential development. Land use categories with significant increase in acreage in riparian zones between 1986 and 1995/97 did include "old field" and "residential".

Another category with significant losses between 1986 and 1995/97 is the "deciduous wooded wetlands" category. Deciduous wooded wetlands probably provide some of the healthiest riparian zones in the Upper Delaware Watershed providing functions such as nutrient processing, stormwater storage, wildlife habitat, rainfall infiltration and more. Continued loss of deciduous wetlands along the streams in the Upper Delaware Watershed will have profound negative effects upon the riparian health and water quality of our streams. Several categories of Land Use/Land Cover and changes in the riparian zones of the five major sub-watersheds of the Upper Delaware Watershed between 1986 and 1995/97 are presented below in Figure 11.

Figure 11: Change in Riparian Zone Land Use Between 1986 and 1995/97 in Five Major Sub-watershed Groups



Strategies to Protect, Enhance or Restore Riparian Zones

Protection and enhancement of riparian zones has been a target of federal and state conservation agencies as well as non-governmental conservation organizations in New Jersey in recent years. These strategies include outright purchase of land in riparian zones, purchase of conservation easements along streams and agreements with landowners to enhance and protect lands in return for some financial incentive. A brief discussion of some of the programs currently used for riparian zone protection follows.

Green Acres Program

The **Green Acres Program** serves as the real estate agent for the Department of Environmental Protection (DEP), acquiring land - much of which has been offered for sale by property owners - that becomes part of the system of state parks, forests, natural areas, and wildlife management areas. Green Acres works with the DEP's divisions of Parks and Forestry, Fish and Wildlife, and the New Jersey Natural Lands Trust to determine which lands should be preserved. Green Acres does not own the land it acquires; instead land is assigned to the divisions for management. Many streamside parcels have been added to state land holdings in recent years. Lands that are acquired or developed with Green Acres funds must be used solely for recreation and conservation purposes. In addition, all lands that a county or municipality holds for recreation and conservation purposes at the time that it accepts Green Acres funds are similarly restricted.

The Program's Appraisal Review Section guides applicants through the real estate appraisal process, reviews appraisals, and certifies the market value of property included in local government, nonprofit and state acquisition projects, and in requests for diversions of land from recreation or conservation use.

United States Department of Agriculture Cost Sharing

The USDA Natural Resources Conservation Service (NRCS) uses several programs that provide direct technical assistance to streamside landowners as well as financial incentives for riparian zone protection. The **Conservation Reserve Program** (CRP) provides up to 90% federal cost sharing for installation of high priority conservation practices along streams including riparian buffers and filter strips. In addition annual rental payments are paid for retiring these lands from crop production for a period of 10-15 years. In order for lands to be eligible for enrollment in CRP they must be devoted to active agriculture and planted to annual crops in recent years. The **Environmental Quality Incentive Program** (EQIP) provides cost sharing for installing riparian lands management or stream corridor management practices on farmland in New Jersey. The NRCS's **Wildlife Habitat Incentives Program** (WHIP) provides cost sharing for stream restoration projects including establishing riparian buffers. WHIP does not require that lands have had been in active agricultural production. The **Wetlands Reserve Program** (WRP) can provide cost sharing assistance and easement purchase for wetland and riparian restoration projects on active or formerly farmed lands. More information on the specifics of each of these programs is available on the USDA NRCS web site at **www.nrcs.usda.gov/**.

Other Federal and State Cost Sharing

The **Partners for Fish & Wildlife Program** (Partners) administered by the US Fish & Wildlife Service, can provide technical and financial assistance to landowners to restore riparian habitats. Riparian tree plantings, streambank stabilization projects and native grass seedings have been popular Partners projects along streams in New Jersey in recent years. A habitat restoration agreement must be entered into on all Partners projects for a minimum of 10 years. The NJ Department of Agriculture's **State Cost Share Program** provides cost sharing for installing Riparian Lands Management practices on farmlands statewide and is a companion to the federal EQIP program mentioned above. The NJ DEP **319 Nonpoint Source Grant Program** can be used to fund installation of best management practices to improve water quality. Funding has been used for riparian restoration and riparian buffer establishment.

Model Ordinances

Local governments have protected natural resources for years by establishing minimal acceptable requirements and implementing specifications that must be followed as a community develops. These ordinances are common for features such as wetlands, forest lands and steep slopes. Many communities nationally have adopted some sort of stream protection ordinance including Baltimore County, Maryland, Napa County, California and Portland Oregon. Information on all of these ordinances can be found on the Storm Water Manager's resource Center web site at www.stormwatercenter.net/ . In addition the US EPA's Office of Water has model ordinance templates for protection of natural resources including a stream buffer ordinance at www.epa.gov/owow/nps/ordinance/.

In New Jersey in 1996, the Stony Brook-Millstone Watershed Association (SBMWA) developed a Model Stream Corridor Ordinance that if adopted by local municipalities would provide greater protection of water quality and ecologically sensitive areas. SBMWA developed a template that could be modified for the specific needs of individual municipalities.

Conclusions

The riparian health model developed and used for the Upper Delaware Watershed provides an easy to understand and accurate picture of relative riparian health in the watershed. The Upper Delaware Watershed includes some of the healthiest riparian zones in New Jersey. This is due to the high percentage of mature woody vegetation covering the landscapes of the watershed. Some areas within the watershed have riparian health levels we have rated as only fair. These areas are generally located where more intense land uses occur such as residential, commercial and agricultural use. Riparian zones rated as fair should be enhanced by planting trees, shrubs and native herbaceous plants. While forested riparian buffers supply the most complete ecological functions, herbaceous buffers can be very beneficial. Enhancement of these riparian zones will help maintain the existing water quality and perhaps help improve water quality in the streams they buffer. Riparian zones defined as excellent, very good or good are all candidates for riparian zone protection. Protection of these riparian zones is needed to maintain the high water quality of the streams in the Upper Delaware Watershed.

The riparian model developed for this project provides important information on the location and health of riparian zones in the Upper Delaware Watershed. Communities can use the riparian zone health information in the local planning process. When this riparian health data is combined with existing data layers such as surface water quality standards, biological monitoring data and other relevant GIS layers, local stakeholders can hopefully make informed decisions on riparian zone enhancement, protection and acquisition.

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Appendix A

Methodology for Delineating and Characterizing the Health of Riparian Areas in the Upper Delaware Watershed Management Area (NJDEP WMA1) using Geographic Information Systems

Methodology for Delineating and Characterizing the Health of Riparian Areas in the Upper Delaware Watershed Management Area (NJDEP WMA1) using Geographic Information Systems

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Sean McGinnis
North Jersey Resource Conservation and Development Council

Table of Contents

Summary

This model is being run as part of the Upper Delaware Watershed Management Project. This model is based on the methodology that was created by Rick Lathrop and Marilyn Hughes at the Rutgers University Center for Remote Sensing and Spatial Analysis and North Jersey Resource Conservation and Development Council. For full documentation on the model, please contact Donna Drewes at the North Jersey Resource Conservation and Development Council.

Model Overview

The purpose of this model is to:

1. Delineate riparian areas within the Upper Delaware Watershed (NJDEP WMA1) based on hydrology
2. To characterize the relative health of these riparian areas

Software Overview

This model was compiled using Environmental Systems Research Institute's ArcView 3.2 with the Spatial Analyst version 2.0a.

Data Overview

All of the datasets that were used in this model, excluding the soils dataset, are available via download from the Internet. For complete data list and documentation on the data, please see Geographic Information System Digital Data Reference at the end of the document. The soils dataset is an updated New Jersey Department of Environmental Protection (NJDEP) Integrated Terrain Unit (ITU) for Hunterdon, Morris, Sussex and Warren. In counties where the Natural Resources Conservation Service (NRCS) certified digital data is available, the following steps are not necessary.

The attributes from the original NJDEP ITU soils dataset have been updated to the Natural Resources Conservation Service Soils Survey Geographic Database (SSURGO). After the attribute information was updated, there was an obvious issue with the soils matching on the Warren and Sussex County border. The soils along the border that did not match were updated in conjunction with the soils scientist updating the Sussex and Warren Counties Soil Survey. The only soils that were changed are the soils that are along the County border. No other soils polygons had their attribute information updated.

Methodology

Delineation of the Riparian Area

In this model, a riparian area is identified based solely on its relation to the local hydrology. USGS Floodprone area, hydric soils and wetlands are the resources that were identified to delineate these areas.

Datasets and Attributes

1. NJDEP Streams
   A 40-foot fixed distance area was placed on all of the streams based on a NRCS Technical Standard. The standard calls for a 35-foot area, but due to the grid size we are using in this project, the area was rounded up to 40-feet. This area was used to pick up the streams that were coming off of the ridges down the steep slopes adjacent to the streams. These streams are often too small to have a mapped flood plain, too step to have hydric soils. Which in turn will not support a wetland area. Still there is a riparian area associated with the stream. This standard sets a fixed distance on all streams.

   NOTE: I found that it is easier to apply the Water Quality Classification Scoring, done in the *Assessing the Health of the Delineated Riparian Area* first. By doing this, the NRCS Technical Standard can have the water quality classification score associated with it by doing a reclass. This will save time when scoring the delinated riparian areas in the *Assessing the Health of the Delineated Riparian Areas.*

2. USGS Floodprone Areas
   In the attribute table, the 'Floodprone Field' was queried to identify the USGS Floodprone areas. The USGS Floodprone Areas are defined as the 100 year Flood Plain plus 20%. The following are the values that are present within the field and what each number is defined as.
   1 – USGS Documented Floodprone Area
   2 – Undocumented Floodprone Area
   8 – Water
   9 – Not a Floodprone Area
   Only the polygons with a value of 1 or 8 were selected and used in delineating the Riparian areas.

3. NJDEP/NRCS/NJRC&D Soils
   To access the Hydric soils information, the "Comp" table was joined to the attribute table on the 'musym' field. The 'Hydric' field was queried for a 'Y' value indicating that the soil is a hydric soil.

4. NJDEP 1995/97 Land Use/Land Cover for WMA1- Freshwater Wetlands
   Table 1 shows all of the wetlands that are present in the Upper Delaware Watershed Management Area. The table is not a complete list of all the wetlands within the State, depending on the location; there may be different wetland areas present.

Table 1. Wetlands in the Upper Delaware Watershed Management Area

LABEL95	LU95
WETLAND RIGHTS-OF-WAY (MODIFIED)	1461
MANAGED WETLAND IN MAINTAINED LAWN GREENSPACE	1750
MANAGED WETLAND IN BUILT-UP MAINTAINED REC AREA	1850
AGRICULTURAL WETLANDS (MODIFIED)	**2140**
FORMER AGRICULTURAL WETLAND-BECOMING SHRUBBY, NOT BUILT-UP)	2150
DECIDUOUS WOODED WETLANDS	6210
CONIFEROUS WOODED WETLANDS	6220
ATLANTIC WHITE CEDAR SWAMP	6221
DECIDUOUS SCRUB/SHRUB WETLANDS	6231
CONIFEROUS SCRUB/SHRUB WETLANDS	6232
MIXED SCRUB/SHRUB WETLANDS (DECIDUOUS DOM.)	6233
MIXED BRUSH AND BOG WETLANDS, CONIFEROUS DOMINATE	6234
HERBACEOUS WETLANDS	6240
MIXED FORESTED WETLANDS (DECIDUOUS DOM.)	6251
MIXED FORESTED WETLANDS (CONIFEROUS DOM.)	6252
DISTURBED WETLANDS (MODIFIED)	7430

NOTE: In this model, 2140 Agricultural Wetlands (Modified) is not included in the wetlands category.

Delineation of the Riparian Area

1. Convert the four datasets from vector to raster grids using 40-foot grid cell sizes throughout the extent of the watershed. The 40-foot grid cell size is roughly equivalent to the New Jersey Department of Environmental Protection Land Use/Land Cover dataset.
2. Recode the attribute tables for the desired resources. The recode is as follows

Wetlands:	0 = Not a delineated Wetland	1 = Wetland
Floodprone:	0 = Not a Floodprone area	2 = Flood potential/water
Soils:	0 = Not Hydric	4 = Hydric
NRCS Standard	0 = No Standard	10 = Standard Area

NOTE: If "NODATA" values exist within the extent of the watershed boundary, the "NODATA" values must be recoded to zero before using the Spatial Analyst Map Calculator in ArcView

3. Add the four grids together in Map Calculator. The resulting values will range from 0 to 17 and give information as to what resources contributed to the delineation of the riparian area.

Assessing the Health of the Delineated Riparian Areas

The health of the riparian areas is defined by using three criteria; NJDEP Surface Water Quality Classification, NJDEP Land Use/Land Cover, and the NJDEP Endangered and Nongame Species Landscape Project.

Scoring the NJDEP Surface Water Quality Classification

This coverage is a representation of the State Surface Water Quality Classification with the Riparian Delineation area created in the previous process. The Surface Water Quality Classification is a dataset that is available for download off of the New Jersey Department of Environmental Protection GIS Digital Download web page.

New Jersey Department of Environmental Protection, Bureau of Watershed Management provided the ranking of the streams based on the surface water quality classification, the "SWC" field in the attribute table, then anitidegradation classification, the "ANTIDEG" field in the attribute table, and the water category, the "CATEGORY" field in the attribute table.

- FW1 and Pinelands Protection area 5
- Trout Production, Trout Maintenance, Non Trout C1 waters 4
- Trout Production Waters 4
- Trout Maintenance and non-Trout FW2 3

In the Surface Water Quality Classification dataset, the main stem of the Delaware is scored using zones established by the Delaware River Basin Commission. These zones did not correspond to the hierarchy established by NJDEP. A ranking was established for the Delaware River based on its geographical location. The river north of the Flat Brook was scored as a 4 and below the confluence of the Flat Brook was scored as a 3. The Upper Delaware Watershed Management Project's Project Team established the ranking for the Delaware River.

The codes were applied to the dataset by querying the attribute table in this order as not to overwrite previous codes applied to the attribute table.

- Category = "FW2-NT" or Category = "FW2-TM"
- Antideg <> "C1" and Trout = "TP"
- Antideg = "C1"
- Swc = "FW1"

Applying the Surface Water Quality Classification Score

This is the step that applies the surface water quality score to the riparian area that was delineated in the first step of the model. All scripts used in this process are available as a free download from the Environmental Systems Research Institute (ESRI) ArcScript web page. The web address for the ArcScript web page is www.esri.com/arcscript. A list of all scripts is included at the end of this report.

The grid in the riparian area has value, between 0 and 17, that defines what resources are present in that grid cell. To generalize the grid based on those values, use the Group Regions

Function of the Grid Generalize extension. This will clump all adjacent cells of equal value in the grid.

Using the r2vpoly.ave script, convert the riparian delineation grid to a vector dataset. This creates contiguous polygons of same resource composition riparian areas. This is the dataset that you will be applying the Surface Water Quality Classification scoring to on a Huc14 by Huc14 basis.

Select the Huc14 using the "Select Feature" tool. Using the "Clip" command in the Geoprocessing wizard, identify the Delineated Riparian Area as the input dataset and the Huc14 as the overlay dataset. This will clip the riparian area within the boundary of the selected Huc14. By doing this, you will remove some of the issues associated with riparian areas on ridge tops that are in two drainage areas with different surface water quality scores.

Place the scored Surface Water Quality Classification dataset on top of the clipped riparian areas. Manually score the riparian areas based on the score associated with the surface water quality classification.

Where stream segments of different water quality classification meet, split the riparian area based on the watersheds of those two reaches. This was completed by using the New Jersey Geological Survey monochromatic topographic images as base map information. They are in the same projection as all of the other datasets and can easily be used as a base map image. Turn off the riparian area coverage to get a better view of the topography, see Figure 1b. At the node where the two stream segments meet, estimate the drainage basin for the upstream line segment at that point. Use the "Draw Polyline" tool in the graphics/drawing control button to delineate that drainage divide, see Figure 1c. Turn the riparian area coverage on, and start editing it. Select the "Split Polygon Features" tool in the shapefile editing tools. Using the line that was drawn to estimate the drainage divide, trace it with the "Split Polygon" tool. Now score the two sections with the appropriate surface water quality classification, see Figure 1d.

Figures 1a to d – Splitting Riparian Areas

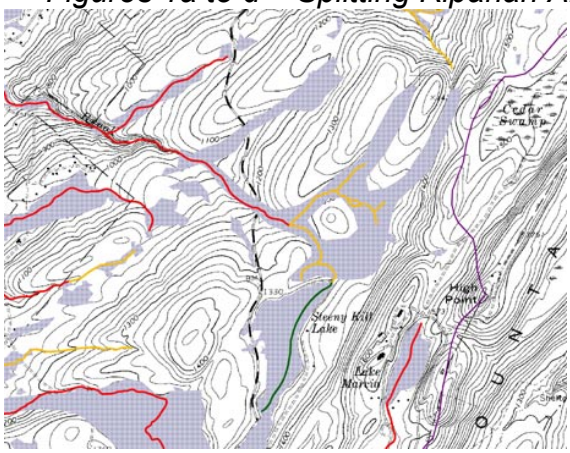

Figure 1a. Surface Water Quality Classification on top of the Delineated Riparian Area

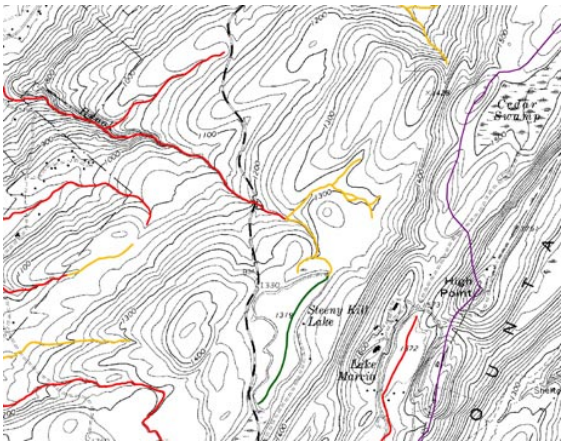

Figure 1b. Topographic base map to delineate drainage basins for individual stream reaches

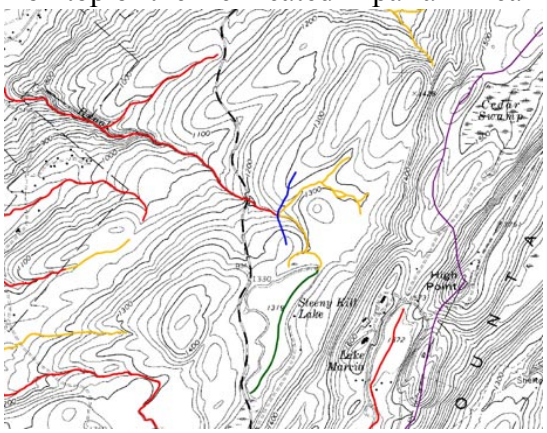

Figure 1c. Delineated Drainage basin break

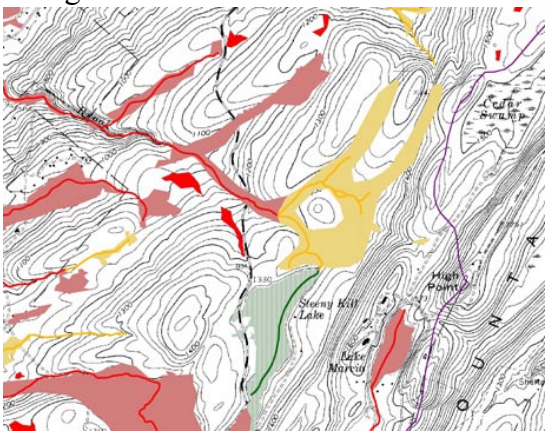

Figure 1d. Scored riparian areas based on surface water quality classification

To attempt to address headwater areas, riparian areas not associated with a water body were individually looked at. In a similar fashion as splitting the riparian areas, the areas are looked at to see if they are associated with a riparian draw. The areas that are associated assume the score of the water body that they drain to. This is better illustrated in Figure 1d.

Scoring the Land Use/Land Cover

The New Jersey Department of Environmental Protection 1995/97 Land Use/Land Cover is scored on a scale of 1, being the lowest, to 5, being the highest, based on its contribution or detriment to the waterway. The scoring was developed by the Natural Resources Conservation Service in the original model development. There were 4 different land use types in the Upper Delaware Watershed Management Area that were not found when the original model was developed. These new land use types are shown in Table 2 as a bold font. The NRCS also provided the scoring for these new land use types. The scoring is applied to the whole land use/land cover dataset; the areas outside of the riparian areas will be removed in one of the following steps.

Summarize the land use/land cover dataset using the descriptive and detailed field in the attribute table. For this model, the "Label95" field was used. The summary provides a list of all of the different land use/land cover classifications in the drainage basin. Apply the

scoring to the Land Use/Land Cover dataset by joining the scored summary table to the attribute table of the land use/land cover shapefile.

Table 2 – Land Use/Land Cover Scoring

LABEL95	SCORE
AGRICULTURAL WETLANDS (MODIFIED)	2
ALTERED LANDS	1
ARTIFICIAL LAKES	2
ATHLETIC FIELDS (SCHOOLS)	2
ATLANTIC WHITE CEDAR SWAMP	**5**
BARE EXPOSED ROCK, ROCK SLIDES, ETC.	2
COMMERCIAL/SERVICES	1
CONFINED FEEDING OPERATIONS	1
CONIFEROUS BRUSH/SHRUBLAND	4
CONIFEROUS FOREST (10-50% CROWN CLOSURE)	4
CONIFEROUS FOREST (>50% CROWN CLOSURE)	5
CONIFEROUS SCRUB/SHRUB WETLANDS	5
CONIFEROUS WOODED WETLANDS	5
CROPLAND AND PASTURELAND	2
DECIDUOUS BRUSH/SHRUBLAND	4
DECIDUOUS FOREST (10-50% CROWN CLOSURE)	4
DECIDUOUS FOREST (>50% CROWN CLOSURE)	5
DECIDUOUS SCRUB/SHRUB WETLANDS	5
DECIDUOUS WOODED WETLANDS	5
DISTURBED WETLANDS (MODIFIED)	2
EXTRACTIVE MINING	1
FORMER AGRICULTURAL WETLAND-BECOMING SHRUBBY, NOT BUILT-UP)	4
HERBACEOUS WETLANDS	4
INDUSTRIAL	1
INDUSTRIAL/COMMERCIAL COMPLEXES	1
MANAGED WETLAND IN BUILT-UP MAINTAINED REC AREA	2
MANAGED WETLAND IN MAINTAINED LAWN GREENSPACE	2
MILITARY RESERVATIONS	1
MIXED BRUSH AND BOG WETLANDS, CONIFEROUS DOMINATE	**5**
MIXED DECIDUOUS/CONIFEROUS BRUSH/SHRUBLAND	5
MIXED FOREST (>50% CONIFEROUS WITH 10%-50% CROWN CLOSURE)	4
MIXED FOREST (>50% CONIFEROUS WITH >50% CROWN CLOSURE)	5
MIXED FOREST (>50% DECIDUOUS WITH 10-50% CROWN CLOSURE)	4
MIXED FOREST (>50% DECIDUOUS WITH >50% CROWN CLOSURE)	5
MIXED FORESTED WETLANDS (CONIFEROUS DOM.)	**5**
MIXED FORESTED WETLANDS (DECIDUOUS DOM.)	5
MIXED RESIDENTIAL	**1**
MIXED SCRUB/SHRUB WETLANDS (DECIDUOUS DOM.)	5
MIXED URBAN OR BUILT-UP LAND	1
NATURAL LAKES	3
OLD FIELD (< 25% BRUSH COVERED)	4
ORCHARDS/VINEYARDS/NURSERIES/HORTICULTURAL AREAS	2
OTHER AGRICULTURE	2

LABEL95	SCORE
OTHER URBAN OR BUILT-UP LAND	1
PLANTATION	2
RECREATIONAL LAND	2
RESIDENTIAL, HIGH DENSITY, MULTIPLE DWELLING	1
RESIDENTIAL, RURAL, SINGLE UNIT	2
RESIDENTIAL, SINGLE UNIT, LOW DENSITY	2
RESIDENTIAL, SINGLE UNIT, MEDIUM DENSITY	1
STREAMS AND CANALS	4
TRANSITIONAL AREAS	4
TRANSPORTATION/COMMUNICATIONS/UTILITIES	2
UNDIFFERENTIATED BARREN LANDS	1
WETLAND RIGHTS-OF-WAY (MODIFIED)	2

After the dataset has been scored, convert the dataset to a grid with 40-foot cells. Use the applied score as the value for the grid.

Wetland Species of Concern – The NJDEP Nongame and Endangered Species Program's Landscape Project

The New Jersey Department of Environmental Protection Nongame and Endangered Species Program's Landscape Project maps areas that have the potential for rare species based on a grouping of identified natural resources. This dataset has been compiled for grassland, forest, wetland and forested wetland endangered and threatened species. For this project, we are only focusing on the wetland threatened and endangered species. The wetland grid includes forested wetlands.

There are two factors that needed to be dealt with before the Landscape Project wetlands grid could be incorporated into the ranking system.

1. The dataset is for the whole State – The areas outside of the dataset are removed through a simple map calculation

2. The Grid Resolution is too coarse - This dataset has an approximate grid cell size of 100 feet. All of the other datasets that we have worked with have been 40-foot grids. The Landscape grid needs to be converted to a 40-foot grid.

In the initial release of the Landscape Project, the areas were prioritized from a 1 (the lowest priority) to a 5 (the highest priority) based upon the potential of species of concern being present. That scoring system was used in assigning a quantitative value to the species of concern potential.

Scoring the Overall Assessed Health of the Riparian Areas

The overall health of the riparian areas are assessed by summing the three quantifying files together. The ranks can range from 1 (having the lowest riparian health) to a 15 (having the highest riparian health). These values were reclassified 5 points based on an equal interval basis.

Original Score	Reclassify
13-15	5
10-12	4
7-9	3
4-6	2
1-3	1

In the scoring of the riparian areas in the Upper Delaware Watershed, the lowest score was a two which comprised 16,563 acres, approximately 26 square miles.

Add the three ranked grids together using the "Map Calculator". The sum of this calculation will be the assessed health.

The land use/land cover grid has a value for every cell within the watershed. The non-riparian areas and water bodies need to be removed from the overall scoring. All of the polygons created in the surface water quality classification represent riparian areas. All grid cells with a score of 3, 4 or 5 have been identified as being associated with water; we can use this information to exclude areas not associated with the riparian areas. Reclassify the attributes with a value of 3, 4, or 5 to 1 and all others to 0. Multiply the reclassification file with the basin wide health assessment. By doing this, all of the areas not associated with the identified riparian areas are excluded.

Geographic Information Systems Digital Datasets

Land Use/Land Cover (Freshwater Wetlands)

New Jersey Department of Environmental Protection, Geographic Information Systems Digital Download Web Page, Land Use Land Cover for Watershed Management Area 1, Online Link: http://www.state.nj.us/dep/gis/digidownload/zips/lulc95/w01lu95.zip

In the delineation of the Riparian Areas, the freshwater wetlands were queried from the dataset using the Query Builder. The request was: ([Type95]=”Wetlands”). The results of the query were converted to a new shapefile.

USGS Floodprone Areas

New Jersey Department of Environmental Protection, Office of Information Resources Management, Bureau of Geographic Information and Analysis GIS Resource Data, Series 1, Volume 3, County Directory, Flood Prone Areas.

The ArcImport (E00) files were imported using Import71. The coverages were then merged together using the Geoprocessing Wizard in ArcView. The resulting shapefile was clipped using the boundary of the Upper Delaware Watershed.

Hydric Soils

This dataset was compiled by North Jersey RC&D and the Natural Resources Conservation Service for the Upper Delaware Watershed Management Project. The original data source was the NJDEP ITUM Soils for Hunterdon, Morris, Sussex and Warren Counties on the New Jersey Department of Environmental Protection, Bureau of Geographic Information and Analysis, Office of Information Resources Management GIS Resources Data CD, Series 1, Volume 3, Northern New Jersey.

At the time this model was run for the upper Delaware Watershed Management Area, the Natural Resources Conservation Service had not completed the Soil Survey Geographic Database (SSURGO) for the project area. These are the steps that were taken to create a usable soils dataset for the project area. If the SSURGO data has been created for the area that this model is being run in, please disregard the following steps.

The ArcImport (E00) files were imported using Import71. The coverages were then merged together using the Geoprocessing Wizard in ArcView. The resulting shapefile was clipped using the boundary of the Upper Delaware Watershed. The attribute table for the soils were updated from the old soil survey map units to the new Natural Resource Conservation Service Soil Survey Geographic Database map unit symbols.

The soils polygons along the Warren and Sussex County border were updated to match across county lines. The map unit edits were done with the aid of the Soils scientist updating the Warren and Sussex County Soils Surveys.

The “Comp” table was compiled for the dataset by creating a new database from the State wide legend provided by the Natural Resource Conservation Service.

Surface Water Quality Classification

New Jersey Department of Environmental Protection, Geographic Information Systems Digital Download Web Page, Land Use Land Cover for Watershed Management Area 1, Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/swqs/swqs01.zip

Endangered and Threatened Species - Landscape Project

New Jersey Division of Fish and Wildlife, Endangered and Nongame Species Program, Landscape Project, Wetland Priority Areas. Currently there is no online linkage.

The wetlands dataset includes forested wetland priority areas.

ESRI ArcScripts and Extensions

Grid Generalization Tools

This extension presents the generalization tools in the Spatial Analyst as a menu of choices added to the view GUI. This extension offers the following menu choices under the "Generalize Grid' menu, which is installed to the right of the Surface Menu; Remove noise, Smooth Surface, Majority Filter, Smooth Edges, Group Regions, Nibble, Expand Shrink and Thin

Raster to Vector Conversion – r2vpoly.ave

These scripts make use of the asPointFTab, asPolyLineFTab, and as PolygonFTab to convert a grid to either a point, line or polygon shapefile.