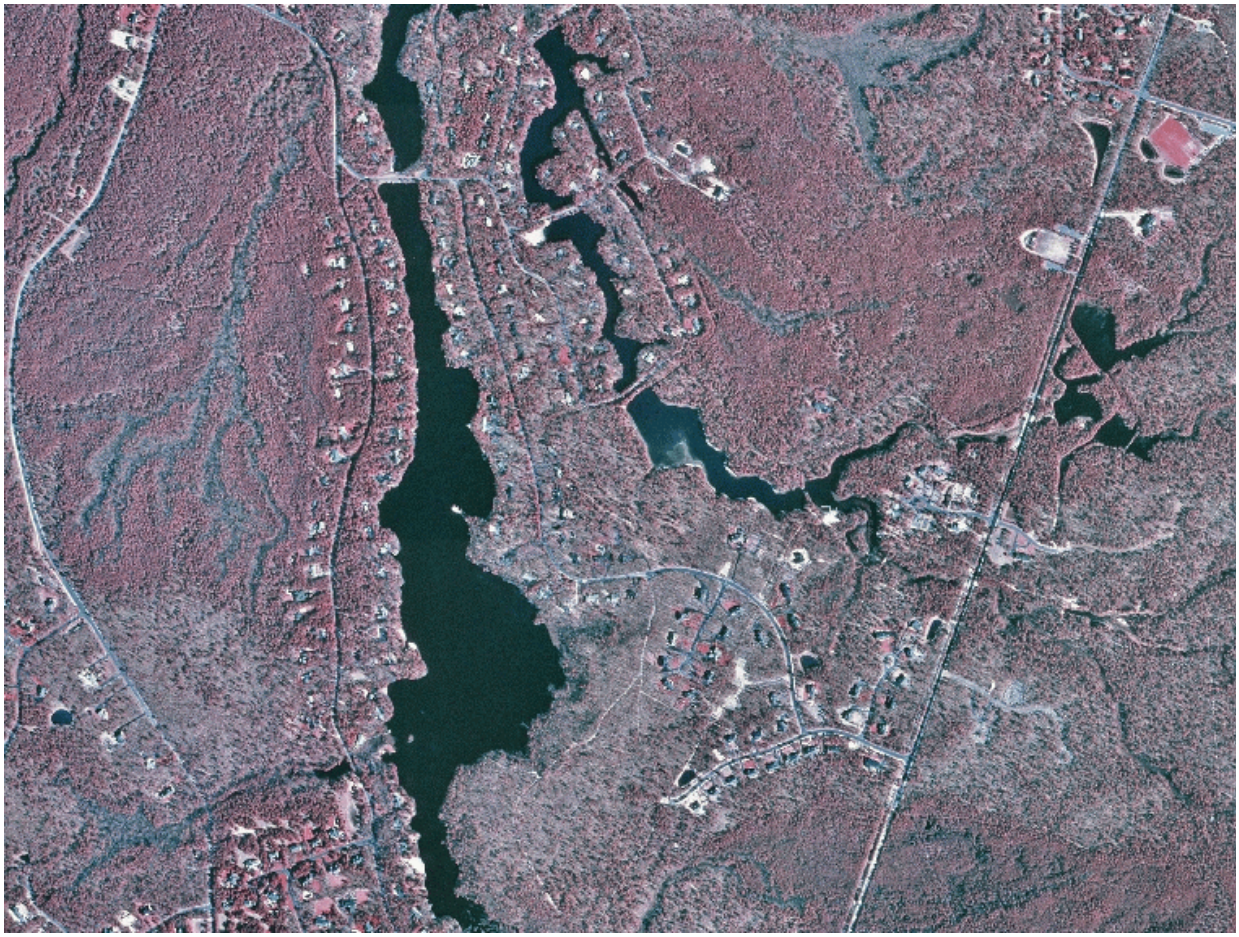
THE RANCOCAS CREEK BASIN

A REPORT TO THE PINELANDS COMMISSION ON THE STATUS OF SELECTED AQUATIC AND WETLAND RESOURCES



Pinelands Commission
Long-term Environmental Monitoring Program
2003

Cover image is a 1995/97 color-infrared aerial photograph (National Aerial Photography Program for the United States Geological Survey) showing developed and forested land within a portion of the Haynes Creek drainage of the Rancocas Creek Basin.

THE RANCOCAS CREEK BASIN

A REPORT TO THE PINELANDS COMMISSION ON THE STATUS OF SELECTED AQUATIC AND WETLAND RESOURCES

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INTRODUCTION

In the early 1990's, the Pinelands Commission initiated a long-term environmental-monitoring program with the ultimate goal of evaluating the ecological consequences of the Comprehensive Management Plan for the Pinelands National Reserve. The main objectives of the program were to characterize the effect of existing land-use patterns on aquatic and wetland resources and to monitor long-term changes in these resources. A study of the Mullica River Basin, which was the initial focus of the monitoring program, demonstrated that changes in the composition of stream vegetation, fish assemblages, and anuran (frog and toad) communities paralleled gradients of increasing land-use intensity and water-quality degradation (Zampella et al. 2001).

Based on the results of the Mullica River Basin study, pH and specific conductance and the presence of disturbance-indicator plants, nonnative fish, and bullfrogs were selected as the primary ecological indicators used to assess the status of surface waters in other Pinelands drainage systems. These water-quality and biological indicators, which distinguish the acid, nutrient-poor conditions and native plant and animal communities of undisturbed Pinelands watersheds from altered watersheds, are tailored to the unique characteristics of the ecosystem.

The Mullica River experience also provided the basis for modified sampling protocols. Stream-fish-assemblage and stream-vegetation surveys in the Mullica River Basin were based on multiple visits to 100-m stream reaches. These inventories characterized the entire plant or animal community of interest. Commission scientists found that by targeting disturbance-indicator plants and nonnative fish, shorter stream reaches (<100 m) located at road crossings can be used to adequately characterize the status of fish and stream vegetation. Additionally, by targeting bullfrogs, anuran-vocalization surveys could be limited to the latter part of the anuran-breeding period.

Using the selected ecological indicators and modified sampling protocols, Commission scientists completed a study of the Rancocas Creek Basin (Figure 1) in 2001 and conducted field surveys in the Great Egg Harbor River and Tuckahoe River Basins in 2002. Surveys in the Toms River, Cedar Creek, and other Barnegat Bay tributary basins are planned for 2003. Monitoring sites in these basins were co-located with New Jersey Department of Environmental Protection (NJDEP) ambient-biomonitoring-network (AMNET) sites. The NJDEP operates the AMNET program throughout the state. Benthic macroinvertebrate (aquatic insects and other macroscopic aquatic invertebrates) data collected through this program are used in the development of the required 305(b) water-quality inventory and other watershed-based regulatory and planning programs.

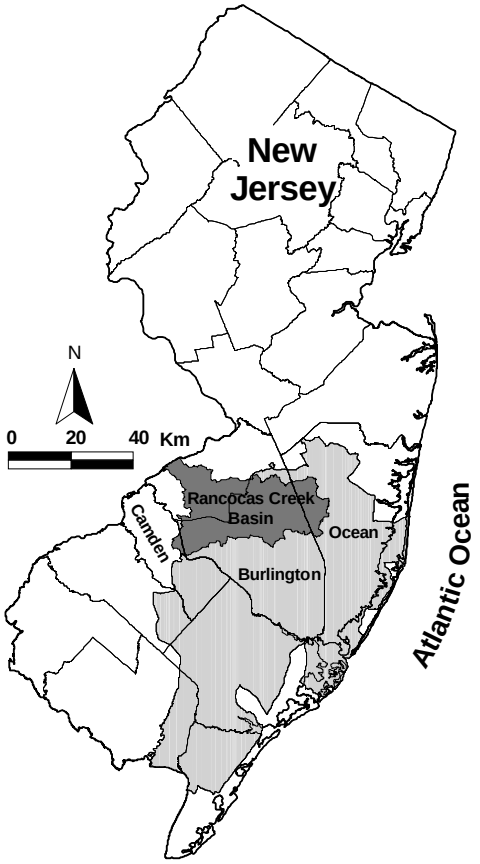

Figure 1. Regional location of the Rancocas Creek Basin in the Pinelands National Reserve.

The purpose of this report is to present the results of the Rancocas Creek Basin long-term environmental-monitoring program. All water-quality and biological data collected during the study are included in the report as appendices. Chapter 1 describes the landscape of the Rancocas Creek Basin. Chapter 2 characterizes the status of the region's surface waters and relates water quality to land-use patterns. In Chapters 3 through 5, the composition of stream vegetation, fish assemblages, and anuran assemblages is described in relation to site-specific and regional drainage-basin characteristics.

1 THE RANCOCAS CREEK BASIN STUDY AREA

INTRODUCTION

About two-thirds (69%) of the Rancocas Creek Basin lie within the Pinelands National Reserve (PNR). The PNR portion of the watershed drains sixteen municipalities in Burlington, Camden, and Ocean Counties (Figure 1.1). The Cohansey Sand and the Kirkwood Formation cover 64% and 27% of the study area, respectively (Figure 1.2). The Kirkwood-Cohansey aquifer is composed of these two Outer Coastal Plain formations. Several Inner Coastal Plain formations, including the Manasquan Marl, Navesink Marl, Vincentown Sand, and Hornerstown Marl, outcrop to the west of the Kirkwood Formation outcrop and cover less then 10% of the PNR portion of the basin.

In this report, the PNR portion of the Rancocas Creek Basin is divided into four study basins, including the Greenwood Branch, North Branch, South Branch, and Southwest Branch (Figure 1.3). The land-use characteristics of each study basin and the management areas designated through the Pinelands Comprehensive Management Plan are summarized in this chapter.

DEVELOPMENT OF LAND-USE, GEOLOGIC, AND MANAGEMENT-AREA PROFILES

Drainage-basin Delineations

Drainage-basin boundaries used throughout this report were obtained from the New Jersey Department of Environmental Protection (NJDEP 1996) digital hydrography data. Because basin boundaries were not available for some monitoring sites, drainage basins for these sites were delineated using digital topographic maps, ArcView software, and on-screen digitizing.

Land-use Profiles

Land-use profiles were prepared for each monitoring site by summing the area of major land-use/land-cover classes (NJDEP, 1995/97 Land Use/Land Cover Update 2001) for the drainage area upstream from the site. The NJDEP data set describes land-use using both the general Anderson Level I classification and various subclasses (Anderson et al. 1976). Wetlands are classified according to Cowardin et al. (1979). The general classes include urban, agriculture, barren land, forest, wetlands, and water. A revised Pinelands terminology is used throughout this report (Table 1.1). Pinelands land-use types are developed land, upland agriculture (including orchards), wetland agriculture, barren land, upland forest, wetlands, and water. In this report, the combined area of upland forest, wetlands, and water is described as forest land.

Geologic Profiles

Profiles of the surficial geology associated with each monitoring site were created using digital data obtained from the NJDEP (1996). Each geologic unit was summed and expressed as a percentage of the drainage area upstream from a monitoring site.

Pinelands Management Areas

The Commission's regional-planning and land-allocation program divides the PNR into several management areas within which land uses of varying intensities are permitted (Pinelands Commission 1980, Collins and Russell 1988). In order of increasing permitted-development intensity, management areas in the Rancocas Creek Basin include the Preservation Area District, Forest Area, Special Agricultural Production Area (blueberry and cranberry agriculture), Agricultural Production Area, Rural Development Area, Pinelands Village, Pinelands Town, and Regional Growth Area (Figure 1.4). Military and Federal Installation Area is also present in the Rancocas Creek Basin. Management-area profiles were prepared for each study basin using ArcView software and a management-area coverage (Pinelands Commission, Land Capability Map, November 1999).

THE RANCOCAS CREEK BASIN

The PNR portion of the Rancocas Creek Basin covers 629-km^2. About 75% of this area is undeveloped forest land (Figures 1.5 and 1.6). The remainder of the basin is developed and farmed, with developed land being the dominant land use. The majority of the developed land is located in the North Branch and Southwest Branch study basins, whereas most of the upland and wetland agriculture lies within the South Branch basin. In the Greenwood Branch

study basin, the area designated as developed and agricultural land combined is <10%.

Preservation Area District and Forest Area, which together encompass about 42% of the Rancocas Creek Basin, are concentrated on the eastern side of the watershed (Figures 1.4 and 1.7). Agricultural Production Areas and Special Agricultural Production Areas are located primarily in the central portion of the basin. Rural Development Areas and Regional Growth Areas are located mostly in the western and north-central portion of the basin. Scattered Pinelands Villages and Pinelands Towns represent a relatively small percentage of the basin area. The only Military and Federal Installation Area (Fort Dix) is located along the northern border of the basin.

Greenwood Branch

The 203-km^2 Greenwood Branch study basin drains portions of Ocean and Burlington Counties and is the only study basin that lies entirely within the Pinelands National Reserve boundary. The three main Greenwood Branch tributaries are the Pole Bridge Branch (including Bucks Cove Run, Cranberry Branch, and Gum Spring), Mount Misery Brook (including the North, Middle, and South Branches), and Bisphams Mill Creek (including McDonalds, Cooper, and Shinns Branches). McDonalds Branch is a United States Geological Survey national benchmark station.

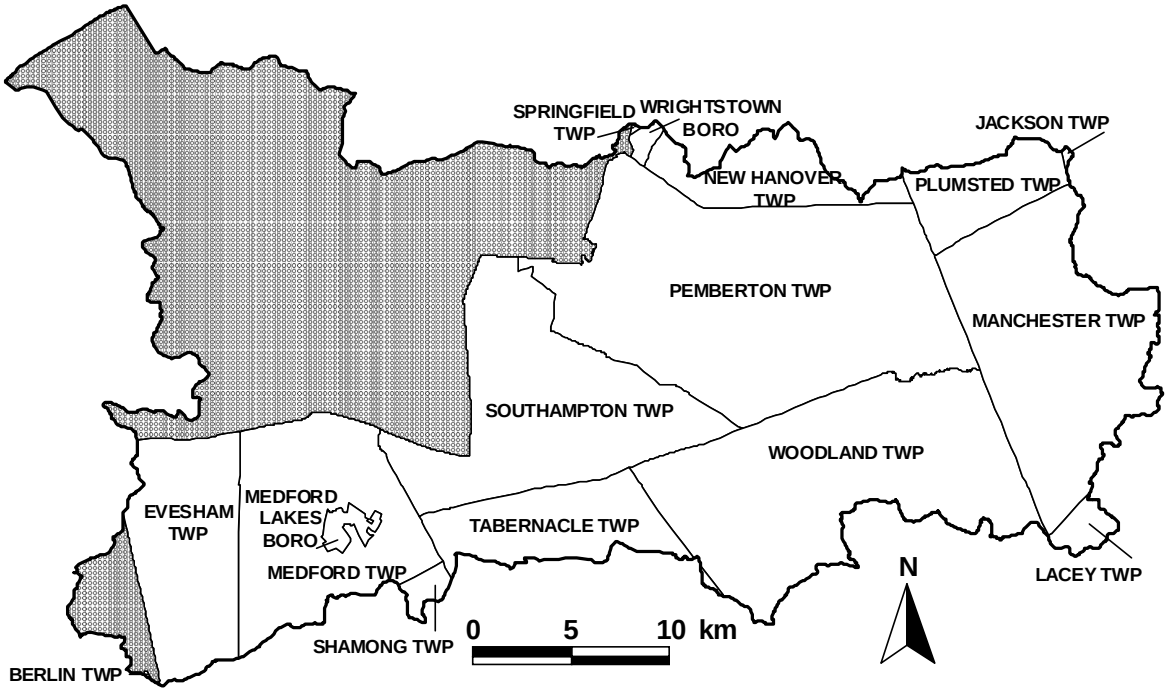

Figure 1.1. Municipalities in the Rancocas Creek Basin. Shaded areas are outside the Pinelands National Reserve.

Table 1.1. New Jersey Department of Environmental Protection land-use/land-cover classes and the revised Pinelands terminology.

Pinelands classes	NJDEP classes	Code	Subclasses (NJDEP 95 Label)
Developed land	Urban	1110	Residential, high density, multiple dwelling
		1120	Residential, single unit, medium density
		1130	Residential, single unit, low density
		1140	Residential, rural, single unit
		1150	Mixed residential
		1200	Commercial/services
		1211	Military reservations
		1300	Industrial
		1400	Transportation/communications/utilities
		1600	Mixed urban or built-up land
		1700	Other urban or built-up land
		1800	Recreational land
		1804	Athletic fields (schools)
Upland agriculture	Agriculture	2100	Cropland and pastureland
		2300	Confined feeding operations
		2400	Other agriculture
		2200	Orchards/vineyards/nurseries/horticultural areas
Wetland agriculture	Wetlands	2140	Agricultural wetlands (modified)
Barren land	Barren land	7100	Beaches
		7300	Extractive mining
		7400	Altered lands
		7500	Transitional areas
		7600	Undifferentiated barren lands
Upland forest	Forest	4110	Deciduous forest (10-50% crown closure)
		4120	Deciduous forest (>50% crown closure)
		4210	Coniferous forest (10-50% crown closure)
		4220	Coniferous forest (>50% crown closure)
		4230	Plantation
		4311	Mixed forest (>50% coniferous with 10%-50% crown closure)
		4312	Mixed forest (>50% coniferous with >50% crown closure)
		4321	Mixed forest (>50% deciduous with 10-50% crown closure)
		4322	Mixed forest (>50% deciduous with >50% crown closure)
		4410	Old field (< 25% brush covered)
		4420	Deciduous brush/shrubland
		4430	Coniferous brush/shrubland
		4440	Mixed deciduous/coniferous brush/shrubland
		4500	Severe burned upland vegetation
Water	Water	5100	Streams and canals
		5200	Natural lakes
		5300	Artificial lakes
		5410	Tidal rivers, inland bays, and other tidal waters
		5420	Dredged lagoon
		5430	Atlantic ocean
Wetlands	Wetlands	1461	Wetland rights-of-way (modified)
		1750	Managed wetland in maintained lawn greenspace
		1850	Managed wetland in built-up maintained rec area
		2150	Former agricultural wetland (becoming shrubby, not built-up)
		6210	Deciduous wooded wetlands
		6220	Coniferous wooded wetlands
		6221	Atlantic white cedar swamp
		6231	Deciduous scrub/shrub wetlands
		6232	Coniferous scrub/shrub wetlands
		6233	Mixed scrub/shrub wetlands (deciduous dom.)
		6234	Mixed scrub/shrub wetlands (coniferous dom.)
		6240	Herbaceous wetlands
		6251	Mixed forested wetlands (deciduous dom.)
		6252	Mixed forested wetlands (coniferous dom.)
		6500	Severe burned wetlands
		7430	Disturbed wetlands (modified)
		6110	Saline marshes
		6120	Freshwater tidal marshes
		6130	Vegetated dune communities

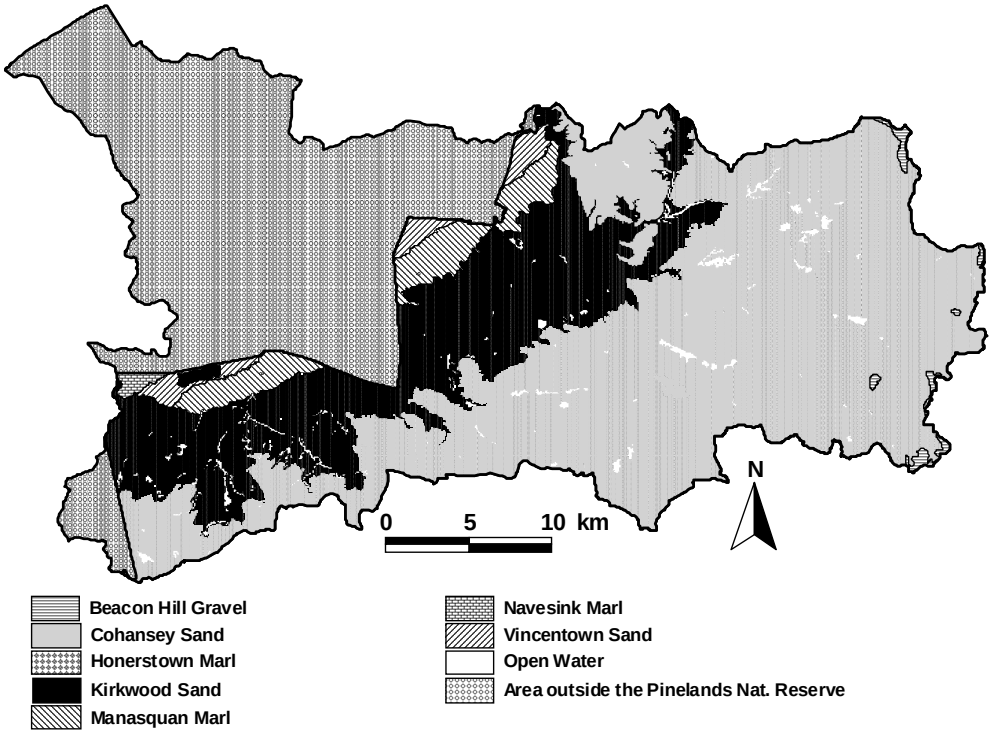

Figure 1.2. Surficial geology of the Pinelands National Reserve portion of the Rancocas Creek Basin.

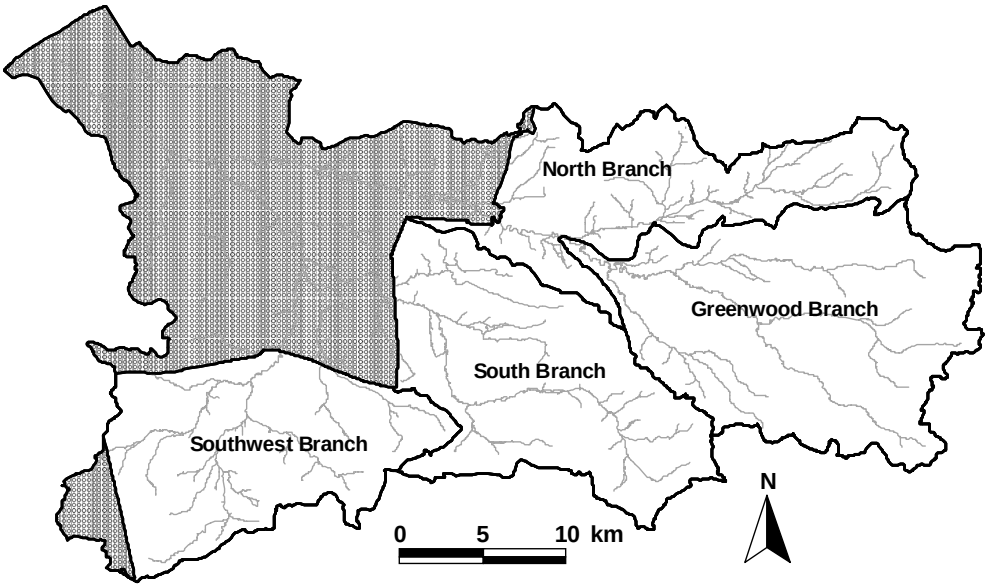

Figure 1.3. Four study basins in the Rancocas Creek Basin. Shaded areas are outside the Pinelands National Reserve.

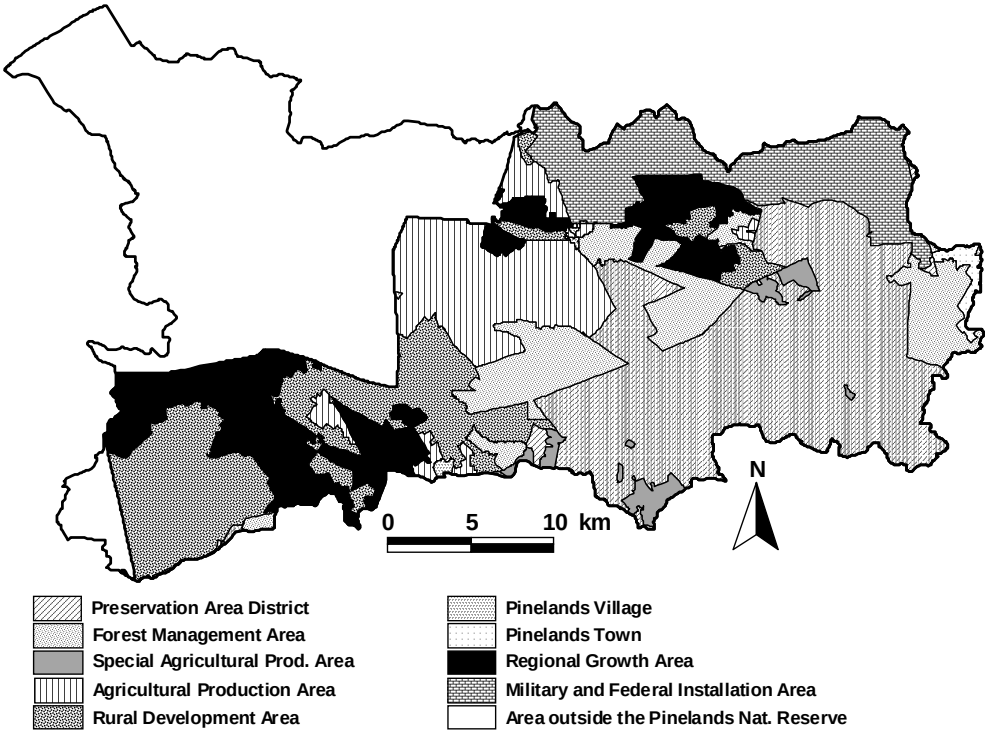

Figure 1.4. Pinelands management areas in the Rancocas Creek Basin.

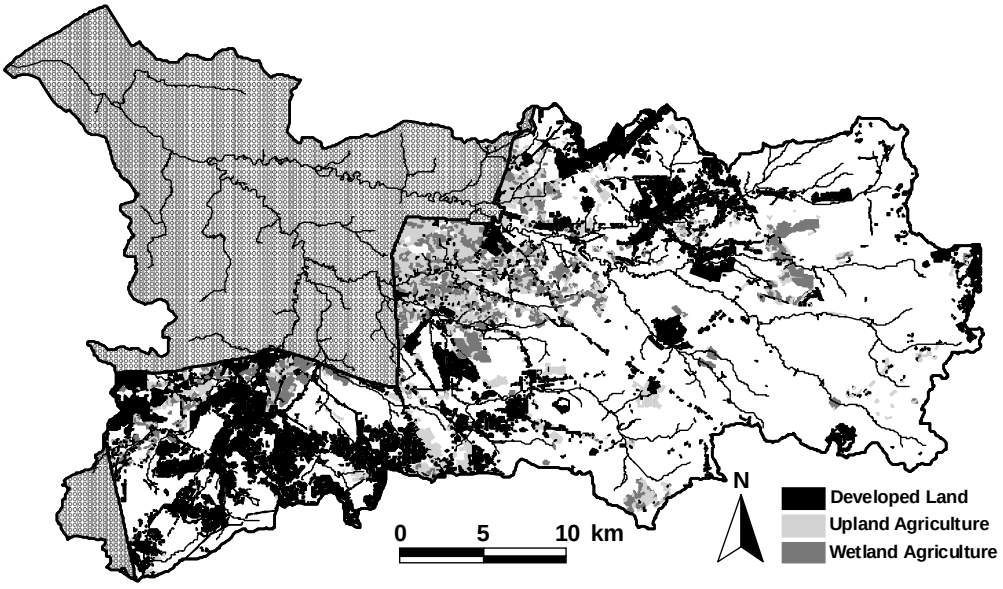

Figure 1.5. Developed land, upland agriculture, and wetland agriculture in the Pinelands National Reserve portion of the Rancocas Creek Basin. Unshaded areas represent forest lands (uplands, wetlands, and water) and barren lands.

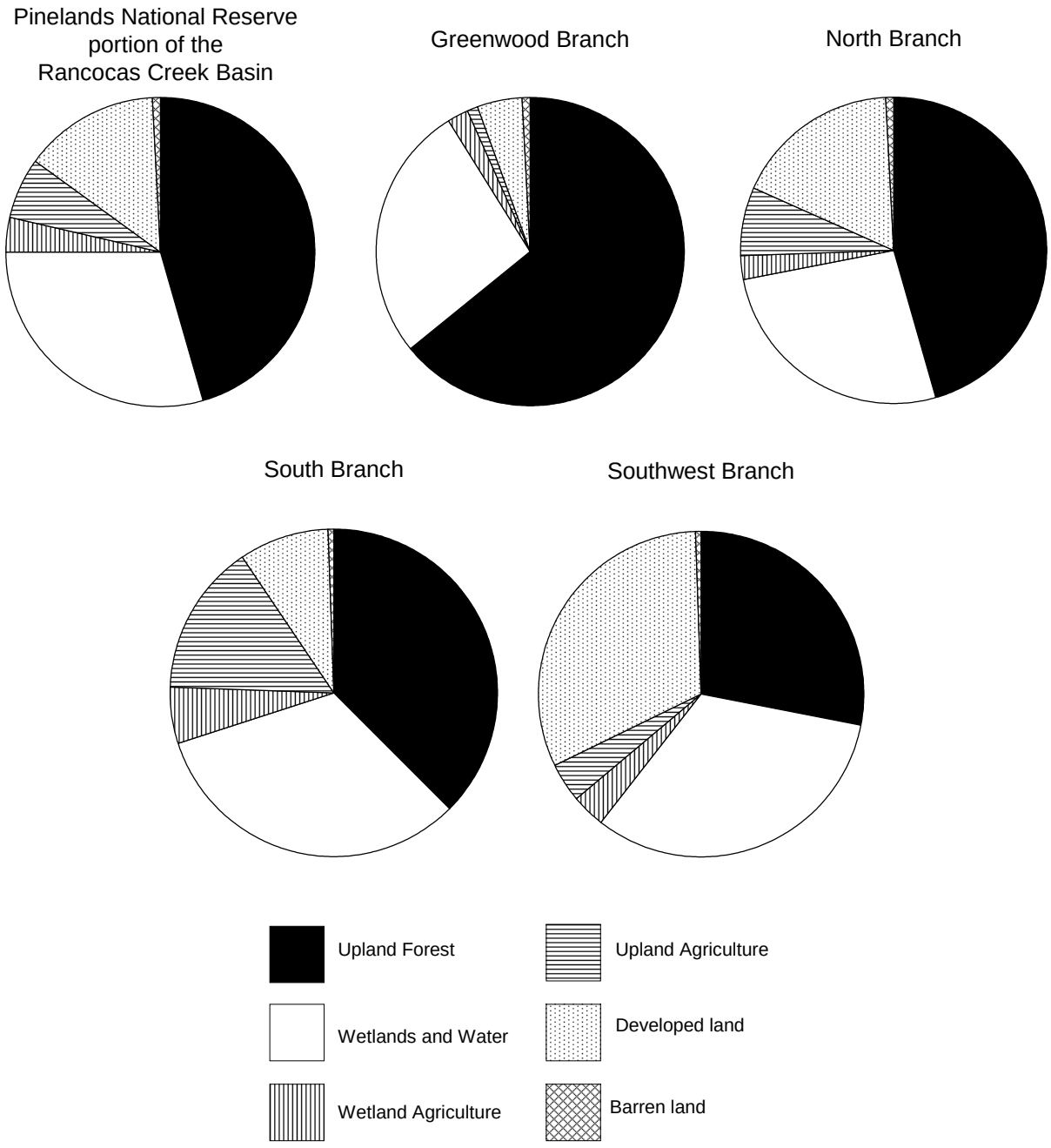

Figure 1.6. Rancocas Creek Basin land-use profiles. Refer to Table 1.1 for descriptions of each land-use/land-cover class.

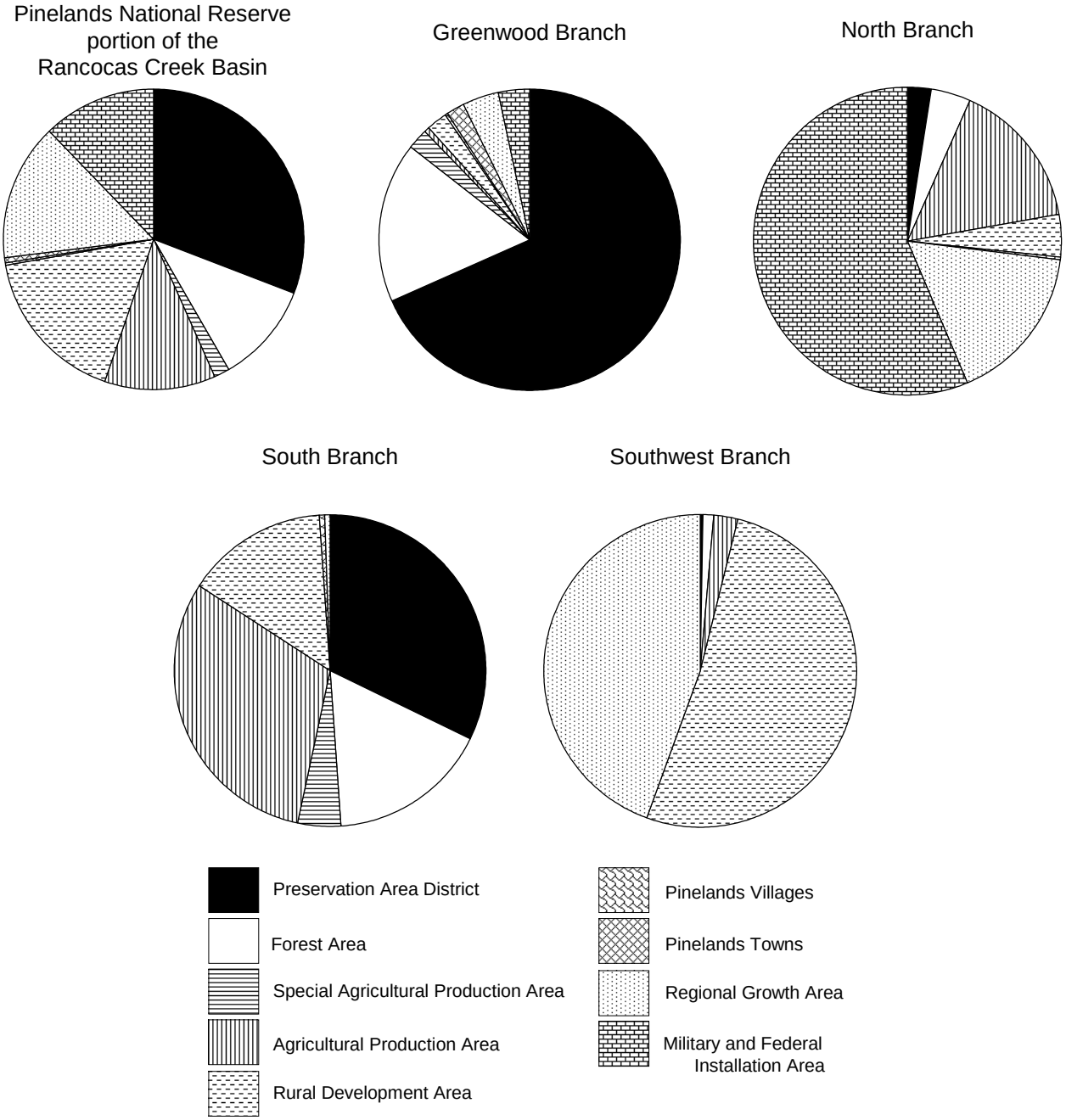

Figure 1.7. Rancocas Creek Basin management-area profiles.

The Greenwood Branch is the only study basin that contains all the major land-use classes and Pinelands management areas. Nearly all of the study-basin area is forested land, which is reflected in the high percentage of land classified as Preservation Area District and Forest Area. Much of this land is state forest. Developed land, which represents <5% of the basin area, is concentrated around a series of impoundments on Pole Bridge Branch (Country Lakes) and Bisphams Mill Creek (Presidential Lakes). Pole Bridge Branch also contains most of the wetland agriculture in the Greenwood Branch study basin.

North Branch

Like the Greenwood Branch basin, the North Branch study basin drains parts of Ocean and Burlington Counties. Several small tributaries, including Gaunts Brook, Jacks Run, Ong Run, and Budds Run, comprise this 125-km^2 basin. Budds Run receives municipal wastewater.

About 75% of the North Branch basin area is forest land. Most of this land is located within the headwater tributaries of Jacks Run and Gaunts Brook and is classified as Military and Federal Installation Area. The remainder of the North Branch basin is developed and agricultural land, which mirrors the high percentage of land area classified as Regional Growth Area and Agricultural Production Area. Developed land is the dominant altered-land use in the North Branch basin and most of this land lies within the middle portion of the basin and along the northern border in the headwater areas of Budds Run, Jacks Run, and Ong Run. Developed land in the central part of the study basin is associated with impoundments on the North Branch, including Little Pine Lake, Big Pine Lake, and Mirror Lake. Upland agriculture, which represents <10% of the study-basin area, is concentrated in the lower part of Budds Run.

South Branch

The160-km^2 South Branch study basin is located in the central portion of the Rancocas Creek Basin and lies entirely within Burlington County. The study basin incorporates Jade Run and all of the South Branch tributaries above Route 206, including the South Branch Burrs Mill Brook, Burrs Mill Brook, Friendship Creek, and Bread and Cheese Run. Gum Spring, a tributary of Burrs Mill Brook, receives institutional wastewater.

Almost 75% of the South Branch study-basin area is undeveloped forested land, which is concentrated primarily in the headwater areas of Burrs Mill Brook and Friendship Creek. Preservation Area District and Forest Area comprise about one-half of the study basin area. Of the remaining developed and agricultural land, upland agriculture is the dominant land use and is concentrated primarily in Jade Run, Bread and Cheese Run, and the lower portion of Friendship Creek. These areas are classified as Agricultural Production Areas and represent nearly one-third of the study-basin area.

Southwest Branch

The 142-km^2 Southwest Branch study basin drains parts of Burlington county and a small portion of Camden county. From west to east, the three major Southwest Branch tributaries are the Southwest Branch (including Sharps Run, Barton Run, and Black Run), Haynes Creek (including Kettle Run, Cedar Run, and several unnamed Haynes Creek tributaries), and Little Creek (including Bear Swamp River). The Southwest Branch and Haynes Creek both receive municipal wastewater. A large number of impoundments are present throughout this study basin.

Compared to the other three study basins, this basin contains the least amount of forested land and greatest amount of developed land. Likewise, this basin is classified almost entirely as Regional Growth Area and Rural Development Area. Most of the forested land is located in Black Run, Kettle Run, Cedar Run, and the headwater areas of Little Creek. A relatively small percentage of the study basin area is agricultural land.

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2 WATER QUALITY

INTRODUCTION

Throughout the Pinelands, variations in stream-water quality are associated with the extent of land-use disturbance in a watershed (Zampella 1994, Dow and Zampella 2000, Zampella et al. 2001). Pinelands stream sites with extensive upstream development and upland agriculture tend to display higher pH and specific conductance values and higher concentrations of dissolved solids than those in basins with little altered land. Elevated pH in degraded streams appears to be related to increases in base cations and alkalinity and enhanced primary productivity associated with nutrient enrichment. In most Pinelands waters, specific conductance, which is a measure of the ability of water to conduct an electrical current, is influenced by the presence of calcium, magnesium, sodium, potassium, chloride, and sulfate ions.

Water-quality degradation represented by changes in pH and specific conductance has ecological consequences. Variations in pH and specific conductance are associated with variations in other water-quality parameters, such as increased nutrient and ion concentrations (Zampella 1994, Zampella et. al 2001), and changes in the composition of biological communities (Zampella and Laidig 1997, Zampella and Bunnell 1998, Zampella and Bunnell 2000, Zampella et al. 2001).

In this chapter, the relationship between land use and pH and specific conductance is described for Rancocas Creek Basin water-quality monitoring sites. Changes in pH and developed land values through time are discussed, and nitrogen and phosphorus data collected through a cooperative Pinelands Commission-Burlington County Health Department ambient-water-quality program (Windisch and Zampella 1989, Windisch 1990, 1991, Dow 1996) are summarized.

METHODS

Field Measurements of pH and Specific Conductance

Between June and November 2001, specific conductance, pH, and temperature data were collected at 51 primary stream sites in the Pinelands portion of the Rancocas Creek Basin (Table 2.1, Figure 2.1). Samples were collected monthly over a two day period. Most sites were sampled six times.

In October 2001, 18 additional sampling sites were added to the monitoring program to supplement the pool of forested watersheds in the western portion of the Rancocas Creek Basin (Table 2.2). These eighteen supplemental sites, along with eight primary monitoring sites, were sampled weekly over a four week period between October and November 2001. Each weekly sampling round was conducted during a single day. The eight primary sites were included to determine how well the results of a short-term weekly monitoring program compared to a longer-term data set based on monthly measurements. The value of short-term pH and specific conductance data sets in characterizing Pinelands water quality has been demonstrated in other Commission studies (Dow and Zampella 2000, Zampella et al. 2001).

At each monitoring site, grab samples were collected directly from the stream or lake outflow using a one-liter Nalgene plastic bottle that was rinsed three times with stream water. All samples were collected under baseflow conditions.

An Orion model 250a pH meter with automatic temperature compensation and a ROSS combination electrode was used to measure pH. An Orion model 122 conductivity meter with temperature compensation was used to measure specific conductance and temperature. To ensure adequate stabilization of the pH meter, pH was measured in three separate 250 ml samples that were split from the grab sample, and the third measurement was recorded. The specific conductance and temperature of the third sample were also measured and recorded. Using two pH buffers (4.0 and 7.0) that bracket the expected pH range found in streams of the New Jersey outer-coastal plain, the pH meter was calibrated at the beginning of every sampling day and after every three hours of use. The conductance meter was checked monthly against two United States Geological Survey standards (50 and 100 μS cm^{-1}). All calibration data were recorded.

Table 2.1. Primary water-quality monitoring sites in the Rancocas Creek Basin. Median pH and specific conductance (SC) (μS cm^{-1}) values are from a six-month period (June - November 2001), except where noted. Refer to Figure 2.1 for site locations. Refer to Appendix 1 for full site descriptions and monthly water-quality data.

			Percentage Land Use			Median Values		
Site Name	Site Code	Site No.	Developed Land	Upland Agriculture	Wetland Agriculture	pH	SC	N
Greenwood Branch Study Basin								
Bisphams Mill Creek at Turkey Buzzard Bridge Road	GBITURKE	9	4.3	0.1	1.2	4.7	66	6
Cooper Branch below Pakim Pond	GCOPAKIS	5	2.2	0.0	0.0	4.4	42	6
Greenwood Branch above New Lisbon Road-Four Mile Road	GGRIMPNT	11	4.8	1.0	2.3	4.6	50	6
McDonalds Branch at Butterworth Road	GMCBUTTE	1	0.0	0.0	0.0	4.1	37	6
Middle Branch Mount Misery Brook at Mount Misery-Pasadena (1)	GMIMOUNT	2	0.0	0.0	0.0	4.1	48	5
Mount Misery Brook at Route 70	GMORTE70	4	1.0	1.1	0.3	4.5	32	6
North Branch Mount Misery Brook at unnamed sand road	GNOSANDR	6	1.7	1.6	0.1	4.5	30	6
Pole Bridge Branch at Whites Bogs-Pasadena Road	GPOWHITE	16	7.1	1.4	3.9	5.1	47	6
Pole Bridge Branch at Wissahickon Trail	GPOWISSA	19	8.0	1.6	5.7	4.7	53	6
North Branch Rancocas Creek Study Basin								
Budds Run at Route 616	NBURT616	40	14.6	25.0	5.3	7.2	235	6
Jacks Run at Range Road	NJARANGE	31	28.3	0.5	0.0	6.2	79	6
North Branch Rancocas Creek at Military Road	NNOMILIT	10	5.3	0.0	0.0	4.6	28	6
North Branch Rancocas Creek above New Lisbon -Four Mile Road	NNONEWLI	26	18.2	1.3	0.4	6.5	85	6
North Branch Rancocas Creek at Route 616	NNORT616	22	9.3	1.8	2.2	5.9	61	6
North Branch Rancocas Creek tributary at Magnolia Road	NNOTRMGU	13	1.6	5.7	18.2	4.7	44	6
Ong Run at West Lakeshore Drive	NONWLAKE	38	36.7	2.3	0.3	6.5	120	6
South Branch Rancocas Creek Study Basin								
Bread and Cheese Run at New Road	SBRNEWRD	49	23.5	32.0	2.1	6.1	204	6
Burrs Mill Brook at Sooy Place Road	SBUSOOYS	17	4.4	4.3	1.3	4.5	61	6
Cedar Run at Burr's Mill Road (1)	SCEBURRS	18	2.5	7.0	0.1	3.8	105	4
Friendship Creek at Camp Inawendiwin	SFRCAMPS	25	12.9	5.7	0.6	5.0	46	6
Friendship Creek at Irick's Causeway (2)	SFRIRICK	12	1.9	4.9	1.7	4.8	41	2
Friendship Creek at Powell Place Road	SFRPOWEL	32	17.0	13.1	0.8	5.9	95	6
Friendship Creek at Retreat Road	SFRRETRE	24	11.3	5.8	1.2	5.1	76	6
Jade Run near Route 616	SJART616	41	4.6	36.7	12.1	6.6	205	6
Jade Run at Stocktons Bridge Road	SJASTOCK	21	3.5	7.6	7.3	4.5	75	6
South Branch Burrs Mill Brook at Sooy Place Road	SSBSOOYS	14	1.9	6.3	3.4	4.1	67	6
South Branch Rancocas Creek at Burr's Mill Road (1)	SSOBURRS	7	1.7	1.6	5.5	4.3	70	5
South Branch Rancocas Creek at Ridge Road	SSORIDGE	23	9.7	6.9	3.6	4.7	73	6
South Branch Rancocas Creek tributary at Burr's Mill Road (1)	SSOTRBUR	27	2.9	18.1	21.1	4.1	78	3
Southwest Branch Rancocas Creek Study Basin								
Barton Run below Jennings Lake	WBAJENNS	48	50.8	1.6	1.2	7.2	151	6
Barton Run at Tuckerton Road	WBATUCKE	37	34.8	1.9	2.0	6.9	156	6
Bear Swamp River at Route 70 (1)	WBERTE70	35	25.7	7.5	3.4	5.2	189	4
Black Run at Route 544 (1)	WBLRT544	15	6.8	1.5	2.6	4.1	60	5
Black Run below abandoned cranberry bog	WBLSPRAY	3	1.4	0.0	0.0	4.4	83	6
Black Run tributary at Kettle Run Road (1)	WBLTRKET	8	1.7	1.9	1.6	4.3	64	4
Cedar Run below Cedar Run Lake (3)	WCEREFUG	20	6.4	3.5	0.0	5.8	43	5
Haynes Creek at Falls Road	WHAPINES	30	27.7	0.7	0.0	6.7	72	6
Haynes Creek at Route 623	WHART623	39	38.1	0.9	0.1	6.7	110	6
Haynes Creek at Breakneck Avenue	WHATAUNT	29	26.4	0.8	0.0	6.3	68	6
Haynes Creek tributary at Jackson Road below Birchwood Lake	WHATRBIR	47	47.9	0.9	0.0	6.8	175	6
Haynes Creek tributary at Route 619	WHATRBLU	34	32.3	0.0	0.0	6.5	129	6
Haynes Creek tributary at Lake Stockwell	WHATRSTO	44	40.1	1.5	0.1	6.5	107	6
Kettle Run at Camp Kettle Run (4)	WKEGIRLS	-	27.7	1.9	0.0	6.2	66	1
Kettle Run below Hopewell Road	WKEHOPEW	45	42.5	1.5	0.0	6.6	106	6
Kettle Run at Sawmill Road	WKESAWMI	36	32.0	1.5	0.0	6.1	67	6
Little Creek at Hawkins Road (3)	WLIHAWKI	33	31.3	0.4	0.1	6.1	100	5
Little Creek at Route 70	WLIRTE70	28	21.4	0.7	0.3	5.9	98	6
Sharps Run at Route 541	WSHRT541	-	20.0	21.4	20.8	7.0	326	6
Southwest Branch Rancocas Creek at Hartford Road	WSOHARTF	46	38.7	5.4	3.8	7.2	331	6
Southwest Branch Rancocas Creek at Route 541	WSORT541	42	38.4	3.0	1.9	6.9	162	6
Southwest Branch Rancocas Creek at Route 70	WSORTE70	43	38.1	3.4	2.3	6.9	163	6

(1) Intermittent flow (2) Period of record (October 2001 - November 2001) (3) Period of record (July 2001 - November 2001) (4) Period of record (June 2001)

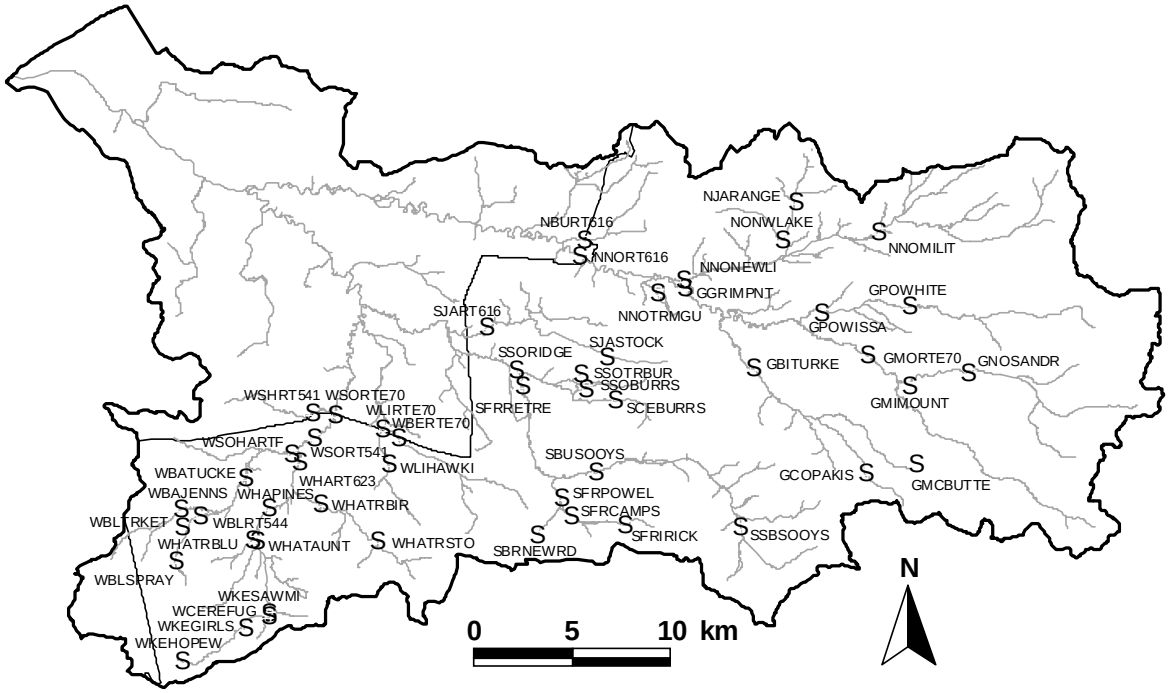

Figure 2.1. Location of 51 primary pH and specific conductance monitoring sites in the Pinelands National Reserve portion of the Rancocas Creek Basin. Refer to Table 2.1 for site descriptions.

Table 2.2. Supplemental water-quality monitoring sites in the Rancocas Creek Basin. Median pH and specific conductance (SC) (μS cm^{-1}) values are from a four week period during October and November 2001, except where noted. Refer to Appendix 1 for full site descriptions and weekly water-quality data.

		Percentage Land Use			Median		
Site Name	Site Code	Developed Land	Upland Agriculture	Wetland Agriculture	pH	SC	N
Greenwood Branch Study Basin							
Presidential Lakes (1)	GBIPRESU	2.9	0.1	1.4	5.4	46	2
Southwest Branch Rancocas Creek Study Basin							
Barton Run below Jennings Lake	WBAJENNS	50.8	1.6	1.2	6.7	161	4
Black Run at Route 544	WBLRT544	6.8	1.5	2.6	4.4	74	4
Black Run below abandoned cranberry bog	WBLSPRAY	1.4	0.0	0.0	4.3	96	4
Black Run tributary at Braddocks Mill Road	WBLTRBRA	0.4	0.5	0.7	4.0	85	4
Black Run tributary at Kettle Run Road	WBLTRKET	1.7	1.9	1.6	4.1	72	4
Black Run tributary at Kettle Run Road (2)	WBLTRSPR	5.3	0.0	0.0	3.6	256	3
Cedar Run at Oak Ridge Drive	WCEOAKRI	3.9	8.8	0.0	4.6	40	4
Cedar Run at powerline road in Woodford Cedar Run Refuge	WCEPOWER	4.4	3.9	0.0	5.9	75	4
Cedar Run below Cedar Run Lake	WCEREFUG	6.4	3.5	0.0	5.2	40	4
Haynes Creek below Falls Road	WHAPINES	27.7	0.7	0.0	6.3	76	4
Haynes Creek tributary at Shanty Dam Road and Cedar Falls Drive	WHATRCED	16.3	0.0	0.0	6.0	57	4
Haynes Creek tributary at Hinchman Drive	WHATRHIN	41.3	0.0	0.0	4.6	81	4
Haynes Creek tributary at Hopewell Road	WHATRHOP	19.6	0.4	0.0	5.8	76	4
Haynes Creek tributary at Jackson-Medford Road (northern Mimosa Lakes inlet)	WHATRJMN	20.0	0.0	0.0	6.8	86	4
Haynes Creek tributary at Jackson-Medford Road	WHATRJMR	2.0	0.0	0.0	5.4	103	4
Haynes Creek tributary at Jackson-Medford Road (southern Mimosa Lakes inlet)	WHATRJMS	20.8	0.4	0.0	5.8	43	4
Haynes Creek tributary at Lake Stockwell (2)	WHATROCU	15.2	0.0	0.0	5.0	46	3
Haynes Creek tributary at Pontiac Drive	WHATRPON	23.0	0.2	0.0	6.2	55	4
Haynes Creek tributary at Scout Drive	WHATRSCO	20.5	0.2	0.0	6.5	49	4
Haynes Creek tributary at Shanty Dam Road	WHATRSHA	21.9	0.2	0.0	6.4	54	4
Kettle Run tributary at Kettle Run Road	WHATRYMC	11.0	0.8	0.0	5.7	32	4
Kettle Run below Hopewell Road	WKEHOPEW	42.5	1.5	0.0	6.5	122	4
Kettle Run at Sawmill Road	WKESAWMI	32.0	1.5	0.0	6.1	70	4
Kettle Run above Sycamore Avenue	WKESYCAM	27.7	0.9	0.0	5.6	44	4
Little Creek at Shawnee Pass (2)	WLISHAWU	63.8	0.0	0.0	6.6	177	3

(1) Period of record (10/29/2001 and 11/07/2001) (2) Period of record (10/22/2001, 10/29/2001, 11/07/2001)

Pinelands Commission-Burlington County Health Department Water-quality Data

Nitrite plus nitrate as nitrogen, ammonia as nitrogen, and total phosphorus as phosphate data collected at 51 Rancocas Creek Basin stream sites were analyzed. All sites were sampled between October, 1983 and May, 1992, with the period of record varying between sites (Table 2.3). Sample collection and laboratory methods are described in Windisch and Zampella (1989), Windisch (1990, 1991), and Dow (1996).

Table 2.3. Pinelands Commission-Burlington County Health Department nutrient-monitoring sites in the Rancocas Creek Basin. Median nitrite plus nitrate as nitrogen, ammonia as nitrogen, and total phosphorus as phosphate concentrations are expressed as mg L^{-1} with the number of samples (N) shown in parentheses. All sites were sampled between October, 1983 and May, 1992, with the period of record varying among sites. Percentage altered land (developed land and upland agriculture) values are from 1986. Nutrient site codes refer to site codes used by Windisch and Zampella (1989), Windisch (1990, 1991), and Dow (1996). The pH/SC site codes refer to 2001 Pinelands Commission pH and specific conductance sampling sites.

Nutrient Site Code	pH/SC Site Code	Stream Station	Period of Record	Median Values: Nitrite+Nitrate	Ammonia	Total P as PO4	% Altered Land (1986)
Greenwwod Branch Study Basin							
B5,6		Bisphams Mill Creek at Route 70	12/1983 - 05/1992	<0.04 (14)	<0.10 (14)	0.03 (14)	1.3
B5,5	GMORTE70	Mount Misery Brook at Route 70	12/1983 - 05/1992	<0.04 (12)	<0.10 (12)	<0.01 (12)	1.8
B5,2		Cranberry Branch at Route 530	12/1983 - 05/1992	<0.04 (13)	0.14 (12)	0.05 (13)	2.0
B5,7	GBIPRESU	Bispham Mill Creek at Presidential Lakes	12/1983 - 10/1990	0.09 (6)	<0.10 (6)	0.02 (6)	2.8
B7,9	GGRIMPNT	Greenwood Branch at New Lisbon Road	10/1983 - 05/1992	0.07 (12)	0.15 (12)	0.04 (12)	5.6
B5,4		Pole Bridge Branch at Route 70	12/1983 - 10/1990	<0.04 (6)	0.21 (6)	0.04 (6)	7.9
B5,1	GPOWISSA	Pole Bridge Branch at Wissahickon Trail	12/1983 - 05/1992	<0.04 (13)	0.12 (13)	0.04 (13)	9.4
North Branch Rancocas Creek Study Basin							
B8,6		North Branch Rancocas Creek at N and S Lakeshore Drive	11/1983 - 08/1990	<0.04 (6)	<0.10 (7)	0.04 (6)	6.2
B7,8	NNORT616	North Branch Rancocas Creek at Route 616	10/1983 - 05/1992	0.09 (13)	0.17 (13)	0.04 (13)	11.1
B7,10	NNONEWLI	North Branch Rancocas Creek at New Lisbon Road	10/1983 - 05/1988	0.08 (7)	0.19 (7)	0.04 (7)	19.4
B8,1		North Branch Rancocas Creek at Route 530	11/1983 - 05/1992	<0.04 (14)	0.11 (14)	0.03 (13)	19.7
B8,5	NJARANGE	Jacks Run at Range Road	11/1983 - 08/1990	0.055 (8)	0.17 (8)	0.04 (7)	28.6
B8,3		Jacks Run at Bayberry Street	02/1984 - 05/1992	0.42 (36)	0.11 (32)	0.02 (36)	31.7
B8,7		North Branch Rancocas Creek at Club House Drive	11/1983 - 08/1990	0.10 (9)	0.16 (9)	0.04 (8)	33.6
B8,2	NONWLAKE	Ong Run at West Lake Shore Drive	11/1983 - 08/1990	0.41 (7)	0.14 (7)	0.03 (5)	37.5
B7,7	NBURT616	Buds Run at Route 616	10/1983 - 05/1988	0.78 (8)	0.59 (8)	0.37 (8)	39.8
South Branch Rancocas Creek Study Basin							
B14,3	SSOBURRS	South Branch Rancocas Creek at Burrs Mill Road	02/1984 - 08/1990	<0.04 (5)	0.12 (5)	0.04 (5)	3.2
B14,10	SSBSOOYS	South Branch Burrs Mill Brook at Sooy Place Road	10/1984 - 08/1990	<0.04 (4)	0.12 (4)	0.05 (4)	5.6
B14,6		Burrs Mill Brook at Burrs Mill Road	02/1985 - 08/1990	0.07 (6)	0.12 (6)	0.05 (6)	6.8
B14,5	SBUSOOYS	Burrs Mill Brook at South Park Road	10/1984 - 05/1992	0.05 (10)	0.11 (10)	0.04 (10)	7.7
B14,2		South Branch Rancocas Creek at Bed Bug Hill Road	02/1984 - 05/1992	0.06 (13)	0.12 (13)	0.12 (12)	12.8
B14,4		Friendship Creek at Route 70	10/1984 - 05/1992	0.28 (11)	<0.10 (11)	0.03 (11)	13.3
B14,1	SFRRETRE	Friendship Creek at Retreat Road	02/1984 - 08/1990	0.17 (7)	0.15 (7)	0.04 (7)	14.9
B4,4		South Branch Rancocas Creek at Route 206	08/1984 - 02/1991	0.08 (10)	0.16 (9)	0.12 (9)	15.1
B4,2		South Branch Rancocas Creek at Mill Street	01/1984 - 02/1991	0.11 (11)	0.25 (11)	0.12 (11)	18.0
B4,6		Jade Run at Route 643	08/1984 - 05/1992	0.32 (14)	0.21 (14)	0.15 (14)	18.9
B14,7	SFRPOWEL	Friendship Creek at Powell Place Road	02/1985 - 08/1990	0.83 (6)	0.15 (6)	<0.01 (5)	26.4
B4,5		Jade Run at Route 206	01/1984 - 02/1991	0.76 (10)	0.28 (10)	0.29 (10)	43.3
B14,8	SBRNEWRD	Bread and Cheese Run at New Road	10/1984 - 05/1992	4.20 (10)	<0.10 (11)	0.02 (10)	54.2
Southwest Branch Rancocas Creek Study Basin							
B11,7		Haynes Creek Trib. at Braddocks Mill Road	01/1984 - 06/1988	0.46 (6)	0.12 (6)	0.02 (6)	4.8
B11,6	WHATRSCO	Haynes Creek Trib. at Scout Drive	01/1984 - 02/1989	<0.04 (8)	0.13 (8)	0.02 (8)	4.8
B10,6	WBLRT544	Black Run at Route 544	07/1984 - 08/1988	<0.04 (5)	0.12 (6)	0.08 (6)	8.1
B11,5	WHATRPON	Haynes Creek Trib. at Pontiac Drive	01/1984 - 02/1989	<0.04 (8)	0.12 (8)	<0.01 (8)	8.8
B10,5	WHATRHOP	Haynes Creek Trib. at Hopewell Road	07/1984 - 08/1988	0.47 (5)	0.12 (5)	0.04 (5)	15.9
B11,3	WHATAUNT	Haynes Creek at Breakneck Avenue	01/1984 - 02/1989	0.26 (8)	0.12 (8)	0.02 (8)	19.1
B11,4		Haynes Creek at Centennial Dam Road	01/1984 - 02/1990	0.38 (9)	<0.10 (9)	0.02 (9)	19.9
B11,2	WHATRBLU	Haynes Creek Trib. at Hopewell Road	01/1984 - 02/1990	0.07 (8)	0.14 (8)	0.03 (8)	23.7
B12,2	WBATUCKE	Barton Run at Tuckerton Road	01/1984 - 10/1987	0.16 (5)	0.12 (6)	0.08 (6)	31.8
B1,3		Haynes Creek Trib. at Beach Trail	01/1984 - 12/1990	<0.04 (11)	0.14 (10)	0.03 (11)	36.8
B12,5	WSORT541	Southwest Branch Rancocas Creek at Rout 541	01/1984 - 11/1990	0.67 (7)	0.41 (8)	0.23 (7)	37.0
B10,4	WKEHOPEW	Kettle Run at Hopewell Road	07/1984 - 08/1988	0.48 (6)	0.16 (6)	<0.01 (6)	37.2
B1,1		Haynes Creek Trib. at Lower Aetna Lake outlet at Stokes Road	01/1984 - 12/1990	0.16 (11)	0.17 (10)	0.02 (11)	39.1
B1,4		Haynes Creek Trib. at Lake Stockwell Inlet at Stokes Road	01/1984 - 06/1990	<0.04 (11)	0.19 (10)	0.02 (11)	41.6
B12,3	WSOHARTF	Southwest Branch Rancocas Creek at Hartford Road	01/1984 - 09/1987	1.07 (5)	0.83 (6)	0.75 (6)	41.6
B10,2		Barton Run Trib. at Kenilworth Road	07/1984 - 08/1988	0.25 (6)	0.16 (6)	0.04 (6)	42.6
B1,8	WHATRBIR	Haynes Creek Trib. at Jackson Road	01/1984 - 12/1990	0.36 (12)	1.01 (11)	0.05 (12)	44.3
B10,7		Barton Run at Route 619	07/1984 - 08/1988	0.16 (6)	0.11 (6)	0.05 (6)	45.7
B1,7		Haynes Creek Trib. at Lake Mishe-Mokwa at Tuckerton Road	08/1984 - 06/1990	0.05 (5)	0.12 (5)	0.03 (5)	51.9
B1,5		Haynes Creek Trib. above Lake Stockwell at Tuckerton Road	08/1984 - 12/1990	0.20 (8)	0.11 (6)	0.02 (8)	61.3
B1,2		Haynes Creek Trib. below Lake Mishe-Mokwa at Lenape Trail	08/1984 - 06/1990	<0.04 (10)	0.15 (9)	0.03 (10)	75.7
B1,6		Haynes Creek Trib. at Lake Mishe-Mokwa at Cheyenne Trail	08/1984 - 06/1990	0.21 (9)	0.14 (8)	0.03 (9)	76.9

Data Analysis

First, second (median), and third quartiles and the 10th and 90th percentiles were calculated for pH, specific conductance, nitrogen species, and phosphorus. Two of the 51 primary monitoring sites were excluded from the analyses. Sharps Run at Route 541 was removed because a large portion of its drainage basin was outside the Pinelands National Reserve. Kettle Run at Camp Kettle Run was removed because it was sampled only once. Using forward stepwise multiple regression, median pH and specific conductance values were related to land use (percentage of developed land, upland agriculture, and wetland agriculture in a basin) and surficial geology (the percentage of a basin where the Cohansey Sand and outcrops of the Kirkwood Formation and Inner Coastal Plain sediments are present). Specific conductance values were log transformed prior to analysis. Spearman rank correlation was used to relate nutrient data to the percentage of altered land (developed land and upland agriculture) in a basin. Regression and correlation analyses were completed using Statistica 5.5 (Statsoft Inc., Tulsa, OK, 1995).

We prepared 1986 and 1995 land-use/land-cover profiles from digital data obtained from the New Jersey Department of Environmental Protection (NJDEP, 1995/97 Land Use/Land Cover Update 2001, Chapter 1). The 1995 data were used in the analysis of pH and specific conductance. The 1986 land-use data were used in the analysis of nutrient data because 1986 was closer to the period when these water-quality data were collected. Profiles of the surficial geology associated with each monitoring site were created using digital data obtained from the NJDEP (Chapter 1).

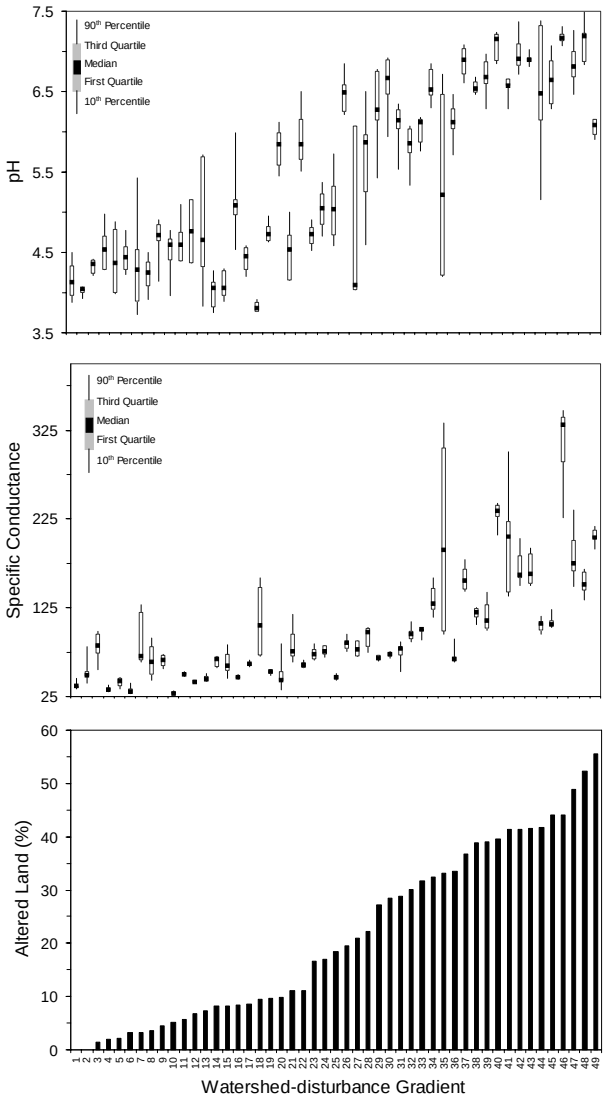

Figure 2.2. Rancocas Creek Basin surface-water-quality gradients. Sites are ordered along the watershed disturbance gradient by increasing altered-land use (developed land and upland agriculture). Refer to Table 2.1 for key to site numbers.

RESULTS

Field Measurements of pH and Specific Conductance

Primary monitoring sites

The drainage basins associated with the primary monitoring sites displayed a wide range of land-use conditions (Table 2.1). The percentage developed land, upland agriculture, and wetland agriculture in these basins ranged from 0% to 57%. Developed land was the dominant altered-land use in most basins. The relationship between stream pH and specific conductance and altered land was similar to that reported in other Commission studies (Zampella 1994, Dow and Zampella 2000, Zampella et al. 2001). Both pH and specific conductance increased as the percentage of altered land in a watershed increased (Figures 2.2 and 2.3).

Results of the multiple regression analyses based solely on land use revealed that developed land and upland agriculture explained 80% and 73% of the variability in pH and specific conductance,

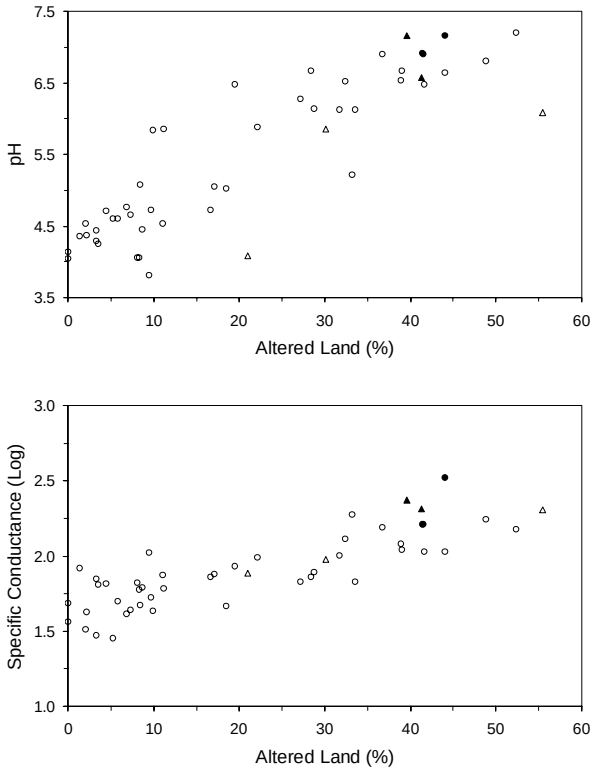

Figure 2.3. The relationship between pH and specific conductance (μS cm^{-1}) and the percentage of altered land (developed land and upland agriculture) in a drainage basin for 49 primary stream monitoring sites in the Rancocas Creek Basin. Triangles depict monitoring sites with >10% upland agriculture in the associated basin. Shaded symbols represent monitoring sites with >10% of the basin falling within the Inner Coastal Plain.

respectively. Developed land explained the greatest portion of the variability in both water-quality variables (Table 2.4). Wetland agriculture was not a significant regressor. Unlike the Mullica River Basin, where upland agriculture is a dominant or a co-dominant altered-land use, upland agriculture is a minor land use in a majority of the drainage basins associated with Rancocas Creek Basin monitoring sites. Thus, the relationship between water quality and altered land in the Rancocas Creek Basin is due largely to variations in the extent of developed land.

Developed land remained the major regressor when both land use and geology were included in the pH and specific conductance models (Table 2.4). In the pH model, agriculture was replaced by the area associated with the Inner Coastal Plain. The percentage of Cohansey Sand and wetland agriculture contributed an additional 5% and 2% of the variability in the specific

Table 2.4. Results of the multiple-regression analyses relating land use to pH (standard units) and specific conductance (μS cm^{-1}) and land use and surficial geology to pH and specific conductance. Specific conductance values were log transformed prior to analyses. All relationships are significant ($p < 0.05$).

Land-use Models

	R-square Values	
	pH	Specific Conductance
Developed Land	0.743	0.448
Upland Agriculture	0.061	0.281
Total	0.804	0.728

Land-use and Surficial-geology Models

	R-square Values	
	pH	Specific Conductance
Developed Land	0.743	0.448
Inner Coastal Plain	0.101	---
Upland Agriculture	---	0.281
Cohansey Sand	---	0.053
Wetland Agriculture	---	0.019
Kirkwood Formation	---	---
Total	0.844	0.800

conductance model based on land use and geology. Although the regression models suggest that surficial geology may influence water-quality, assessing its importance is complicated because basins associated with the Inner Coastal Plain are also characterized by a high percentage of altered land. Overall, the effect of land use appeared to overshadow that of surficial geology.

Median pH in the Rancocas Creek Basin ranged from a minimum of 3.8 to a maximum of 7.2 (Table 2.1, Figure 2.4). With two exceptions, the median pH of the 20 streams draining basins with less than 10% altered lands ranged from 3.8 to 4.8. These minimally disturbed reference-stream sites provide a standard for comparing water quality at other sites. In contrast, the pH of streams in the ten most heavily altered basins ranged from 6.1 to 7.2, with a median value of 6.8. Altered land in these impacted basins ranged from 40% to 56%. Monitoring pH during the growing season of a drought year probably heightened the contrast in pH between reference sites and degraded sites. The pH of Pinelands surface waters is generally higher during

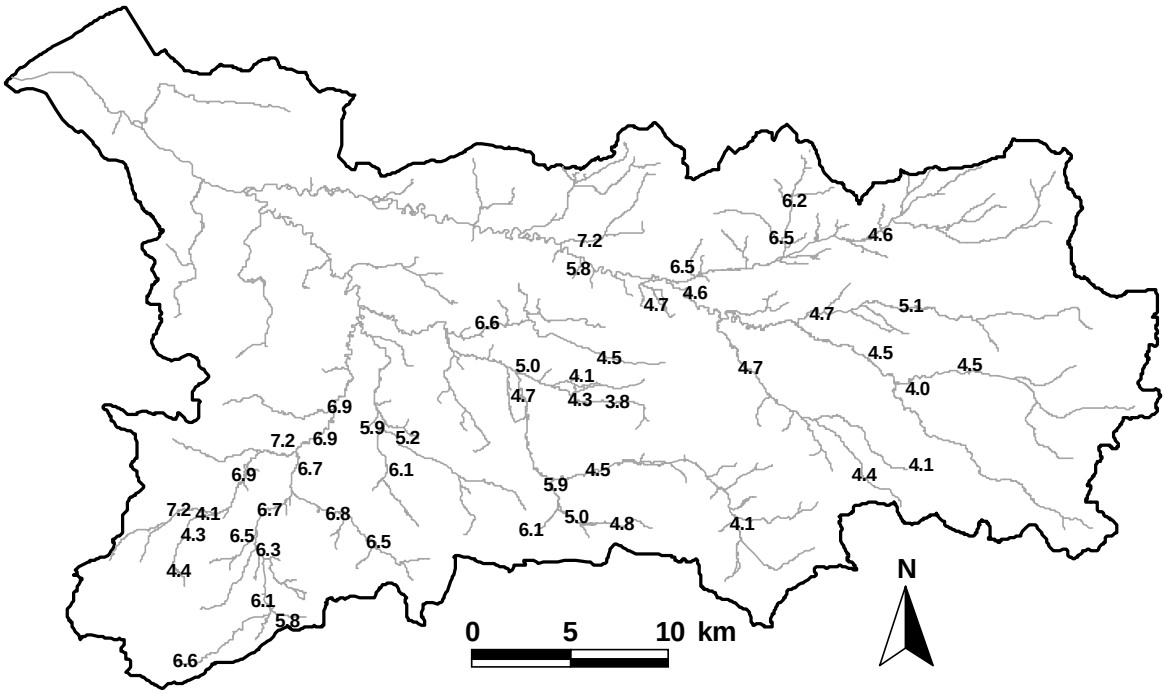

Figure 2.4. Median pH values for 49 primary stream monitoring-sites in the Rancocas Creek Basin.

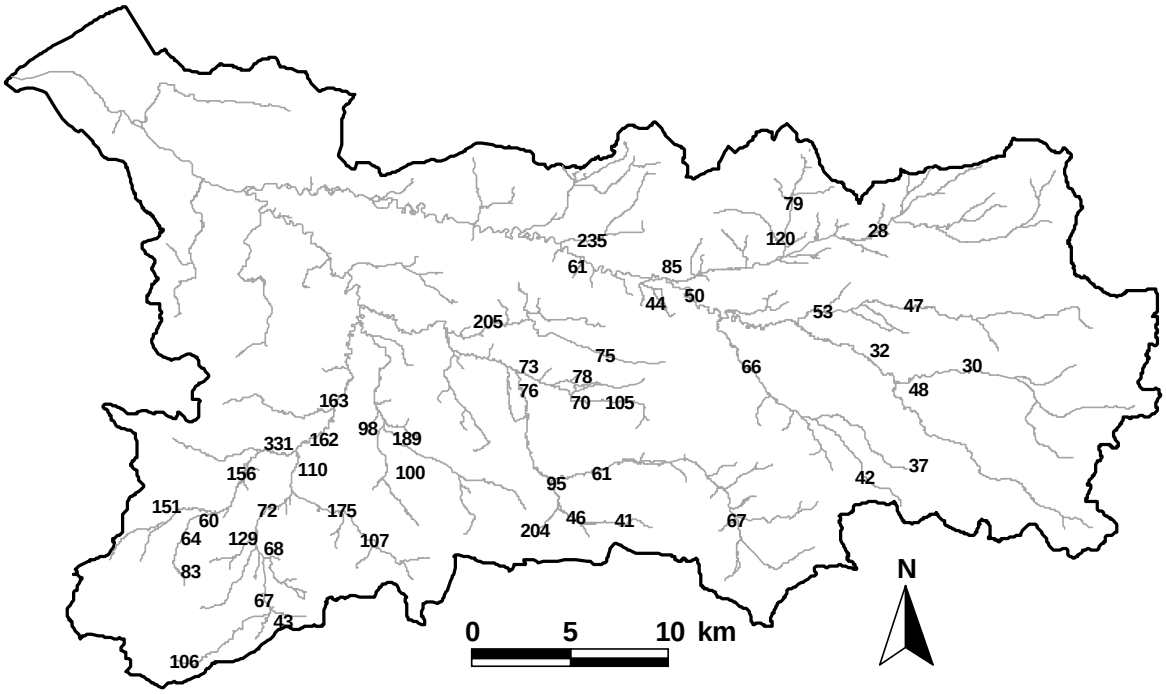

Figure 2.5. Median specific conductance (μS cm^{-1}) values for 49 primary stream-monitoring sites in the Rancocas Creek Basin.

periods of low flow (Zampella 1994, Zampella et al. 2001), and differences in pH between nutrient-poor and nutrient- rich Pinelands waters are more obvious during the growing season (Morgan 1985).

Median specific conductance ranged from a minimum of 28 μS cm^{-1} to a maximum of 331 μS cm^{-1} (Table 2.1, Figure 2.5). With the exception of an extreme value (105 μS cm^{-1}), median specific conductance at the 20 minimally disturbed reference sites ranged from 28 to 83 μS cm^{-1}, with a median of 49 μS cm^{-1}. The extreme value was associated with the most acidic site. The contribution of hydrogen ions to specific conductance increases exponentially in highly acid waters, resulting in a dramatic increase in specific conductance (Figure 2.6, Zampella et al. 2001). Median specific conductance recorded for the ten most heavily altered stream basins with 40% or more altered land cover ranged from 106 to 331 μS cm^{-1}.

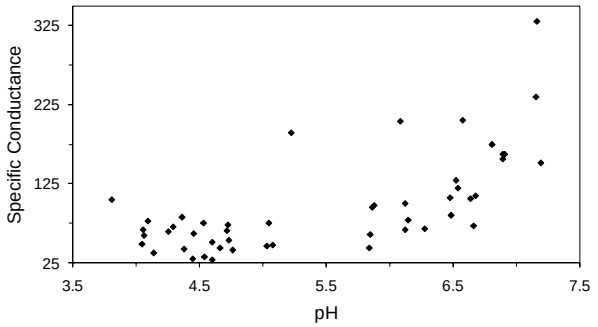

Figure 2.6. The relationship between pH and specific conductance (μS cm^{-1}) for primary stream-monitoring sites in the Rancocas Creek Basin.

Supplemental monitoring sites

The median pH and specific conductance values calculated using data collected on a monthly (June - November) and weekly (October - November) basis were similar for the eight primary monitoring sites included in the supplemental surveys (Table 2.2, Figure 2.7), indicating that the short-term data sets collected for the supplemental sites provided a good relative comparison of conditions at those sites. Furthermore, the relationship between stream pH, specific conductance, and land use revealed using the weekly data followed the same watershed-disturbance pattern as that found using monthly data for the primary monitoring sites (Figure 2.8).

Several additional acid-water stream systems were

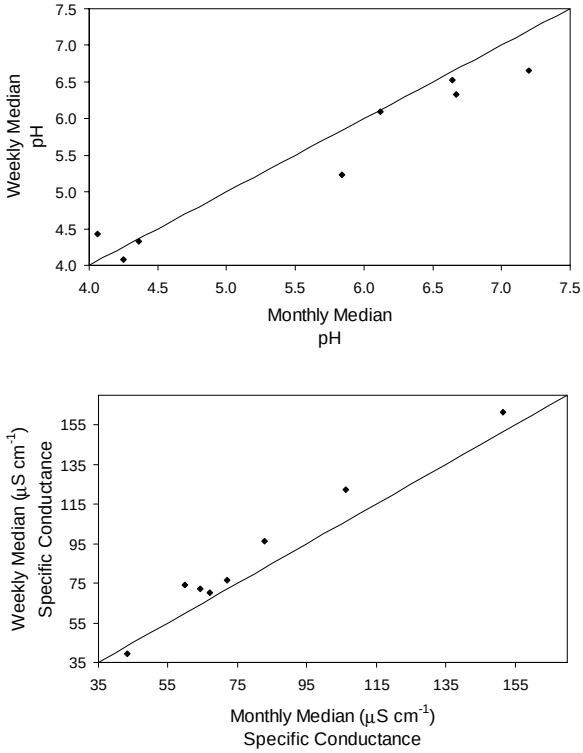

Figure 2.7. A comparison of median pH and specific conductance (μS cm^{-1}) values for 8 primary stream-monitoring sites based on data collected on a monthly (June - November) and weekly (October - November) basis in the Rancocas Creek Basin.

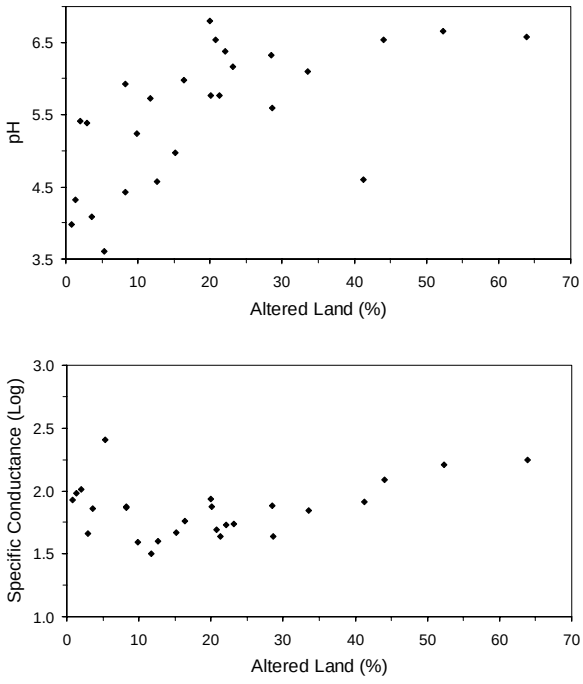

Figure 2.8. The relationship between pH and specific conductance (μS cm^{-1}) and the percentage of altered land (developed land and upland agriculture) in a drainage basin for 26 supplemental stream sites in the Rancocas Creek Basin.

identified from the supplemental data in the western portion of the Rancocas Creek basin. In addition to Black Run, a primary monitoring site, portions of Cedar Run and one tributary of Haynes Creek displayed a typical Pinelands acid-water signature. Median pH and specific conductance in Cedar Run at Oak Ridge Road was 4.6 and 40 μS cm^{-1}, respectively. A median pH of 4.6 and a median specific conductance of 81 μS cm^{-1} was recorded for a Haynes Creek tributary at Hinchman Drive. This tributary flows into Taunton Lake. Median pH and specific conductance values for Taunton Lake were 6.3 and 68 μS cm^{-1}, respectively.

Relationship of pH and Specific Conductance to Changing Land-use Patterns

Comparison of the supplemental data collected at four Mimosa Lake sites to data collected by Morgan (1989) during the summer of 1988 suggests that pH has increased during the intervening 13 years. In 2001, median pH at all four Commission sites was equal to or greater than 6.0, whereas in October 1988, pH did not exceed 4.8. Morgan (1989), who described the Mimosa Lakes area as very typical of undisturbed Pinelands streams, reported that from December 1987 through October 1988, pH measurements at 10 monitoring sites did not exceed 5.0. The apparent increase in pH from 1988 to 2001 may be associated with changes in land use. From 1986 to 1995, developed land in the Mimosa Lakes watershed increased from 8.8% to 23%.

Patrick et al. (1979) summarized water-quality data for 20 lake-monitoring sites in the Rancocas Creek Basin using data collected by the Academy of Natural Sciences in 1973 and the New Jersey Division of Fish and Game in 1951. Lake outflows at or near six of these lakes were monitored by the Commission in 2001 (Table 2.5). A transition from acidic to near-neutral conditions is evident at four of the sites, including Braddocks Millpond, Lake Pine, Squaw Lake (measured by the Commission at the outflow of Lake Stockwell approximately 1.3 km downstream from Squaw Lake), and Taunton Lake. In 1973, median pH at these lakes was below 5.0. In 2001, median pH exceeded 6.0 at each of these lakes. These changes in pH are probably associated with increases in the percentage of developed land. For example, from 1986 to 1995, the average increase in the developed land within the associated drainage basins was 5.2%.

These trends should be viewed with the understanding that they may reflect different sampling methods and sampling season (winter vs. summer). However, they do suggest that changes in pH may have occurred as developed land in the basins increased.

Table 2.5. The pH values collected at 6 lake/pond monitoring sites by Patrick et al. (1979) in 1973 and the New Jersey Pinelands Commission in 2001. See Table 2.1 for site code descriptions.

Lake/Pond	Pinelands Site Code	Patrick et al. (1973)	NJPC (2001)	Percentage Altered Land (1986)	Percentage Altered Land (1995/97)
Birchwood Lake	WHATRBIR	6.3	6.8	44.3	48.8
Braddocks Millpond	WKESAWMI	4.8	6.1	27.2	33.5
Pakim Pond*	GCOPAKIS	4.1	4.4	2.2	2.2
Lake Pine	WHAPINES	4.5	6.7	20.3	28.4
Squaw Lake	WHATRSTO	4.4	6.5	37.3	41.6
Taunton Lake	WHATAUNT	4.3	6.3	19.1	27.2

* Monitored in 1951 by NJ Division of Fish and Game.

Pinelands Commission-Burlington County Health Department Water-quality Data

Nitrite Plus Nitrate as Nitrogen

Nitrite plus nitrate as nitrogen concentrations generally increased as the percentage of altered land in a basin increased (Figure 2.9). Although weak, the relationship between this variable and the total percentage of altered land in a basin was significant ($r = 0.50$, $p < 0.01$).

Nitrite plus nitrate as nitrogen was measured above the detection level of 0.04 mg L^{-1} at least once at all but four of the 51 sites where nutrients were measured. Median values were at or below the detection limit for 15 sites. The highest median concentrations were reported from Bread and Cheese Run at New Road (4.20 mg L^{-1}) and Southwest Branch Rancocas Creek at Hartford Road (1.07 mg L^{-1}) (Table 2.3). More than 40% of the drainage area associated with both sites is composed of altered land. The Hartford Road site is also downstream from a sewage discharge.

Ammonia as Nitrogen

Although ammonia levels increased along the watershed-disturbance gradient (Figure 2.9), the relationship between this nutrient and altered land in a basin was weak ($r = 0.36$, $p < 0.01$). Ammonia was detected above the detection limit of 0.10 mg L^{-1} at

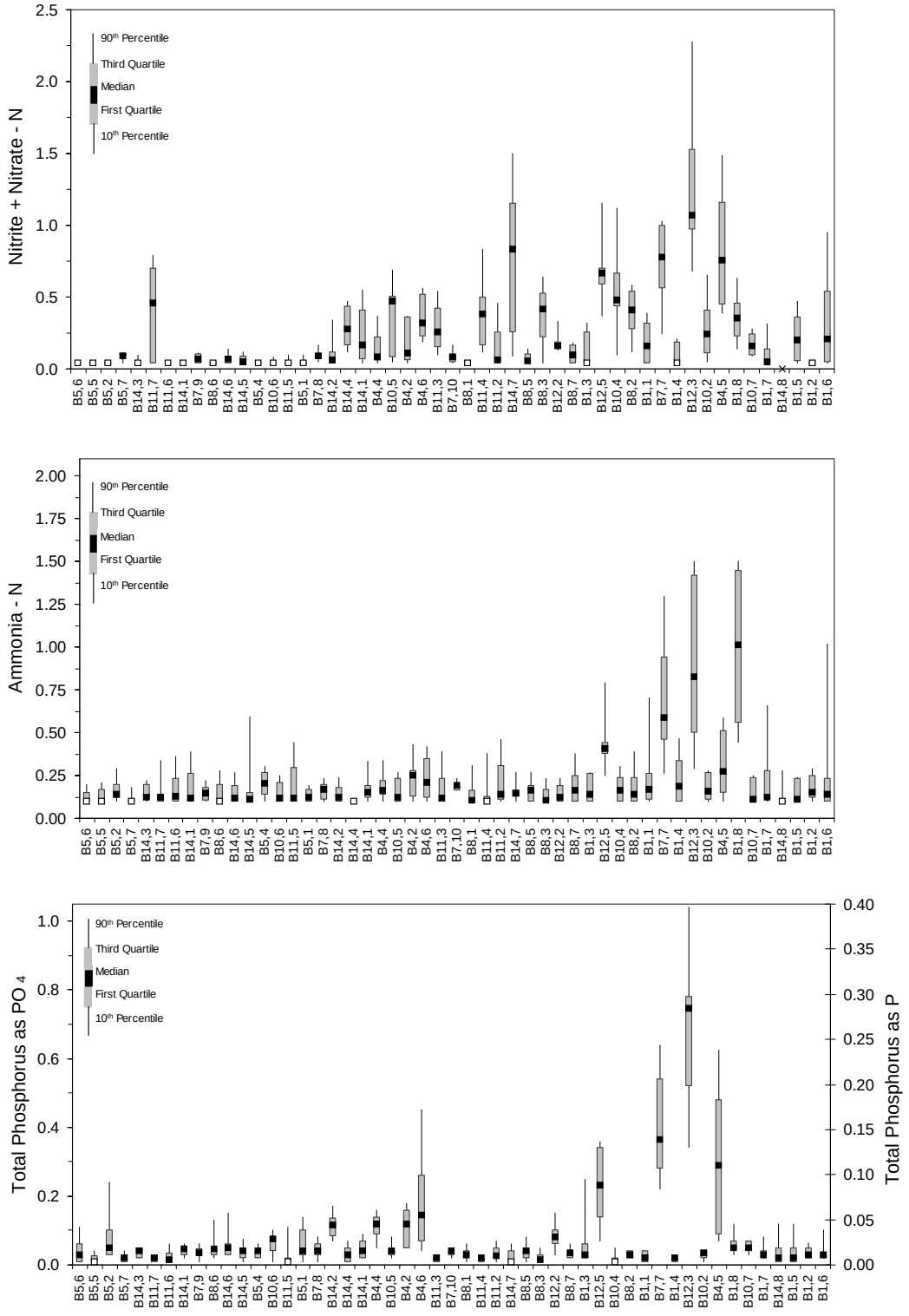

Figure 2.9. Rancocas Creek Basin surface-water-quality gradients. Sites are ordered along the watershed-disturbance gradient by increasing percentage of altered-land cover (developed land and upland agriculture) based on 1986 Land Use/Land Cover data. Water-quality values are medians, quartiles, and 10th and 90th percentiles. Values below detection limit for nitrite + nitrate - N (0.04 mg L^{-1}), ammonia - N (0.10 mg L^{-1}), and total phosphorus as phosphate (0.01 mg L^{-1}) are shown as open squares. A single extreme nitrite + nitrate-N value is not shown. Total phosphorus as phosphorus was calculated from the measured phosphate data. Data were collected between 1983 and 1992. Stream station names and median values are given in Table 2.3.

least once at all 51 sites. Median ammonia levels were at or below detection limit at seven sites. Of these seven sites, three sites were located in basins with greater than 10% altered lands ranging from 13% to 54%. The highest median concentrations were reported from a Haynes Creek tributary at the outflow of Birchwood Lakes (1.01 mg L^{-1}) and the Southwest Branch Rancocas Creek at Hartford Road (0.83 mg L^{-1}) (Table 2.3, Figure 2.9). More than 40% of the drainage area associated with both sites is composed of altered land, and both sites are located downstream from a sewage discharge.

Total Phosphorus as Phosphate

Although elevated total phosphorus as phosphate and total phosphorus as phosphorus (calculated from the phosphate data) concentrations were associated with the more highly altered basins (Figure 2.9), the relationship with land use was not significant ($r = 0.01$, $p = 0.97$).

Phosphate was detected above the detection limit of 0.01 mg L^{-1} at least once at all 51 sites. Median phosphate as phosphate concentrations exceeded the detection limit at all but four sites. The highest median phosphorus values were reported at the Southwest Branch at Hartford Road (0.24 mg L^{-1}) and Budds Run at Route 616 (0.12 mg L^{-1})(Figure 2.9). More than 40% of the drainage area associated with both sites is composed of altered land, and both sites are located downstream from a sewage discharge.

Study-basin Characterizations

Greenwood Branch

Water quality in the Greenwood Branch study basin was characterized by low pH and low specific conductance values typical of unaltered Pinelands drainage basins. At all nine primary monitoring sites (Table 2.1), median pH was less than 5.2 and median specific conductance was below 70 μS cm^{-1} (Figure 2.10). These conditions can be attributed to the fact that six of the nine monitoring sites and the headwaters of this stream system are located within Brendan T. Byrne State Forest. Nutrient levels were low compared to other Rancocas Creek Basin sites (Table 2.3). Nitrite plus nitrate-N concentrations ranged from 0.04 to 0.09 mg L^{-1}. Ammonia and phosphorus as phosphate concentrations ranged from 0.10 to 0.21 mg L^{-1} and 0.01 to 0.05 mg L^{-1}, respectively.

North Branch

Specific conductance and pH were measured at seven monitoring sites in the North Branch Rancocas Creek study basin (Table 2.1). Two sites (North Branch Rancocas Creek at Military Road and a North Branch Rancocas Creek tributary at Magnolia Road) displayed pH and specific conductance values characteristic of undisturbed Pinelands drainage basins, whereas median pH and specific conductance values at the other five sites were elevated (Figure 2.10). The North Branch basin showed a wide range of nutrient levels (Table 2.3). Nitrite plus nitrate-N concentrations ranged from 0.04 to 0.78 mg L^{-1}. Ammonia and phosphorus concentrations ranged from 0.10 to 0.59 mg L^{-1} and 0.02 to 0.37 mg L^{-1}, respectively.

South Branch

The thirteen South Branch Rancocas Creek sites displayed a wider range of water-quality conditions than that observed in the Greenwood Branch and North Branch (Table 2.1, Figure 2.10). The basin was characterized by a number of sites with low pH and slightly elevated specific conductance values. Median pH in the basin ranged from 3.8 at Cedar Run at Burr's Mill Road to 6.6 at Jade Run near Route 616. Specific conductance ranged from 41 μS cm^{-1} at Friendship Creek at Irick's Causeway to 205 μS cm^{-1} at Jade Run near Route 616. Nitrite plus nitrate-N concentrations ranged from 0.04 to 4.20 mg L^{-1} (Table2.3). Ammonia and phosphorus concentrations ranged from 0.10 to 0.28 mg L^{-1} and 0.01 to 0.29 mg L^{-1}, respectively.

Southwest Branch

The majority of the 20 monitoring sites in the Southwest Branch Rancocas Creek were characterized by elevated pH and specific conductance values (Table 2.1, Figure 2.10). Although a portion of a municipal wastewater spray field is located in the Black Run basin, Black Run proved to be the only acid-water system included in the primary monitoring network of the Southwest Branch basin. At the other seventeen primary monitoring sites, median pH and specific

conductance ranged from 5.2 to 7.2 and 43 to 331 μS cm^{-1}, respectively. Nitrite plus nitrate concentrations ranged from 0.04 to 1.07 mg L^{-1} (Table 2.3). Ammonia and phosphorus concentrations ranged from 0.10 to 1.01 mg L^{-1} and 0.01 to 0.75 mg L^{-1}, respectively.

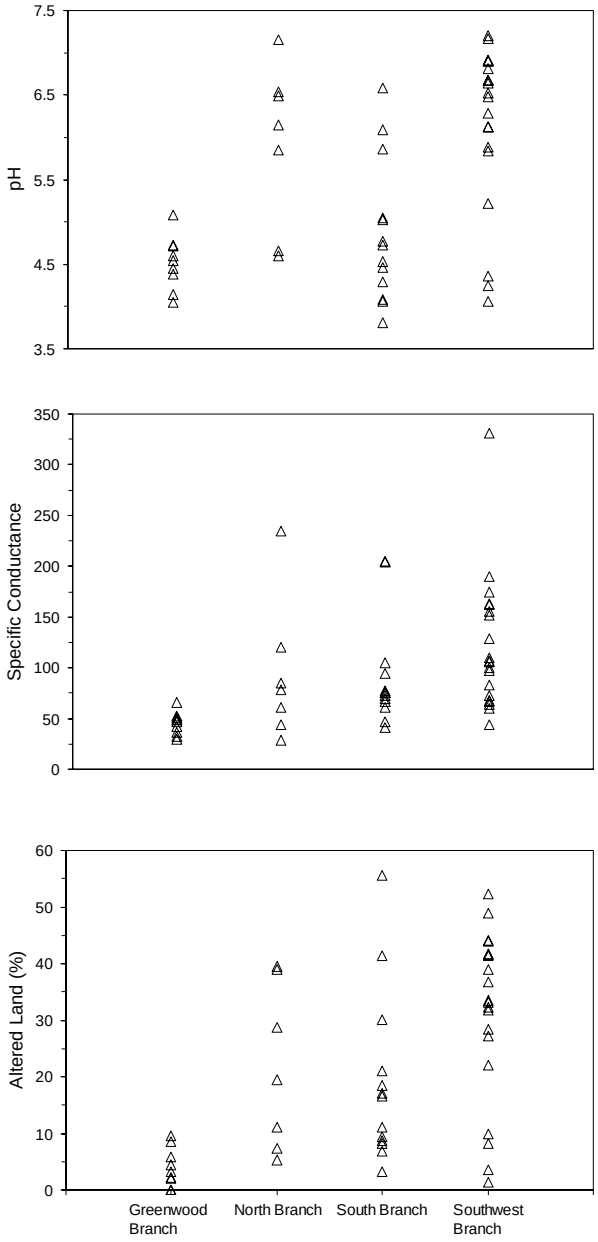

Figure 2.10. Comparison of median pH and specific conductance (μS cm^{-1}) and the percentage of altered land (developed land and upland agriculture) recorded for 49 primary sites in the four study basins of the Rancocas Creek Basin.

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3 STREAM VEGETATION

INTRODUCTION

Commission stream-vegetation studies in the Mullica River Basin evaluated the use of aquatic and wetland plants as indicators of watershed disturbance in Pinelands streams (Zampella and Laidig 1997, Zampella et al. 2001). These studies revealed that plant-species composition was related to a watershed-disturbance gradient characterized primarily by increasing upland-agriculture and developed-land uses and increasing surface-water pH and specific conductance. Plant-species composition in streams associated with heavily farmed and developed watersheds was characterized by a high percentage of plants characteristic of the region to the north and west of the Pine Barrens, referred to by Stone (1911) as the Middle District. Stream sites in more heavily degraded watersheds also supported a higher percentage of a group of 29 Middle District and exotic plants, referred to by Zampella and Laidig (1997) as disturbance-indicator species (Table 3.1). Plants of Stone's (1911) Pine Barrens District dominated the flora of streams in forested watersheds.

In 2001, Commission scientists surveyed aquatic and wetland vegetation at stream sites in the Pinelands portion of the Rancocas Creek Basin. These surveys and the evaluation methods developed in the Mullica River Basin study were then used to assess the status of stream vegetation in the Rancocas Creek Basin. The results of this assessment are presented in this chapter.

METHODS

Study Sites

Forty-five Rancocas Creek Basin stream sites were surveyed as part of the stream-vegetation monitoring program. Many of the survey sites were New Jersey Department of Environmental Protection Ambient Biomonitoring Network stations. Criteria used to select additional survey stations were drainage-area land-use characteristics, accessibility, and suitability as plant-survey sites. Most sites consisted of a 20-m length of stream divided into two 10-m sections located upstream and downstream of a bridge or road crossing. Several sites consisted of a single 20-m section located downstream of a crossing. The sampling area at each site included the channel and a two-meter wide belt transect along each bank. The location of each sampling station was registered with a global positioning system (GPS).

Characterizing Stream Conditions

Several drainage-basin and local-habitat attributes were characterized at each stream site. The variables included pH, specific conductance, land use (upland agriculture, wetland agriculture, and developed land), and geographic position. Upstream land-use profiles were prepared using ArcView software and 1995/1997 land-use data (Chapter 1). Specific conductance was measured with an Orion model 122 meter and pH was measured with an Orion model 250A meter (Chapter 2). Geographic position was determined using the GPS data.

Plant-species Surveys

Except for the use of a shorter sampling reach, plant-survey methods were similar to those used by Zampella and Laidig (1997) and Zampella et al. (2001). At each site, channel and bank plants were surveyed on a single occasion during each of two time periods (July-August and September-October) in 2001. Following Stone (1911), all plants were classified as either Pine Barrens District species, Middle District species, or species found in both the Pine Barrens District and the Middle District. Southern New Jersey plants not included in Stone's biogeographic lists, but described in his individual species accounts as uncharacteristic of the Pine Barrens District, were assigned to the Middle District category. Using Gleason and Cronquist (1991), species that are not native to North America were classified as exotic. Both Middle District and exotic species represent non-Pinelands species.

The complete plant-survey data set and distribution maps for species that were found at two or more sites are presented in Appendix 2. Taxonomic nomenclature follows Gleason and Cronquist (1991). Both scientific and common names are given in Appendix 2. The appendix also describes the location of each site, including latitude and longitude coordinates. The Commission maintains a herbarium collection that includes voucher specimens for many of the plant species encountered during the Rancocas Creek Basin stream surveys.

Table 3.1. Disturbance-indicator species at Mullica River Basin stream sites (Zampella and Laidig 1997).

Scientific name	Common name
Asclepias incarnata	swamp milkweed
Bidens connata	purple-stemmed beggar ticks
Bidens frondosa	beggar ticks
Boehmeria cylindrica	false nettle
Callitriche heterophylla	larger water starwort
Carex lurida	sallow sedge
Cinna arundinacea	wood-reed
Cyperus strigosus	straw-colored cyperus
Dioscorea villosa	common wild yam
Echinochloa muricata	American barnyard grass
Erechtites hieracifolia	pilewort
Eupatorium dubium	eastern joe-pye weed
Galium tinctorium	stiff marsh bedstraw
Impatiens capensis	spotted touch-me-not
Lindernia dubia	short-stalked false pimpernel
Lobelia cardinalis	cardinal flower
Ludwigia palustris	water purslane
Microstegium vimineum	stiltgrass
Mikania scandens	climbing hempweed
Panicum clandestinum	deertongue grass
Polygonum arifolium	halberd-leaved tearthumb
Polygonum hydropiperoides	mild water pepper
Polygonum punctatum	dotted smartweed
Polygonum sagittatum	arrow-leaved tearthumb
Potamogeton epihydrus	Nuttall's pondweed
Potamogeton pusillus	small pondweed
Sambucus canadensis	common elder or elderberry
Thelypteris palustris	marsh fern
Typha latifolia	broad-leaved cattail

Stream-vegetation Gradients

Detrended correspondence analysis (DCA, Hill 1979a, Hill and Gauch 1980) and TWINSPAN (Hill 1979b) were used to ordinate and classify plant species and sampling sites based on presence/absence data. These analyses were completed using PC-ORD, Version 4 (McCune and Mefford 1999).

With DCA, sites are ordered along axes based on species-composition data. TWINSPAN is a classification technique which groups sites based on species composition. The use of both methods in the Commission's monitoring program is more fully described in Zampella et al. (2001). To limit the effect of rare species on the ordinations, only species occurring at two or more sites were included in the analyses. Plant specimens that were identified only to genus were eliminated from the analyses if the genus was represented by known species. Excluding these plants from the analyses had very little effect on the results. Because a number of study sites appeared to be located within or near the boundary of Stone's (1911) Middle District biogeographic region (Figure 3.1), a second ordination that excluded these sites was completed and compared to the initial ordination.

Spearman rank correlation and graphical analysis were used to determine if species composition, represented by the DCA axes, varied in relation to environmental factors. The environmental factors included the percentage of upland agriculture, wetland agriculture, and developed land in a basin, pH, specific conductance, and longitude. Selection of these variables was based on the results of previous Commission stream-vegetation studies (Zampella and Laidig 1997, Zampella et al. 2001). An alpha level of 0.05 was used to identify significant relationships revealed by the correlation analysis.

RESULTS

Plant-species Surveys

A total of 241 vascular plant species, including 164 herbaceous and 77 woody species, were found at the 45 Rancocas Creek Basin stream sites. Total and herbaceous plant-species richness ranged from 11 to 63 and 2 to 49, respectively. The mean (± 1 SD) number of species found at the 45 sites was 30 ± 12. Median species richness was 27. The gradient analysis was limited to 156 species occurring at two or more sites. One site, Sharps Run at Route 541, was excluded from the ordination because the majority of the basin's area was outside the Pinelands National Reserve.

All 29 disturbance-indicator species (Table 3.1) were found during the plant surveys. Three quarters of the survey sites supported one or more disturbance-indicator species (Figure 3.1). Indicator plants that occurred at more than one quarter of the sites were *Microstegium vimineum*, *Panicum clandestinum*, *Impatiens capensis*, *Ludwigia palustris*, *Boehmeria cylindrica*, *Polygonum punctatum*, and *Carex lurida*. The rest of the disturbance indicators occurred at two to eleven study sites.

The number of plant species classified by Stone (1911) as being characteristic of the Pine Barrens District represented only 17% of the total species inventory for the 45 sites. Many species typically associated with Pine Barrens streams (e.g., *Eriocaulon* spp., *Scirpus subterminalis*, *Orontium aquaticum*, *Potamogeton confervoides*, and *Juncus militaris*) were absent or rarely encountered at the 45 sites. Approximately one quarter of the species were wide-ranging plants that are common to

both the Pine Barrens and Middle Districts. Nearly half of the species inventory consisted of plants characteristic of Stone's Middle District.

Eighteen plant species were exotics. One exotic species, *Microstegium vimineum*, occurred at over half of the survey sites and was the second most frequently encountered herbaceous plant species. Two other exotic species, *Lonicera japonica* and *Polygonum cespitosum*, occurred at more than one quarter of the sites. The rest of the exotic species occurred at four or fewer sites. Non-Pinelands species (exotic and Middle District plants combined) comprised the majority of species found at nearly half of the sites (Figure 3.2). Nearly two thirds of the most frequently occurring herbaceous species and nearly one third of the most frequently occurring woody species consisted of non-Pinelands plants (Table 3.2).

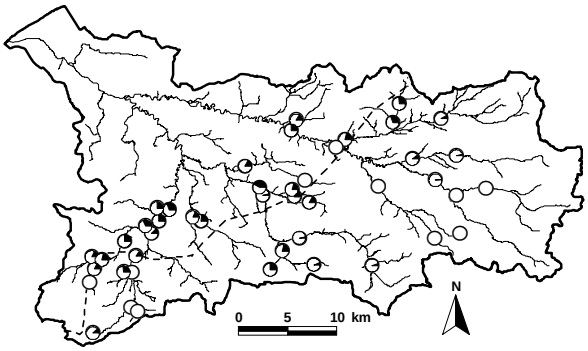

Figure 3.1. Pie charts showing as black the percentage of disturbance-indicator species found at 45 Rancocas Creek Basin stream sites. The dashed line represents the approximate boundary betweeen Stone's (1911) Middle District (to the west) and Pine Barrens District.

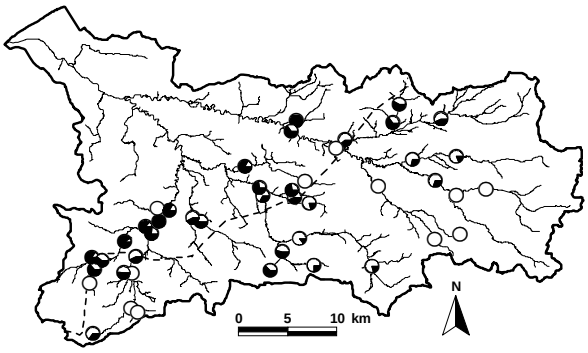

Figure 3.2. Pie charts showing as black the percentage of non-Pinelands plant species found at 45 Rancocas Creek Basin stream sites. The dashed line represents the approximate boundary betweeen Stone's (1911) Middle District (to the west) and Pine Barrens District.

Table 3.2. Biogeography of the most frequently occurring herbaceous and woody species found at 45 stream sites in the Rancocas Creek Basin. Codes refer to Stone's (1911) Pine Barrens District (PB) and Middle District (M). Plants characteristic of both districts are listed as PB & M. Classification of a species as exotic is based on Gleason and Cronquist (1991). Plants are ordered by decreasing number of occurrences within herbaceous and woody species categories. Middle District and exotic species represent non-Pinelands species.

Species	Bio-geography	Number of Occurrences
Herbaceous species:		
Leersia oryzoides	M	30
Microstegium vimineum	Exotic	26
Osmunda cinnamomea	PB & M	22
Juncus effusus	PB & M	21
Panicum clandestinum	M	20
Triadenum virginicum	PB & M	19
Impatiens capensis	M	18
Sparganium americanum	PB	17
Ludwigia palustris	M	16
Peltandra virginica	M	15
Boehmeria cylindrica	M	14
Carex stricta	M	14
Polygonum punctatum	M	14
Apios americana	PB & M	13
Glyceria obtusa	PB & M	13
Lycopus virginicus	M	13
Carex lurida	M	12
Nuphar variegata	PB	12
Onoclea sensibilis	M	12
Polygonum cespitosum	Exotic	12
Pilea pumila	M	11
Polygonum sagittatum	M	11
Scirpus cyperinus	PB & M	11
Woodwardia areolata	PB & M	11
Woody species:		
Acer rubrum	PB	42
Clethra alnifolia	PB & M	37
Smilax rotundifolia	PB & M	29
Vaccinium corymbosum	PB	29
Eubotrys racemosa	PB & M	24
Parthenocissus quinquefolia	M	23
Rhododendron viscosum	PB	22
Liquidambar styraciflua	M	21
Nyssa sylvatica	PB & M	21
Toxicodendron radicans	M	19
Vitis labrusca	M	15
Alnus serrulata	PB & M	14
Lonicera japonica	Exotic	13
Chamaecyparis thyoides	PB	11
Magnolia virginiana	PB & M	11

Stream-vegetation Gradients

All sites

The first DCA axis produced by ordinating all 44 stream sites contrasted sites with a high percentage of Pine Barrens District and wide-ranging species with those sites supporting a high percentage of non-Pinelands (Middle District and exotic) species (Figure 3.3, Table 3.3). Three general trends, representing a decrease in the percentage of Pine Barrens District species, an increase in the percentage of non-Pinelands species, and an increase in the percentage of disturbance-indicator plant species, were evident along this stream-community gradient (Figures 3.4 and 3.5). These trends were related to differences in the range of pH, specific conductance, and the percentage of altered land (upland agriculture and developed land) associated with each plant species (Figure 3.6, Table 3.4).

First-axis stream-site scores produced by the DCA site ordination were associated with increasing pH ($r = 0.66$, $p < 0.001$), specific conductance ($r = 0.70$, $p < 0.001$), and the percentage of developed land ($r = 0.63$, $p < 0.001$) and weakly associated with percentage of upland agriculture ($r = 0.39$, $p < 0.001$) and wetland agriculture ($r = 0.39$, $p < 0.001$) in the basin (Figure 3.7). The first axis was also correlated with geographic position represented by longitude ($r = -0.52$, $p < 0.001$). The ordering of sites along the second DCA axis was not related to plant biogeography or environmental factors.

The TWINSPAN classification revealed patterns similar to those obtained using DCA. The first TWINSPAN division separated a group of 34 sites with a higher percentage of native Pine Barrens District and wide-ranging plants (Pinelands site class) from 10 sites characterized by a lower percentage of native plants and a higher percentage of disturbance-indicator species (non-Pinelands site class) (Figure 3.8). The range of disturbance-indicator species and the percentage of Pine Barrens species at sites included in the Pinelands class suggested that this class included some moderately degraded streams. The Pinelands and non-Pinelands site classes were also distinguished by contrasting pH, specific conductance, and the percentage of altered land (Figure 3.8). All sites in the non-Pinelands site class were located near or within the boundary of the Middle District.

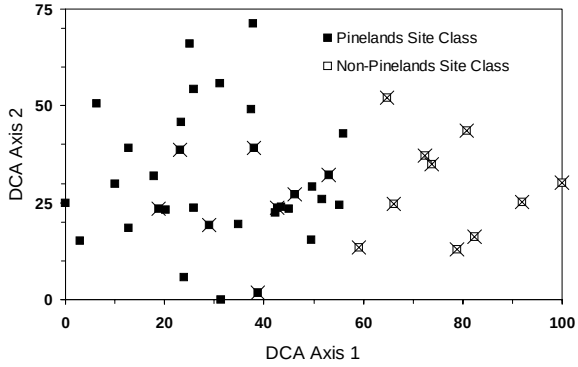

Figure 3.3. DCA ordination diagram and TWINSPAN classification for 44 Rancocas Creek Basin stream sites. Sites that appear to be near or within Stone's (1911) Middle District are denoted by an "X". Refer to Table 3.3 for site names ordered by DCA axis 1 scores.

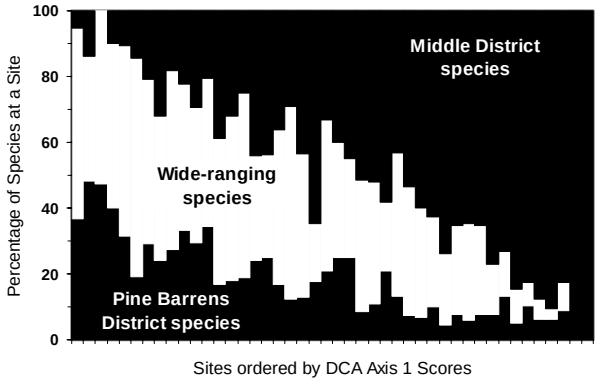

Figure 3.4. Biogeography of plants found at 44 Rancocas Creek Basin stream sites. Wide-ranging species are native to both the Pine Barrens District and the Middle District. Refer to Table 3.3 for site names ordered by DCA axis 1 scores.

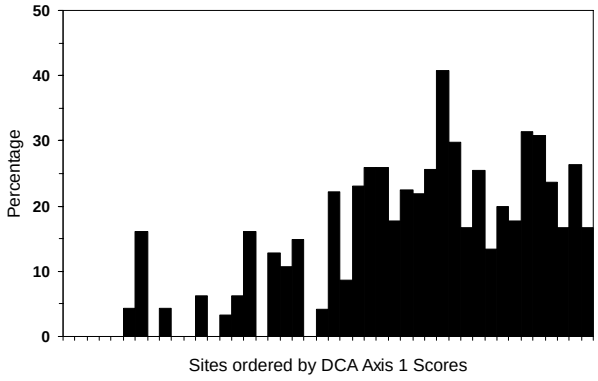

Figure 3.5. Percentage of indicator species at 44 Rancocas Creek Basin stream sites. Refer to Table 3.3 for site names ordered by DCA axis 1 scores.

Table 3.3. Raw DCA axis 1 and axis 2 site scores for 44 stream-vegetation monitoring sites in the Rancocas Creek Basin based on an ordination of species presence/absence data. Sites are ordered by axis 1 scores. Refer to Appendix 2 for additional information on each site

Study Basin	Site Name	Site Code	Axis 1	Axis 2
Greenwood Branch	Middle Branch Mount Misery Brook at Mount Misery-Pasadena Road	GMIMOUNT	0	99
Greenwood Branch	Cooper Branch below Pakim Pond	GCOPAKIS	12	60
Greenwood Branch	McDonalds Branch at Butterworth Road	GMCBUTTE	25	201
Greenwood Branch	North Branch Mount Misery Brook at unnamed sand road	GNOSANDR	40	119
South Branch	Burrs Mill Brook at Sooy Place Road	SBUSOOYS	51	73
Greenwood Branch	Bisphams Mill Creek at Turkey Buzzard Bridge Road	GBITURKE	51	156
South Branch	Cedar Run at Burr's Mill Road	SCEBURRS	71	127
Greenwood Branch	Greenwood Branch at Meadowview Lane	GGRMEADO	75	93
Greenwood Branch	Pole Bridge Branch at Whites Bogs-Pasadena Road	GPOWHITE	80	92
South Branch	Jade Run at Stocktons Bridge Road	SJASTOCK	92	154
Southwest Branch	Cedar Run below Cedar Run Lake	WCEREFUG	93	182
South Branch	South Branch Burrs Mill Brook at Sooy Place Road	SSBSOOYS	95	23
Southwest Branch	Black Run below abandoned cranberry bog	WBLSPRAY	100	263
Greenwood Branch	Mount Misery Brook at Route 70	GMORTE70	103	94
South Branch	Friendship Creek at Irick's Causeway	SFRIRICK	103	216
South Branch	South Branch Rancocas Creek at Burr's Mill Road	SSOBURRS	115	76
Southwest Branch	Kettle Run at Sawmill Road	WKESAWMI	124	222
Southwest Branch	Kettle Run below Hopewell Road	WKEHOPEW	125	0
Greenwood Branch	Pole Bridge Branch at Wissahickon Trail	GPOWISSA	139	77
Southwest Branch	Haynes Creek below Falls Road	WHAPINES	149	195
Southwest Branch	Haynes Creek below Breakneck Avenue	WHATAUNT	150	284
South Branch	Friendship Creek at Retreat Road	SFRRETRE	151	156
North Branch	North Branch Rancocas Creek above New Lisbon-Four Mile Road	NNONEWLI	154	7
North Branch	North Branch Rancocas Creek at Military Road	NNOMILIT	168	89
Southwest Branch	Bear Swamp River at Route 70	WBERTE70	170	94
Southwest Branch	Haynes Creek tributary at Hopewell Road	WHATRBLU	173	95
North Branch	Jacks Run at Range Road	NJARANGE	179	93
Southwest Branch	Little Creek at Route 70	WLIRTE70	184	108
South Branch	Friendship Creek at Powell Place Road	SFRPOWEL	197	61
Southwest Branch	Black Run at Route 544	WBLRT544	198	116
South Branch	Bread and Cheese Run at New Road	SBRNEWRD	206	103
South Branch	South Branch Rancocas Creek at Ridge Road	SSORIDGE	211	128
North Branch	Ong Run at West Lakeshore Drive	NONWLAKE	220	97
Southwest Branch	Black Run tributary at Kettle Run Road	WBLTRKET	223	171
North Branch	North Branch Rancocas Creek at Route 616	NNORT616	235	54
Southwest Branch	Haynes Creek at Route 623	WHART623	258	207
South Branch	South Branch Rancocas Creek tributary at Burr's Mill Road	SSOTRBUR	263	98
Southwest Branch	Barton Run below Jennings Lake	WBAJENNS	288	148
Southwest Branch	Southwest Branch Rancocas Creek at Route 70	WSORTE70	294	139
Southwest Branch	Southwest Branch Rancocas Creek at Hartford Road	WSOHARTF	314	52
Southwest Branch	Barton Run at Tuckerton Road	WBATUCKE	322	174
South Branch	Jade Run near Route 616	SJART616	328	64
Southwest Branch	Southwest Branch Rancocas Creek at Route 541	WSORT541	366	100
North Branch	Budds Run above Route 616	NBURT616	398	120

Table 3.4. Raw DCA axis 1 and axis 2 species scores for 156 plants included in the stream-vegetation analyses based on an ordination of species presence/absence data. Species are ordered by axis 1 scores.

Species	Axis 1	Axis 2	Species	Axis 1	Axis 2	Species	Axis 1	Axis 2
Orontium aquaticum	-189	265	*Scirpus cyperinus*	123	52	*Salix sp.*	277	110
Nymphaea odorata	-173	-9	*Eupatorium dubium*	123	61	*Mikania scandens*	278	-20
Kalmia angustifolia	-158	227	*Apios americana*	124	12	*Bidens polylepis*	284	15
Lachnanthes caroliniana	-153	-39	*Smilax rotundifolia*	126	186	*Rubus sp.*	285	-31
Carex striata	-131	34	*Juncus effusus*	127	-3	*Hypericum mutilum*	290	-5
Carex collinsii	-117	276	*Nuphar variegata*	131	-14	*Polygonum punctatum*	292	140
Vaccinium macrocarpon	-116	-72	*Quercus prinus*	140	258	*Ludwigia palustris*	295	61
Carex bullata	-107	-113	*Lycopus uniflorus*	141	-147	*Prunus serotina*	297	21
Chamaecyparis thyoides	-84	59	*Typha latifolia*	143	-46	*Scutellaria lateriflora*	309	21
Drosera intermedia	-79	-143	*Acer rubrum*	144	174	*Bidens frondosa*	311	170
Osmunda regalis	-78	0	*Potamogeton diversifolius*	150	34	*Toxicodendron radicans*	312	219
Gaylussacia frondosa	-47	241	*Celastrus orbiculatus*	152	31	*Lindernia dubia*	318	119
Lyonia ligustrina	-45	26	*Solidago rugosa*	153	-76	*Myosotis laxa*	322	26
Quercus velutina	-39	110	*Alnus serrulata*	157	17	*Rosa sp.*	323	114
Quercus alba	-38	336	*Betula populifolia*	158	199	*Thelypteris palustris*	326	158
Itea virginica	-31	147	*Leersia oryzoides*	160	100	*Bidens connata*	332	-12
Chamaedaphne calyculata	-26	-94	*Peltandra virginica*	167	17	*Aster racemosus*	336	26
Dulichium arundinaceum	-13	-40	*Dioscorea villosa*	170	-5	*Ailanthus altissima*	336	271
Eubotrys racemosa	2	187	*Ilex opaca*	172	402	*Impatiens capensis*	346	112
Rhododendron viscosum	2	241	*Asclepias incarnata*	177	-98	*Sambucus canadensis*	348	220
Viola lanceolata	8	-121	*Amelanchier canadensis*	178	237	*Polygonum cespitosum*	361	138
Lysimachia terrestris	16	-16	*Chasmanthium laxum*	182	402	*Polygonum cuspidatum*	365	127
Rubus hispidus	19	8	*Ilex verticillata*	186	242	*Lobelia cardinalis*	367	48
Panicum longifolium	22	-86	*Ludwigia alternifolia*	194	-34	*Callitriche heterophylla*	368	9
Vaccinium corymbosum	24	184	*Symplocarpus foetidus*	194	331	*Chelone glabra*	375	-49
Mitchella repens	28	465	*Cyperus strigosus*	198	-13	*Clematis terniflora*	375	-49
Decodon verticillatus	29	-18	*Cephalanthus occidentalis*	199	-21	*Lemna sp.*	376	-23
Panicum verrucosum	37	-33	*Carex lurida*	199	-9	*Fagus grandifolia*	376	306
Woodwardia areolata	43	242	*Eupatorium serotinum*	202	164	*Potamogeton pusillus*	378	30
Hypericum canadense	44	-208	*Berberis thunbergii*	202	382	*Platanus occidentalis*	380	208
Eleocharis acicularis	45	-80	*Sparganium americanum*	207	75	*Lonicera japonica*	381	143
Magnolia virginiana	46	174	*Galium tinctorium*	208	19	*Juglans nigra*	382	173
Panicum virgatum	52	61	*Erechtites hieracifolia*	208	100	*Pilea pumila*	387	42
Pinus rigida	57	-27	*Potamogeton epihydrus*	214	121	*Boehmeria cylindrica*	392	162
Kalmia latifolia	67	355	*Vitis labrusca*	215	277	*Cinna arundinacea*	395	243
Osmunda cinnamomea	68	233	*Polygonum hydropiperoides*	223	215	*Lindera benzoin*	397	288
Lycopodium obscurum	71	473	*Liquidambar styraciflua*	225	280	*Cornus amomum*	408	37
Rhexia virginica	74	-68	*Cyperus dentatus*	227	-105	*Commelina communis*	414	236
Andropogon virginicus var. abbreviatus	85	-214	*Echinochloa muricata*	235	48	*Ambrosia artemisiifolia*	425	3
Phragmites australis	90	3	*Eupatorium perfoliatum*	238	-68	*Saururus cernuus*	425	28
Clethra alnifolia	92	191	*Panicum clandestinum*	239	64	*Arisaema triphyllum*	429	275
Viburnum nudum var. nudum	98	-2	*Cuscuta sp.*	240	-6	*Iris versicolor*	437	56
Quercus phellos	99	0	*Andropogon virginicus var. virginicus*	252	38	*Sanicula canadensis*	437	224
Triadenum virginicum	104	63	*Parthenocissus quinquefolia*	254	128	*Oxalis sp.*	450	160
Aronia arbutifolia	106	18	*Onoclea sensibilis*	257	-4	*Pontederia cordata*	457	-45
Euthamia tenuifolia	108	-105	*Polygonum arifolium*	257	99	*Fraxinus pennsylvanica*	462	89
Glyceria obtusa	112	-4	*Carex crinita*	264	-7	*Carpinus caroliniana*	474	140
Nyssa sylvatica	115	263	*Lycopus virginicus*	266	115	*Thalictrum pubescens*	484	52
Carex stricta	116	262	*Viburnum dentatum*	266	296	*Betula nigra*	506	7
Myriophyllum humile	116	315	*Microstegium vimineum*	269	81	*Acer negundo*	539	26
Aster novi-belgii	122	2	*Polygonum sagittatum*	274	3	*Acer platanoides*	573	95
Juncus canadensis	123	-72	*Apocynum cannabinum*	277	-158	*Acer saccharinum*	573	95

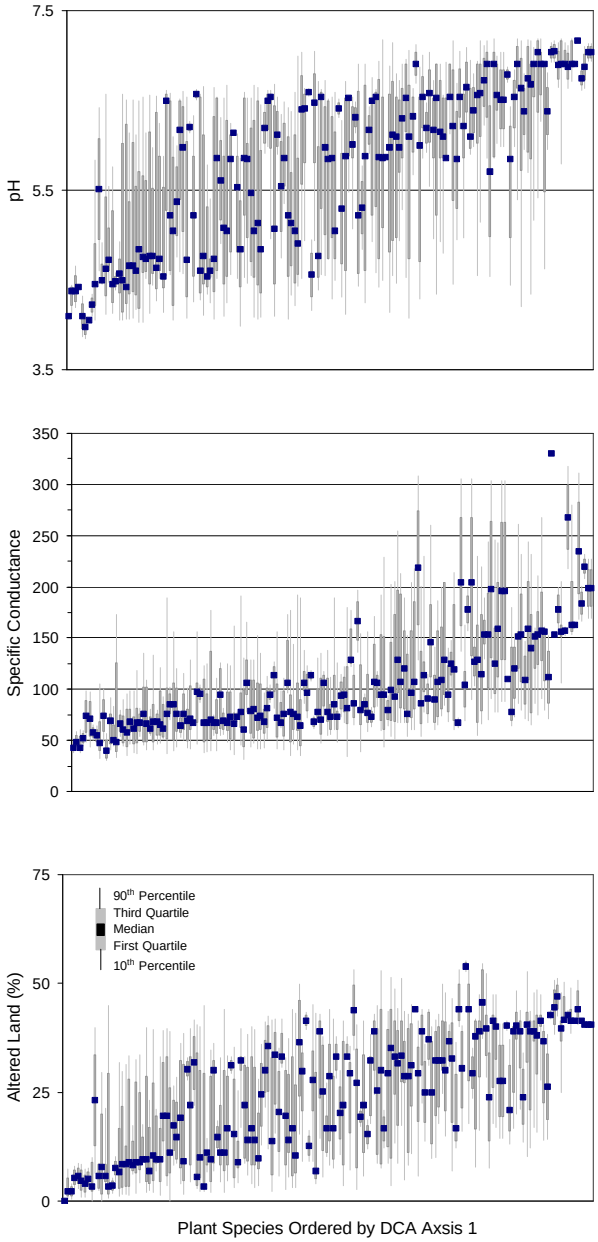

Figure 3.6. The pH, specific conductance (:S cm^{-1}) and percentage of altered land (developed land and upland agriculture) associated with plant species found at 44 stream sites. Refer to Table 3.4 for species names ordered by DCA axis 1 scores.

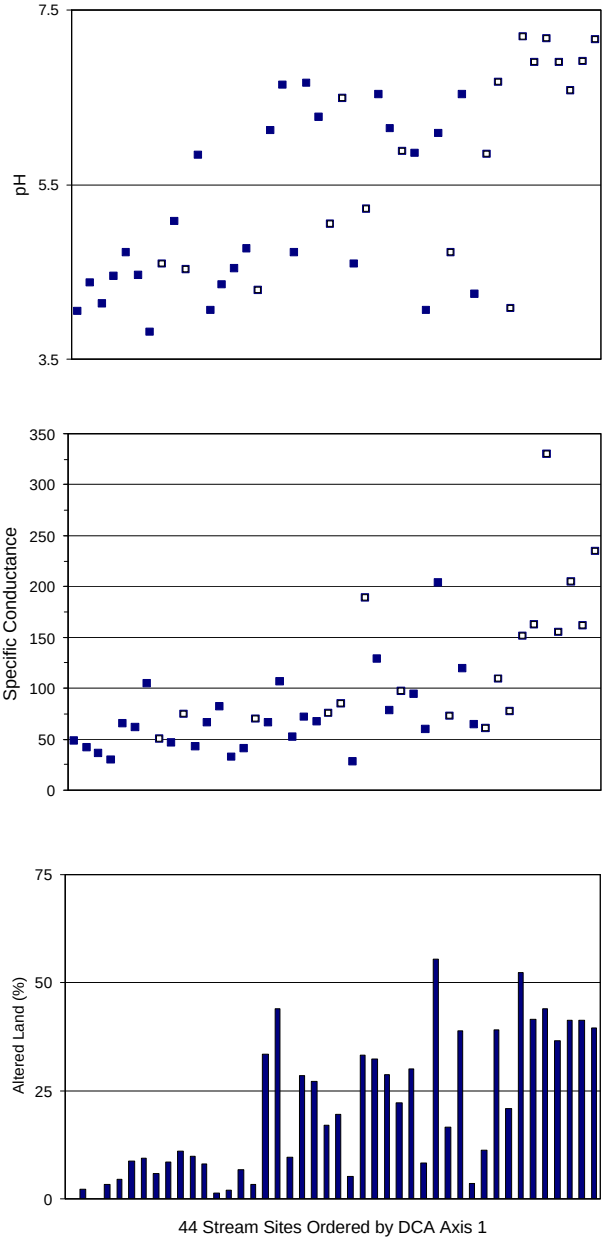

Figure 3.7. The pH, specific conductance (μS cm^{-1}), and percentage of altered land (developed land and upland agriculture) for 44 Rancocas Creek Basin stream sites. Sites that appear to be near or within Stone's (1911) Middle District are represented by an open square. DCA Axis 1 represents a stream-vegetation community gradient. Refer to Table 3.3 for site names ordered by DCA axis 1 scores.

Pine Barrens District sites

Eighteen sites were located near or within the approximate boundary of Stone's (1911) Middle District. Ordination of the remaining 26 sites located within the Pine Barrens District produced results similar to the analysis of all sites. Site scores from both ordinations were highly correlated (first axis r = 0.97, $p < 0.001$; second axis r = 0.95, $p < 0.001$). As with the ordination of all sites, the first axis of the Pine Barrens District plant-species ordination was associated with increasing pH (r = 0.52, $p < 0.01$), specific conductance (r = 0.57, $p < 0.01$), percentage of developed land (r = 0.67, $p < 0.001$), and longitude (r = -0.50, $p < 0.01$). The first axis of the Pine Barrens District ordination was not associated with upland agriculture or wetland agriculture.

Effect of biogeography

Establishing a relationship between land-use disturbance and disturbance-indicator plants in the Rancocas Creek Basin is complicated because, unlike the Mullica River Basin, a significant portion of the Rancocas Creek Basin is located within or near the approximate boundary of Stone's (1911) Middle District. Thus, it may not be possible to satisfactorily determine if a Middle District plant is present due to watershed disturbance or because an area falls within its natural range. The fact remains that Middle District plants are not generally associated with acid waters. As discussed in Chapter 2 (Water Quality), land use is the major factor affecting water quality in the Rancocas Creek Basin.

Study-basin Characterizations

Greenwood Branch

The nine sites in the Greenwood Branch study basin were associated with the end of the stream-vegetation community gradient characterized by forest land and low pH and specific conductance values (Table 3.3, Figure 3.9). Stream sites in the Greenwood Branch generally supported a higher percentage of Pine Barrens District species than streams in other watersheds (Table 3.5). Four sites in this drainage basin, Cooper Branch, McDonalds Branch, North Branch Mount Misery Brook, and Middle Branch Mount Misery Brook, supported the highest percentage of Pine Barrens District species of all study sites in the Rancocas Creek Basin. The percentage of non-Pinelands species, though comprising nearly a third of the flora at three sites, was generally low at streams throughout the study basin. Disturbance-indicator species were absent or low in number at Greenwood Branch stream sites.

North Branch

Except for Budds Run, North Branch study-basin stream sites occupied a transitional position along the stream-vegetation community gradient (Table 3.3, Figure 3.9). Pine Barrens District species were not a prominent component of the six sites in this drainage basin (Table 3.5). Budds Run above Route 616 supported only non-Pinelands species. From two to 17 disturbance-indicator species were found at the North Branch stream sites. *Microstegium vimineum*, an invasive and exotic species, was found at all but one of the sites.

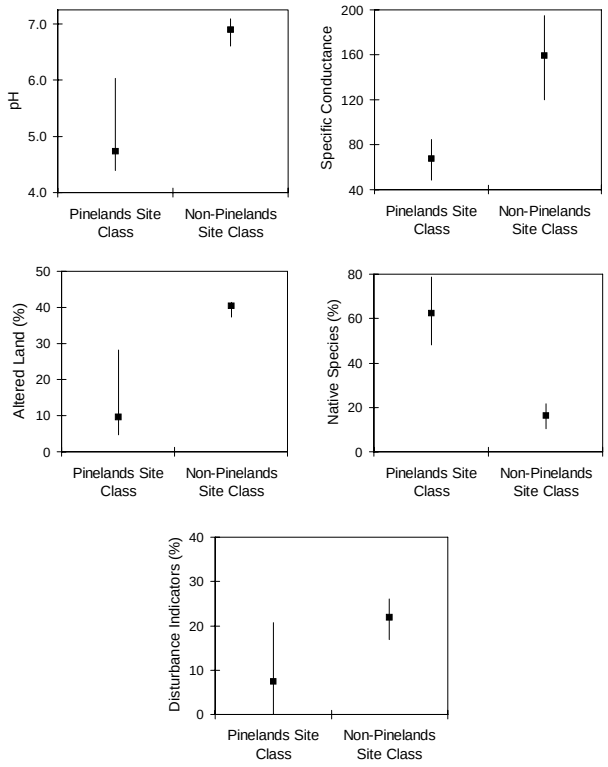

Figure 3.8. Median and 1st and 3rd quartile specific conductance (μS cm^{-1}), pH, percentage of altered land (developed land and upland agriculture), percentage of native species (Pine Barrens District and wide-ranging species), and percentage of disturbance-indicator species values for two TWINSPAN-derived site classes for 44 Rancocas Creek Basin stream sites.

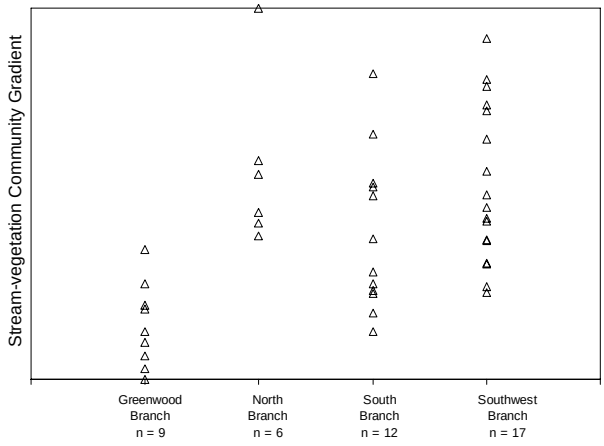

Figure 3.9. Position of stream-vegetation survey sites along the stream-vegetation community gradient, represented by DCA axis 1 site scores, in four Rancocas Creek Basin stream systems. Refer to Table 3.3 for site names ordered by DCA axis 1 scores.

Table 3.5. The percentage of Pine Barrens District, wide-ranging, and non-Pinelands species and number of disturbance-indicator species present at 45 stream sites in the Rancocas Creek Basin. Wide-ranging species are native to both the Pine Barrens District and the Middle District. Non-Pinelands species include plants native to the Middle District and exotic species. Stream-site codes are listed alphabetically by basin. Refer to Table 3.3 for site code explanations.

Study Basin/ Site Code	Pine Barrens District Species	Wide-ranging Species	Non-Pinelands Species	Disturbance-indicator Species
Greenwood Branch:				
GBITURKE	32	58	11	0
GCOPAKIS	48	38	14	0
GGRMEADO	24	44	32	0
GMCBUTTE	47	53	0	0
GMIMOUNT	37	58	5	0
GMORTE70	18	50	32	1
GNOSANDR	40	50	10	0
GPOWHITE	27	55	18	1
GPOWISSA	13	58	29	3
North Branch:				
NBURT616	0	0	100	3
NJARANGE	21	21	58	7
NNOMILIT	25	30	45	2
NNONEWLI	25	35	40	10
NNORT616	8	27	65	16
NONWLAKE	8	27	65	17
South Branch:				
SBRNEWRD	10	28	63	11
SBUSOOYS	19	67	14	1
SCEBURRS	29	50	21	4
SFRIRICK	19	56	25	1
SFRPOWEL	7	39	54	11
SFRRETRE	21	46	33	1
SJART616	9	9	83	5
SJASTOCK	33	44	22	0
SSBSOOYS	34	45	21	2
SSOBURRS	24	32	44	4
SSORIDGE	4	22	74	11
SSOTRBUR	13	13	73	4
Southwest Branch:				
WBAJENNS	5	10	85	8
WBATUCKE	6	3	91	9
WBERTE70	9	40	51	9
WBLRT544	7	33	60	7
WBLSPRAY	17	44	39	0
WBLTRKET	6	29	65	3
WCEREFUG	29	41	29	0
WHAPINES	13	43	43	4
WHART623	8	15	77	2
WHATAUNT	18	18	65	0
WHATRBLU	11	37	52	14
WKEHOPEW	17	47	36	5
WKESAWMI	25	31	44	0
WLIRTE70	13	43	43	6
WSHRT541	0	12	88	11
WSOHARTF	6	6	88	12
WSORT541	0	0	100	10
WSORTE70	10	7	83	11

South Branch

The vegetation composition of South Branch study-basin stream sites, represented by DCA axis 1 scores, was highly variable (Table 3.3, Figure 3.9). Pine Barrens District species represented from 4% to 34% of all species at the 12 sites in this drainage-basin (Table 3.5). The percentage of non-Pinelands species ranged from less than a quarter to over three quarters of the species present at a site. Disturbance-indicator species were either absent or nearly absent at only four sites. The other eight sites supported from two to eleven indicator species. Non-Pinelands plant species represented over eighty percent of the plants present at Jade Run near Route 616. *Microstegium vimineum* was present at nine of the South Branch sites.

Southwest Branch

Although the vegetation composition of the 18 Southwest Branch study-basin stream sites was highly variable, many sites were located toward the end of the community gradient characterized by elevated pH and specific conductance and a higher percentage of developed and upland-agricultural land (Table 3.3, Figure 3.9). Pine Barrens District species comprised up to a quarter or more of all species at only two sites in this basin (Table 3.5). Non-Pinelands species dominated the vegetation of most of the sites and comprised over eighty percent of the species at six of the sites. Disturbance-indicator species were absent at four sites in this basin. From two to 14 indicator species were present at the other 14 sites. Southwest Branch Rancocas Creek at Route 541 supported only non-Pinelands species. The high percentage of non-Pinelands plants at two streams, Black Run at Route 544 and Black Run tributary at Kettle Run Road, belied the low pH and specific conductance values and the high percentage of forest land at these sites.

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4 FISH ASSEMBLAGES

INTRODUCTION

The Commission's Mullica River Basin studies demonstrated the utility of fish as reliable indicators of land-use related watershed disturbance in the Pinelands (Zampella and Bunnell 1998, Zampella et al. 2001). Results from these studies indicated that the presence of peripheral and introduced species was associated with basins characterized by a high percentage of upland agriculture and developed land and surface waters with elevated pH and specific conductance values. Peripheral species are normally distributed outside the Pinelands, and introduced species are not native to New Jersey (Hastings 1984). In contrast to these non-Pinelands fish assemblages, relatively unaltered basins supported native Pinelands fish assemblages. Hastings (1984) categorized the native Pinelands fish species as restricted-characteristic and widespread-characteristic. Restricted-characteristic species are generally limited to the Pinelands, whereas widespread-characteristic species are distributed throughout most of the state.

In 2001, Commission scientists surveyed fish in Rancocas Creek Basin streams. Stream sites were located at road crossings or impoundment outflows, where the water tended to be relatively deep and where pools were more common. Impoundments were also surveyed in the Rancocas Creek Basin. In the Mullica River Basin, the frequency of occurrence and average relative abundance of non-Pinelands fish species was greater for impoundments compared to stream sites (Zampella et al. 2001), suggesting that impoundment-fish assemblages may be a better indicator of water-quality degradation compared to stream assemblages.

METHODS

Study Sites

Forty-three stream sites and 15 impoundments were surveyed in the Rancocas Creek Basin (Tables 4.1 and 4.2). The majority of the stream sites are located at New Jersey Department of Environmental Protection Ambient Biomonitoring Network stations. Other criteria used to select survey sites were drainage-area land-use characteristics, accessibility, and suitability as fish-survey sites. Most stream sites consisted of a 20-m length of stream divided into two 10-m sections located upstream and downstream of a bridge or road crossing. For several survey sites, a single 20-m upstream or downstream section was sampled. The location of each sampling station was registered with a global positioning system (GPS).

Characterizing Stream Conditions

Several site-specific, local, and regional watershed disturbance variables were used to characterize each fish-survey site. The variables included pH, specific conductance, land use, latitude, and longitude. Specific conductance and pH were measured under baseflow conditions at stream sampling sites (Table 4.1, Chapter 2). In-stream measurements taken at the outflow of impoundments were used to characterize the pH and specific conductance of impoundment sites (Table 4.2). Upstream land-use profiles were prepared using ArcView software and New Jersey Department of Environmental Protection 1995/1997 land-use data (Chapter 1).

Fish Surveys

Fish sampling methods were similar to those used in previous Commission studies (Zampella and Bunnell 1998, Zampella et al. 2001). At each stream station, all habitats within the 20-m long stream reach were sampled using a 4-mm mesh nylon seine. Stream sites were sampled for 15 minutes on one occasion between August and October 2001. Impoundments were sampled on a single occasion for a period of one-half hour in October and November. The fish-survey data, which include the number of individuals of each species collected at each site and distribution maps for each species, are presented in Appendix 3. This appendix also describes the location of each sampling site and includes latitude and longitude. Taxonomic nomenclature follows that used in Page and Burr (1991). The Commission maintains a fish collection that includes voucher specimens for each stream site.

The number of individuals collected at a site was used to determine presence/absence and to calculate relative abundance. Relative abundance was calculated as: (number of individuals of a species/total number of individuals) × 100. Some juvenile *Esox* species (*E. niger* or *E. americanus*), *Enneacanthus* species (*E. obesus* or *E. gloriosus*), and *Lepomis* species (*L. gibbosus* or *L. macrochirus*) could not be identified to species and were not included in subsequent data analyses.

Table 4.1. Median pH and specific conductance (μS cm^{-1}) values and the percentage of upland agriculture and developed land in the basin for the 43 Rancocas Creek Basin stream-fish survey sites. Except for GGRMEADO, where water quality (WQ) was measured upstream at GGRIMPNT, fish and water quality sites are the same. Refer to Chapter 2 for details regarding water-quality monitoring.

Site Code	pH	SC	Upland Ag.	Developed
GBITURKE	4.72	65.5	0.1	4.3
GCOPAKIS	4.38	42.2	0.0	2.2
GGRMEADO	4.60	50.2	1.0	4.8
GMCBUTTE	4.14	36.7	0.0	0.0
GMORTE70	4.54	32.3	1.1	1.0
GNOSANDR	4.45	29.9	1.6	1.7
GPOWHITE	5.08	46.9	1.4	7.1
GPOWISSA	4.73	52.8	1.6	8.0
NBURT616	7.16	234.5	25.0	14.6
NJARANGE	6.15	78.5	0.5	28.3
NNOMILIT	4.60	28.4	0.0	5.3
NNONEWLI	6.49	84.9	1.3	18.2
NNORT616	5.85	61.0	1.8	9.3
NNOTRMGU	4.66	43.9	5.7	1.6
NONWLAKE	6.54	119.9	2.3	36.7
SBRNEWRD	6.09	204.0	32.0	23.5
SBUSOOYS	4.46	61.3	4.3	4.4
SFRIRICK	4.77	41.4	4.9	1.9
SFRPOWEL	5.86	94.6	13.1	17.0
SFRRETRE	5.05	75.7	5.8	11.3
SJART616	6.58	205.1	36.7	4.6
SJASTOCK	4.53	75.3	7.6	3.5
SSBSOOYS	4.06	66.8	6.3	1.9
SSORIDGE	4.73	72.7	6.9	9.7
WBAJENNS	7.20	151.4	1.6	50.8
WBATUCKE	6.90	155.8	1.9	34.8
WBERTE70	5.22	189.4	7.5	25.7
WBLRT544	4.06	59.8	1.5	6.8
WBLSPRAY	4.36	82.7	0.0	1.4
WBLTRKET	4.25	64.3	1.9	1.7
WCEREFUG	5.84	43.4	3.5	6.4
WHAPINES	6.67	72.1	0.7	27.7
WHART623	6.68	109.7	0.9	38.1
WHATAUNT	6.28	67.8	0.8	26.4
WHATRBLU	6.53	129.1	0.0	32.3
WKEHOPEW	6.64	106.3	1.5	42.5
WKESAWMI	6.12	66.9	1.5	32.0
WLIHAWKI	6.12	100.3	0.4	31.3
WLIRTE70	5.88	97.6	0.7	21.4
WSHRT541	7.01	325.5	21.4	20.0
WSOHARTF	7.17	330.5	5.4	38.7
WSORT541	6.91	162.3	3.0	38.4
WSORTE70	6.90	162.9	3.4	38.1

Fish-community Gradients

Detrended correspondence analysis (DCA) was used to order fish species and survey sites based on presence/absence data. The same data were used to classify or group species and sites using TWINSPAN. These analysis techniques are described in greater detail in Zampella et al. (2001). Stream sites and impoundments were analyzed separately. Because rare species can have a disproportionate effect on ordinations, only species occurring at two or more sites were included in the gradient analysis. Two sites were not included in the stream ordination. Sharps Run at Route 541 was excluded because most of its drainage area was outside the Pinelands National Reserve. McDonalds Branch at Butterworth Road was excluded because the upstream portion of the survey site lacked a distinct stream channel.

Table 4.2. Median pH and specific conductance (μS cm^{-1}) values and the percentage of upland agriculture and developed land in the basin for the 15 Rancocas Creek Basin impoundment-fish survey sites. The corresponding water-quality (WQ) monitoring-station code is given for each fish-survey site. Except for GMOUCAMP, where water quality was measured downstream at GMORTE70, water quality was sampled at the outflow of the impoundments. A dash indicates that water-quality data were not available for a particular fish site. Refer to Chapter 2 for details regarding water-quality monitoring.

Fish Site Code	WQ Site Code	pH	SC	Upland Ag.	Developed
GBIPRESU	GBIPRESU	5.39	45.7	0.1	2.9
GCOPAKIM	GCOPAKIS	4.38	42.2	0.0	2.2
GCRCOUND	-	-	-	0.8	5.8
GGRIMPNT	GGRIMPNT	4.60	50.2	1.0	4.8
GMOUCAMP	GMORTE70	4.54	32.3	1.1	1.0
GNOMMBOG	-	-	-	1.7	1.9
GPOCOUNU	-	-	-	2.0	8.1
GSONORMA	-	-	-	1.2	0.4
NNOHANOV	NNOMILIT	4.60	28.4	0.0	5.3
SFRCAMPI	SFRCAMPS	5.03	46.4	5.7	12.9
WBAJENNL	WBAJENNS	7.20	151.4	1.6	50.8
WBLABBOG	WBLSPRAY	4.36	82.7	0.0	1.4
WCEDARLK	WCEREFUG	5.84	43.4	3.5	6.4
WHATRSQU	WHATRSTO	6.48	106.8	2.6	43.1
WKEGIRLS	WKEGIRLS	6.21	66.1	1.9	27.7

Spearman rank correlation and graphical analysis were used to determine if the fish-community composition of streams and impoundments, represented by the DCA-ordination axes, varied in relation to watershed conditions. Based on the results of the Commission's initial Mullica River Basin fish studies, the first-axis site scores of the DCA ordinations were correlated with median pH, median specific conductance, latitude, longitude, and the percentage of developed land, upland agriculture, and wetland agriculture in a basin. An alpha level of 0.05 was used to identify important relationships revealed by the correlation analysis.

For streams and impoundments, differences in biogeography and watershed conditions between the TWINSPAN-derived site classes were compared using graphical analysis. Biogeography was represented by

the percentage composition of native and non-Pinelands fish species. Watershed conditions were represented by pH, specific conductance, and the percentage of altered land (developed land and upland agriculture).

RESULTS

Stream-fish Surveys

Twenty-six fish species were collected during the stream surveys, including 13 native Pinelands species, 10 peripheral species, and three introduced species (Table 4.3). Species richness ranged from 1 to 10 species. The mean (± 1 SD) and median number of species collected at the 43 sites was 5.7 ± 2.0 and 6.0, respectively.

Table 4.3. Common and scientific names for 26 fish species collected in Rancocas Creek Basin streams and impoundments. A positive sign (+) indicates that the species was present and a negative sign (-) indicates that a species was not collected during the surveys. Nomenclature follows Page and Burr (1991). Biogeographic classifications are from Hastings (1979, 1984).

Scientific Name	Species Code	Common Name	Streams	Imps.
Native Pinelands Species				
Restricted-characteristic Species				
Acantharchus pomotis	AcanPomo	mud sunfish	+	+
Ameiurus natalis	AmeiNata	yellow bullhead	+	+
Aphredoderus sayanus	AphrSaya	pirate perch	+	+
Enneacanthus chaetodon	EnneChae	blackbanded sunfish	+	+
Enneacanthus obesus	EnneObes	banded sunfish	+	+
Etheostoma fusiforme	EtheFusi	swamp darter	+	+
Widespread-characteristic Species				
Anguilla rostrata	AnguRost	American eel	+	-
Enneacanthus gloriosus	EnneGlor	bluespotted sunfish	+	+
Erimyzon oblongus	ErimOblo	creek chubsucker	+	+
Esox americanus	EsoxAmer	redfin pickerel	+	+
Esox niger	EsoxNige	chain pickerel	+	+
Noturus gyrinus	NotuGyri	tadpole madtom	+	-
Umbra pygmaea	UmbrPygm	eastern mudminnow	+	+
Non-Pinelands Species				
Peripheral Species				
Ameiurus nebulosus	AmeiNebu	brown bullhead	+	+
Ameiurus catus	AmeiCatu	white catfish	+	-
Cyprinella analostana	CyprAnal	satinfin shiner	+	-
Etheostoma olmstedi	EtheOlms	tesselated darter	+	-
Lepomis gibbosus	LepoGibb	pumpkinseed	+	+
Lepomis auritus	LepoAuri	redbreast sunfish	+	+
Notemigonus crysoleucas	NoteCrys	golden shiner	+	+
Notropis procne	NotrProc	swallowtail shiner	+	-
Perca flavescens	PercFlav	yellow perch	+	+
Semotilus corporalis	SemoCorp	fallfish	+	-
Introduced Species				
Lepomis macrochirus	LepoMacr	bluegill	+	+
Micropterus salmoides	MicrSalm	largemouth bass	+	+
Pomoxis nigromaculatus	PomoNigr	black crappie	+	+

Native species were present at all stream sites except for Barton Run at Tuckerton Road (Figure 4.1). The chain pickerel (*E. niger*), eastern mudminnow (*Umbra pygmaea*), and swamp darter (*Etheostoma fusiforme*) were the most frequently encountered native species and occurred at more than 50% of the sites (Figure 4.2). The native tadpole madtom occurred at only 7% of the sites. The most abundant native species were the banded sunfish (*E. obesus*), swamp darter, and eastern mudminnow (Figure 4.3).

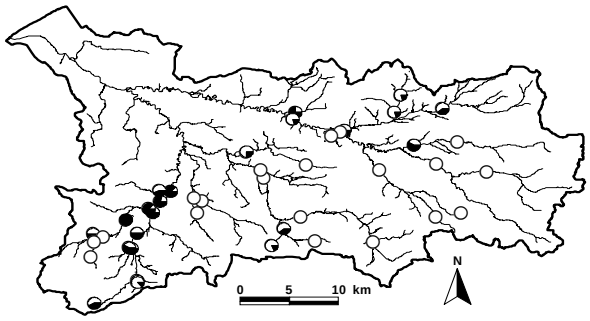

Figure 4.1. Pie charts showing the percentage of native species (white) and nonnative species (black) present at 43 Rancocas Creek Basin stream sites.

Nonnative species were present at 23 stream sites. The two most frequently encountered nonnative species were the largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*). These two introduced species were present at more than 30% of the sites (Figure 4.2). The bluegill was the most abundant nonnative species (Figure 4.3). The fallfish (*Semotilus corporalis*), satinfin shiner (*Cyprinella analostana*), and white catfish (*Ameiurus catus*) were each present at only one site.

Impoundment-fish Surveys

Nineteen fish species were collected from the 15 impoundments, including 11 native Pinelands species, five peripheral species, and three introduced species (Table 4.3). Species richness ranged from 1 to 12 species. Similar to the stream sites, the mean (± 1 SD) and median number of species collected at the 15 impoundments was 5.7 (± 3.0) and 6.0, respectively.

Native species were present in all 15 impoundments. The swamp darter, chain pickerel, banded sunfish, and blackbanded sunfish (*Enneacanthus chaetodon*) occurred at more than 50% of the sites (Figure 4.4). The banded and blackbanded sunfish were the most abundant species in the impoundment assemblages (Figures 4.5). The American eel (*Anguilla rostrata*) and tadpole madtom were the only native species not collected from impoundments.

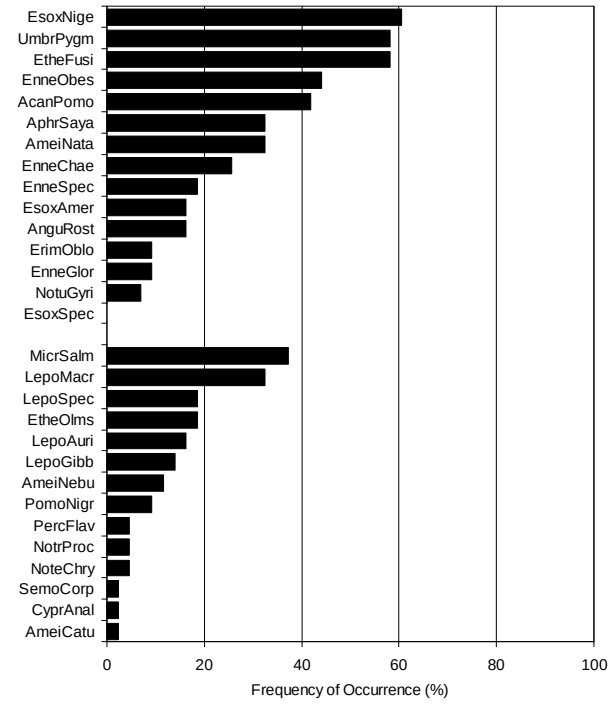

Figure 4.2. Frequency of occurrence of fish species at 43 Rancocas Creek Basin stream sites. Refer to Table 4.3 for key to fish names.

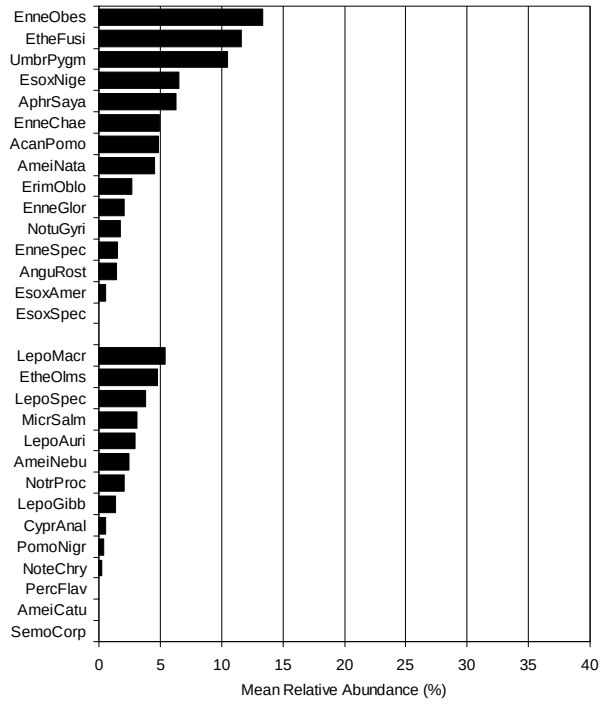

Figure 4.3. Mean relative abundance of fish species at 43 Rancocas Creek Basin stream sites. Refer to Table 4.3 for key to fish names.

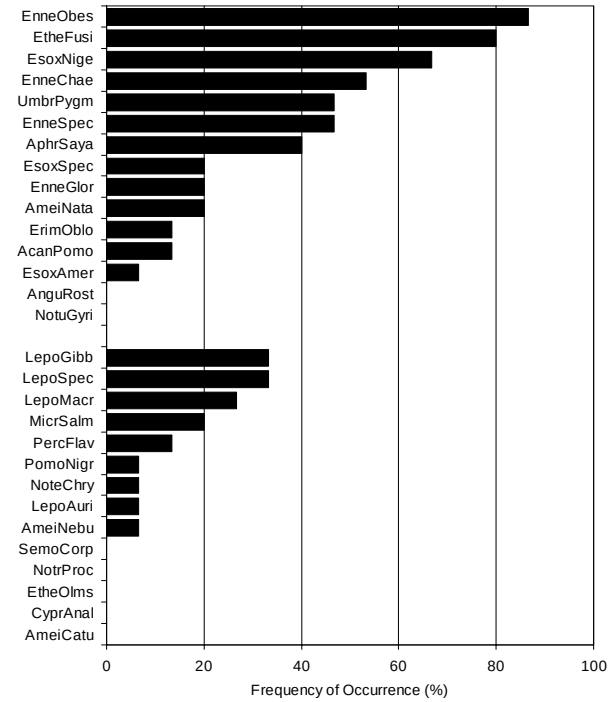

Figure 4.4. Frequency of occurrence of fish species at 15 Rancocas Creek Basin impoundments. Refer to Table 4.3 for key to fish names.

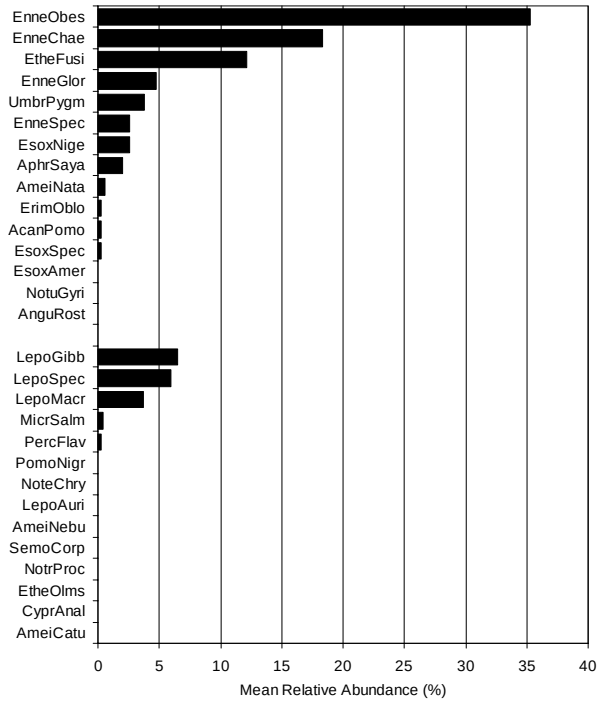

Figure 4.5. Mean relative abundance of fish species at 15 Rancocas Creek Basin impoundments. Refer to Table 4.3 for key to fish names.

Nonnative species were present at six impoundments (Figure 4.6). The bluegill and pumpkinseed (*Lepomis gibbosus*) were the most frequently encountered and abundant nonnative species (Figures 4.4 and 4.5). Although present at some stream sites, the tessellated darter (*Etheostoma olmstedi*), fallfish, swallowtail shiner (*Notropis procne*), satinfin shiner, and white catfish were absent from all 15 impoundments (Table 4.3).

Stream-fish Community Gradient

The first DCA axis of the site ordination contrasted stream sites with fish assemblages composed entirely of native species with those supporting a high percentage of nonnative species (Tables 4.4 and 4.5, Figure 4.7). The percentage of native species decreased and the percentage of nonnative species increased along this community gradient (Figure 4.8). Restricted-characteristic species were absent from the seven sites at the disturbed end of the community gradient. These trends were associated with differences in the range of pH, specific conductance, and altered land values where the native and nonnative species were found (Figure 4.9).

The order of stream sites along the first DCA axis was associated with increasing pH (r = 0.87), specific conductance (r = 0.63), and the percentage of developed land (r = 0.74) in a basin (Figure 4.10). The p level for these three relationships was < 0.001. Neither the percentage of upland agriculture, wetland agriculture, latitude, or longitude were associated with this stream-community gradient.

The Inner Coastal Plain represented between 18% and 52% of the drainage-basin area of five stream sites (Budds Run at Route 616, Jade Run at Route 616, and the Southwest Branch Rancocas Creek at Hartford Road, Route 541, and Route 70). The removal of these five sites from the ordination did not substantially affect the relationship between species composition and pH (r = 0.82, p < 0.001), specific conductance (r = 0.51, p < 0.002), and developed land (r = 0.76, p < 0.001).

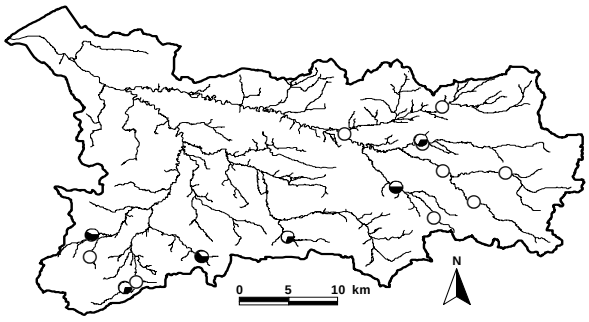

Figure 4.6. Pie charts showing the percentage of native species (white) and nonnative species (black) present at 15 Rancocas Creek Basin impoundment sites.

Table 4.4. Raw DCA axis 1 and axis 2 species scores for 23 stream-fish species and 14 impoundment-fish species in the Rancocas Creek Basin. Species are ordered by axis 1 scores. Refer to Table 4.3 for key to fish names.

Stream Fish				Impoundment Fish			
Species	Species Code	Axis 1	Axis 2	Species	Species Code	Axis 1	Axis 2
Esox americanus	EsoxAmer	-107	87	*Ameiurus natalis*	AmeiNata	-91	170
Enneacanthus obesus	EnneObes	2	218	*Acantharchus pomotis*	AcanPomo	-91	72
Acantharcus pomotis	AcanPomo	8	66	*Enneacanthus obesus*	EnneObes	0	74
Umbra pygmaea	UmbrPygm	97	41	*Umbra pygmaea*	UmbrPygm	57	6
Perca flavescens	PercFlav	129	449	*Aphredoderus sayanus*	AphrSaya	77	178
Ameiurus natalis	AmeiNata	129	69	*Enneacanthus chaetodon*	EnneChae	86	180
Etheostoma fusiforme	EtheFusi	132	217	*Etheostoma fusiforme*	EtheFusi	158	114
Enneacanthus chaetodon	EnneChae	133	279	*Esox niger*	EsoxNige	170	-39
Ameiurus nebulosus	AmeiNebu	143	277	*Enneacanthus gloriosus*	EnneGlor	193	278
Aphredoderus sayanus	AphrSaya	148	-52	*Perca flavescens*	PercFlav	263	-189
Esox niger	EsoxNige	233	109	*Lepomis gibbosus*	LepoGibb	274	-98
Enneacanthus gloriosus	EnneGlor	236	8	*Erimyzon oblongus*	ErimOblo	295	318
Lepomis gibbosus	LepoGibb	266	163	*Lepomis macrochirus*	LepoMacr	299	84
Erimyzon oblongus	ErimOblo	278	-188	*Micropterus salmoides*	MicrSalm	320	122
Micropterus salmoides	MicrSalm	302	204				
Lepomis macrochirus	LepoMacr	312	278				
Anguilla rostrata	AnguRost	328	-21				
Notemigonus chrysoleucas	NoteChry	368	-64				
Noturus gyrinus	NotuGyri	394	27				
Pomoxis nigromaculatus	PomoNigr	437	278				
Etheostoma olmstedi	EtheOlms	463	64				
Notropis procne	NotrProc	474	211				
Lepomis auritus	LepoAuri	489	97				

Table 4.5. Raw DCA axis 1 and axis 2 site scores for 41 stream sites in the Rancocas Creek Basin based on an ordination of species presence/absence data. Sites are ordered by axis 1 scores. Refer to Appendix 3 for additional information on each site.

Study Basin	Site Name	Site Code	Axis 1	Axis 2
North Branch	North Branch Rancocas Creek tributary above Magnolia Road	NNOTRMGU	0	103
Southwest Branch	Black Run below abandoned cranberry bog	WBLSPRAY	8	110
Southwest Branch	Black Run at Route 544	WBLRT544	60	135
Greenwood Branch	Cooper Branch below Pakim Pond	GCOPAKIS	61	123
Southwest Branch	Black Run tributary at Kettle Run Road	WBLTRKET	61	123
South Branch	Jade Run at Stocktons Bridge Road	SJASTOCK	63	78
Greenwood Branch	Pole Bridge Branch at Whites Bogs-Pasadena Road	GPOWHITE	67	218
Southwest Branch	Bear Swamp River at Route 70	WBERTE70	76	50
Greenwood Branch	North Branch Mount Misery Brook at unnamed sand road	GNOSANDR	86	93
Greenwood Branch	Greenwood Branch at Meadowview Lane	GGRMEADO	93	120
Southwest Branch	Cedar Run below Cedar Run Lake	WCEREFUG	106	142
South Branch	Burrs Mill Brook at Sooy Place Road	SBUSOOYS	108	125
South Branch	Friendship Creek at Irick's Causeway	SFRIRICK	111	123
Southwest Branch	Little Creek at Route 70	WLIRTE70	116	98
South Branch	South Branch Burrs Mill Brook at Sooy Place Road	SSBSOOYS	120	173
Greenwood Branch	Pole Bridge Branch at Wissahickon Trail	GPOWISSA	123	255
South Branch	South Branch Rancocas Creek at Ridge Road	SSORIDGE	128	60
North Branch	North Branch Rancocas Creek at Route 616	NNORT616	131	136
Southwest Branch	Little Creek at Hawkin Road	WLIHAWKI	145	8
South Branch	Bread and Cheese Run at New Road	SBRNEWRD	150	65
North Branch	North Branch Rancocas Creek at Military Road	NNOMILIT	157	258
South Branch	Friendship Creek at Powell Place Road	SFRPOWEL	161	192
Greenwood Branch	Bisphams Mill Creek at Turkey Buzzard Bridge Road	GBITURKE	166	202
Greenwood Branch	Mount Misery Brook at Route 70	GMORTE70	182	163
North Branch	North Branch Rancocas Creek above New Lisbon-Four Mile Road	NNONEWLI	184	149
South Branch	Friendship Creek at Retreat Road	SFRRETRE	184	31
Southwest Branch	Kettle Run below Hopewell Road	WKEHOPEW	186	154
Southwest Branch	Kettle Run at Sawmill Road	WKESAWMI	191	171
Southwest Branch	Haynes Creek below Breakneck Avenue	WHATAUNT	193	166
North Branch	Ong Run at West Lake Shore Drive	NONWLAKE	200	116
North Branch	Jack's Run at Range Road	NJARANGE	200	97
Southwest Branch	Haynes Creek tributary near Route 619 and Hopewell Roads	WHATRBLU	232	162
South Branch	Jade Run near Route 616	SJART616	268	12
Southwest Branch	Haynes Creek below Falls Road	WHAPINES	291	178
Southwest Branch	Southwest Branch Rancocas Creek at Hartford Road	WSOHARTF	361	115
Southwest Branch	Southwest Branch Rancocas Creek at Route 541	WSORT541	371	135
Southwest Branch	Haynes Creek at Route 623	WHART623	376	151
Southwest Branch	Barton Run at Tuckerton Road	WBATUCKE	378	181
Southwest Branch	Southwest Branch Rancocas Creek at Route 70	WSORTE70	387	177
Southwest Branch	Barton Run below Jennings Lake	WBAJENNS	406	0
North Branch	Budds Run above Route 616	NBURT616	426	47

Table 4.6. Raw DCA axis 1 and axis 2 site scores for 15 impoundments in the Rancocas Creek Basin based on an ordination of species presence/absence data. Sites are ordered by axis 1 scores. Refer to Appendix 3 for additional information on each site.

Study Basin	Site	Site Code	Axis 1	Axis2
Southwest Branch	Black Run Bog	WBLABBOG	0	74
Southwest Branch	Cedar Run Lake	WCEDARLK	0	74
Greenwood Branch	Country Lake south - above Choctaw Road	GPOCOUNU	28	113
Greenwood Branch	Greenwood Branch impoundment above New Lisbon-Four Mile Road	GGRIMPNT	69	143
Greenwood Branch	Pakim Pond	GCOPAKIM	76	14
Greenwood Branch	Mount Misery Brook impoundment at Mount Misery	GMOUCAMP	91	85
Greenwood Branch	South Branch Mount Misery Brook impoundment at sand road	GSONORMA	91	85
Greenwood Branch	North Branch Mount Misery Brook impoundment at dike	GNOMMBOG	110	50
Greenwood Branch	Country Lake north - below Choctaw Road	GCRCOUND	117	36
Southwest Branch	Kettle Run at camp Kettle Run	WKEGIRLS	125	89
North Branch	Hanover Lake	NNOHANOV	146	193
South Branch	Friendship Creek impoundment at Camp Inawendiwin	SFRCAMPI	151	13
Greenwood Branch	Presidential Lakes - upper	GBIPRESU	165	52
Southwest Branch	Squaw Lake	WHATRSQU	220	0
Southwest Branch	Jennings Lake	WBAJENNL	223	120

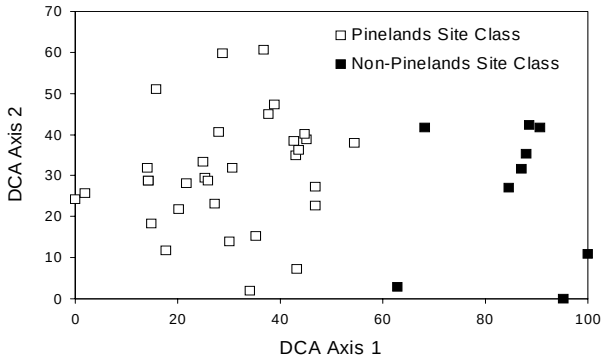

Figure 4.7. DCA ordination diagram and TWINSPAN classification for 41 Rancocas Creek Basin stream-fish sites. Refer to Table 4.5 for site names ordered by DCA axis 1 scores.

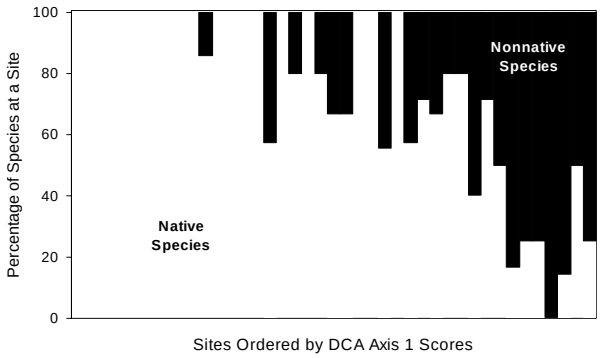

Figure 4.8. Percentage of native and nonnative fish species found at 41 Rancocas Creek Basin streams. Refer to Table 4.5 for site names ordered by DCA axis 1 scores.

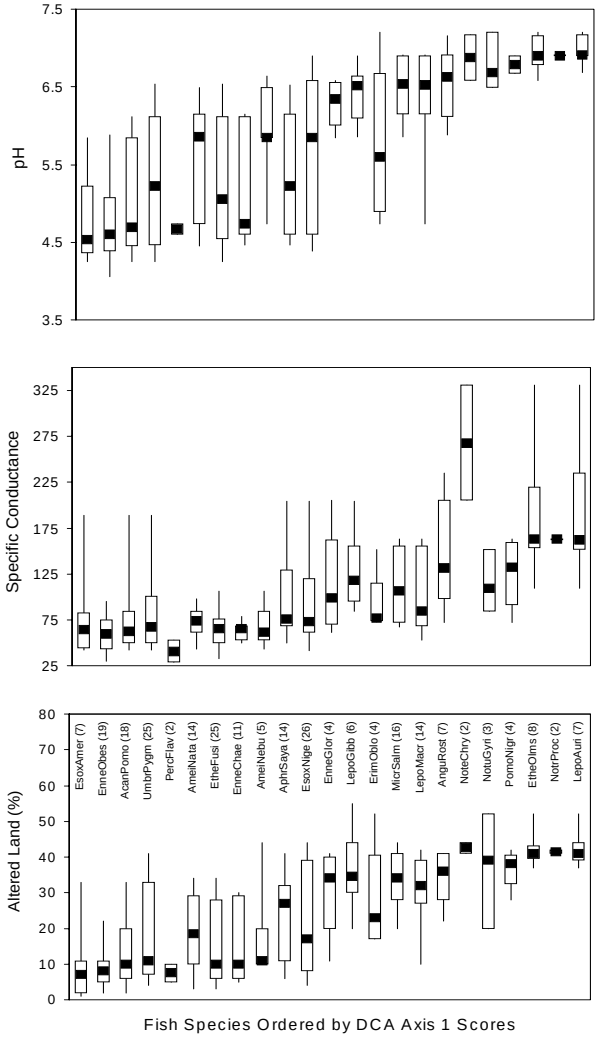

Figure 4.9. The pH, specific conductance (μS cm^{-1}), and percentage of altered land (developed land and upland agriculture) associated with fish species found at 41 Rancocas Creek Basin streams. Box plots show the first, second (median), and third quartiles and the 10th and 90th percentiles for each variable. Refer to Table 4.3 for key to fish names. The number of sites in which a species was found is given in parentheses.

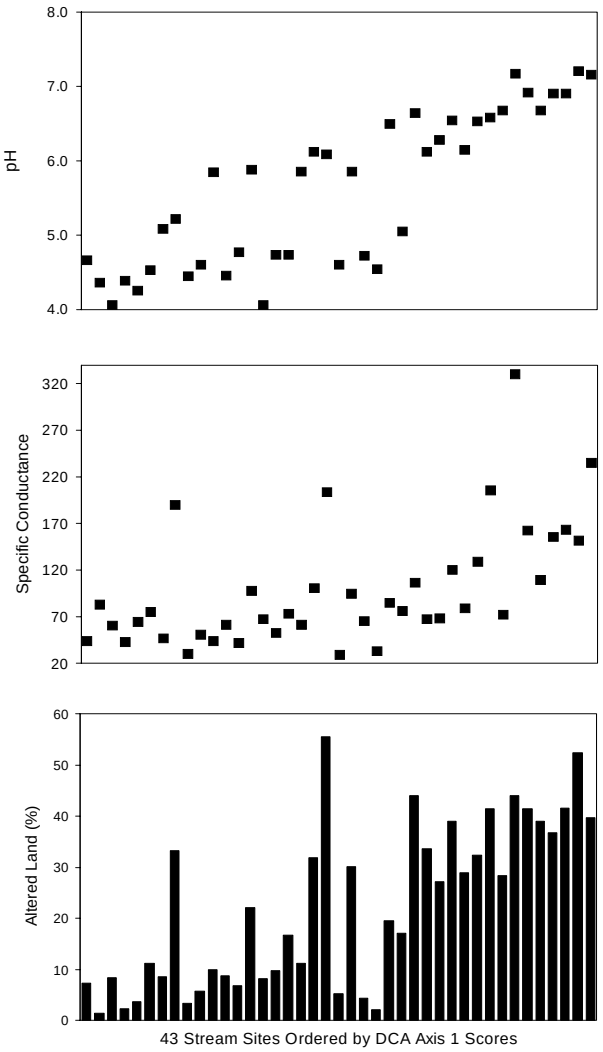

Figure 4.10. Median pH, specific conductance (μS cm^{-1}), and percentage of altered land (developed land and upland agriculture) for 41 Rancocas Creek Basin streams. DCA axis 1 represents a stream-fish community gradient. Refer to Table 4.5 for site names ordered by DCA axis 1 scores.

The first division of the TWINSPAN classification separated a group of nine stream sites, characterized by a high percentage of nonnative fish species (non-Pinelands site class), from the other 32 sites, which were dominated by native species (Pinelands site class) (Figures 4.7 and 4.11). The mean number of nonnative species present in the non-Pinelands site class was 4.3 (± 1.8). Compared to the Pinelands site class, the non-Pinelands site class was also characterized by higher pH, specific conductance, and altered (upland agriculture and developed land) land values.

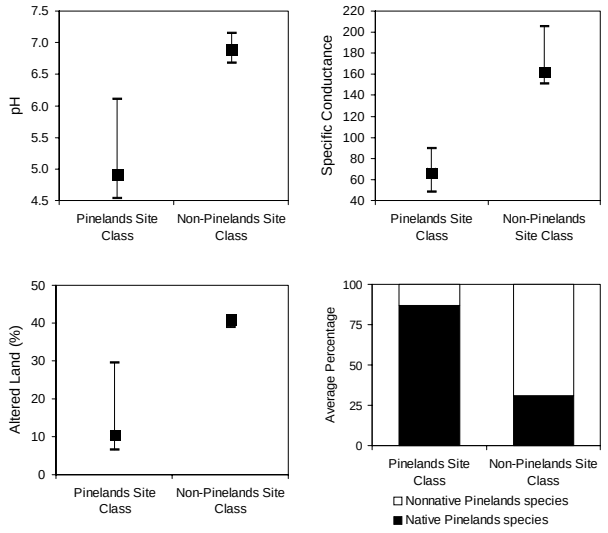

Figure 4.11. The percentage of sites with native and nonnative fish species and median and 1st and 3rd quartile pH, specific conductance (μS cm^{-1}), and altered land (developed land and upland agriculture) values for two TWINSPAN-derived site classes for 41 Rancocas Creek Basin streams.

Impoundment-fish Community Gradient

Similar to the ordination of stream sites, the first DCA axis of the impoundment ordination contrasted sites with and without nonnative species (Tables 4.4 and 4.6, Figure 4.12). The percentage of native species decreased and the percentage of nonnative species increased along this community gradient (Figure 4.13). These results were related to the range of watershed conditions associated with each fish species (Figure 4.14).

The order of impoundments along the first DCA axis was associated with increasing pH ($n = 11$, $r = 0.65$, $p < 0.029$) (Figure 4.15). Specific conductance, developed land, upland agriculture, wetland agriculture, longitude, and latitude were not related to the impoundment-community gradient.

The first division of the TWINSPAN classification separated a group of six impoundments, characterized by a high percentage of nonnative fish species (non-Pinelands site class), from the remaining nine impoundments that supported only native species (Pinelands site class) (Figures 4.12 and 4.16). The non-Pinelands site class had higher pH, specific conductance, and altered land (developed land and upland agriculture) values compared to the Pinelands site class.

Most of the important relationships between fish-species composition and watershed conditions revealed by the Rancocas Creek Basin study and the Mullica River Basin study (Zampella et al. 2001) were similar. In both basins, the stream-fish community gradient was related to pH, specific conductance, and the percentage of developed land in a basin. The impoundment-fish community gradient in the Mullica River Basin was also related to these three factors. However, developed land and specific conductance were not associated with variations in fish-species composition in Rancocas Creek Basin impoundments. Unlike the Mullica River Basin, fish-species composition in the Rancocas Creek Basin was not related to the percentage of upland agriculture in a basin. This lack of association may be due to differences in landscape patterns between the two basins. Unlike the Mullica River Basin, upland agriculture is not a dominant land use in the Rancocas Basin. Although longitude was related to species composition in the Mullica River Basin, it was not an important correlate in the Rancocas Creek Basin. The lack of association between longitude and fish-community composition in the Rancocas Creek Basin is probably due to the presence of nonnative fish species at altered sites on the eastern and western side of the basin.

Study-basin Characterizations

Greenwood Branch

Fourteen fish species were collected from the Greenwood Branch study basin. Fish assemblages in this study basin were characterized by the general absence of nonnative fish species. The majority of the 15 sites surveyed in this basin supported native fish assemblages and occupied a position on the undisturbed end of both fish-community gradients (Figures 4.17 and 4.18). Three sites supported nonnative fish species. These included the Presidential Lakes impoundment, the Country Lakes

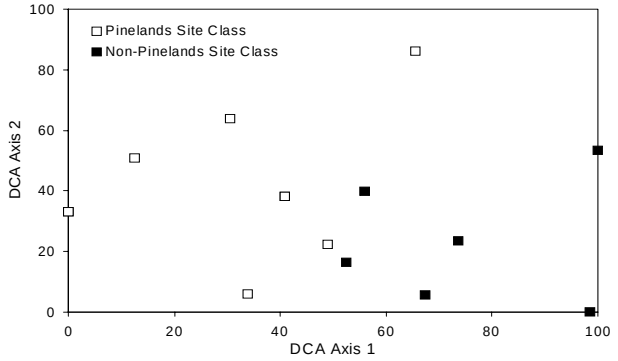

Figure 4.12. DCA ordination diagram and TWINSPAN classification for 15 Rancocas Creek Basin impoundment-fish sites. Refer to Table 4.6 for site names ordered by DCA axis 1 scores.

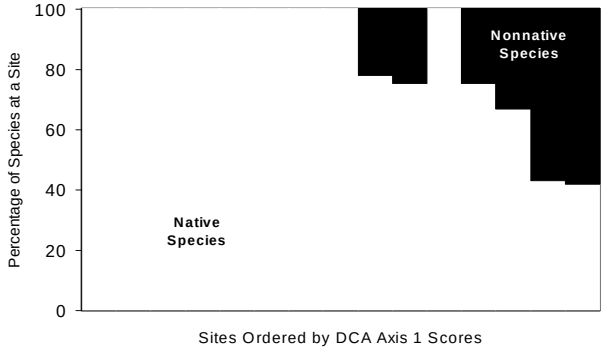

Figure 4.13. Percentage of native and nonnative species found at 15 Rancocas Creek Basin impoundments. Refer to Table 4.6 for site names ordered by DCA axis 1 scores.

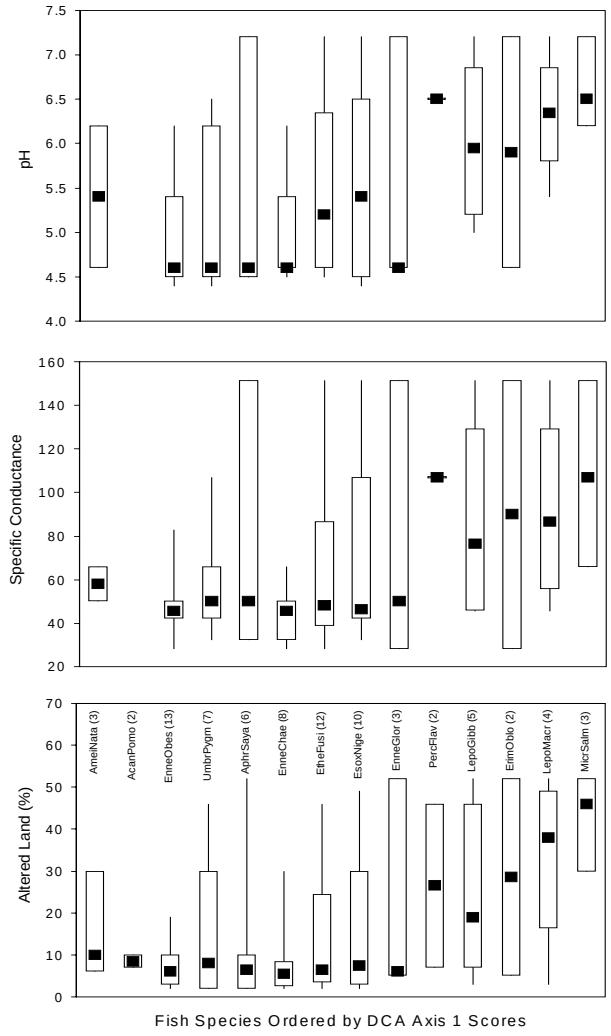

Figure 4.14. The pH, specific conductance (μS cm^{-1}), and percentage of altered land (developed land and upland agriculture) associated with fish species found at 15 Rancocas Creek Basin impoundments. Box plots show the first, second (median), and third quartiles and the 10th and 90th percentiles for each variable. Refer to Table 4.3 for key to fish names. The number of sites in which a species was found is given in parentheses.

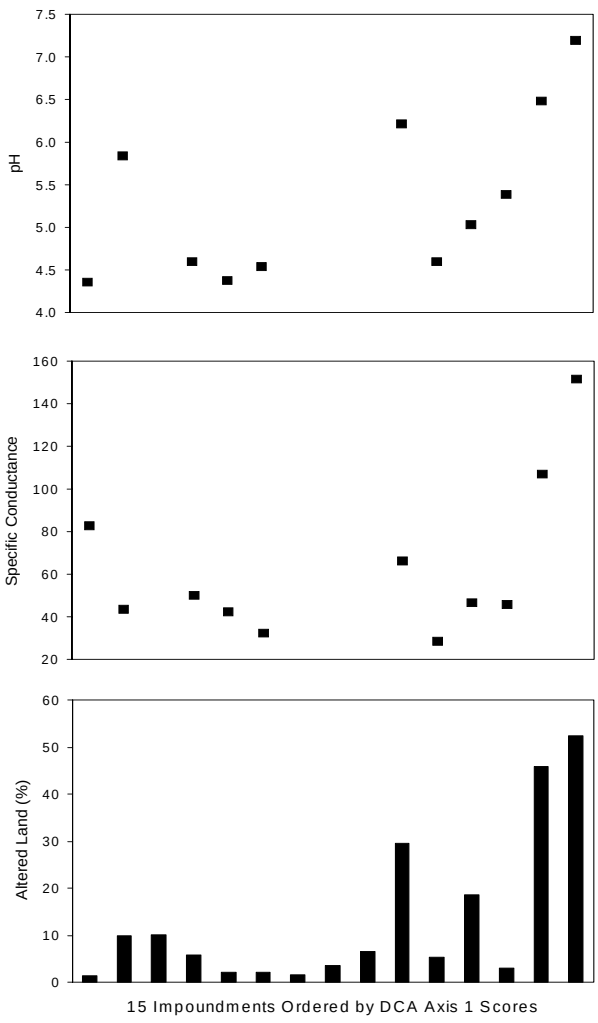

Figure 4.15. Median pH, specific conductance (μS cm^{-1}), and percentage of altered land (developed land and upland agriculture) for 15 Rancocas Creek Basin impoundments. DCA axis 1 represents an impoundment-fish community gradient. Refer to Table 4.6 for site names ordered by DCA axis 1 scores.

lower impoundment, and Pole Bridge Branch at Wissahickon Drive (Appendix 3). Residential development borders both impoundments and the Pole Bridge Branch stream site drains the Country Lakes impoundment.

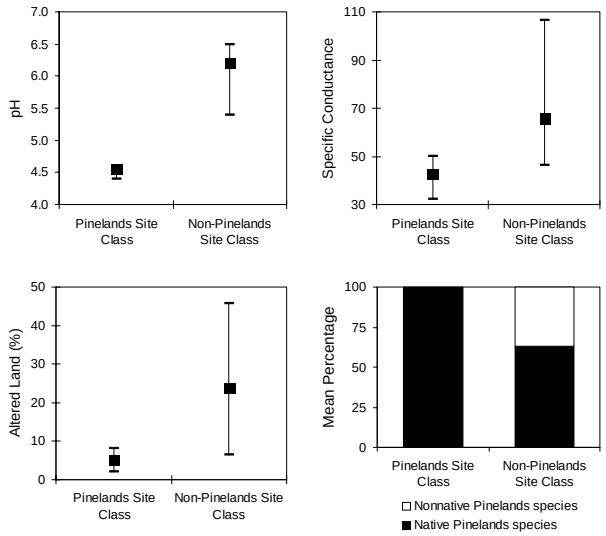

Figure 4.16. The percentage of sites with native and non-Pinelands fish species and median and 1st and 3rd quartile pH, specific conductance (μS cm^{-1}), and altered land (developed land and upland agriculture) values for two TWINSPAN-derived site classes for 15 Rancocas Creek Basin impoundments.

North Branch

Although the widest range of conditions was found in the North Branch study basin, the ordination placed most of the sites in the middle of the fish-community gradients (Figures 4.17 and 4.18). Twenty-one fish species were found in this basin. Nonnative fish species were found at all sites in the basin except for Hanover Lake and the North Branch Rancocas Creek tributary at Magnolia Road (Appendix 3). These two sites were among the only North Branch sites surveyed with a median pH < 5.0 (Tables 4.1 and 4.2). The only North Branch site that lacked restricted-characteristic species was Budds Run at Route 616, which was located at the extreme end of the stream-fish community gradient. This stream site also displayed the highest median pH value and had the only occurrence for fallfish in the Rancocas Creek Basin.

South Branch

Sixteen fish species were collected in the South Branch study basin. Except for a single stream site and the only impoundment surveyed, sites in this basin occupied a position on the undisturbed end of the fish community gradient (Figures 4.17 and 4.18). Native Pinelands species were found at all 10 sites surveyed in the basin. Although nonnative species were present at three stream sites and the impoundment, all but one of these occurrences were peripheral rather than introduced species. The only occurrence of an introduced species was a single largemouth bass from Friendship Creek at Powell Place Road.

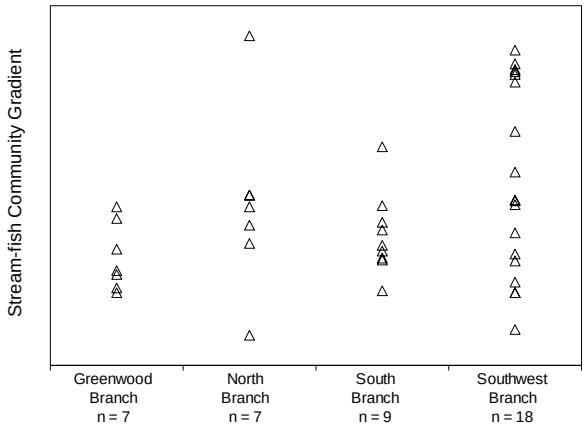

Figure 4.17. Position of fish-survey sites along the stream-fish community gradient, represented by DCA axis 1 site scores, in the four Rancocas Creek Basin stream systems. Refer to Table 4.5 for site names ordered by the first DCA axis.

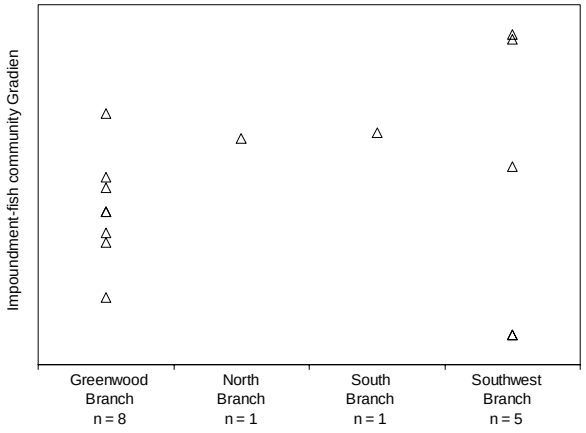

Figure 4.18. Position of fish-survey sites along the impoundment-fish community gradient, represented by DCA axis 1 site scores, in the four Rancocas Creek Basin stream systems. Refer to Table 4.6 for site names ordered by the first DCA axis.

Southwest Branch

Sites in the Southwest Branch basin displayed a wide range of conditions (Figures 4.17 and 4.18). This study basin supported the highest fish-species

richness at 25 species. Native species were present at 18 of the 19 stream sites and at all five impoundments surveyed in the basin. Cedar Run Lake and sites on the Little Creek, Bear Swamp River, Black Run, and Black Run tributary supported only native fish communities. In contrast, nonnative species were present at two-thirds of the stream sites and three of the five impoundments surveyed in the basin. The six sites at the disturbed end of the stream-fish community gradient lacked restricted-characteristic species and, along with Budds Run from the North Branch study basin, were the only Rancocas Creek survey sites that supported the nonnative redbreast sunfish. Four other nonnative fish species, including the satinfin shiner, swallowtail shiner (*Notropis procne*), white catfish, and black crappie (*Pomoxis nigromaculatus*), were found only in the Southwest Branch study basin.

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5 ANURAN ASSEMBLAGES

INTRODUCTION

Previous Commission studies conducted in the Mullica River Basin demonstrated the value of anurans as indicators of landscape alteration and water-quality degradation in the Pinelands (Bunnell and Zampella 1999, Zampella and Bunnell 2000, Zampella et al. 2001). These studies indicated that the presence of individual border-entrant species and assemblages dominated by these species were associated with watersheds characterized by a high percentage of developed land and upland agriculture and surface waters with elevated pH and dissolved-solid concentrations. Border entrants are anuran species that are widely distributed outside the Pinelands, but usually do not occur in the region except in habitats altered by human activity (Table 5.1) (Conant 1962, 1979). The distribution of these non-Pinelands assemblages contrasted with those composed of native Pine Barrens species and wide-ranging species. Pine Barrens species are restricted to Pinelands habitats, whereas wide-ranging species are distributed throughout southern New Jersey (Conant 1962, 1979).

The majority of Mullica River Basin sites with border-entrant species present were stream habitats, suggesting that on-stream anuran assemblages may be better indicators of overall watershed conditions compared to off-stream assemblages. Pine Barrens treefrogs and carpenter frogs were generally absent from sites with bullfrogs, which was the most frequently encountered border-entrant species. The negative relationship between bullfrogs and carpenter frogs is especially significant because carpenter frogs prefer similar permanent-water habitat types as bullfrogs. In addition to sharing similar habitat types, the breeding period for these two species overlaps (Figure 5.1).

In 2001, Commission scientists surveyed anurans in the Rancocas Creek Basin. Based on the results of initial Commission studies in the Mullica River Basin, Rancocas Creek Basin surveys were conducted at permanent on-stream sites and centered around the calling season for bullfrogs and carpenter frogs.

METHODS

Study Sites

Sixty-seven sites were surveyed for vocalizing anurans in the Rancocas Creek Basin. Sites were selected based on land-use characteristics, accessibility, and suitability as survey sites. The location of each listening point was registered with a global positioning system (GPS). Twenty-five sites were removed from the pool of 67 sites prior to data analysis. Fourteen sites were deleted because no anurans were heard calling. Inventories for adjacent survey sites that represented the same habitat type were pooled, reducing eight pairs of survey sites to eight single sites. A set of three adjacent survey sites was also combined as one site. One site was excluded from the analysis because it was not connected to a stream. Of the 42 sites analyzed, four were at or downstream from the Pinelands National Reserve boundary. Forty-one sites were impoundments and one was a stream site. Impoundments ranged from small, tributary impoundments to flooded, abandoned cranberry bogs and large lakes. For simplicity, the 42 sites analyzed will be referred to as impoundments.

Table 5.1. Common and scientific names for Pine Barrens, wide-ranging, and border-entrant anuran species found in the New Jersey Pinelands (Conant 1979). Nomenclature follows Conant and Collins (1998).

Scientific Name	Common Name
Native Pinelands Species	
Pine Barrens Species	
Hyla andersonii	Pine Barrens treefrog
Rana virgatipes	carpenter frog
Wide-ranging Species	
Bufo woodhousii fowleri	Fowler's toad
Pseudacris c. crucifer	northern spring peeper
Rana clamitans melanota	green frog
Rana utricularia	southern leopard frog
Scaphiopus h. holbrooki	eastern spadefoot
Non-Pinelands Species	
Border-entrant Species	
Acris c. crepitans	northern cricket frog
Hyla versicolor	gray treefrog
Pseudacris triseriata kalmi	New Jersey chorus frog
Rana catesbeiana	bullfrog
Rana palustris	pickerel frog
Rana sylvatica	wood frog

Characterizing Survey-site Conditions

Several site-specific, local, and regional watershed-disturbance variables were used to characterize each anuran-survey site. The variables included pH, specific conductance, land use, latitude and longitude. The first three variables are good indicators of aquatic degradation in the Pinelands (Zampella 1994, Zampella and Laidig 1997, Zampella and Bunnell 1998, Dow and Zampella 2000, Zampella et al. 2001). Specific conductance and pH were measured under baseflow conditions (Chapter 2) at or near anuran-survey sites (Table 5.2). Drainage-basin land-use profiles were prepared using ArcView software and 1995/97 land-use data obtained from the New Jersey Department of Environmental Protection (Chapter 1). The latitude and longitude of each site was obtained from the GPS points.

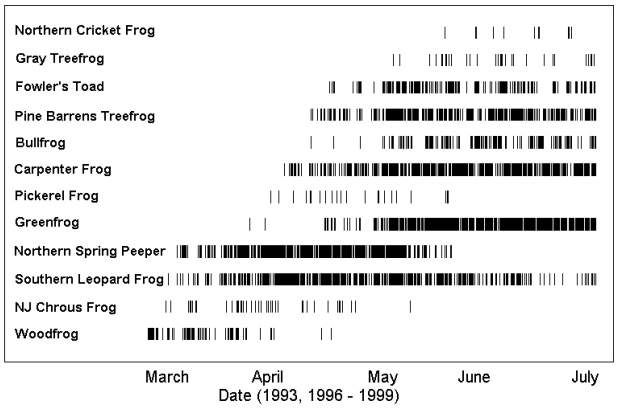

Figure 5.1. Breeding phenology of 12 anurans in the Mullica River Basin. Each vertical bar represents a survey night when a species was heard calling (Zampella et al. 2001).

Anuran-vocalization Surveys

Nighttime vocalization surveys were conducted in June and July 2001. Each site was visited on one occasion. The number of calling individuals heard during a five-minute period was estimated using a ranking system where 0 = none, 1 = 1 calling, 2 = 2-5 calling, 3 = 6-10 calling, and 4 = >10 calling individuals. This ranking system is the same as that used in earlier Commission studies (Bunnell and Zampella 1999, Zampella and Bunnell 2000, Zampella et al. 2001).

Appendix 4 contains the anuran-survey data for the 67 Rancocas Creek Basin sites surveyed. The appendix includes the number of individuals of each species heard at each site, distribution maps for each species, the air temperature and relative humidity recorded during site visits, the individuals who conducted the surveys, site-location descriptions, and latitude and longitude. Non-vocalizing individuals observed during the surveys are also indicated. Taxonomic nomenclature follows Conant and Collins (1998).

Anuran-community Gradient

Presence/absence was determined for each species heard at the 42 sites included in the analysis. Detrended correspondence analysis (DCA) was used to order anuran species and survey sites based on presence/absence data. The same data were used to classify or group species and sites using TWINSPAN. These analysis techniques are described in greater detail in Zampella et al. (2001).

Table 5.2. Median pH and specific conductance (μS cm^{-1}) values for the 42 Rancocas Creek Basin anuran-survey sites. The location of the nearest water-quality (WQ) monitoring station is given in relation to each anuran-survey site. Supplemental water-quality sites that were also included in the analysis are noted. A dash indicates that water-quality data were not available for a particular anuran site. Refer to Chapter 2 for details regarding water-quality monitoring.

Anuran Site Code	pH	SC	WQ Site Code	Location of WQ Station
GBIPRESD	5.39	45.7	GBIPRESU	supplemental - at anuran site
GCOPAKIM	4.38	42.2	GCOPAKIS	at outlet of impoundment
GCRCOUND	-	-		
GCRWHITE	-	-		
GGUMBOGD	-	-		
GMCTRBOG	-	-		
GMCWIDEN	4.14	36.7	GMCBUTTE	downstream from anuran site
GMOUCAMP	4.54	32.3	GMORTE70	downstream from anuran site
GPOCOUND	-	-		
GPORT70D	5.08	46.9	GPOWHITE	downstream from anuran site
GSONORMA	-	-		
NJABPHAN	6.15	78.5	NJARANGE	upstream from anuran site
NJACLUBD	-	-		
NNORT616	5.85	61.0	NNORT616	at anuran site
NNOTRMGD	4.66	43.9	NNOTRMGU	at anuran site
SBRCAMPI	5.86	94.6	SFRPOWEL	downstream from anuran site
SBURNR70	-	-		
SBUSOOYL	4.46	61.3	SBUSOOYS	downstream from anuran site
SFRCAMPI	5.03	46.4	SFRCAMPS	at outlet of impoundment
SFRHAMPT	5.05	75.7	SFRRETRE	downstream from anuran site
SJAR616D	6.58	205.1	SJART616	at anuran site
SSBSOOYL	4.06	66.8	SSBSOOYS	downstream from anuran site
SSOVINCE	-	-		
WBACONDO	6.90	155.8	WBATUCKE	downstream from anuran site
WBAJENNL	7.20	151.4	WBAJENNS	at outlet of impoundment
WBLABBOG	4.36	82.7	WBLSPRAY	downstream from anuran site
WCEDARLK	5.84	43.4	WCEREFUG	at outlet of impoundment
WHACEDAR	6.68	109.7	WHART623	at outlet of impoundment
WHAPINEL	6.67	72.1	WHAPINES	at outlet of impoundment
WHATAUNL	6.28	67.8	WHATAUNT	at outlet of impoundment
WHATRMCK	-	-		
WHATRMIS	-	-		
WHATROAK	6.81	174.5	WHATRBIR	at inlet of impoundment
WHATROCD	6.48	106.8	WHATRSTO	at outlet of impoundment
WHATRYMC	5.73	31.9	WHATRYMC	supplemental data - at outlet
WKEGIRLS	6.21	66.1	WKEGIRLS	at outlet of impoundment
WKEMARLT	6.64	106.3	WKEHOPEW	at outlet of impoundment
WKESANCT	-	-		
WLICHURC	-	-		
WLISHAWU	7.00	176.6	WLISHAWU	supplemental data - at anuran site
WSOCOTOX	6.90	162.9	WSORTE70	upstream from anuran site
WSOMEDPK	6.91	162.3	WSORT541	downstream from anuran site

Spearman rank correlation was used to determine if the anuran-community gradient varied in relation to watershed conditions. The first DCA-axis site scores were correlated with median pH, median specific conductance, latitude, longitude, and the percentage of developed land, upland agriculture, and wetland agriculture in a basin. The environmental variables were selected based on results of the Commission's Mullica River Basin studies. An alpha level of 0.05 was used to identify important relationships revealed by the correlation analysis.

Differences in biogeography and watershed conditions between the TWINSPAN-derived site classes were evaluated using graphical analysis. The percentage of sites with native species and bullfrogs, pH, specific conductance, and the percentage of altered land (developed land and upland agriculture) were compared between the first two site classes. Graphical analysis was also used to compare pH, specific conductance, latitude, longitude, and the percentage of altered land (developed land and upland agriculture) between sites with bullfrogs, sites with carpenter frogs, and sites with both species.

RESULTS

Seven anuran species were heard during the surveys, including the two Pine Barrens species, three of the wide-ranging species, and two of the border-entrant species reported to occur in the Pinelands (Table 5.3). In order of decreasing frequency of occurrence, the species heard during the surveys were the green frog, bullfrog, Fowler's toad, carpenter frog, southern leopard frog, Pine Barrens treefrog, and northern gray treefrog. The green frog was also the most frequently encountered anuran species heard during Mullica River Basin surveys (Zampella et al. 2001). For Rancocas Creek sites, the relatively low frequency of occurrence for Pine Barrens treefrogs and northern gray treefrogs is probably due to the surveys being conducted mostly at permanent-water impoundments. These two species typically prefer to breed at temporary-water, off-stream habitats (Zampella et al. 2001). The northern gray treefrog was excluded from subsequent Rancocas Creek Basin analyses because this species was present at only one site (Appendix 4).

There were several differences in anuran assemblages between Rancocas Creek Basin and Mullica River Basin impoundments (Zampella et al. 2001). First, the mean (± SD) number of species heard at Rancocas Creek impoundments (2.2 ± 1.1) was lower than that for Mullica River impoundments (4.0 ± 1.5). Second, northern cricket frogs, northern spring peepers, and pickerel frogs were present at Mullica River impoundments, but these species were not heard at Rancocas Creek impoundments. These differences were probably due to the timing and length of the survey period used for Rancocas Creek surveys. Pickerel frogs and northern spring peepers were not heard at Rancocas Creek sites because surveys were conducted after the breeding season for these species had already ended (Figure 5.1). Impoundments in the Mullica River Basin were surveyed from March through June to capture the entire species composition at a site, whereas Rancocas Creek surveys focused only on the breeding season for carpenter frogs and bullfrogs. Northern cricket frogs were present at almost 10% of the Mullica River impoundments (Zampella et al. 2001). The absence of cricket frogs from Rancocas Creek impoundments is noteable because the surveys were conducted during their breeding period (Figure 5.1) and, in the Mullica River Basin, cricket frogs shared similar permanent-water habitats as bullfrogs (Zampella et al. 2001).

Table 5.3. Frequency of occurrence of seven anuran species heard at 42 Rancocas Creek Basin impoundments. For geographic affinity, PB = Pine Barrens species, WR = wide-ranging species, and BE = border-entrant species. Data for 67 Mullica River Basin impoundments are included for comparison (Zampella et al. 2001).

		Rancocas Creek Basin		Mullica River Basin
Species	Geo. Aff.	# of Sites	% of Total	% of Total
Green frog	WR	26	62	75
Bullfrog	BE	22	52	49
Fowler's toad	WR	21	50	67
Carpenter frog	PB	17	40	66
Southern leopard frog	WR	4	10	54
Pine Barrens treefrog	PB	3	7	19
Northern gray treefrog	BE	1	2	0

Lastly, there was a difference in the frequency of occurrence for species heard at both Rancocas Creek and Mullica River impoundments. Except for northern gray treefrogs, which were generally absent from impoundments in both basins, the only species that occurred more frequently at Rancocas Creek impoundments was the bullfrog (Table 5.3). The largest differences in frequency of occurrence between the two basins were observed for the southern leopard frog and carpenter frog. The slightly higher frequency of occurrence for bullfrogs and the substantially lower occurrence for carpenter frogs and southern leopard frogs at Rancocas Creek impoundments may be related to watershed disturbance. The Rancocas Creek Basin contains a higher percentage of developed and agricultural land and a lower

percentage of Preservation Area District and Forest Area compared to the Mullica River Basin (Chapter 1, Zampella et al. 2001). In addition to the previously mentioned negative relationship for carpenter frogs and bullfrogs, results from the Commission's initial Mullica River Basin study (Zampella and Bunnell 2000) indicated that southern leopard frogs occurred infrequently at sites with bullfrogs.

The first DCA axis of the site ordination contrasted sites where native species were heard with those that supported only bullfrogs (Tables 5.4 and 5.5, Figure 5.2). The number of native Pinelands species heard at a site decreased along this community gradient (Figure 5.3). These trends reflected differences in the range of watershed conditions for sites where native species and bullfrogs were heard calling (Figure 5.4).

The order of sites along the first DCA axis was associated with increasing pH ($r = 0.74$, $p < 0.001$), specific conductance ($r = 0.62$, $p < 0.001$), and the percentage of developed land ($r = 0.69$, $p < 0.001$) in the associated drainage (Figure 5.5). The first DCA axis was also correlated with increasing longitude ($r = 0.60$, $p < 0.000$), which indicated that bullfrogs were found more frequently on the western side of the basin (Figure 5.6). Upland agriculture, wetland agriculture, and latitude were not related to the anuran-community gradient.

Table 5.4. Raw DCA axis 1 and 2 scores for species heard at anuran-survey impoundment sites in the Rancocas Creek Basin. Species are ordered by axis 1 scores.

Species	Axis 1	Axis 2
Pine Barrens treefrog	0	175
Carpenter frog	130	142
Southern leopard frog	164	350
Green frog	229	0
Fowler's toad	292	216
Bullfrog	413	132

Table 5.5. Raw DCA axis 1 and 2 site scores for 42 anuran-survey impoundment sites in the Rancocas Creek Basin based on an ordination of species presence/absence data. Sites are ordered by axis 1 scores. Refer to Appendix 4 for additional information on each site.

Study Basin	Site Name	Site Code	Axis 1	Axis 2
Greenwood Branch	McDonalds Branch near gaging station	GMCWIDEN	0	158
Greenwood Branch	Mount Misery Brook impoundment at Mount Misery	GMOUCAMP	55	106
Greenwood Branch	Cranberry Branch impoundment at Whitesbog	GCRWHITE	65	142
Greenwood Branch	McDonalds Branch tributary impoundment above dike	GMCTRBOG	98	177
Greenwood Branch	Pakim Pond	GCOPAKIM	115	71
Greenwood Branch	South Branch Mount Misery Brook impoundment at sand road	GSONORMA	115	71
South Branch	South Branch Burrs Mill Brook impoundment above Sooy Place Road	SSBSOOYL	115	71
Greenwood Branch	Gum Spring Run impoundment - lower (combined with GGUMBOGU)	GGUMBOGD	139	177
South Branch	Burrs Mill Brook impoundment near Route 70	SBURNR70	146	179
Greenwood Branch	Country Lake north - below Choctaw Road (combined with GBUR530D and GBUR530U)	GCRCOUND	152	119
Greenwood Branch	Pole Bridge Branch impoundment below Route 70	GPORT70D	152	119
South Branch	Friendship Creek impoundment at Camp Inawendiwin	SFRCAMPI	152	119
Southwest Branch	Cedar Run Lake	WCEDARLK	164	0
Southwest Branch	Haynes Creek tributary at McKendimen and Bear Head Roads	WHATRMCK	164	0
Southwest Branch	Lake Stockwell at tributary (combined with WHATROCU)	WHATROCD	164	0
Southwest Branch	Kettle Run impoundment above Georgia O'Keefe Way	WKESANCT	164	0
Southwest Branch	Little Creek at Church Road	WLICHURC	164	0
North Branch	North Branch Rancocas Creek tributary below Magnolia Road (combined with NNOTRMGU)	NNOTRMGD	169	156
South Branch	Burrs Mill Brook bog above Sooy Place Road	SBUSOOYL	180	168
Southwest Branch	Black Run bog	WBLABBOG	192	91
Southwest Branch	Kettle Run at camp Kettle Run	WKEGIRLS	192	91
Southwest Branch	Little Creek at Shawnee Pass - upstream	WLISHAWU	195	108
Greenwood Branch	Presidential Lakes - lower (combined with GBIPRESU)	GBIPRESD	213	163
Greenwood Branch	Country Lake south - below Choctaw Road (combined with GPOCOUNB)	GPOCOUND	227	216
Southwest Branch	Lake Cotoxen	WSOCOTOX	227	216
North Branch	North Branch Rancocas Creek above Route 616	NNORT616	246	116
South Branch	Bread and Cheese Run impoundment at Camp Inawendiwin	SBRCAMPI	246	116
South Branch	Vincentown Millpond	SSOVINCE	246	116
Southwest Branch	Haynes Creek tributary above Kettle Run Road	WHATRYMC	246	116
Southwest Branch	Kettle Run above Hopewell Road	WKEMARLT	246	116
South Branch	Jade Run near Route 616 - downstream (combined with SJAR616U)	SJAR616D	256	66
Southwest Branch	Jennings Lake	WBAJENNL	256	66
North Branch	Big Pine Lake above Hanover Boulevard (combined with NJABPBAY)	NJABPHAN	287	174
North Branch	Mirror Lake below Club House Road (combined with NJACLUBU)	NJACLUBD	287	174
South Branch	Old Forge Lake	SFRHAMPT	287	174
Southwest Branch	Haynes Creek at Cedar Trail	WHACEDAR	287	174
Southwest Branch	Lake Pine	WHAPINEL	287	174
Southwest Branch	Barton Run impoundment above Tuckerton Road	WBACONDO	348	132
Southwest Branch	Taunton Lake	WHATAUNL	348	132
Southwest Branch	Lake Mishe-Mokwa	WHATRMIS	348	132
Southwest Branch	Haynes Creek tributary impoundment below Jackson - Medford Road	WHATROAK	348	132
Southwest Branch	Southwest Branch Rancocas Creek impoundment at Medford Park	WSOMEDPK	348	132

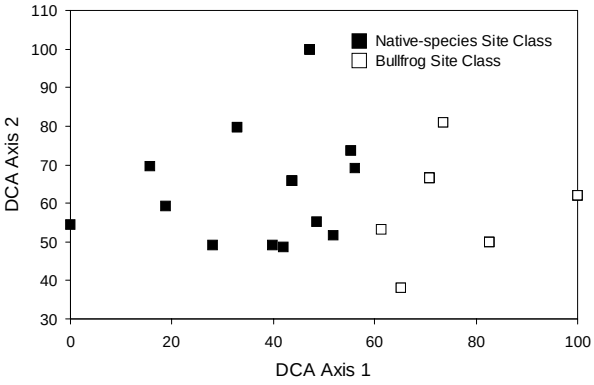

Figure 5.2. DCA ordination diagram and TWINSPAN classification for 42 Rancocas Creek Basin impoundments. Refer to Table 5.5 for site names ordered by DCA axis 1 scores.

Figure 5.3. Percentage of native species and bullfrogs heard at 42 Rancocas Creek Basin impoundments. Refer to Table 5.5 for site names ordered by DCA axis 1 scores.

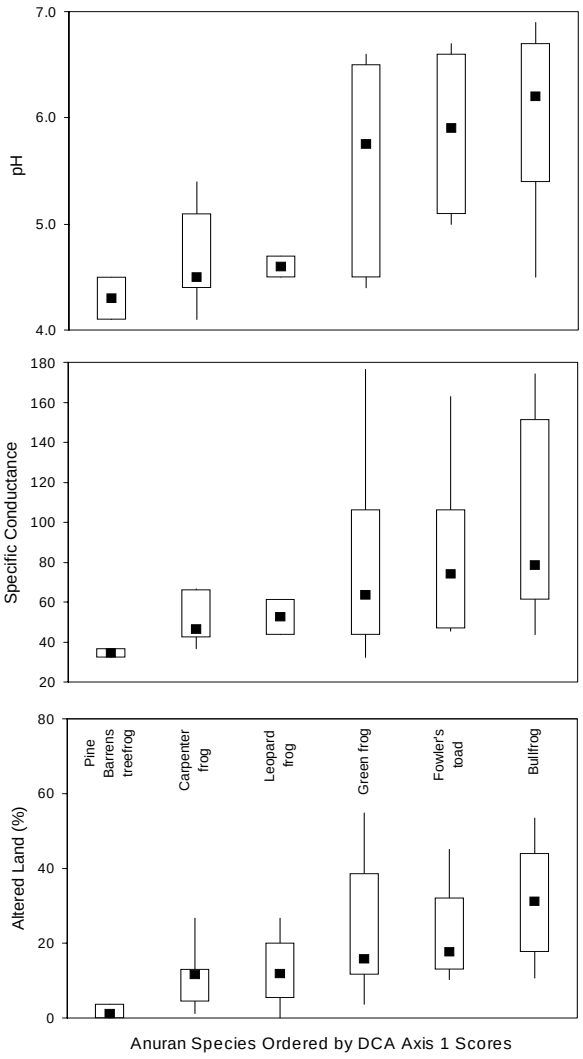

Figure 5.4. The pH, specific conductance (μS cm^{-1}), and percentage of altered land (developed land and upland agriculture) associated with anuran species heard at 42 Rancocas Creek Basin impoundments. Box plots show the first, second (median), and third quartiles and the 10th and 90th percentiles for each variable.

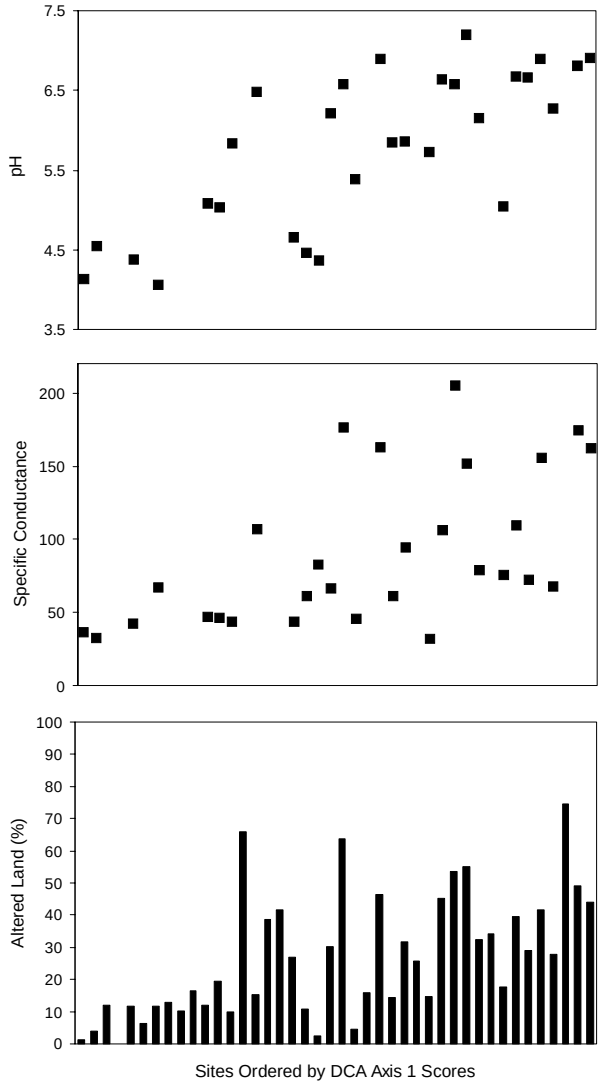

Figure 5.5. Median pH, specific conductance (μS cm^{-1}), and percentage of altered land (developed land and upland agriculture) for 42 Rancocas Creek Basin impoundments. DCA axis 1 represents an anuran-community gradient. Refer to Table 5.5 for site names ordered by DCA axis 1 scores.

The Inner Coastal Plain represented between 13% and 25% of the drainage-basin area of four anuran sites (Little Creek at Church Road, Lake Cotoxen, Jade Run near Route 616, and Southwest Branch Rancocas Creek impoundment at Medford Park). The removal of these four sites from the ordination did not substantially affect the relationship between species composition and pH ($r = 0.75$, $p < 0.001$), specific conductance ($r = 0.62$, $p < 0.001$), and developed land ($r = 0.73$, $p < 0.001$).

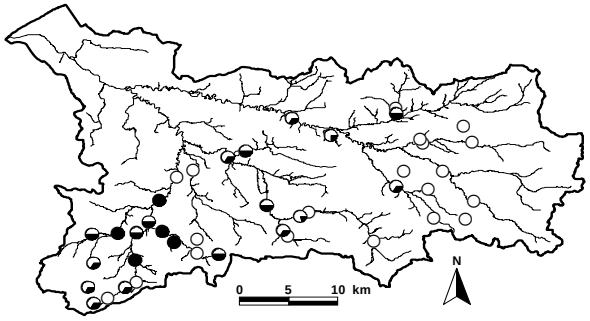

Figure 5.6. Pie charts showing the percentage of native species (white) and bullfrogs (black) present at 42 Rancocas Creek Basin impoundment sites.

The first division of the TWINSPAN classification separated a group of 20 sites, the majority of which had bullfrogs present (Bullfrog site class), from a group of 22 sites, where bullfrogs were mostly absent (Native-species site class) (Figure 5.7). Compared to the native-species site class, the bullfrog site class displayed higher pH, specific conductance, and altered land values.

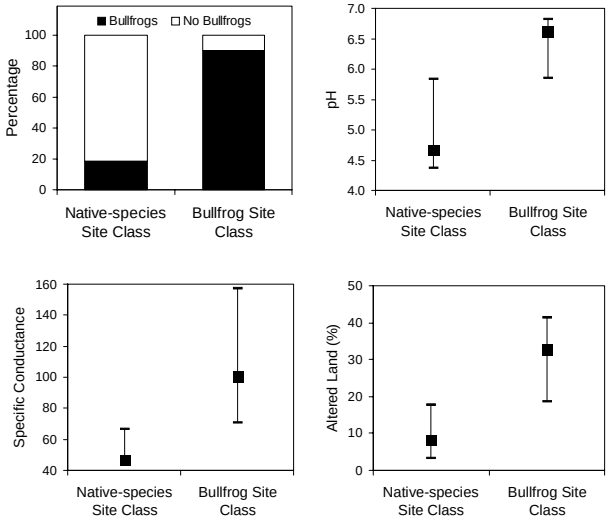

Figure 5.7. The percentage of sites with and without bullfrogs, and median and 1st and 3rd quartile pH, specific conductance (μS cm^{-1}), and altered land (developed land and upland agriculture) values for two TWINSPAN-derived site classes for 42 Rancocas Creek Basin impoundments.

Thirty-four of the 42 sites analyzed supported carpenter frogs, bullfrogs, or both species. Carpenter frogs were heard at 12 sites, bullfrogs at 17 sites, and both species at five sites. There was a difference in pH, specific conductance, longitude, and altered land between sites with carpenter frogs and sites with bullfrogs. Sites that supported carpenter frogs generally displayed low pH and specific conductance values and were located within relatively undeveloped drainages on the eastern side of the basin (Figure 5.8). In contrast, bullfrogs were more frequently encountered on the degraded western side of the basin. Except for geographic position, sites with both species present displayed conditions more similar to sites with carpenter frogs. There was no difference in latitude between the three groups.

For the most part, the relationships between the anuran-community gradient, represented by the DCA axis 1 site scores, and the watershed disturbance variables for Rancocas Creek Basin survey sites are similar to those found for permanent on-stream sites in the Mullica River Basin (Zampella et al. 2001). For sites in both basins, the anuran-community gradients were related to pH, specific conductance, developed land, and longitude. Values for all four of these parameters and the occurrence of bullfrogs increased from east to the west in both basins. Unlike the Mullica River Basin, anuran-species composition in

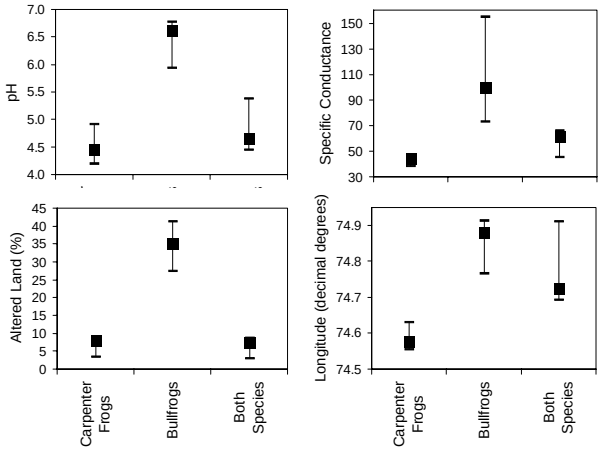

Figure 5.8. First, second (median), and third quartiles for pH, specific conductance (μS cm^{-1}), longitude, and altered land (developed land and upland agriculture) at Rancocas Creek Basin impoundments with carpenter frogs (n = 12), with bullfrogs (n = 17), and with both species (n = 5).

the Rancocas Creek Basin was not related to the percentage of upland or wetland agriculture. This lack of association may be due to differences in landscape patterns between the two basins. Unlike the Mullica River Basin, upland and wetland agriculture are not dominant land uses in the Rancocas Creek Basin.

Study-basin Characterizations

Greenwood Branch

Impoundments in the Greenwood Branch study basin generally supported native-anuran assemblages and were associated with the undisturbed end of the community gradient (Tables 5.4 and 5.5, Figure 5.9). Carpenter frogs were heard at nearly all of the Greenwood Branch sites, including the off-stream Route 70 borrow pit site that was excluded from the analysis (Appendix 4). Pine Barrens treefrogs were present at three sites in the basin. Bullfrogs were heard only at the Presidential Lakes site, an impoundment just downstream from state-owned land and bordered on one side by residential development. These results reflect the predominance of undeveloped land in the Greenwood Branch stream systems (Chapter 1).

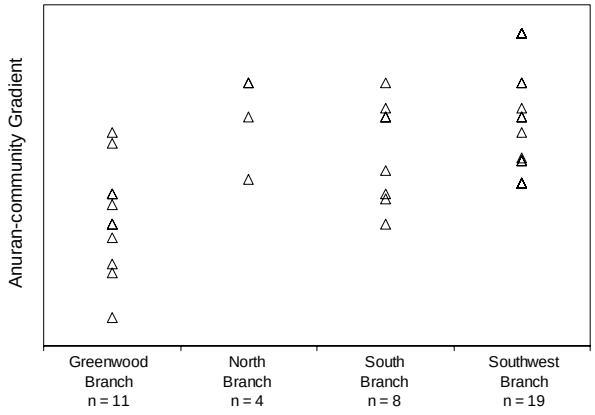

Figure 5.9. Position of anuran-survey sites along the anuran-community gradient, represented by DCA axis 1 site scores, in the four Rancocas Creek Basin study basins. Refer to Table 5.5 for site names ordered by the first DCA axis.

North Branch

In contrast to sites in the Greenwood Branch study basin, impoundments in the North Branch study basin were associated with the disturbed end of the anuran-community gradient (Tables 5.4 and 5.5, Figure 5.9). Although both of these study basins originate on the eastern side of the Rancocas Creek Basin, the differences in anuran assemblages between the two basins reflect the disparity in land-use characteristics (Chapter 1). Compared to the Greenwood Branch study basin, the North Branch study basin is more heavily developed and farmed. Bullfrogs were heard calling from all four North Branch sites. Carpenter frogs were found only at the North Branch tributary below Magnolia Road, which was the only anuran-survey site in the North Branch study basin with a median pH < 5.0 (Table 5.2).

South Branch

Anuran assemblages at sites in the South Branch study basin represented a range of watershed conditions (Tables 5.4 and 5.5, Figure 5.9). Carpenter frogs were found at four of the eight sites. All four impoundments were low pH sites located on Burrs Mill Brook or Friendship Creek above the confluence with Bread and Cheese Run (Table 5.2). Bullfrogs were heard calling at five sites in the South Branch basin. One of these sites, Vincentown Millpond, was located downstream from the Pinelands boundary (Figure 5.6).

Southwest Branch

Impoundments in the Southwest Branch study basin were distributed along the disturbed half of the anuran-community gradient (Tables 5.4 and 5.5, Figure 5.9). Carpenter frogs were heard calling from only two sites in this basin, Black Run bog and Kettle Run at Camp Kettle Run. The Camp Kettle Run impoundment had a single carpenter frog calling, but the Black Run bog supported a large chorus of this species. Black Run is one of the few stream systems on the western side of the Rancocas Creek Basin with a median pH value < 4.5 (Chapter 2).

In addition to a non-vocalizing individual observed at Little Creek at Shawnee Pass, bullfrogs were heard at 12 of the 19 Southwest Branch study basin sites. Neither bullfrogs nor carpenter frogs were present at the Lake Cotoxen and Little Creek at Church Road sites, which were located downstream from the National Reserve boundary (Figure 5.6). The northern gray treefrog, the only other border-entrant species heard during the anuran surveys, was present at one South Branch site (Appendix 4). In his zoogeographical review of Pinelands anurans, Conant (1979) reported that, during the 25 years he lived on the shore of Taunton Lake, he only heard bullfrogs calling on three occasions. These records were limited to a single individual calling in late spring

during 1962, 1969, and 1970. During the Commission anuran surveys, the only species heard at or near this impoundment was the bullfrog, suggesting a dramatic change at this site over the past 30 years.

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SUMMARY

MAJOR FINDINGS

The results of the Rancocas Creek and Mullica River Basin studies were generally similar. In both studies, the surface-water quality and biological communities found in forested stream basins contrasted with those attributes found in basins with a high percentage of altered land (developed land and upland agriculture). Acid waters and typical Pinelands biological communities characterized survey sites in forest-dominated stream basins. Elevated pH and specific conductance and nonnative plant and animal species were associated with stream basins with a high percentage of altered lands.

Although the results of the two studies were similar, differences in geology, geography, and land-use patterns were given greater consideration when interpreting the Rancocas Creek data. In addition to the Cohansey Formation, which dominated the Mullica River Basin, the Kirkwood Formation and several Inner Coastal Plain formations (primarily the Vincentown Formation and the Manasquan Formation) outcrop in the Rancocas Basin. To account for the greater geologic diversity in the Rancocas Creek Basin, variations in surficial geology were included in the assessment of Rancocas Creek water-quality variables.

Unlike the Mullica River Basin, where upland agriculture is a dominant or a co-dominant altered-land use, upland agriculture is a minor land use in a majority of the drainage basins associated with Rancocas Creek Basin monitoring sites. Thus, the relationship between water quality and biological-community gradients and altered land in the Rancocas Creek Basin was due largely to variations in the extent of developed land. Overall, the effect of land-use on water-quality appeared to overshadow that of geology.

In the Rancocas Creek Basin, both pH and specific conductance increased in relation to the percentage of altered land in a drainage basin, with developed land explaining the greatest portion of the variability in both water-quality variables. Nitrate concentrations were also higher in the more heavily altered basins. Although most of the surface-water impacts observed in the basin were associated with nonpoint sources of nutrients and other dissolved solids, wastewater discharges probably contributed to water-quality degradation at a few sites.

The composition of Rancocas Creek Basin stream-fish assemblages varied along a watershed-disturbance gradient characterized by increasing in pH, specific conductance, and the percentage of altered land in a basin. The percentage of native species decreased and the percentage of nonnative species increased along this disturbance gradient. Similar changes in impoundment-fish assemblages were associated with variations in pH.

Conditions at sites where native anuran species were heard contrasted with those observed at sites that supported only bullfrogs. Compared with carpenter frogs, bullfrogs were found at impoundments with elevated pH and specific conductance and a high percentage of altered land in the associated drainage basin.

Variations in stream-vegetation patterns, represented by a decrease in the percentage of Witmer Stone's Pine Barrens District species, an increase in the percentage of non-Pinelands species (primarily species associated with Stone's Middle District), and an increase in the percentage of disturbance-indicator plant species, were associated primarily with increasing pH, specific conductance, and the percentage of developed land in a basin. Similar patterns were observed in the Mullica River Basin. However, establishing a clear relationship between land-use disturbance and non-Pinelands or disturbance-indicator plants in the Rancocas Creek Basin was complicated because, unlike the Mullica River Basin, a significant portion of the Rancocas Creek Basin is located within or near the approximate boundary of the Middle District. Thus, it may not be possible to satisfactorily determine if a Middle District plant is present due to watershed disturbance or because an area falls within its natural range. Regardless, Middle District plants were generally associated with waters characterized by elevated pH.

COMPARISON OF STUDY BASINS

The Rancocas Creek Basin comprises four major study basins, including the Greenwood Branch, North Branch, South Branch, and Southwest Branch basins. Ecological integrity, based on land-use related disturbance, water quality, and the composition of

stream vegetation and fish and anuran assemblages, varied among the four basins.

The results of the different water-quality and biological inventories and analyses presented in this report are summarized in Table 1. Ecological-integrity scores were derived by ranking pH, specific conductance, and altered-land values and community-ordination scores and converting the scores to a relative scale of 0 to 100. Low pH, specific conductance, and altered-land values and biological communities characterized by native species are represented by high attribute scores. In contrast, high pH, specific conductance, and altered land values and biological communities with a higher percentage of nonnative plant or animal species are represented by low attribute scores. The individual attribute scores were used to calculate median survey-site scores that were then divided into five parts (quintiles) and assigned a one to five star rating. Five stars indicate a relatively high degree of ecological integrity and one star indicates a relatively low degree of ecological integrity. Median study-basin ratings were also calculated using the individual survey-site ratings. Confidence in the accuracy of a survey-site rating increases with the number of individual attributes used to derive the rating.

Of the four study basins, the Greenwood Branch sites had the highest ecological-integrity ratings. Low pH and low specific conductance values typical of Pinelands basins with a high percentage of forest land characterized water quality in the Greenwood Branch study basin. Stream sites in the Greenwood Branch basin also supported a higher percentage of Pine Barrens District plant species than streams in other basins, and native fish and anuran assemblages were generally found at the survey sites.

The ecological-integrity ratings for most North Branch study-basin sites ranged from intermediate to low. Elevated pH and specific conductance values were reported for most North Branch stream sites. Disturbance-indicator plants were found at all North Branch survey sites, and nonnative fish species were collected at most sites. Bullfrogs were heard calling from all four North Branch study-basin impoundment sites, while native carpenter frogs were found at only one site.

The ecological-integrity ratings for the South Branch study-basin sites were intermediate between the Greenwood Branch and North Branch study basins. Acid-water conditions were reported for a majority of South Branch sampling sites. Most South Branch stream sites supported disturbance-indicator plants and other non-Pinelands plant species, but most fish assemblages were generally characterized by the absence of nonnative fish species. The native carpenter frog was heard calling at four impoundments, whereas bullfrogs were heard calling at five sites.

The Southwest Branch study basin had the lowest overall ecological-ratings of the four study basins. The majority of Southwest Branch monitoring sites were characterized by elevated pH and specific conductance values. A comparison of historical data sets with data collected during the Commission's survey suggests that pH has increased at some Southwest Branch sites during the past thirty years. Disturbance-indicator plants and other non-Pinelands plant species dominated the vegetation of most Southwest Branch sites. Although biogeography may be partly responsible for these patterns, non-Pinelands vegetation was associated with altered water quality. Nonnative fish species and bullfrogs were also found at most Southwest Branch survey sites. The presence of bullfrogs at Taunton Lake, where they were generally absent thirty years ago, suggests that a dramatic change in conditions at this lake occurred over the last three decades.

CONCLUSION

A significant portion of the Rancocas Creek Basin did not display water-quality or biological characteristics considered typical of the Pinelands. Although variations in stream-vegetation may be related in part to the natural distribution of plant species, altered water-quality and the presence of nonnative fish and bullfrogs indicate that land-use practices have had a substantial impact on most of the North Branch and Southwest Branch study basins and portions of the South Branch study basin. In contrast, the Greenwood Branch basin, which is dominated by state forest land, displays those qualities associated with the essential character of the Pinelands.

Table 1. Ecological-integrity scores for each survey site were derived by ranking pH, specific conductance, and altered-land values and community-ordination scores, converting the scores to a relative scale of 0 to 100, and using the final attribute scores to calculate a median ecological-integrity score for each site. The median scores were then divided into five parts (quintiles) and assigned a one to five star ecological-integrity rating. Five stars indicate a relatively high degree of ecological-integrity and one star indicates a relatively low degree of ecological-integrity. Median study-basin ratings were calculated for each study basin using the individual survey-site ratings. Confidence in the accuracy of a survey-site rating increases with the number of individual attributes used to derive the rating.

		Attribute Scores							
Study Basin and Site Name	Water Quality Site Code	Altered Land	pH	Specific Conductance	Stream Vegetation	Stream Fish	Anurans	Median Score	Ecological-Integrity Rating
Greenwood Branch									
Middle Branch Mount Misery Brook at Mount Misery-Pasadena	GMIMOUNT	100	98	80	100	-	-	99	i i i i i
McDonalds Branch at Butterworth Road	GMCBUTTE	100	90	94	95	-	100	95	i i i i i
North Branch Mount Misery Brook at unnamed sand road	GNOSANDR	92	80	98	93	80	-	92	i i i i i
Cooper Branch below Pakim Pond	GCOPAKIS	94	82	90	98	90	85	90	i i i i i
Mount Misery Brook at Route 70	GMORTE70	96	73	96	70	43	98	85	i i i i i
Greenwood Branch above New Lisbon Road-Four Mile Road	GGRIMPNT	81	69	78	84	78	-	78	i i i i i
Pole Bridge Branch at Whites Bogs-Pasadena Road	GPOWHITE	71	53	82	81	85	73	77	i i i i i
Bisphams Mill Creek at Turkey Buzzard Bridge Road	GBITURKE	85	65	65	91	45	-	65	i i i i
Pole Bridge Branch at Wissahickon Trail	GPOWISSA	65	61	76	58	63	-	63	i i i
Median Greenwood Branch Study-basin Rating									i i i i i
North Branch									
North Branch Rancocas Creek tributary at Magnolia Road	NNOTRMGU	77	67	86	-	100	59	77	i i i i i
North Branch Rancocas Creek at Military Road	NNOMILIT	83	69	100	47	50	-	69	i i i i
North Branch Rancocas Creek at Route 616	NNORT616	58	47	71	21	58	29	52	i i i
North Branch Rancocas Creek above New Lisbon-Four Mile Road	NNONEWLI	50	27	39	49	40	-	40	i i i
Jacks Run at Range Road	NJARANGE	40	35	43	40	25	12	37	i i
Ong Run at West Lakeshore Drive	NONWLAKE	23	22	22	26	28	-	23	i
Budds Run at Route 616	NBURT616	19	4	2	0	0	-	2	i
Median North Branch Study-basin Rating									i i i
South Branch									
Cedar Run at Burr's Mill Road	SCEBURRS	67	100	31	86	-	-	76	i i i i
Jade Run at Stocktons Bridge Road	SJASTOCK	60	76	49	79	88	-	76	i i i i
South Branch Rancocas Creek at Burr's Mill Road	SSOBURRS	90	86	55	65	-	-	75	i i i i
South Branch Burrs Mill Brook at Sooy Place Road	SSBSOOYS	75	96	61	74	65	85	75	i i i i
Burrs Mill Brook at Sooy Place Road	SBUSOOYS	69	78	69	88	73	56	71	i i i i
Friendship Creek at Irick's Causeway	SFRIRICK	79	59	92	67	70	-	70	i i i i
Friendship Creek at Camp Inawendiwin	SFRCAMPS	52	57	84	-	-	73	65	i i i
South Branch Rancocas Creek at Ridge Road	SSORIDGE	56	63	51	28	60	-	56	i i i
Friendship Creek at Retreat Road	SFRRETRE	54	55	47	51	38	12	49	i i i
South Branch Rancocas Creek tributary at Burr's Mill Road	SSOTRBUR	48	92	45	16	-	-	46	i i i
Friendship Creek at Powell Place Road	SFRPOWEL	35	45	37	35	48	29	36	i i
Bread and Cheese Run at New Road	SBRNEWRD	0	41	6	30	53	-	30	i i
Jade Run near Route 616	SJART616	17	20	4	5	20	24	18	i
Median South Branch Study-basin Rating									i i i
Southwest Branch									
Black Run tributary at Kettle Run Road	WBLTRKET	88	88	67	23	90	-	88	i i i i i
Black Run below abandoned cranberry bog	WBLSPRAY	98	84	41	72	98	51	78	i i i i i
Black Run at Route 5544	WBLRT544	73	94	73	33	95	-	73	i i i i
Cedar Run below Cedar Run Lake	WCEREFUG	63	49	88	77	75	61	69	i i i i
Kettle Run at Camp Kettle Run	WKEGIRLS	38	33	63	-	-	51	44	i i i
Bear Swamp River at Route 70	WBERTE70	29	51	8	44	83	-	44	i i i
Little Creek at Route 70	WLIRTE70	46	43	35	37	68	-	43	i i i
Haynes Creek at Breakneck Avenue	WHATAUNT	44	31	57	53	30	0	37	i i
Kettle Run at Sawmill Road	WKESAWMI	27	37	59	63	33	-	37	i i
Little Creek at Hawkins Road	WLIHAWKI	33	37	33	-	55	-	35	i i
Haynes Creek at Falls Road	WHAPINES	42	16	53	56	18	12	30	i i
Kettle Run below Hopewell Road	WKEHOPEW	8	18	29	60	35	29	29	i i
Haynes Creek tributary at Lake Stockwell	WHATRSTO	10	29	27	-	-	61	28	i i
Haynes Creek tributary at Route 619	WHATRBLU	31	24	20	42	23	-	24	i i
Haynes Creek at Route 623	WHART623	21	14	24	19	10	12	16	i
Southwest Branch Rancocas Creek at Route 70	WSORTE70	13	8	12	12	5	41	12	i
Southwest Branch Rancocas Creek at Route 541	WSORT541	15	6	14	2	13	0	9	i
Barton Run below Jennings Lake	WBAJENNS	2	0	18	14	3	24	8	i
Barton Run at Tuckerton Road	WBATUCKE	25	8	16	7	8	0	8	i
Haynes Creek tributary at Jackson Road below Birchwood Lake	WHATRBIR	4	12	10	-	-	0	7	i
Southwest Branch Rancocas Creek at Hartford Road	WSOHARTF	6	2	0	9	15	-	6	i
Median Southwest Branch Study-basin Rating									i i

APPENDIX 1. pH AND SPECIFIC CONDUCTANCE DATA

Appendix 1.1. Primary water-quality monitoring sites in the Rancocas Creek Basin. Latitude, longitude, and USGS 7.5 minute topographic quadrangle names are given in parentheses. Sites are ordered alphabetically by site code.

Site Name and Description	Site Code
Bisphams Mill Creek at Turkey Buzzard Bridge Road Pemberton Twp., Burlington Co. (lat 39°55'26.05", long 74°35'30.03", Browns Mills quad).	GBITURKE
Cooper Branch below Pakim Pond Woodland Twp., Burlington Co. (lat 39°52'51.98", long 74°31'56.83", Browns Mills quad).	GCOPAKIS
Greenwood Branch above New Lisbon Road-Four Mile Road Pemberton Twp., Burlington Co. (lat 39°57'22.63", long 74°37'39.54", Pemberton quad).	GGRIMPNT
McDonalds Branch at Butterworth Road Woodland Twp., Burlington Co. (lat 39°53'05.99", long 74°30'19.36", Browns Mills quad).	GMCBUTTE
Middle Branch Mount Misery Brook at Mount Misery-Pasadena Road Woodland Twp., Burlington Co. (lat 39°54'59.96", long 74°30'31.10", Browns Mills quad).	GMIMOUNT
Mount Misery Brook at Route 70 Pemberton Twp., Burlington Co. (lat 39°55'44.97", long 74°31'52.13", Browns Mills quad).	GMORTE70
North Branch Mount Misery Brook at unnamed sand road Woodland Twp., Burlington Co. (lat 39°55'20.42", long 74°28'42.11", Whiting quad).	GNOSANDR
Pole Bridge Branch at Whites Bogs-Pasadena Road Pemberton Twp., Burlington Co. (lat 39°56'56.71", long 74°30'32.48", Browns Mills quad).	GPOWHITE
Pole Bridge Branch at Wissahickon Trail Pemberton Twp., Burlington Co. (lat 39°56'48.68", long 74°33'20.12", Browns Mills quad).	GPOWISSA
Budds Run at Route 616 Pemberton Twp., Burlington Co. (lat 39°58'34.43", long 74°40'51.28", Pemberton quad).	NBURT616
Jacks Run at Range Road New Hanover Twp., Burlington Co. (lat 39°59'30.8", long 74°34'12", Browns Mills quad). *Latitude and longitude values were obtained using ArcView software.	NJARANGE
North Branch Rancocas Creek at Military Road (below Hanover Lake) Pemberton Twp., Burlington Co. (lat 39°58'46.75", long 74°31'31.06", Browns Mills quad).	NNOMILIT
North Branch Rancocas Creek at New Lisbon Road-Four Mile Road Pemberton Twp., Burlington Co. (lat 39°57'36.62", long 74°37'44.75", Pemberton quad).	NNONEWLI
North Branch Rancocas Creek at Route 616 Pemberton Boro., Burlington Co. (lat 39°58'12.22", long 74°41'02.70", Pemberton quad).	NNORT616
North Branch Rancocas Creek tributary at Magnolia Road Pemberton Twp., Burlington Co. (lat 39°57'16.67", long 74°38'34.17", Pemberton quad).	NNOTRMGU
Ong Run at West Lakeshore Drive Pemberton Twp., Burlington Co. (lat 39°58'35.83", long 74°34'35.90", Browns Mills quad).	NONWLAKE
Bread and Cheese Run at New Road Tabernacle Twp., Burlington Co. (lat 39°51'20.96", long 74°42'21.17", Indian Mills quad).	SBRNEWRD
Burrs Mill Brook at Sooy Place Road Southampton Twp., Burlington Co. (lat 39°52'54.97", long 74°40'30.51", Pemberton quad).	SBUSOOYS
Cedar Run at Burr's Mill Road Southampton Twp., Burlington Co. (lat 39°54'39.54", long 74°39'52.89", Pemberton quad).	SCEBURRS
Friendship Creek at Camp Inawendiwin Tabernacle Twp., Burlington Co. (lat 39°51'50.18", long 74°41'17.86", Indian Mills quad).	SFRCAMPS
Friendship Creek at Irick's Causeway Tabernacle Twp., Burlington Co. (lat 39°51'36.07", long 74°39'35.68", Indian Mills quad).	SFRIRICK
Friendship Creek at Powell Place Road Tabernacle Twp., Burlington Co. (lat 39°52'15.73", long 74°41'35.06", Indian Mills quad).	SFRPOWEL
Friendship Creek at Retreat Road Southampton Twp., Burlington Co. (lat 39°54'59.64", long 74°42'49.85", Pemberton quad).	SFRRETRE
Jade Run near Route 616 Southampton Twp., Burlington Co. (lat 39°56'26.45", long 74°43'57.45", Pemberton quad).	SJART616
Jade Run at Stocktons Bridge Road Pemberton Twp., Burlington Co. (lat 39°55'44.40", long 74°40'07.60", Pemberton quad).	SJASTOCK

Site Name and Description	Site Code
South Branch Burrs Mill Brook at Sooy Place Road Woodland Twp., Burlington Co. (lat 39°51'34.09", long 74°35'53.34", Chatsworth quad).	SSBSOOYS
South Branch Rancocas Creek at Burr's Mill Road Southampton Twp., Burlington Co. (lat 39°54'56.46", long 74°40'49.53", Pemberton quad).	SSOBURRS
South Branch Rancocas Creek at Ridge Road Southampton Twp., Burlington Co. (lat 39°55'23.68", long 74°43'03.18", Pemberton quad).	SSORIDGE
South Branch Rancocas Creek tributary at Burr's Mill Road Southampton Twp., Burlington Co. (lat 39°55'17.08", long 74°40'59.58", Pemberton quad).	SSOTRBUR
Barton Run below Jennings Lake Evesham Twp., Burlington Co. (lat 39°51'56.45", long 74°53'40.96", Clementon quad).	WBAJENNS
Barton Run at Tuckerton Road Medford Twp., Burlington Co. (lat 39°52'43.75", long 74°51'36.28", Mount Holly quad).	WBATUCKE
Bear Swamp River at Route 70 Southampton Twp., Burlington Co. (lat 39°53'44.02", long 74°46'44.61", Mount Holly quad).	WBERTE70
Black Run at Route 544 Evesham Twp., Burlington Co. (lat 39°51'48.21", long 74°53'01.95", Clementon quad).	WBLRT544
Black Run below abandoned bogs Evesham Twp., Burlington Co. (lat 39°50'40.30", long 74°53'49.89", Clementon quad).	WBLSPRAY
Black Run tributary at Kettle Run Road Evesham Twp., Burlington Co. (lat 39°51'31.28", long 74°53'37.38", Clementon quad).	WBLTRKET
Cedar Run below Cedar Run Lake (at Woodford Cedar Run Refuge) Medford Twp., Burlington Co. (lat 39°49'19.25", long 74°50'50.35", Medford Lakes quad).	WCEREFUG
Haynes Creek at Falls Road (below Lake Pine) Medford Twp., Burlington Co. (lat 39°51'59.41", long 74°50'53.73", Medford Lakes quad).	WHAPINES
Haynes Creek at Route 623 Medford Twp., Burlington Co. (lat 39°53'06.86", long 74°49'53.66", Mount Holly quad).	WHART623
Haynes Creek at Breakneck Avenue (below Taunton Lake) Medford Twp., Burlington Co. (lat 39°51'10.24", long 74°51'14.50", Medford Lakes quad).	WHATAUNT
Haynes Creek tributary at Jackson Road (below Birchwood Lake) Medford Twp., Burlington Co. (lat 39°52'04.01", long 74°49'14.85", Medford Lakes quad).	WHATRBIR
Haynes Creek tributary at Hopewell Road (below Blue Lake) Medford Twp., Burlington Co. (lat 39°51'11.52", long 74°51'23.53", Medford Lakes quad).	WHATRBLU
Haynes Creek tributary at Lake Stockwell (at Camp Ockanickon) Medford Twp., Burlington Co. (lat 39°50'55.40", long 74°47'01.14", Medford Lakes quad).	WHATRSTO
Kettle Run at Camp Kettle Run Medford Twp., Burlington Co. (lat 39°49'02.61", long 74°51'35.73", Medford Lakes quad).	WKEGIRLS
Kettle Run at Hopewell Road (below Marlton Lakes) Evesham Twp., Burlington Co. (lat 39°48'11.71", long 74°53'35.05", Clementon quad).	WKEHOPEW
Kettle Run at Sawmill Road (below Braddocks Millpond) Medford Twp., Burlington Co. (lat 39°49'23.70", long 74°50'50.25", Medford Lakes quad).	WKESAWMI
Little Creek at Hawkins Road Medford Twp., Burlington Co. (lat 39°53'04.03", long 74°47'03.98", Mount Holly quad).	WLIHAWKI
Little Creek at Route 70 Southampton Twp., Burlington Co. (lat 39°53'54.29", long 74°47'17.18", Mount Holly quad).	WLIRTE70
Sharps Run at Route 541 Medford Twp., Burlington Co. (lat 39°54'18.81", long 74°49'28.89", Mount Holly quad).	WSHRT541
Southwest Branch Rancocas Creek at Hartford Road Medford Twp., Burlington Co. (lat 39°53'18.83", long 74°50'08.39", Mount Holly quad).	WSOHARTF
Southwest Branch Rancocas Creek at Route 541 Medford Twp., Burlington Co. (lat 39°53'43.82", long 74°49'25.13", Mount Holly quad).	WSORT541
Southwest Branch Rancocas Creek at Route 70 Medford Twp., Burlington Co. (lat 39°54'16.52", long 74°48'45.01", Mount Holly quad).	WSORTE70

Appendix 1.2. Specific conductance (SC, μS cm^{-1}) and pH values for 51 primary water-quality sites in the Rancocas Creek Basin. Refer to Chapter 2 (Water Quality) for methodology. A dash (-) indicates that a steam was dry.

Site Name	Site Code	Date	pH	SC
Bisphams Mill Creek at Turkey Buzzard Bridge Road	GBITURKE	06/07/2001	4.14	59.1
Bisphams Mill Creek at Turkey Buzzard Bridge Road	GBITURKE	07/10/2001	4.64	56.6
Bisphams Mill Creek at Turkey Buzzard Bridge Road	GBITURKE	08/07/2001	4.75	72.5
Bisphams Mill Creek at Turkey Buzzard Bridge Road	GBITURKE	09/04/2001	4.68	67.2
Bisphams Mill Creek at Turkey Buzzard Bridge Road	GBITURKE	10/11/2001	4.90	63.7
Bisphams Mill Creek at Turkey Buzzard Bridge Road	GBITURKE	11/14/2001	4.85	71.7
Cooper Branch below Pakim Pond	GCOPAKIS	06/07/2001	3.99	46.5
Cooper Branch below Pakim Pond	GCOPAKIS	07/10/2001	4.00	45.4
Cooper Branch below Pakim Pond	GCOPAKIS	08/07/2001	4.79	33.8
Cooper Branch below Pakim Pond	GCOPAKIS	09/04/2001	4.17	45.0
Cooper Branch below Pakim Pond	GCOPAKIS	10/11/2001	4.58	39.3
Cooper Branch below Pakim Pond	GCOPAKIS	11/14/2001	4.88	37.1
Greenwood Branch above New Lisbon Road-Four Mile Road	GGRIMPNT	06/07/2001	4.39	50.4
Greenwood Branch above New Lisbon Road-Four Mile Road	GGRIMPNT	07/10/2001	4.50	47.7
Greenwood Branch above New Lisbon Road-Four Mile Road	GGRIMPNT	08/07/2001	4.70	53.3
Greenwood Branch above New Lisbon Road-Four Mile Road	GGRIMPNT	09/04/2001	4.39	49.4
Greenwood Branch above New Lisbon Road-Four Mile Road	GGRIMPNT	10/11/2001	4.75	49.9
Greenwood Branch above New Lisbon Road-Four Mile Road	GGRIMPNT	11/14/2001	5.09	51.1
McDonalds Branch at Butterworth Road	GMCBUTTE	06/07/2001	4.05	45.0
McDonalds Branch at Butterworth Road	GMCBUTTE	07/10/2001	3.88	37.1
McDonalds Branch at Butterworth Road	GMCBUTTE	08/07/2001	4.50	35.0
McDonalds Branch at Butterworth Road	GMCBUTTE	09/04/2001	4.22	33.8
McDonalds Branch at Butterworth Road	GMCBUTTE	10/11/2001	3.96	36.3
McDonalds Branch at Butterworth Road	GMCBUTTE	11/14/2001	4.33	37.3
Middle Branch Mount Misery Brook at Mount Misery -Pasadena Road	GMIMOUNT	06/07/2001	3.93	52.9
Middle Branch Mount Misery Brook at Mount Misery -Pasadena Road	GMIMOUNT	07/10/2001	4.07	48.2
Middle Branch Mount Misery Brook at Mount Misery -Pasadena Road	GMIMOUNT	08/07/2001	4.05	40.1
Middle Branch Mount Misery Brook at Mount Misery -Pasadena Road	GMIMOUNT	09/04/2001	4.05	48.1
Middle Branch Mount Misery Brook at Mount Misery -Pasadena Road	GMIMOUNT	10/11/2001	4.00	81.5
Middle Branch Mount Misery Brook at Mount Misery -Pasadena Road	GMIMOUNT	11/14/2001	-	-
Mount Misery Brook at Route 70	GMORTE70	06/07/2001	4.28	37.8
Mount Misery Brook at Route 70	GMORTE70	07/10/2001	4.48	34.8
Mount Misery Brook at Route 70	GMORTE70	08/07/2001	4.60	32.6
Mount Misery Brook at Route 70	GMORTE70	09/04/2001	4.28	31.2
Mount Misery Brook at Route 70	GMORTE70	10/11/2001	4.70	32.0
Mount Misery Brook at Route 70	GMORTE70	11/14/2001	4.98	30.9
North Branch Mount Misery Brook at unnamed sand road	GNOSANDR	06/07/2001	4.23	40.4
North Branch Mount Misery Brook at unnamed sand road	GNOSANDR	07/10/2001	4.44	34.0
North Branch Mount Misery Brook at unnamed sand road	GNOSANDR	08/07/2001	4.29	30.5
North Branch Mount Misery Brook at unnamed sand road	GNOSANDR	09/04/2001	4.45	28.3
North Branch Mount Misery Brook at unnamed sand road	GNOSANDR	10/11/2001	4.77	29.3
North Branch Mount Misery Brook at unnamed sand road	GNOSANDR	11/14/2001	4.57	27.8
Pole Bridge Branch at Whites Bogs-Pasadena Road	GPOWHITE	06/07/2001	5.99	46.0
Pole Bridge Branch at Whites Bogs-Pasadena Road	GPOWHITE	07/10/2001	5.04	49.3
Pole Bridge Branch at Whites Bogs-Pasadena Road	GPOWHITE	08/07/2001	4.96	43.9
Pole Bridge Branch at Whites Bogs-Pasadena Road	GPOWHITE	09/04/2001	4.53	46.1
Pole Bridge Branch at Whites Bogs-Pasadena Road	GPOWHITE	10/11/2001	5.12	47.8
Pole Bridge Branch at Whites Bogs-Pasadena Road	GPOWHITE	11/14/2001	5.16	47.7
Pole Bridge Branch at Wissahickon Trail	GPOWISSA	06/07/2001	4.64	52.2
Pole Bridge Branch at Wissahickon Trail	GPOWISSA	07/10/2001	4.63	48.2
Pole Bridge Branch at Wissahickon Trail	GPOWISSA	08/07/2001	4.95	53.3
Pole Bridge Branch at Wissahickon Trail	GPOWISSA	09/04/2001	4.69	51.3
Pole Bridge Branch at Wissahickon Trail	GPOWISSA	10/11/2001	4.82	53.8
Pole Bridge Branch at Wissahickon Trail	GPOWISSA	11/14/2001	4.77	55.1

Site Name	Site Code	Date	pH	SC
Budds Run at Route 616	NBURT616	06/08/2001	7.13	207.0
Budds Run at Route 616	NBURT616	07/11/2001	7.22	228.0
Budds Run at Route 616	NBURT616	08/07/2001	7.18	230.0
Budds Run at Route 616	NBURT616	09/05/2001	7.24	243.0
Budds Run at Route 616	NBURT616	10/10/2001	6.88	241.0
Budds Run at Route 616	NBURT616	11/15/2001	6.85	239.0
Jacks Run at Range Road	NJARANGE	06/07/2001	5.54	52.5
Jacks Run at Range Road	NJARANGE	07/26/2001	6.04	79.6
Jacks Run at Range Road	NJARANGE	08/07/2001	6.27	86.5
Jacks Run at Range Road	NJARANGE	09/04/2001	6.20	78.3
Jacks Run at Range Road	NJARANGE	10/11/2001	6.35	78.7
Jacks Run at Range Road	NJARANGE	11/14/2001	6.09	71.3
North Branch Rancocas Creek at Military Road (below Hanover Lake)	NNOMILIT	06/07/2001	4.55	28.1
North Branch Rancocas Creek at Military Road (below Hanover Lake)	NNOMILIT	07/26/2001	3.96	30.3
North Branch Rancocas Creek at Military Road (below Hanover Lake)	NNOMILIT	08/07/2001	4.67	31.7
North Branch Rancocas Creek at Military Road (below Hanover Lake)	NNOMILIT	09/04/2001	4.65	28.6
North Branch Rancocas Creek at Military Road (below Hanover Lake)	NNOMILIT	10/11/2001	4.40	27.4
North Branch Rancocas Creek at Military Road (below Hanover Lake)	NNOMILIT	11/14/2001	4.77	27.8
North Branch Rancocas Creek at New Lisbon Road-Four Mile Road	NNONEWLI	06/07/2001	6.22	78.6
North Branch Rancocas Creek at New Lisbon Road-Four Mile Road	NNONEWLI	07/10/2001	6.50	75.9
North Branch Rancocas Creek at New Lisbon Road-Four Mile Road	NNONEWLI	08/07/2001	6.84	84.8
North Branch Rancocas Creek at New Lisbon Road-Four Mile Road	NNONEWLI	09/04/2001	6.58	85.0
North Branch Rancocas Creek at New Lisbon Road-Four Mile Road	NNONEWLI	10/11/2001	6.25	85.9
North Branch Rancocas Creek at New Lisbon Road-Four Mile Road	NNONEWLI	11/14/2001	6.47	95.1
North Branch Rancocas Creek at Route 616	NNORT616	06/08/2001	5.51	57.6
North Branch Rancocas Creek at Route 616	NNORT616	07/11/2001	5.66	56.8
North Branch Rancocas Creek at Route 616	NNORT616	08/07/2001	6.15	62.6
North Branch Rancocas Creek at Route 616	NNORT616	09/05/2001	5.75	60.1
North Branch Rancocas Creek at Route 616	NNORT616	10/10/2001	6.50	61.8
North Branch Rancocas Creek at Route 616	NNORT616	11/15/2001	5.95	65.6
North Branch Rancocas Creek tributary at Magnolia Road	NNOTRMGU	06/07/2001	4.39	44.7
North Branch Rancocas Creek tributary at Magnolia Road	NNOTRMGU	07/10/2001	3.83	47.3
North Branch Rancocas Creek tributary at Magnolia Road	NNOTRMGU	08/07/2001	4.93	51.3
North Branch Rancocas Creek tributary at Magnolia Road	NNOTRMGU	09/04/2001	4.32	42.6
North Branch Rancocas Creek tributary at Magnolia Road	NNOTRMGU	10/11/2001	5.69	42.7
North Branch Rancocas Creek tributary at Magnolia Road	NNOTRMGU	11/14/2001	5.72	43.1
Ong Run at West Lakeshore Drive	NONWLAKE	06/07/2001	6.49	105.9
Ong Run at West Lakeshore Drive	NONWLAKE	07/10/2001	6.62	114.3
Ong Run at West Lakeshore Drive	NONWLAKE	08/07/2001	6.52	125.2
Ong Run at West Lakeshore Drive	NONWLAKE	09/04/2001	6.68	124.0
Ong Run at West Lakeshore Drive	NONWLAKE	10/11/2001	6.47	121.6
Ong Run at West Lakeshore Drive	NONWLAKE	11/14/2001	6.55	118.2
Bread and Cheese Run at New Road	SBRNEWRD	06/07/2001	5.91	217.0
Bread and Cheese Run at New Road	SBRNEWRD	07/10/2001	6.16	213.0
Bread and Cheese Run at New Road	SBRNEWRD	08/08/2001	6.15	191.1
Bread and Cheese Run at New Road	SBRNEWRD	09/04/2001	5.97	204.0
Bread and Cheese Run at New Road	SBRNEWRD	10/11/2001	6.02	204.0
Bread and Cheese Run at New Road	SBRNEWRD	11/14/2001	6.16	203.0
Burrs Mill Brook at Sooy Place Road	SBUSOOYS	06/07/2001	4.20	58.4
Burrs Mill Brook at Sooy Place Road	SBUSOOYS	07/10/2001	4.28	60.7
Burrs Mill Brook at Sooy Place Road	SBUSOOYS	08/07/2001	4.50	61.8
Burrs Mill Brook at Sooy Place Road	SBUSOOYS	09/04/2001	4.41	59.2
Burrs Mill Brook at Sooy Place Road	SBUSOOYS	10/11/2001	4.56	65.8
Burrs Mill Brook at Sooy Place Road	SBUSOOYS	11/14/2001	4.58	62.4
Cedar Run at Burr's Mill Road	SCEBURRS	06/07/2001	3.77	72.8
Cedar Run at Burr's Mill Road	SCEBURRS	07/10/2001	3.92	70.6
Cedar Run at Burr's Mill Road	SCEBURRS	08/07/2001	-	-
Cedar Run at Burr's Mill Road	SCEBURRS	09/04/2001	-	-

Site Name	Site Code	Date	pH	SC
Cedar Run at Burr's Mill Road	SCEBURRS	10/11/2001	3.85	158.6
Cedar Run at Burr's Mill Road	SCEBURRS	11/14/2001	3.76	136.5
Friendship Creek at Camp Inawendiwin	SFRCAMPS	06/08/2001	4.58	50.6
Friendship Creek at Camp Inawendiwin	SFRCAMPS	07/10/2001	4.90	47.9
Friendship Creek at Camp Inawendiwin	SFRCAMPS	08/07/2001	5.32	48.6
Friendship Creek at Camp Inawendiwin	SFRCAMPS	09/05/2001	4.72	44.9
Friendship Creek at Camp Inawendiwin	SFRCAMPS	10/11/2001	5.16	44.2
Friendship Creek at Camp Inawendiwin	SFRCAMPS	11/14/2001	5.73	43.5
Friendship Creek at Irick's Causeway	SFRIRICK	10/11/2001	4.37	42.8
Friendship Creek at Irick's Causeway	SFRIRICK	11/14/2001	5.16	40.0
Friendship Creek at Powell Place Road	SFRPOWEL	06/07/2001	5.33	98.2
Friendship Creek at Powell Place Road	SFRPOWEL	07/10/2001	5.74	89.7
Friendship Creek at Powell Place Road	SFRPOWEL	08/07/2001	6.07	109.0
Friendship Creek at Powell Place Road	SFRPOWEL	09/04/2001	6.03	96.6
Friendship Creek at Powell Place Road	SFRPOWEL	10/11/2001	5.75	85.9
Friendship Creek at Powell Place Road	SFRPOWEL	11/14/2001	5.97	92.5
Friendship Creek at Retreat Road	SFRRETRE	06/08/2001	4.85	72.2
Friendship Creek at Retreat Road	SFRRETRE	07/10/2001	4.70	68.8
Friendship Creek at Retreat Road	SFRRETRE	08/07/2001	5.13	76.5
Friendship Creek at Retreat Road	SFRRETRE	09/04/2001	4.97	74.9
Friendship Creek at Retreat Road	SFRRETRE	10/11/2001	5.23	82.1
Friendship Creek at Retreat Road	SFRRETRE	11/14/2001	5.37	81.6
Jade Run near Route 616	SJART616	06/08/2001	6.57	142.0
Jade Run near Route 616	SJART616	07/11/2001	6.28	137.7
Jade Run near Route 616	SJART616	08/07/2001	6.58	199.2
Jade Run near Route 616	SJART616	09/05/2001	6.65	301.0
Jade Run near Route 616	SJART616	10/10/2001	6.66	211.0
Jade Run near Route 616	SJART616	11/15/2001	6.57	222.0
Jade Run at Stocktons Bridge Road	SJASTOCK	06/07/2001	4.16	70.3
Jade Run at Stocktons Bridge Road	SJASTOCK	07/10/2001	4.57	71.7
Jade Run at Stocktons Bridge Road	SJASTOCK	08/07/2001	5.00	95.2
Jade Run at Stocktons Bridge Road	SJASTOCK	09/04/2001	4.72	78.9
Jade Run at Stocktons Bridge Road	SJASTOCK	10/11/2001	4.15	117.2
Jade Run at Stocktons Bridge Road	SJASTOCK	11/14/2001	4.49	64.0
South Branch Burrs Mill Brook at Sooy Place Road	SSBSOOYS	06/07/2001	3.75	70.7
South Branch Burrs Mill Brook at Sooy Place Road	SSBSOOYS	07/10/2001	3.82	69.4
South Branch Burrs Mill Brook at Sooy Place Road	SSBSOOYS	08/07/2001	4.13	56.9
South Branch Burrs Mill Brook at Sooy Place Road	SSBSOOYS	09/04/2001	4.00	64.1
South Branch Burrs Mill Brook at Sooy Place Road	SSBSOOYS	10/11/2001	4.11	69.5
South Branch Burrs Mill Brook at Sooy Place Road	SSBSOOYS	11/14/2001	4.27	58.5
South Branch Rancocas Creek at Burr's Mill Road	SSOBURRS	06/07/2001	3.73	66.0
South Branch Rancocas Creek at Burr's Mill Road	SSOBURRS	07/10/2001	4.29	70.0
South Branch Rancocas Creek at Burr's Mill Road	SSOBURRS	08/07/2001	4.53	63.8
South Branch Rancocas Creek at Burr's Mill Road	SSOBURRS	09/04/2001	-	-
South Branch Rancocas Creek at Burr's Mill Road	SSOBURRS	10/11/2001	5.43	120.2
South Branch Rancocas Creek at Burr's Mill Road	SSOBURRS	11/14/2001	3.89	128.5
South Branch Rancocas Creek at Ridge Road	SSORIDGE	06/08/2001	4.74	67.3
South Branch Rancocas Creek at Ridge Road	SSORIDGE	07/10/2001	4.52	66.4
South Branch Rancocas Creek at Ridge Road	SSORIDGE	08/07/2001	4.61	73.8
South Branch Rancocas Creek at Ridge Road	SSORIDGE	09/04/2001	4.81	71.6
South Branch Rancocas Creek at Ridge Road	SSORIDGE	10/11/2001	4.71	83.8
South Branch Rancocas Creek at Ridge Road	SSORIDGE	11/14/2001	4.91	77.5
South Branch Rancocas Creek tributary at Burr's Mill Road	SSOTRBUR	06/07/2001	6.07	87.6
South Branch Rancocas Creek tributary at Burr's Mill Road	SSOTRBUR	07/10/2001	4.04	70.0
South Branch Rancocas Creek tributary at Burr's Mill Road	SSOTRBUR	08/07/2001	4.09	77.6
South Branch Rancocas Creek tributary at Burr's Mill Road	SSOTRBUR	09/04/2001	-	-
South Branch Rancocas Creek tributary at Burr's Mill Road	SSOTRBUR	10/11/2001	-	-
South Branch Rancocas Creek tributary at Burr's Mill Road	SSOTRBUR	11/14/2001	-	-

Site Name	Site Code	Date	pH	SC
Barton Run below Jennings Lake	WBAJENNS	06/08/2001	7.22	146.4
Barton Run below Jennings Lake	WBAJENNS	07/11/2001	7.49	144.3
Barton Run below Jennings Lake	WBAJENNS	08/08/2001	7.23	164.7
Barton Run below Jennings Lake	WBAJENNS	09/05/2001	7.17	156.4
Barton Run below Jennings Lake	WBAJENNS	10/10/2001	6.87	133.4
Barton Run below Jennings Lake	WBAJENNS	11/15/2001	6.83	168.1
Barton Run at Tuckerton Road	WBATUCKE	06/08/2001	6.71	145.7
Barton Run at Tuckerton Road	WBATUCKE	07/11/2001	6.61	143.1
Barton Run at Tuckerton Road	WBATUCKE	08/08/2001	6.86	163.4
Barton Run at Tuckerton Road	WBATUCKE	09/05/2001	6.93	148.2
Barton Run at Tuckerton Road	WBATUCKE	10/10/2001	7.04	168.0
Barton Run at Tuckerton Road	WBATUCKE	11/15/2001	7.08	179.5
Bear Swamp River at Route 70	WBERTE70	06/08/2001	4.23	95.5
Bear Swamp River at Route 70	WBERTE70	07/11/2001	4.20	101.8
Bear Swamp River at Route 70	WBERTE70	08/08/2001	-	-
Bear Swamp River at Route 70	WBERTE70	09/05/2001	6.21	277.0
Bear Swamp River at Route 70	WBERTE70	10/10/2001	6.72	333.0
Bear Swamp River at Route 70	WBERTE70	11/15/2001	-	-
Black Run at Route 544	WBLRT544	06/08/2001	3.89	59.8
Black Run at Route 544	WBLRT544	07/11/2001	4.06	45.5
Black Run at Route 544	WBLRT544	08/08/2001	-	-
Black Run at Route 544	WBLRT544	09/05/2001	3.97	54.2
Black Run at Route 544	WBLRT544	10/10/2001	4.27	72.1
Black Run at Route 544	WBLRT544	11/15/2001	4.30	83.4
Black Run below abandoned cranberry bogs	WBLSPRAY	06/08/2001	4.22	81.3
Black Run below abandoned cranberry bogs	WBLSPRAY	07/11/2001	4.24	73.6
Black Run below abandoned cranberry bogs	WBLSPRAY	08/08/2001	4.36	55.0
Black Run below abandoned cranberry bogs	WBLSPRAY	09/05/2001	4.42	84.0
Black Run below abandoned cranberry bogs	WBLSPRAY	10/10/2001	4.41	95.2
Black Run below abandoned cranberry bogs	WBLSPRAY	11/15/2001	4.36	98.3
Black Run tributary at Kettle Run Road	WBLTRKET	07/11/2001	4.50	43.8
Black Run tributary at Kettle Run Road	WBLTRKET	08/08/2001	-	-
Black Run tributary at Kettle Run Road	WBLTRKET	09/05/2001	4.26	55.9
Black Run tributary at Kettle Run Road	WBLTRKET	10/10/2001	3.92	72.7
Black Run tributary at Kettle Run Road	WBLTRKET	11/15/2001	4.24	90.2
Cedar Run below Cedar Run Lake (at Woodford Cedar Run Refuge)	WCEREFUG	07/11/2001	6.12	52.7
Cedar Run below Cedar Run Lake (at Woodford Cedar Run Refuge)	WCEREFUG	08/08/2001	5.99	83.8
Cedar Run below Cedar Run Lake (at Woodford Cedar Run Refuge)	WCEREFUG	09/05/2001	5.58	43.4
Cedar Run below Cedar Run Lake (at Woodford Cedar Run Refuge)	WCEREFUG	10/10/2001	5.45	32.6
Cedar Run below Cedar Run Lake (at Woodford Cedar Run Refuge)	WCEREFUG	11/15/2001	5.84	42.7
Haynes Creek at Falls Road (below Lake Pine)	WHAPINES	06/08/2001	5.94	69.8
Haynes Creek at Falls Road (below Lake Pine)	WHAPINES	07/11/2001	6.55	68.6
Haynes Creek at Falls Road (below Lake Pine)	WHAPINES	08/08/2001	6.78	73.5
Haynes Creek at Falls Road (below Lake Pine)	WHAPINES	09/05/2001	6.89	70.6
Haynes Creek at Falls Road (below Lake Pine)	WHAPINES	10/10/2001	6.92	75.2
Haynes Creek at Falls Road (below Lake Pine)	WHAPINES	11/15/2001	6.46	74.2
Haynes Creek at Route 623	WHART623	06/08/2001	6.29	98.9
Haynes Creek at Route 623	WHART623	07/11/2001	6.60	105.0
Haynes Creek at Route 623	WHART623	08/08/2001	6.74	142.3
Haynes Creek at Route 623	WHART623	09/05/2001	6.61	101.9
Haynes Creek at Route 623	WHART623	10/10/2001	6.97	128.0
Haynes Creek at Route 623	WHART623	11/15/2001	6.87	114.3
Haynes Creek at Breakneck Avenue (below Taunton Lake)	WHATAUNT	06/08/2001	5.43	64.5
Haynes Creek at Breakneck Avenue (below Taunton Lake)	WHATAUNT	07/11/2001	6.14	67.3
Haynes Creek at Breakneck Avenue (below Taunton Lake)	WHATAUNT	08/08/2001	6.75	68.2
Haynes Creek at Breakneck Avenue (below Taunton Lake)	WHATAUNT	09/05/2001	6.24	65.6
Haynes Creek at Breakneck Avenue (below Taunton Lake)	WHATAUNT	10/10/2001	6.77	71.1
Haynes Creek at Breakneck Avenue (below Taunton Lake)	WHATAUNT	11/15/2001	6.31	71.4

Site Name	Site Code	Date	pH	SC
Haynes Creek tributary at Jackson Road (below Birchwood Lake)	WHATRBIR	06/08/2001	6.79	148.9
Haynes Creek tributary at Jackson Road (below Birchwood Lake)	WHATRBIR	07/11/2001	6.82	167.0
Haynes Creek tributary at Jackson Road (below Birchwood Lake)	WHATRBIR	08/08/2001	7.26	201.0
Haynes Creek tributary at Jackson Road (below Birchwood Lake)	WHATRBIR	09/05/2001	7.00	181.9
Haynes Creek tributary at Jackson Road (below Birchwood Lake)	WHATRBIR	10/10/2001	6.47	166.2
Haynes Creek tributary at Jackson Road (below Birchwood Lake)	WHATRBIR	11/15/2001	6.68	235.0
Haynes Creek tributary at Route 619 (below Blue Lake)	WHATRBLU	06/08/2001	6.30	114.4
Haynes Creek tributary at Route 619 (below Blue Lake)	WHATRBLU	07/11/2001	6.46	123.4
Haynes Creek tributary at Route 619 (below Blue Lake)	WHATRBLU	08/08/2001	6.77	123.2
Haynes Creek tributary at Route 619 (below Blue Lake)	WHATRBLU	09/05/2001	6.45	134.8
Haynes Creek tributary at Route 619 (below Blue Lake)	WHATRBLU	10/10/2001	6.84	146.7
Haynes Creek tributary at Route 619 (below Blue Lake)	WHATRBLU	11/15/2001	6.59	158.9
Haynes Creek tributary at Lake Stockwell (at Camp Ockanickon)	WHATRSTO	06/08/2001	5.15	95.2
Haynes Creek tributary at Lake Stockwell (at Camp Ockanickon)	WHATRSTO	07/11/2001	6.55	99.3
Haynes Creek tributary at Lake Stockwell (at Camp Ockanickon)	WHATRSTO	08/08/2001	7.38	106.1
Haynes Creek tributary at Lake Stockwell (at Camp Ockanickon)	WHATRSTO	09/05/2001	7.32	107.5
Haynes Creek tributary at Lake Stockwell (at Camp Ockanickon)	WHATRSTO	10/10/2001	6.41	108.1
Haynes Creek tributary at Lake Stockwell (at Camp Ockanickon)	WHATRSTO	11/15/2001	6.14	115.2
Kettle Run at Camp Kettle Run	WKEGIRLS	06/08/2001	6.21	66.1
Kettle Run at Hopewell Road (below Marlton Lakes)	WKEHOPEW	06/08/2001	7.07	104.8
Kettle Run at Hopewell Road (below Marlton Lakes)	WKEHOPEW	07/11/2001	6.88	102.5
Kettle Run at Hopewell Road (below Marlton Lakes)	WKEHOPEW	08/08/2001	6.75	107.4
Kettle Run at Hopewell Road (below Marlton Lakes)	WKEHOPEW	09/05/2001	6.28	105.1
Kettle Run at Hopewell Road (below Marlton Lakes)	WKEHOPEW	10/10/2001	6.34	110.5
Kettle Run at Hopewell Road (below Marlton Lakes)	WKEHOPEW	11/15/2001	6.53	122.6
Kettle Run at Sawmill Road (below Braddocks Millpond)	WKESAWMI	06/08/2001	6.04	69.3
Kettle Run at Sawmill Road (below Braddocks Millpond)	WKESAWMI	07/11/2001	6.47	65.4
Kettle Run at Sawmill Road (below Braddocks Millpond)	WKESAWMI	08/08/2001	6.29	65.8
Kettle Run at Sawmill Road (below Braddocks Millpond)	WKESAWMI	09/05/2001	6.09	64.2
Kettle Run at Sawmill Road (below Braddocks Millpond)	WKESAWMI	10/10/2001	6.15	68.0
Kettle Run at Sawmill Road (below Braddocks Millpond)	WKESAWMI	11/15/2001	5.72	89.4
Little Creek at Hawkins Road	WLIHAWKI	07/11/2001	5.87	88.6
Little Creek at Hawkins Road	WLIHAWKI	08/08/2001	6.12	100.3
Little Creek at Hawkins Road	WLIHAWKI	09/05/2001	6.15	98.1
Little Creek at Hawkins Road	WLIHAWKI	10/10/2001	5.76	103.0
Little Creek at Hawkins Road	WLIHAWKI	11/15/2001	6.18	100.4
Little Creek at Route 70	WLIRTE70	06/08/2001	4.60	75.1
Little Creek at Route 70	WLIRTE70	07/11/2001	5.25	81.4
Little Creek at Route 70	WLIRTE70	08/08/2001	5.96	96.1
Little Creek at Route 70	WLIRTE70	09/05/2001	6.50	99.0
Little Creek at Route 70	WLIRTE70	10/10/2001	5.95	101.2
Little Creek at Route 70	WLIRTE70	11/15/2001	5.80	102.6
Sharps Run at Route 541	WSHRT541	06/08/2001	6.94	330.0
Sharps Run at Route 541	WSHRT541	07/11/2001	7.12	310.0
Sharps Run at Route 541	WSHRT541	08/08/2001	6.89	240.0
Sharps Run at Route 541	WSHRT541	09/05/2001	7.20	324.0
Sharps Run at Route 541	WSHRT541	10/10/2001	6.92	327.0
Sharps Run at Route 541	WSHRT541	11/15/2001	7.07	387.0
Southwest Branch Rancocas Creek at Hartford Road	WSOHARTF	06/08/2001	7.13	226.0
Southwest Branch Rancocas Creek at Hartford Road	WSOHARTF	07/11/2001	7.13	289.0
Southwest Branch Rancocas Creek at Hartford Road	WSOHARTF	08/08/2001	7.20	340.0
Southwest Branch Rancocas Creek at Hartford Road	WSOHARTF	09/05/2001	7.31	332.0
Southwest Branch Rancocas Creek at Hartford Road	WSOHARTF	10/10/2001	7.07	329.0
Southwest Branch Rancocas Creek at Hartford Road	WSOHARTF	11/15/2001	7.21	347.0
Southwest Branch Rancocas Creek at Route 541	WSORT541	06/08/2001	6.82	150.5
Southwest Branch Rancocas Creek at Route 541	WSORT541	07/11/2001	6.72	164.0
Southwest Branch Rancocas Creek at Route 541	WSORT541	08/08/2001	6.96	203.0
Southwest Branch Rancocas Creek at Route 541	WSORT541	09/05/2001	6.86	158.8

Site Name	Site Code	Date	pH	SC
Southwest Branch Rancocas Creek at Route 541	WSORT541	10/10/2001	7.09	160.6
Southwest Branch Rancocas Creek at Route 541	WSORT541	11/15/2001	7.37	183.2
Southwest Branch Rancocas Creek at Route 70	WSORTE70	06/08/2001	6.92	150.3
Southwest Branch Rancocas Creek at Route 70	WSORTE70	07/11/2001	6.92	167.8
Southwest Branch Rancocas Creek at Route 70	WSORTE70	08/08/2001	6.87	192.0
Southwest Branch Rancocas Creek at Route 70	WSORTE70	09/05/2001	6.87	157.9
Southwest Branch Rancocas Creek at Route 70	WSORTE70	10/10/2001	6.81	152.1
Southwest Branch Rancocas Creek at Route 70	WSORTE70	11/15/2001	7.02	185.6

Appendix 1.3. Supplemental water-quality monitoring sites in the Rancocas Creek Basin. Latitude, longitude, and USGS 7.5 minute topographic quadrangle names are given in parentheses. Sites are ordered alphabetically by site code.

Site Name and Description	Site Code
Presidential Lakes Pemberton Twp., Burlington Co. (lat 39°54'32.47", long 74°34'25.29", Browns Mills quad).	GBIPRESU
Barton Run below Jennings Lake Evesham Twp., Burlington Co. (lat 39°51'56.45", long 74°53'40.96", Clementon quad).	WBAJENNS
Black Run at Kettle Run Road Evesham Twp., Burlington Co. (lat 39°49'58.65", long 74°53'34.47", Clementon quad).	WBLKETTL
Black Run at Route 544 Evesham Twp., Burlington Co. (lat 39°51'48.21", long 74°53'01.95", Clementon quad).	WBLRT544
Black Run below abandoned cranberry bog Evesham Twp., Burlington Co. (lat 39°50'40.30", long 74°53'49.89", Clementon quad).	WBLSPRAY
Black Run tributary at Braddocks Mill Road Evesham Twp., Burlington Co. (lat 39°51'0.68", long 74°54'22.17", Clementon quad).	WBLTRBRA
Black Run tributary at Kettle Run Road Evesham Twp., Burlington Co. (lat 39°51'31.28", long 74°53'37.38", Clementon quad).	WBLTRKET
Black Run tributary at Kettle Run Road Evesham Twp., Burlington Co. (lat 39°50'29.41", long 74°53'53.93", Clementon quad).	WBLTRSPR
Cedar Run at Oak Ridge Drive Medford Twp., Burlington Co. (lat 39°48'24.04", long 74°51'36.66", Medford Lakes quad).	WCEOAKRI
Cedar Run at powerline road in Woodford Cedar Run Refuge Medford Twp., Burlington Co. (lat 39°49'06.52", long 74°50'58.09", Medford Lakes quad).	WCEPOWER
Cedar Run below Cedar Run Lake (at Woodford Cedar Run Refuge) Medford Twp., Burlington Co. (lat 39°49'19.25", long 74°50'50.35", Medford Lakes quad).	WCEREFUG
Haynes Creek at Falls Road (below Lake Pine) Medford Twp., Burlington Co. (lat 39°51'59.41", long 74°50'53.73", Medford Lakes quad).	WHAPINES
Haynes Creek tributary at Shanty Dam Road and Cedar Falls Drive Medford Twp., Burlington Co. (lat 39°50'31.90", long 74°50'38.54", Medford Lakes quad).	WHATRCED
Haynes Creek tributary at Hinchman Drive Medford Twp., Burlington Co. (lat 39°51'05.02", long 74°50'56.98", Medford Lakes quad).	WHATRHIN
Haynes Creek tributary at Hopewell Road (below Harmony Lake) Evesham Twp., Burlington Co. (lat 39°49'35.52", long 74°52'30.15", Clementon quad).	WHATRHOP
Haynes Creek tributary at Jackson-Medford Road (northern Mimosa Lakes inlet) Medford Twp., Burlington Co. (lat 39°50'14.81", long 74°50'00.71", Medford Lakes quad).	WHATRJMN
Haynes Creek tributary at Jackson-Medford Road Medford Twp., Burlington Co. (lat 39°49'24.73", long 74°50'26.84", Medford Lakes quad).	WHATRJMR
Haynes Creek tributary at Jackson-Medford Road (southern Mimosa Lakes inlet) Medford Twp., Burlington Co. (lat 39°50'03.28", long 74°50'05.90", Medford Lakes quad).	WHATRJMS
Haynes Creek tributary above Lake Stockwell Medford Twp., Burlington Co. (lat 39°51'09.37", long 74°47'23.60", Medford Lakes quad).	WHATROCU
Haynes Creek tributary at Pontiac Drive Medford Twp., Burlington Co. (lat 39°50'42.31", long 74°50'45.59", Medford Lakes quad).	WHATRPON
Haynes Creek tributary at Scout Drive Medford Twp., Burlington Co. (lat 39°50'16.58", long 74°50'37.20", Medford Lakes quad).	WHATRSCO
Haynes Creek tributary at Shanty Dam Road Medford Twp., Burlington Co. (lat 39°50'28.82", long 74°50'44.47", Medford Lakes quad).	WHATRSHA
Kettle Run tributary at Kettle Run Road Evesham Twp., Burlington Co. (lat 39°49'03.88", long 74°53'55.99", Clementon quad).	WHATRYMC
Kettle Run at Hopewell Road (below Marlton Lakes) Evesham Twp., Burlington Co. (lat 39°48'11.71", long 74°53'35.05", Clementon quad).	WKEHOPEW
Kettle Run at Sawmill Road (below Braddocks Millpond) Medford Twp., Burlington Co. (lat 39°49'23.70", long 74°50'50.25", Medford Lakes quad).	WKESAWMI

Site Name and Description	Site Code
Kettle Run at Sycamore Avenue Evesham Twp., Burlington Co. (lat 39°48'36.45", long 74°54'28.28", Clementon quad).	WKESYCAM
Little Creek at Shawnee Pass Medford Twp., Burlington Co. (lat 39°51'41.76", long 74°47'01.24", Medford Lakes quad).	WLISHAWU

Appendix 1.4. Specific conductance (SC, μS cm^{-1}) and pH values for 27 supplemental water-quality sites in the Rancocas Creek Basin. Refer to Chapter 2 (Water Quality) for methodology.

Site Name	Site Code	Date	pH	SC
Presidential Lakes	GBIPRESU	10/29/2001	5.44	42.4
Presidential Lakes	GBIPRESU	11/07/2001	5.33	49.0
Barton Run below Jennings Lake	WBAJENNS	10/15/2001	6.36	158.5
Barton Run below Jennings Lake	WBAJENNS	10/22/2001	6.77	156.1
Barton Run below Jennings Lake	WBAJENNS	10/29/2001	6.54	169.6
Barton Run below Jennings Lake	WBAJENNS	11/07/2001	7.22	163.7
Black Run at Kettle Run Road	WBLKETTL	10/15/2001	4.76	39.2
Black Run at Route 544	WBLRT544	10/15/2001	4.21	61.3
Black Run at Route 544	WBLRT544	10/22/2001	4.31	70.2
Black Run at Route 544	WBLRT544	10/29/2001	5.11	78.1
Black Run at Route 544	WBLRT544	11/07/2001	4.55	79.1
Black Run below spray fields	WBLSPRAY	10/15/2001	4.29	90.7
Black Run below spray fields	WBLSPRAY	10/22/2001	4.29	96.7
Black Run below spray fields	WBLSPRAY	10/29/2001	4.35	96.1
Black Run below spray fields	WBLSPRAY	11/07/2001	4.35	100.4
Black Run tributary at Braddocks Mill Road	WBLTRBRA	10/15/2001	3.99	85.7
Black Run tributary at Braddocks Mill Road	WBLTRBRA	10/22/2001	3.90	84.0
Black Run tributary at Braddocks Mill Road	WBLTRBRA	10/29/2001	3.97	79.8
Black Run tributary at Braddocks Mill Road	WBLTRBRA	11/07/2001	4.01	90.3
Black Run tributary at Kettle Run Road	WBLTRKET	10/15/2001	3.96	60.5
Black Run tributary at Kettle Run Road	WBLTRKET	10/22/2001	3.74	77.6
Black Run tributary at Kettle Run Road	WBLTRKET	10/29/2001	4.20	66.3
Black Run tributary at Kettle Run Road	WBLTRKET	11/07/2001	4.23	93.6
Black Run tributary at Kettle Run Road	WBLTRSPR	10/22/2001	3.53	279.0
Black Run tributary at Kettle Run Road	WBLTRSPR	10/29/2001	3.72	256.0
Black Run tributary at Kettle Run Road	WBLTRSPR	11/07/2001	3.61	243.0
Cedar Run at Oak Ridge Drive	WCEOAKRI	10/15/2001	4.21	36.8
Cedar Run at Oak Ridge Drive	WCEOAKRI	10/22/2001	5.89	38.0
Cedar Run at Oak Ridge Drive	WCEOAKRI	10/29/2001	4.47	42.2
Cedar Run at Oak Ridge Drive	WCEOAKRI	11/07/2001	4.68	44.8
Cedar Run at powerline road in Woodford Cedar Run Refuge	WCEPOWER	10/15/2001	5.65	53.1
Cedar Run at powerline road in Woodford Cedar Run Refuge	WCEPOWER	10/22/2001	5.78	77.8
Cedar Run at powerline road in Woodford Cedar Run Refuge	WCEPOWER	10/29/2001	6.09	87.3
Cedar Run at powerline road in Woodford Cedar Run Refuge	WCEPOWER	11/07/2001	6.08	72.0
Cedar Run below Cedar Run Lake (at Woodford Cedar Run Refuge)	WCEREFUG	10/15/2001	4.66	35.2
Cedar Run below Cedar Run Lake (at Woodford Cedar Run Refuge)	WCEREFUG	10/22/2001	4.76	35.4
Cedar Run below Cedar Run Lake (at Woodford Cedar Run Refuge)	WCEREFUG	10/29/2001	5.71	43.6
Cedar Run below Cedar Run Lake (at Woodford Cedar Run Refuge)	WCEREFUG	11/07/2001	6.05	46.7
Haynes Creek at Falls Road (below Lake Pine)	WHAPINES	10/15/2001	6.06	72.6
Haynes Creek at Falls Road (below Lake Pine)	WHAPINES	10/22/2001	6.30	76.1
Haynes Creek at Falls Road (below Lake Pine)	WHAPINES	10/29/2001	6.36	76.5
Haynes Creek at Falls Road (below Lake Pine)	WHAPINES	11/07/2001	6.46	83.0
Haynes Creek tributary at Shanty Dam Road and Cedar Falls Drive	WHATRCED	10/15/2001	5.71	52.2
Haynes Creek tributary at Shanty Dam Road and Cedar Falls Drive	WHATRCED	10/22/2001	5.81	54.8
Haynes Creek tributary at Shanty Dam Road and Cedar Falls Drive	WHATRCED	10/29/2001	6.14	59.5
Haynes Creek tributary at Shanty Dam Road and Cedar Falls Drive	WHATRCED	11/07/2001	6.82	63.7
Haynes Creek tributary at Hinchman Drive	WHATRHIN	10/15/2001	4.36	80.8
Haynes Creek tributary at Hinchman Drive	WHATRHIN	10/22/2001	4.60	81.7
Haynes Creek tributary at Hinchman Drive	WHATRHIN	10/29/2001	4.65	81.6
Haynes Creek tributary at Hinchman Drive	WHATRHIN	11/07/2001	4.60	79.1
Haynes Creek tributary at Hopewell Road (below Harmony Lake)	WHATRHOP	10/15/2001	5.71	74.9
Haynes Creek tributary at Hopewell Road (below Harmony Lake)	WHATRHOP	10/22/2001	5.51	77.4
Haynes Creek tributary at Hopewell Road (below Harmony Lake)	WHATRHOP	10/29/2001	5.97	76.1
Haynes Creek tributary at Hopewell Road (below Harmony Lake)	WHATRHOP	11/07/2001	5.83	74.8
Haynes Creek tributary at Jackson-Medford Road (northern Mimosa Lakes inlet)	WHATRJMN	10/15/2001	6.23	67.1
Haynes Creek tributary at Jackson-Medford Road (northern Mimosa Lakes inlet)	WHATRJMN	10/22/2001	6.93	94.8
Haynes Creek tributary at Jackson-Medford Road (northern Mimosa Lakes inlet)	WHATRJMN	10/29/2001	6.67	87.8
Haynes Creek tributary at Jackson-Medford Road (northern Mimosa Lakes inlet)	WHATRJMN	11/07/2001	7.01	83.3

Site Name	Site Code	Date	pH	SC
Haynes Creek tributary at Jackson-Medford Road	WHATRJMR	10/15/2001	4.64	39.3
Haynes Creek tributary at Jackson-Medford Road	WHATRJMR	10/22/2001	4.45	44.2
Haynes Creek tributary at Jackson-Medford Road	WHATRJMR	10/29/2001	6.19	161.8
Haynes Creek tributary at Jackson-Medford Road	WHATRJMR	11/07/2001	6.89	243.0
Haynes Creek tributary at Jackson-Medford Road (southern Mimosa Lakes inlet)	WHATRJMS	10/15/2001	5.63	41.9
Haynes Creek tributary at Jackson-Medford Road (southern Mimosa Lakes inlet)	WHATRJMS	10/22/2001	5.91	43.8
Haynes Creek tributary at Jackson-Medford Road (southern Mimosa Lakes inlet)	WHATRJMS	10/29/2001	5.24	43.6
Haynes Creek tributary at Jackson-Medford Road (southern Mimosa Lakes inlet)	WHATRJMS	11/07/2001	6.03	43.3
Haynes Creek tributary above Lake Stockwell	WHATROCU	10/22/2001	4.96	45.5
Haynes Creek tributary above Lake Stockwell	WHATROCU	10/29/2001	5.28	46.8
Haynes Creek tributary above Lake Stockwell	WHATROCU	11/07/2001	4.97	46.4
Haynes Creek tributary at Pontiac Drive	WHATRPON	10/15/2001	6.14	51.7
Haynes Creek tributary at Pontiac Drive	WHATRPON	10/22/2001	5.86	59.6
Haynes Creek tributary at Pontiac Drive	WHATRPON	10/29/2001	6.18	53.2
Haynes Creek tributary at Pontiac Drive	WHATRPON	11/07/2001	6.35	56.2
Haynes Creek tributary at Scout Drive	WHATRSCO	10/15/2001	6.25	47.7
Haynes Creek tributary at Scout Drive	WHATRSCO	10/22/2001	6.52	48.9
Haynes Creek tributary at Scout Drive	WHATRSCO	10/29/2001	6.54	48.8
Haynes Creek tributary at Scout Drive	WHATRSCO	11/07/2001	6.71	50.3
Haynes Creek tributary at Shanty Dam Road	WHATRSHA	10/15/2001	6.32	51.9
Haynes Creek tributary at Shanty Dam Road	WHATRSHA	10/22/2001	6.23	54.2
Haynes Creek tributary at Shanty Dam Road	WHATRSHA	10/29/2001	6.44	53.3
Haynes Creek tributary at Shanty Dam Road	WHATRSHA	11/07/2001	6.49	53.8
Kettle Run tributary at Kettle Run Road	WHATRYMC	10/15/2001	5.66	30.9
Kettle Run tributary at Kettle Run Road	WHATRYMC	10/22/2001	5.80	32.9
Kettle Run tributary at Kettle Run Road	WHATRYMC	10/29/2001	5.54	34.1
Kettle Run tributary at Kettle Run Road	WHATRYMC	11/07/2001	5.86	29.1
Kettle Run at Hopewell Road (below Marlton Lakes)	WKEHOPEW	10/15/2001	6.24	109.7
Kettle Run at Hopewell Road (below Marlton Lakes)	WKEHOPEW	10/22/2001	6.37	121.1
Kettle Run at Hopewell Road (below Marlton Lakes)	WKEHOPEW	10/29/2001	6.69	123.5
Kettle Run at Hopewell Road (below Marlton Lakes)	WKEHOPEW	11/07/2001	6.97	124.0
Kettle Run at Sawmill Road (below Braddocks Millpond)	WKESAWMI	10/15/2001	6.18	67.9
Kettle Run at Sawmill Road (below Braddocks Millpond)	WKESAWMI	10/22/2001	6.32	70.5
Kettle Run at Sawmill Road (below Braddocks Millpond)	WKESAWMI	10/29/2001	6.02	69.9
Kettle Run at Sawmill Road (below Braddocks Millpond)	WKESAWMI	11/07/2001	6.02	93.8
Kettle Run at Sycamore Avenue	WKESYCAM	10/15/2001	5.61	40.9
Kettle Run at Sycamore Avenue	WKESYCAM	10/22/2001	5.59	44.8
Kettle Run at Sycamore Avenue	WKESYCAM	10/29/2001	5.50	57.9
Kettle Run at Sycamore Avenue	WKESYCAM	11/07/2001	5.72	42.5
Little Creek at Shawnee Pass	WLISHAWU	10/22/2001	6.57	172.8
Little Creek at Shawnee Pass	WLISHAWU	10/29/2001	6.38	176.6
Little Creek at Shawnee Pass	WLISHAWU	11/07/2001	6.70	179.2

APPENDIX 2. STREAM-VEGETATION DATA

Appendix 2.0. Stream-vegetation monitoring sites in the Rancocas Creek Basin. Stream sections are 10 m in length. Latitude, longitude, and USGS 7.5 minute topographic quadrangle names are given in parentheses. Sites are ordered alphabetically by site code.

Site Name and Description	Site Code
Bisphams Mill Creek at Turkey Buzzard Bridge Road Pemberton Twp., Burlington Co. (lat 39°55'26.05", long 74°35'30.03", Browns Mills quad). Sections located upstream and downstream from Turkey Buzzard Bridge Road.	GBITURKE
Cooper Branch below Pakim Pond Woodland Twp., Burlington Co. (lat 39°52'51.98", long 74°31'56.83", Browns Mills quad). Both sections located downstream from Batona Trail, below Pakim Pond.	GCOPAKIS
Greenwood Branch at Meadowview Lane Pemberton Twp., Burlington Co. (lat 39°57'30.75", long 74°37'59.16", Pemberton quad). Sections located upstream and downstream from Meadowview Lane.	GGRMEADO
McDonalds Branch at Butterworth Road Woodland Twp., Burlington Co. (lat 39°53'05.99", long 74°30'19.36", Whiting quad). Sections located upstream from USGS gaging station and downstream from Butterworth Road.	GMCBUTTE
Middle Branch Mount Misery Brook at Mount Misery-Pasadena Road Woodland Twp., Burlington Co. (lat 39°54'59.96", long 74°30'31.10", Browns Mills quad). Sections located upstream from USGS gaging station and downstream from Mount Misery-Pasadena Road.	GMIMOUNT
Mount Misery Brook at Route 70 Pemberton Twp., Burlington Co. (lat 39°55'44.97", long 74°31'52.13", Browns Mills quad). Sections located upstream and downstream from Route 70.	GMORTE70
North Branch Mount Misery Brook at unnamed sand road Pemberton and Woodland Twps., Burlington Co. (lat 39°55'20.42", long 74°28'42.11", Whiting quad). Sections located upstream and downstream from unnamed sand road.	GNOSANDR
Pole Bridge Branch at Whites Bogs-Pasadena Road Pemberton Twp., Burlington Co. (lat 39°56'56.71", long 74°30'32.48", Browns Mills quad). Sections located upstream and downstream from Whites Bogs-Pasadena Road.	GPOWHITE
Pole Bridge Branch at Wissahickon Trail Pemberton Twp., Burlington Co. (lat 39°56'48.68", long 74°33'20.12", Browns Mills quad). Sections located upstream and downstream from Wissahickon Trail, below Country Lake.	GPOWISSA
Budds Run above Route 616 Pemberton Twp., Burlington Co. (lat 39°58'34.43", long 74°40'51.28", Pemberton quad). Both sections located upstream from Hanover Street (Route 616).	NBURT616
Jacks Run at Range Road New Hanover Twp., Burlington Co. (lat 39°59'30.80", long 74°34'12.00", Browns Mills quad). Sections located upstream and downstream from Range Road.	NJARANGE
North Branch Rancocas Creek at Military Road Pemberton Twp., Burlington Co. (lat 39°58'46.75", long 74°31'31.06", Browns Mills quad). Sections located upstream and downstream from Military Road.	NNOMILIT
North Branch Rancocas Creek above New Lisbon-Four Mile Road Pemberton Twp., Burlington Co. (lat 39°57'36.62", long 74°37'44.75", Pemberton quad). Both sections located approximately 250 m upstream from New Lisbon-Four Mile Road.	NNONEWLI
North Branch Rancocas Creek at Route 616 Pemberton Twp., Burlington Co. (lat 39°58'12.22", long 74°41'02.70", Pemberton quad). Sections located upstream and downstream from Hanover Street (Route 616).	NNORT616
Ong Run at West Lakeshore Drive Pemberton Twp., Burlington Co. (lat 39°58'35.83", long 74°34'35.90", Browns Mills quad). Sections located upstream and downstream from West Lakeshore Drive.	NONWLAKE
Bread and Cheese Run at New Road Tabernacle Twp., Burlington Co. (lat 39°51'20.96", long 74°42'21.17", Indian Mills quad). Sections located upstream and downstream from New Road.	SBRNEWRD
Burrs Mill Brook at Sooy Place Road Southampton Twp., Burlington Co. (lat 39°52'54.97", long 74°40'30.51", Pemberton quad). Sections located upstream and downstream from Sooy Place Road.	SBUSOOYS

Site Name and Description	Site Code
Cedar Run at Burr's Mill Road Southampton Twp., Burlington Co. (lat 39°54'39.54", long 74°39'52.89", Pemberton quad). Sections located upstream and downstream from Burr's Mill Road.	SCEBURRS
Friendship Creek at Irick's Causeway Tabernacle Twp., Burlington Co. (lat 39°51'36.07", long 74°39'35.68", Indian Mills quad). Sections located upstream and downstream from Irick's Causeway.	SFRIRICK
Friendship Creek at Powell Place Road Tabernacle Twp., Burlington Co. (lat 39°52'15.73", long 74°41'35.06", Indian Mills quad). Sections located upstream and downstream from Powell Place Road.	SFRPOWEL
Friendship Creek at Retreat Road Southampton Twp., Burlington Co. (lat 39°54'59.64", long 74°42'49.85", Pemberton quad). Sections located upstream and downstream from Retreat Road.	SFRRETRE
Jade Run near Route 616 Southampton Twp., Burlington Co. (lat 39°56'26.45", long 74°43'57.45", Pemberton quad). Sections located upstream and downstream from unnamed sand road, south of Pemberton Road (Route 616), between Brace Road and Route 206.	SJART616
Jade Run at Stocktons Bridge Road Southampton Twp., Burlington Co. (lat 39°55'44.40", long 74°40'07.60", Pemberton quad). Sections located upstream and downstream from Stocktons Bridge Road.	SJASTOCK
South Branch Burrs Mill Brook at Sooy Place Road Woodland Twp., Burlington Co. (lat 39°51'34.09", long 74°35'53.34", Chatsworth quad). Sections located upstream and downstream from Sooy Place Road.	SSBSOOYS
South Branch Rancocas Creek at Burr's Mill Road Southampton Twp., Burlington Co. (lat 39°54'56.46", long 74°40'49.53", Pemberton quad). Sections located upstream and downstream from Burr's Mill Road.	SSOBURRS
South Branch Rancocas Creek at Ridge Road Southampton Twp., Burlington Co. (lat 39°55'23.68", long 74°43'03.18", Pemberton quad). Sections located upstream and downstream from Ridge Road (Buddtown-Beaverville Road).	SSORIDGE
South Branch Rancocas Creek tributary at Burr's Mill Road Southampton Twp., Burlington Co. (lat 39°55'17.08", long 74°40'59.58", Pemberton quad). Both sections located downstream from Burr's Mill Road.	SSOTRBUR
Barton Run below Jennings Lake Evesham Twp., Burlington Co. (lat 39°51'56.45", long 74°53'40.96", Clementon quad). Both sections located downstream from Tomlinson Mill Road, below Jennings Lake.	WBAJENNS
Barton Run at Tuckerton Road Medford Twp., Burlington Co. (lat 39°52'43.75", long 74°51'36.28", Mount Holly quad). Sections located upstream and downstream from Tuckerton Road.	WBATUCKE
Bear Swamp River at Route 70 Southampton Twp., Burlington Co. (lat 39°53'44.02", long 74°46'44.61", Mount Holly quad). Sections located upstream and downstream from Route 70.	WBERTE70
Black Run at Route 544 Evesham Twp., Burlington Co. (lat 39°51'48.21", long 74°53'01.95", Clementon quad). Sections located upstream and downstream from Tomlinson Mill Road (Route 544).	WBLRT544
Black Run below abandoned cranberry bog Evesham Twp., Burlington Co. (lat 39°50'40.30", long 74°53'49.89", Clementon quad). Both sections located downstream from abandoned cranberry bog.	WBLSPRAY
Black Run tributary at Kettle Run Road Evesham Twp., Burlington Co. (lat 39°51'31.28", long 74°53'37.38", Clementon quad). Sections located upstream and downstream from Kettle Run Road.	WBLTRKET
Cedar Run below Cedar Run Lake Medford Twp., Burlington Co. (lat 39°49'19.25", long 74°50'50.35", Medford Lakes quad). Both sections located downstream from sand road, below Cedar Run Lake.	WCEREFUG
Haynes Creek below Falls Road Medford Twp., Burlington Co. (lat 39°51'59.41", long 74°50'53.73", Medford Lakes quad). Both sections located downstream from Falls Road, below Lake Pine.	WHAPINES

Site Name and Description	Site Code
Haynes Creek at Route 623 Medford Twp., Burlington Co. (lat 39°53'06.86", long 74°49'53.66", Mount Holly quad). Sections located upstream and downstream from Himmelein Road (Route 623).	WHART623
Haynes Creek below Breakneck Avenue Medford Twp., Burlington Co. (lat 39°51'10.24", long 74°51'14.50", Medford Lakes quad). Both sections located downstream from Breakneck Avenue, below Taunton Lake.	WHATAUNT
Haynes Creek tributary at Hopewell Road Medford Twp., Burlington Co. (lat 39°51'11.52", long 74°51'23.53", Medford Lakes quad). Sections located upstream and downstream from Hopewell Road, near intersection with Breakneck Road.	WHATRBLU
Kettle Run below Hopewell Road Evesham Twp., Burlington Co. (lat 39°48'11.71", long 74°53'35.05", Clementon quad). Both sections located downstream from Hopewell Road.	WKEHOPEW
Kettle Run at Sawmill Road Medford Twp., Burlington Co. (lat 39°49'23.70", long 74°50'50.25", Medford Lakes quad). Sections located upstream and downstream from Sawmill Road.	WKESAWMI
Little Creek at Route 70 Medford and SouthamptonTwps., Burlington Co. (lat 39°53'54.29", long 74°47'17.18", Mount Holly quad). Sections located upstream and downstream from Route 70.	WLIRTE70
Sharps Run at Route 541 Medford Twp., Burlington Co. (lat 39°54'18.81", long 74°49'28.89", Mount Holly quad). Sections located upstream and downstream from Main Street (Stokes Road or Route 541).	WSHRT541
Southwest Branch Rancocas Creek at Hartford Road Medford Twp., Burlington Co. (lat 39°53'18.83", long 74°50'08.39", Mount Holly quad). Sections located upstream and downstream from Hartford Road.	WSOHARTF
Southwest Branch Rancocas Creek at Route 541 Medford Twp., Burlington Co. (lat 39°53'43.82", long 74°49'25.13", Mount Holly quad). Sections located upstream and downstream from Main Street (Stokes Road or Route 541).	WSORT541
Southwest Branch Rancocas Creek at Route 70 Medford Twp., Burlington Co. (lat 39°54'16.52", long 74°48'45.01", Mount Holly quad). Sections located upstream and downstream from Route 70.	WSORTE70

Appendix 2.1. Plant species at stream-monitoring sites in the Rancocas Creek Basin. Filled circles indicate a species was present at a site. Refer to Chapter 3 (Stream Vegetation) for sampling details. Refer to Appendix 2.0 for detailed site information. Plant common names are presented in Appendix 2.2.

Species	Sites															
	GBITURKE	GCOPAKIS	GGRMEADO	GMCBUTTE	GMIMOUNT	GMORTE70	GNOSANDR	GPOWHITE	GPOWISSA	NBURT616	NJARANGE	NNOMILIT	NNONEWLI	NNORT616	NONWLAKE
Herbaceous plants:															
Agrostis hyemalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agrostis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ambrosia artemisiifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Andropogon virginicus var. abbreviatus	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Andropogon virginicus var. virginicus	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Apios americana	-	-	C	-	-	C	-	C	C	-	-	-	C	C	C
Apocynum cannabinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arisaema triphyllum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asclepias incarnata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Aster divaricatus	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Aster nemoralis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster novi-belgii	C	-	-	-	-	C	-	C	-	-	-	-	C	C	-
Aster racemosus	-	-	-	-	-	-	-	-	-	-	-	C	-	C	C
Aster sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Azolla sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Bartonia paniculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bidens connata	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Bidens coronata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bidens frondosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Bidens laevis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bidens polylepis	-	-	-	-	-	-	-	-	-	-	-	-	-	C	C
Bidens sp.	-	-	-	-	-	-	-	-	C	-	C	-	C	-	-
Boehmeria cylindrica	-	-	-	-	-	-	-	-	-	C	-	-	-	C	-
Botrychium dissectum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Callitriche heterophylla	-	-	-	-	-	-	-	-	-	-	-	-	C	C	C
Carex atlantica var. capillacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex bullata	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex collinsii	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-
Carex crinita	-	-	-	-	-	-	-	-	-	C	-	-	C	C	C
Carex debilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex intumescens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex lurida	-	-	-	-	-	-	-	-	-	-	C	-	C	C	C
Carex sp.	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Carex stipata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex striata	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex stricta	C	-	-	-	-	C	-	C	-	-	C	C	-	C	-
Carex trisperma	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-
Ceratophyllum echinatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chasmanthium laxum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Species	Sites														
	GBITURKE	GCOPAKIS	GGRMEADO	GMCBUTTE	GMIMOUNT	GMORTE70	GNOSANDR	GPOWHITE	GPOWISSA	NBURT616	NJARANGE	NNOMILIT	NNONEWLI	NNORT616	NONWLAKE
Chelone glabra	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Cinna arundinacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Cladium mariscoides	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Commelina communis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cuscuta sp.	-	-	-	-	-	-	-	C	-	-	-	C	-	C	C
Cyperus brevifoliodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyperus dentatus	-	-	-	-	-	-	-	-	-	-	-	-	C	C	-
Cyperus erythrorhizos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyperus retrorsus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyperus strigosus	-	-	-	-	-	-	-	-	C	-	-	-	C	C	-
Decodon verticillatus	-	C	-	-	C	-	-	-	C	-	-	-	-	C	C
Dioscorea villosa	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Drosera intermedia	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Drosera rotundifolia	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-
Dryopteris carthusiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dulichium arundinaceum	-	C	-	-	C	-	-	-	-	-	C	-	C	-	-
Echinochloa muricata	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Eleocharis acicularis	-	-	C	-	-	C	-	-	-	-	-	-	C	-	-
Eleocharis flavescens var. olivacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eleocharis robbinsii	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium coloratum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Equisetum arvense	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Erechtites hieracifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Eupatorium dubium	-	-	-	-	-	C	-	C	-	-	-	C	-	C	-
Eupatorium perfoliatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Eupatorium rugosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eupatorium serotinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eupatorium sp.	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Euthamia tenuifolia	-	-	-	-	-	-	-	-	C	-	-	-	C	-	-
Galium tinctorium	-	-	-	-	-	-	-	-	-	-	C	-	-	C	C
Glechoma hederacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glyceria obtusa	-	-	-	-	-	-	C	C	C	-	-	-	C	C	-
Glyceria striata	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Hypericum canadense	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Hypericum mutilum	-	-	-	-	-	-	-	-	-	-	-	-	C	C	C
Impatiens capensis	-	-	-	-	-	-	-	-	-	C	C	-	C	C	C
Iris versicolor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus acuminatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus caesariensis	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Juncus canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus effusus	-	C	-	-	-	C	-	-	C	-	-	C	C	C	C
Juncus pelocarpus	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Lachnanthes caroliniana	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-

Species	Sites														
	GBITURKE	GCOPAKIS	GGRMEADO	GMCBUTTE	GMIMOUNT	GMORTE70	GNOSANDR	GPOWHITE	GPOWISSA	NBURT616	NJARANGE	NNOMILIT	NNONEWLI	NNORT616	NONWLAKE
Leersia oryzoides	C	C	C	-	-	C	C	-	C	-	C	C	-	C	C
Lemna sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Lespedeza sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Lindernia dubia	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Lobelia cardinalis	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Lobelia nuttallii	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-
Ludwigia alternifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Ludwigia palustris	-	-	-	-	-	-	-	-	-	-	C	-	C	C	C
Lycopodium obscurum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lycopus uniflorus	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Lycopus virginicus	-	-	-	-	-	-	-	-	-	-	-	-	C	C	C
Lygodium palmatum	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-
Lysimachia terrestris	-	-	C	-	C	C	-	C	-	-	-	-	C	-	-
Lythrum salicaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microstegium vimineum	-	-	-	-	-	-	-	-	C	C	C	-	C	C	C
Mikania scandens	-	-	-	-	-	-	-	-	-	-	-	-	-	C	C
Mimulus alatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mimulus ringens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mitchella repens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Morus alba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myosotis laxa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Myriophyllum humile	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Nuphar variegata	-	C	-	-	-	-	-	C	-	-	C	C	C	C	-
Nymphaea odorata	-	C	-	-	C	-	-	-	-	-	-	-	-	-	-
Onoclea sensibilis	-	-	C	-	-	C	-	-	-	-	C	-	-	C	-
Orontium aquaticum	-	-	-	C	C	-	-	-	-	-	-	-	-	-	-
Osmunda cinnamomea	C	-	C	C	C	-	-	-	-	-	-	C	-	-	C
Osmunda regalis	-	-	-	-	-	C	C	C	-	-	-	-	-	-	-
Oxalis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panicum clandestinum	-	-	-	-	-	-	-	-	C	-	-	C	C	C	C
Panicum longifolium	-	-	-	-	-	-	-	-	C	-	-	-	C	-	-
Panicum sp.	C	-	-	-	-	C	-	-	C	-	-	-	C	-	-
Panicum verrucosum	-	-	C	-	-	-	-	-	C	-	-	-	C	-	-
Panicum virgatum	-	-	C	-	-	-	-	-	-	-	C	-	-	-	-
Peltandra virginica	-	C	C	-	-	C	-	C	-	-	-	C	-	C	-
Penthorum sedoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phalaris arundinacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phragmites australis	-	C	C	-	-	-	-	-	-	-	-	C	-	-	C
Pilea pumila	-	-	-	-	-	-	-	-	-	C	-	-	-	C	-
Polygonum arifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Polygonum cespitosum	-	-	-	-	-	-	-	-	C	C	-	-	-	-	C
Polygonum cuspidatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonum hydropiperoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Species	Sites														
	GBITURKE	GCOPAKIS	GGRMEADO	GMCBUTTE	GMIMOUNT	GMORTE70	GNOSANDR	GPOWHITE	GPOWISSA	NBURT616	NJARANGE	NNOMILIT	NNONEWLI	NNORT616	NONWLAKE
Polygonum persicaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonum punctatum	-	-	-	-	-	-	-	-	-	-	-	-	C	-	C
Polygonum sagittatum	-	-	-	-	-	-	-	-	-	-	C	-	C	C	C
Polygonum sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pontederia cordata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamogeton confervoides	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-
Potamogeton crispus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamogeton diversifolius	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Potamogeton epihydrus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamogeton pusillus	-	-	-	-	-	-	-	-	-	-	-	-	-	C	C
Pteridium aquilinum	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhexia virginica	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-
Rhynchospora capitellata	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Rumex obtusifolius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Sagittaria engelmanniana	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Sagittaria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Sanicula canadensis	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Saururus cernuus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scirpus cyperinus	-	C	-	-	-	-	-	-	C	-	C	-	-	C	C
Scirpus subterminalis	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-
Scirpus validus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scutellaria lateriflora	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Solidago rugosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solidago sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Sparganium americanum	C	-	-	C	-	C	-	-	-	-	C	C	C	-	C
Symplocarpus foetidus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Thalictrum pubescens	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Thelypteris palustris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thelypteris simulata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Triadenum virginicum	-	C	-	-	C	-	C	-	C	-	C	C	C	C	-
Typha latifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Unidentified herb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utricularia sp.	-	C	-	C	C	-	-	-	-	-	-	-	-	C	-
Utricularia vulgaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola lanceolata	-	-	C	-	-	-	-	-	-	-	-	-	C	-	-
Viola sp.	-	-	-	-	-	-	-	-	-	C	-	-	C	-	-
Woodwardia areolata	-	-	-	C	-	C	-	-	-	-	-	-	-	C	-
Woodwardia virginica	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Xyris difformis	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Woody plants:															
Acer negundo	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Acer platanoides	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-

Species	Sites														
	GBITURKE	GCOPAKIS	GGRMEADO	GMCBUTTE	GMIMOUNT	GMORTE70	GNOSANDR	GPOWHITE	GPOWISSA	NBURT616	NJARANGE	NNOMILIT	NNONEWLI	NNORT616	NONWLAKE
Acer rubrum	C	C	C	C	C	C	C	C	C	-	C	C	C	C	C
Acer saccharinum	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Ailanthus altissima	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alnus serrulata	-	-	-	-	C	C	-	C	-	-	C	C	C	C	-
Amelanchier canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amorpha fruticosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aronia arbutifolia	-	-	C	-	-	-	-	-	-	-	-	-	-	-	C
Berberis thunbergii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Betula nigra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula populifolia	-	-	-	C	-	-	-	-	-	-	-	-	-	C	-
Betula sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Campsis radicans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carpinus caroliniana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carya sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Catalpa bignonioides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Celastrus orbiculatus	-	-	-	-	-	C	-	-	-	-	-	-	-	-	C
Cephalanthus occidentalis	-	-	-	-	-	-	-	-	C	-	C	C	-	C	-
Chamaecyparis thyoides	C	C	-	C	C	C	C	C	-	-	-	-	-	-	-
Chamaedaphne calyculata	-	C	-	-	C	-	-	-	-	-	-	C	C	-	-
Clematis terniflora	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Clethra alnifolia	C	C	C	C	C	C	C	C	C	-	-	C	C	C	C
Cornus amomum	-	-	-	-	-	-	-	-	-	-	-	-	-	C	C
Cornus florida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corylus americana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eubotrys racemosa	C	C	C	C	C	C	C	C	C	-	C	-	-	C	-
Fagus grandifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fraxinus pennsylvanica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gaylussacia frondosa	C	C	-	C	C	-	-	-	-	-	-	-	-	-	-
Hypericum densiflorum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ilex glabra	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Ilex opaca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ilex verticillata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Itea virginica	-	-	C	-	-	-	-	C	-	-	-	-	-	-	-
Juglans nigra	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Juniperus virginiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalmia angustifolia	C	C	-	C	-	-	-	-	-	-	-	-	-	-	-
Kalmia latifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Lindera benzoin	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Liquidambar styraciflua	-	-	C	-	-	-	-	-	-	-	-	-	C	-	-
Liriodendron tulipifera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lonicera japonica	-	-	-	-	-	-	-	-	-	C	-	-	-	-	C
Lyonia ligustrina	C	C	C	-	-	-	-	C	-	-	-	-	-	-	-
Magnolia virginiana	-	-	-	C	C	-	-	-	-	-	-	-	-	-	C

Species	Sites														
	GBITURKE	GCOPAKIS	GGRMEADO	GMCBUTTE	GMIMOUNT	GMORTE70	GNOSANDR	GPOWHITE	GPOWISSA	NBURT616	NJARANGE	NNOMILIT	NNONEWLI	NNORT616	NONWLAKE
Morus rubra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myrica pensylvanica	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-
Nyssa sylvatica	C	-	-	C	-	C	-	C	C	-	-	-	-	-	C
Parthenocissus quinquefolia	-	-	-	-	-	-	-	C	C	C	C	C	-	C	C
Picea abies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinus rigida	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Platanus occidentalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Prunus serotina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quercus alba	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-
Quercus phellos	-	-	C	-	-	-	-	-	-	-	-	-	-	C	-
Quercus prinus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Quercus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quercus velutina	-	-	-	-	C	-	C	-	-	-	-	-	-	-	-
Rhododendron viscosum	C	C	C	C	C	C	C	C	-	-	-	-	-	-	C
Rosa sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	C	C
Rubus hispidus	C	-	-	-	-	C	-	C	C	-	-	-	-	-	-
Rubus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix sp.	-	-	-	-	-	-	-	-	C	-	C	C	-	-	-
Sambucus canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Sassafras albidum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smilax glauca	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smilax rotundifolia	C	C	C	C	-	C	-	C	C	-	-	-	-	C	C
Spiraea tomentosa	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Toxicodendron radicans	-	-	-	-	-	C	-	-	-	C	C	-	-	C	-
Ulmus rubra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ulmus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium corymbosum	C	C	C	C	C	C	C	C	C	-	C	-	C	-	C
Vaccinium macrocarpon	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Viburnum dentatum	-	-	-	-	-	-	-	-	-	-	C	C	-	-	-
Viburnum nudum var. nudum	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-
Vitis labrusca	-	-	-	-	-	C	-	-	C	-	-	C	-	-	-
Wisteria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C

Species	Sites														
	SBRNEWRD	SBUSOOYS	SCEBURRS	SFRIRICK	SFRPOWEL	SFRRETRE	SJART616	SJASTOCK	SSBSOOYS	SSOBURRS	SSORIDGE	SSOTRBUR	WBAJENNS	WBATUCKE	WBERTE70
Herbaceous plants:															
Agrostis hyemalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agrostis sp.	-	-	-	-	C	-	-	-	-	-	C	-	-	-	C
Ambrosia artemisiifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Andropogon virginicus var. abbreviatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Andropogon virginicus var. virginicus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apios americana	C	-	C	-	C	C	-	-	-	-	-	-	-	-	-
Apocynum cannabinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arisaema triphyllum	-	-	-	-	-	-	-	-	-	-	-	-	C	C	-
Asclepias incarnata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster divaricatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster nemoralis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster novi-belgii	C	-	-	-	C	-	-	-	-	C	-	-	-	-	C
Aster racemosus	-	-	-	-	-	-	C	-	C	-	-	-	-	C	-
Aster sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Azolla sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bartonia paniculata	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-
Bidens connata	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bidens coronata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bidens frondosa	-	-	-	-	C	-	-	-	-	-	-	-	-	C	-
Bidens laevis	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Bidens polylepis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bidens sp.	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-
Boehmeria cylindrica	-	-	-	-	-	-	C	-	-	-	C	C	C	C	-
Botrychium dissectum	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Callitriche heterophylla	C	-	-	-	-	-	C	-	-	-	-	-	-	C	-
Carex atlantica var. capillacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex bullata	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Carex collinsii	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-
Carex crinita	C	-	-	-	C	-	-	-	-	C	-	-	-	-	C
Carex debilis	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Carex intumescens	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex lurida	C	-	-	-	C	-	-	-	-	C	C	-	-	-	C
Carex sp.	-	C	C	-	C	-	-	-	C	-	C	-	-	C	C
Carex stipata	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-
Carex striata	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-
Carex stricta	C	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Carex trisperma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ceratophyllum echinatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chasmanthium laxum	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Chelone glabra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cinna arundinacea	-	-	-	-	-	-	-	-	-	-	-	-	C	C	-
Cladium mariscoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Species	Sites														
	SBRNEWRD	SBUSOOYS	SCEBURRS	SFRIRICK	SFRPOWEL	SFRRETRE	SJART616	SJASTOCK	SSBSOOYS	SSOBURRS	SSORIDGE	SSOTRBUR	WBAJENNS	WBATUCKE	WBERTE70
Commelina communis	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Cuscuta sp.	C	-	-	-	C	-	-	-	C	-	-	-	C	-	-
Cyperus brevifoliodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyperus dentatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyperus erythrorhizos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyperus retrorsus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyperus strigosus	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Decodon verticillatus	-	C	-	-	-	-	-	C	-	C	-	-	-	-	-
Dioscorea villosa	-	-	C	-	-	-	-	-	-	-	-	-	C	-	-
Drosera intermedia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Drosera rotundifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dryopteris carthusiana	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dulichium arundinaceum	-	C	-	-	-	-	-	-	C	C	-	-	-	-	-
Echinochloa muricata	-	-	-	-	-	-	-	-	-	-	C	-	-	-	C
Eleocharis acicularis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Eleocharis flavescens var. olivacea	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Eleocharis robbinsii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium coloratum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum arvense	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Erechtites hieracifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Eupatorium dubium	-	-	C	-	-	-	-	-	-	-	-	-	-	-	C
Eupatorium perfoliatum	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-
Eupatorium rugosum	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Eupatorium serotinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eupatorium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Euthamia tenuifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Galium tinctorium	-	-	-	-	C	-	-	-	-	C	-	-	-	-	-
Glechoma hederacea	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Glyceria obtusa	-	-	-	-	-	-	-	C	C	-	-	-	-	-	C
Glyceria striata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hypericum canadense	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Hypericum mutilum	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Impatiens capensis	C	-	-	-	C	-	C	-	-	-	-	C	C	C	-
Iris versicolor	-	-	-	-	-	-	C	-	-	-	-	-	C	-	-
Juncus acuminatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus caesariensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus canadensis	-	-	-	-	C	-	-	-	C	-	-	-	-	-	C
Juncus effusus	-	C	C	-	C	C	-	-	C	C	-	-	-	-	C
Juncus pelocarpus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lachnanthes caroliniana	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Leersia oryzoides	C	C	-	-	C	C	C	-	C	-	C	C	C	-	C
Lemna sp.	-	-	-	-	-	-	C	-	-	-	-	C	-	-	-
Lespedeza sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Species	Sites														
	SBRNEWRD	SBUSOOYS	SCEBURRS	SFRIRICK	SFRPOWEL	SFRRETRE	SJART616	SJASTOCK	SSBSOOYS	SSOBURRS	SSORIDGE	SSOTRBUR	WBAJENNS	WBATUCKE	WBERTE70
Lindernia dubia	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Lobelia cardinalis	-	-	-	-	C	-	-	-	-	-	-	-	C	-	-
Lobelia nuttallii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ludwigia alternifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ludwigia palustris	C	-	-	-	C	-	-	-	-	-	C	C	-	C	C
Lycopodium obscurum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lycopus uniflorus	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Lycopus virginicus	C	-	-	-	C	C	-	-	-	-	-	-	C	-	C
Lygodium palmatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lysimachia terrestris	-	-	C	-	C	-	-	-	C	-	-	-	-	-	C
Lythrum salicaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microstegium vimineum	C	-	C	C	C	-	C	-	C	C	C	C	C	C	C
Mikania scandens	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Mimulus alatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mimulus ringens	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-
Mitchella repens	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-
Morus alba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myosotis laxa	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myriophyllum humile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nuphar variegata	-	-	-	-	-	-	-	C	C	C	-	-	-	-	-
Nymphaea odorata	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Onoclea sensibilis	C	-	-	-	-	C	C	-	-	C	-	-	C	-	-
Orontium aquaticum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Osmunda cinnamomea	C	C	C	C	-	C	-	-	-	C	C	-	-	-	C
Osmunda regalis	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxalis sp.	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Panicum clandestinum	C	C	C	-	C	C	-	-	C	-	C	-	C	C	C
Panicum longifolium	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Panicum sp.	-	C	-	-	C	-	-	-	-	-	-	-	C	-	-
Panicum verrucosum	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Panicum virgatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peltandra virginica	-	-	-	-	C	-	C	C	C	-	C	-	C	-	-
Penthorum sedoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phalaris arundinacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phragmites australis	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Pilea pumila	C	-	-	-	C	-	C	-	-	C	-	-	C	C	-
Polygonum arifolium	C	-	-	-	-	-	-	-	-	-	C	-	-	-	C
Polygonum cespitosum	C	-	-	-	C	-	-	-	-	-	-	-	C	C	-
Polygonum cuspidatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonum hydropiperoides	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Polygonum persicaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonum punctatum	-	-	-	-	C	-	-	-	-	-	C	-	-	C	C
Polygonum sagittatum	C	-	-	-	C	-	C	-	-	-	-	-	-	-	-

Species	Sites														
	SBRNEWRD	SBUSOOYS	SCEBURRS	SFRIRICK	SFRPOWEL	SFRRETRE	SJART616	SJASTOCK	SSBSOOYS	SSOBURRS	SSORIDGE	SSOTRBUR	WBAJENNS	WBATUCKE	WBERTE70
Polygonum sp.	-	-	-	-	-	-	C	-	-	-	-	C	-	-	-
Pontederia cordata	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-
Potamogeton confervoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamogeton crispus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamogeton diversifolius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamogeton epihydrus	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamogeton pusillus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pteridium aquilinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhexia virginica	-	-	-	-	-	-	-	-	C	-	-	-	-	-	C
Rhynchospora capitellata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rumex obtusifolius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sagittaria engelmanniana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sagittaria sp.	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Sanicula canadensis	-	-	-	-	-	C	-	-	-	-	-	-	C	C	-
Saururus cernuus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scirpus cyperinus	-	C	-	-	C	-	-	-	-	-	-	-	-	-	C
Scirpus subterminalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scirpus validus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scutellaria lateriflora	-	-	-	-	C	-	-	-	-	-	-	-	C	-	-
Solidago rugosa	-	-	-	-	C	-	-	-	-	-	-	-	-	-	C
Solidago sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sparganium americanum	C	-	-	-	C	C	C	-	C	-	-	C	-	C	-
Symplocarpus foetidus	-	-	-	-	-	-	-	-	-	-	C	-	-	C	-
Thalictrum pubescens	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Thelypteris palustris	C	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Thelypteris simulata	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-
Triadenum virginicum	-	C	-	-	C	-	-	-	C	-	-	-	C	-	-
Typha latifolia	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Unidentified herb	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Utricularia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utricularia vulgaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola lanceolata	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Viola sp.	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-
Woodwardia areolata	C	C	C	C	-	-	-	C	-	-	-	-	-	-	C
Woodwardia virginica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xyris difformis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Woody plants:															
Acer negundo	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-
Acer platanoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acer rubrum	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Acer saccharinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ailanthus altissima	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-

Species	Sites														
	SBRNEWRD	SBUSOOYS	SCEBURRS	SFRIRICK	SFRPOWEL	SFRRETRE	SJART616	SJASTOCK	SSBSOOYS	SSOBURRS	SSORIDGE	SSOTRBUR	WBAJENNS	WBATUCKE	WBERTE70
Alnus serrulata	C	-	-	-	C	-	-	-	-	-	-	C	-	-	C
Amelanchier canadensis	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-
Amorpha fruticosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aronia arbutifolia	-	C	-	-	C	-	-	-	-	-	-	-	-	-	-
Berberis thunbergii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula nigra	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-
Betula populifolia	-	-	-	-	-	C	-	C	-	-	-	-	-	-	C
Betula sp.	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Campsis radicans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carpinus caroliniana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carya sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Catalpa bignonioides	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Celastrus orbiculatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cephalanthus occidentalis	-	-	-	-	-	C	C	-	C	-	C	-	-	-	-
Chamaecyparis thyoides	-	-	C	-	-	-	-	-	-	C	-	-	-	-	-
Chamaedaphne calyculata	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Clematis terniflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clethra alnifolia	C	C	C	C	C	C	-	C	C	C	C	-	C	-	C
Cornus amomum	-	-	-	-	-	-	C	-	-	-	-	-	C	-	-
Cornus florida	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corylus americana	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Eubotrys racemosa	-	C	C	C	-	C	-	-	C	C	-	-	-	-	C
Fagus grandifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fraxinus pennsylvanica	-	-	-	-	-	-	C	-	-	-	-	-	C	C	-
Gaylussacia frondosa	-	-	-	-	-	C	-	C	-	-	-	-	-	-	-
Hypericum densiflorum	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Ilex glabra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ilex opaca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ilex verticillata	-	-	-	C	-	-	-	-	-	C	-	-	C	-	-
Itea virginica	-	-	C	C	-	-	-	C	-	C	-	-	-	-	-
Juglans nigra	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Juniperus virginiana	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-
Kalmia angustifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalmia latifolia	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-
Lindera benzoin	-	-	-	C	-	-	-	-	-	-	-	-	C	C	-
Liquidambar styraciflua	-	-	-	-	-	C	-	C	-	-	C	C	C	C	C
Liriodendron tulipifera	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Lonicera japonica	-	-	-	-	-	-	C	-	-	-	-	C	C	C	C
Lyonia ligustrina	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Magnolia virginiana	C	-	C	-	C	C	-	C	-	C	-	-	-	-	-
Morus rubra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myrica pensylvanica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nyssa sylvatica	C	-	C	C	C	C	-	C	-	-	C	-	C	-	-

Species	Sites														
	SBRNEWRD	SBUSOOYS	SCEBURRS	SFRIRICK	SFRPOWEL	SFRRETRE	SJART616	SJASTOCK	SSBSOOYS	SSOBURRS	SSORIDGE	SSOTRBUR	WBAJENNS	WBATUCKE	WBERTE70
Parthenocissus quinquefolia	C	-	C	-	C	C	C	-	-	-	C	C	C	-	C
Picea abies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinus rigida	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Platanus occidentalis	-	-	-	-	-	-	-	-	-	-	-	-	C	C	-
Prunus serotina	C	-	-	-	C	-	C	-	-	-	-	C	-	-	-
Quercus alba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quercus phellos	-	-	-	-	-	-	-	C	C	-	C	-	-	-	-
Quercus prinus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quercus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quercus velutina	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhododendron viscosum	C	-	C	-	C	C	-	C	C	C	-	-	-	-	-
Rosa sp.	-	-	-	-	-	-	C	-	-	-	-	C	-	-	-
Rubus hispidus	-	-	C	C	C	-	-	-	C	-	-	-	-	-	-
Rubus sp.	-	-	-	-	C	-	-	-	-	-	-	-	-	-	C
Salix sp.	-	-	-	-	C	-	C	-	-	-	-	C	-	-	-
Sambucus canadensis	C	-	-	-	-	-	-	-	-	-	-	-	C	C	-
Sassafras albidum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smilax glauca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smilax rotundifolia	C	C	C	C	C	C	-	C	C	-	C	C	C	C	C
Spiraea tomentosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toxicodendron radicans	C	-	-	-	-	-	C	-	-	-	C	-	C	C	C
Ulmus rubra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ulmus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium corymbosum	C	C	C	C	-	C	-	C	C	C	-	-	C	-	C
Vaccinium macrocarpon	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Viburnum dentatum	-	-	-	-	-	-	-	-	-	-	-	-	C	C	-
Viburnum nudum var. nudum	C	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Vitis labrusca	-	-	-	-	C	C	-	C	-	-	-	-	C	C	C
Wisteria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Species	Sites														
	WBLRT544	WBLSPRAY	WBLTRKET	WCEREFUG	WHAPINES	WHART623	WHATAUNT	WHATRBLU	WKEHOPEW	WKESAWMI	WLIRTE70	WSHRT541	WSOHARTF	WSORT541	WSORTE70
Herbaceous plants:															
Agrostis hyemalis	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Agrostis sp.	C	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Ambrosia artemisiifolia	-	-	-	-	-	-	-	-	-	-	-	C	-	C	-
Andropogon virginicus var. abbreviatus	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Andropogon virginicus var. virginicus	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Apios americana	-	-	-	-	-	-	-	C	-	-	-	C	-	-	-
Apocynum cannabinum	-	-	-	-	-	-	-	-	C	-	-	-	C	-	-
Arisaema triphyllum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asclepias incarnata	-	-	-	-	-	-	-	-	C	-	-	C	-	-	-
Aster divaricatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster nemoralis	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Aster novi-belgii	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Aster racemosus	-	-	-	-	-	-	-	C	-	-	-	-	C	C	C
Aster sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Azolla sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bartonia paniculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bidens connata	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Bidens coronata	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Bidens frondosa	-	-	-	-	-	-	-	C	-	-	-	-	-	-	C
Bidens laevis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bidens polylepis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bidens sp.	-	-	-	-	-	-	-	-	-	-	-	C	-	C	-
Boehmeria cylindrica	-	-	C	-	-	C	-	C	-	-	-	C	C	C	C
Botrychium dissectum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Callitriche heterophylla	-	-	-	-	-	-	-	-	-	-	-	-	C	C	-
Carex atlantica var. capillacea	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-
Carex bullata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex collinsii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex crinita	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex debilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex intumescens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex lurida	C	-	-	-	-	-	-	-	C	-	-	C	-	-	-
Carex sp.	-	-	-	-	-	-	-	-	-	C	-	C	-	-	-
Carex stipata	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-
Carex striata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex stricta	C	-	-	C	C	-	C	-	-	C	C	-	-	-	-
Carex trisperma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ceratophyllum echinatum	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-
Chasmanthium laxum	-	C	-	-	C	-	C	-	-	-	-	-	-	-	-
Chelone glabra	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Cinna arundinacea	-	-	C	-	-	-	-	-	-	-	-	C	-	C	-
Cladium mariscoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Species	Sites														
	WBLRT544	WBLSPRAY	WBLTRKET	WCEREFUG	WHAPINES	WHART623	WHATAUNT	WHATRBLU	WKEHOPEW	WKESAWMI	WLIRTE70	WSHRT541	WSOHARTF	WSORT541	WSORTE70
Commelina communis	C	-	-	-	-	-	-	-	-	-	-	C	-	C	-
Cuscuta sp.	-	-	-	-	-	-	-	-	-	-	-	C	C	-	-
Cyperus brevifoliodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Cyperus dentatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyperus erythrorhizos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Cyperus retrorsus	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Cyperus strigosus	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-
Decodon verticillatus	-	-	-	-	-	-	-	C	C	-	-	-	-	-	-
Dioscorea villosa	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Drosera intermedia	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Drosera rotundifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dryopteris carthusiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dulichium arundinaceum	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-
Echinochloa muricata	-	-	-	-	-	-	-	C	-	-	-	-	-	-	C
Eleocharis acicularis	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Eleocharis flavescens var. olivacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eleocharis robbinsii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium coloratum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum arvense	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Erechtites hieracifolia	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-
Eupatorium dubium	C	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Eupatorium perfoliatum	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Eupatorium rugosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eupatorium serotinum	C	-	-	-	-	-	-	C	-	-	-	-	-	-	-
Eupatorium sp.	-	-	-	-	-	-	-	-	C	-	-	-	-	-	C
Euthamia tenuifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Galium tinctorium	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-
Glechoma hederacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glyceria obtusa	C	-	C	-	-	-	-	C	C	-	C	-	-	-	-
Glyceria striata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hypericum canadense	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Hypericum mutilum	C	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Impatiens capensis	C	-	-	-	C	C	-	-	-	-	-	C	C	C	C
Iris versicolor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus acuminatus	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Juncus caesariensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus canadensis	-	-	-	-	-	-	-	C	C	-	-	-	-	-	-
Juncus effusus	C	-	-	-	C	-	-	C	C	-	C	C	C	-	-
Juncus pelocarpus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lachnanthes caroliniana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leersia oryzoides	C	C	C	C	-	-	-	C	C	C	C	C	C	-	-
Lemna sp.	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-
Lespedeza sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Species	Sites														
	WBLRT544	WBLSPRAY	WBLTRKET	WCEREFUG	WHAPINES	WHART623	WHATAUNT	WHATRBLU	WKEHOPEW	WKESAWMI	WLIRTE70	WSHRT541	WSOHARTF	WSORT541	WSORTE70
Lindernia dubia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Lobelia cardinalis	-	-	-	-	-	-	-	-	-	-	C	-	C	C	C
Lobelia nuttallii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ludwigia alternifolia	C	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Ludwigia palustris	-	-	-	-	-	-	-	C	-	-	C	C	C	C	C
Lycopodium obscurum	-	-	-	-	-	-	C	-	-	C	-	-	-	-	-
Lycopus uniflorus	-	-	-	-	-	-	-	-	C	-	-	C	-	-	-
Lycopus virginicus	-	-	-	-	-	-	-	C	-	C	-	C	-	C	C
Lygodium palmatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lysimachia terrestris	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-
Lythrum salicaria	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Microstegium vimineum	C	-	-	-	C	-	-	C	-	-	C	C	C	C	C
Mikania scandens	-	-	-	-	-	-	-	C	C	-	-	C	C	-	C
Mimulus alatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Mimulus ringens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mitchella repens	-	C	-	-	-	-	C	-	-	-	-	-	-	-	-
Morus alba	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Myosotis laxa	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Myriophyllum humile	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-
Nuphar variegata	C	-	-	-	-	-	-	-	-	-	C	-	C	-	-
Nymphaea odorata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Onoclea sensibilis	-	-	-	-	-	-	-	-	C	-	-	-	C	C	-
Orontium aquaticum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Osmunda cinnamomea	C	C	C	-	C	-	-	C	C	C	C	-	-	-	-
Osmunda regalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxalis sp.	-	-	-	-	-	-	-	-	-	-	-	C	-	C	C
Panicum clandestinum	-	-	-	-	C	-	-	-	-	-	C	-	C	C	C
Panicum longifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panicum sp.	-	-	-	-	C	-	C	C	-	C	-	-	-	-	-
Panicum verrucosum	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Panicum virgatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peltandra virginica	-	-	-	C	-	-	-	-	-	-	-	C	C	-	-
Penthorum sedoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Phalaris arundinacea	C	-	-	-	-	-	-	-	-	-	-	C	-	-	-
Phragmites australis	-	-	C	-	-	-	-	C	C	-	-	C	-	-	-
Pilea pumila	-	-	-	-	-	-	-	-	-	-	-	C	C	C	-
Polygonum arifolium	C	-	-	-	-	-	-	C	-	-	-	-	C	-	-
Polygonum cespitosum	-	-	-	-	C	-	-	-	-	-	-	C	C	C	C
Polygonum cuspidatum	-	-	C	-	-	-	-	-	-	-	-	-	C	-	-
Polygonum hydropiperoides	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Polygonum persicaria	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-
Polygonum punctatum	C	-	C	-	C	-	-	C	-	-	-	C	C	C	C
Polygonum sagittatum	C	-	-	-	-	-	-	C	-	-	-	C	C	-	-

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Polygonum sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pontederia cordata	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Potamogeton confervoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamogeton crispus	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-
Potamogeton diversifolius	-	-	-	-	-	-	-	-	C	C	-	-	-	-	-
Potamogeton epihydrus	-	-	-	-	-	-	-	C	-	-	-	C	-	-	-
Potamogeton pusillus	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Pteridium aquilinum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhexia virginica	-	-	-	-	-	-	-	-	C	-	C	-	-	-	-
Rhynchospora capitellata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rumex obtusifolius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sagittaria engelmanniana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sagittaria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sanicula canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Saururus cernuus	-	-	-	-	-	-	-	-	-	-	-	-	C	-	C
Scirpus cyperinus	-	-	-	C	-	-	-	C	-	-	C	-	-	-	-
Scirpus subterminalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scirpus validus	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-
Scutellaria lateriflora	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-
Solidago rugosa	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Solidago sp.	-	-	-	-	-	-	-	C	-	-	-	C	-	-	-
Sparganium americanum	-	-	-	-	-	-	-	C	-	-	C	-	-	-	C
Symplocarpus foetidus	-	C	-	C	-	-	-	-	-	C	-	-	-	-	-
Thalictrum pubescens	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-
Thelypteris palustris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thelypteris simulata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Triadenum virginicum	C	C	C	-	C	-	-	C	C	-	C	-	-	-	-
Typha latifolia	-	-	-	-	-	-	-	C	C	-	-	-	-	-	-
Unidentified herb	-	-	-	-	-	-	-	-	-	-	-	-	C	-	C
Utricularia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utricularia vulgaris	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Viola lanceolata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola sp.	-	-	-	C	C	-	-	C	-	-	-	-	-	C	-
Woodwardia areolata	-	C	-	-	-	-	-	-	-	-	C	-	-	-	-
Woodwardia virginica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xyris difformis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Woody plants:															
Acer negundo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acer platanoides	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Acer rubrum	C	C	C	C	C	C	C	C	C	C	C	-	C	-	C
Acer saccharinum	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Ailanthus altissima	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-

Species	Sites														
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Alnus serrulata	C	-	-	-	-	-	-	C	-	-	-	C	-	-	-
Amelanchier canadensis	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amorpha fruticosa	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-
Aronia arbutifolia	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-
Berberis thunbergii	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-
Betula nigra	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Betula populifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C
Betula sp.	-	-	-	-	-	C	-	-	-	-	C	-	-	C	C
Campsis radicans	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-
Carpinus caroliniana	-	-	-	-	-	-	-	-	-	-	-	-	-	C	C
Carya sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Catalpa bignonioides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Celastrus orbiculatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cephalanthus occidentalis	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Chamaecyparis thyoides	-	-	-	C	-	-	-	-	C	-	-	-	-	-	-
Chamaedaphne calyculata	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-
Clematis terniflora	-	-	-	-	-	-	-	-	-	-	-	C	C	-	-
Clethra alnifolia	C	C	C	C	C	C	C	C	C	C	C	-	-	-	C
Cornus amomum	-	-	-	-	-	-	-	-	-	-	-	C	C	C	C
Cornus florida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corylus americana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eubotrys racemosa	C	C	-	C	C	-	-	C	-	C	-	-	-	-	-
Fagus grandifolia	-	-	-	-	-	C	-	-	-	-	-	-	-	-	C
Fraxinus pennsylvanica	-	-	-	-	-	-	-	-	-	-	-	C	C	C	-
Gaylussacia frondosa	-	-	-	-	C	-	-	C	-	-	-	-	-	-	-
Hypericum densiflorum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ilex glabra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ilex opaca	-	C	-	-	-	C	C	C	-	-	-	-	-	-	-
Ilex verticillata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Itea virginica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juglans nigra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juniperus virginiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalmia angustifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalmia latifolia	-	C	-	C	C	-	-	-	-	C	-	-	-	-	-
Lindera benzoin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Liquidambar styraciflua	C	C	C	C	C	C	C	C	-	C	C	-	-	C	C
Liriodendron tulipifera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lonicera japonica	C	-	-	-	-	C	-	-	-	-	C	C	C	C	-
Lyonia ligustrina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnolia virginiana	-	-	-	C	-	-	-	-	-	-	C	-	-	-	-
Morus rubra	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myrica pensylvanica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nyssa sylvatica	-	C	C	C	C	-	C	-	C	-	-	-	-	-	C

Species	Sites														
	WBLRT544	WBLSPRAY	WBLTRKET	WCEREFUG	WHAPINES	WHART623	WHATAUNT	WHATRBLU	WKEHOPEW	WKESAWMI	WLIRTE70	WSHRT541	WSOHARTF	WSORT541	WSORTE70
Parthenocissus quinquefolia	C	-	-	-	-	C	C	C	C	-	-	C	-	C	-
Picea abies	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinus rigida	-	-	-	C	-	-	-	C	-	-	-	-	-	-	-
Platanus occidentalis	-	-	C	-	-	-	-	-	-	-	-	C	C	-	C
Prunus serotina	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-
Quercus alba	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Quercus phellos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quercus prinus	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-
Quercus sp.	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Quercus velutina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhododendron viscosum	-	C	-	C	C	-	C	C	-	C	-	-	-	-	-
Rosa sp.	-	-	-	-	-	C	-	-	-	-	C	-	-	-	-
Rubus hispidus	-	-	-	-	-	-	-	C	C	-	-	-	-	-	-
Rubus sp.	-	-	-	-	-	-	-	C	C	-	-	-	C	C	-
Salix sp.	-	-	C	-	-	-	-	C	-	C	C	C	C	C	-
Sambucus canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sassafras albidum	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Smilax glauca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smilax rotundifolia	C	-	-	-	C	C	C	C	C	C	-	-	-	-	-
Spiraea tomentosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toxicodendron radicans	C	-	C	-	-	C	C	C	-	-	C	C	C	C	-
Ulmus rubra	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-
Ulmus sp.	-	-	-	-	-	-	-	-	-	-	-	C	C	-	-
Vaccinium corymbosum	-	C	-	C	C	-	C	C	C	C	-	-	-	-	-
Vaccinium macrocarpon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Viburnum dentatum	-	-	C	-	C	-	C	C	-	-	-	-	-	-	C
Viburnum nudum var. nudum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vitis labrusca	-	C	C	-	-	C	C	C	-	-	-	-	-	-	C
Wisteria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 2.2. Scientific and common names of plants found at stream-vegetation sites in the Rancocas Creek Basin. Taxonomic nomenclature follows Gleason and Cronquist (1991). Common names are taken from various sources.

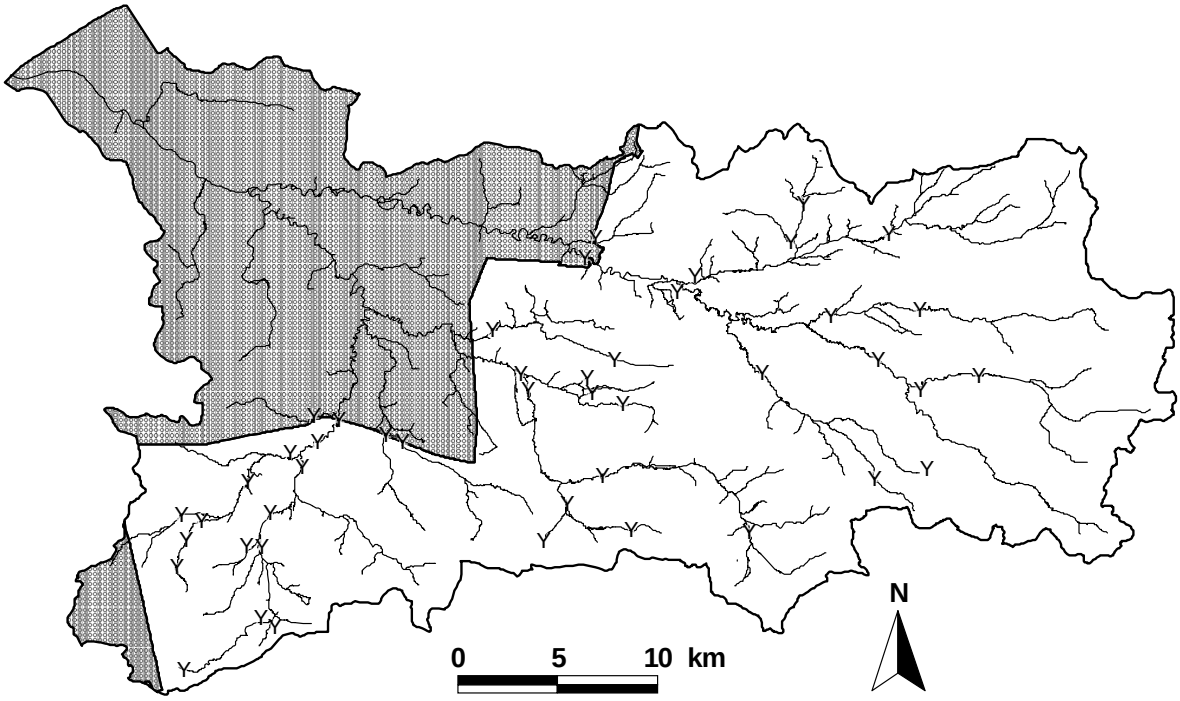
Scientific/Common Name	Scientific/Common Name	Scientific/Common Name
Herbaceous plants:		
Agrostis hyemalis ticklegrass	*Botrychium dissectum* cut-leaved grape fern	*Cyperus brevifolioides* short-leaved Cyperus
Ambrosia artemisiifolia common ragweed	*Callitriche heterophylla* larger water starwort	*Cyperus dentatus* toothed cyperus
Andropogon virginicus var. abbreviatus bushy beard-grass	*Carex atlantica var. capillacea* Howe's sedge	*Cyperus erythrorhizos* red-rooted cyperus
Andropogon virginicus var. virginicus broomsedge	*Carex bullata* button sedge	*Cyperus retrorsus* Pine Barrens cyperus
Apios americana groundnut	*Carex collinsii* Collins' sedge	*Cyperus strigosus* straw-colored cyperus
Apocynum cannabinum Indian hemp	*Carex crinita* fringed sedge	*Decodon verticillatus* swamp loosestrife
Arisaema triphyllum Jack-in-the-pulpit	*Carex debilis* white-edged sedge	*Dioscorea villosa* common wild yam
Asclepias incarnata swamp milkweed	*Carex intumescens* bladder sedge	*Drosera intermedia* spatulate-leaved sundew
Aster divaricatus white wood Aster	*Carex lurida* sallow sedge	*Drosera rotundifolia* round-leaved sundew
Aster nemoralis bog aster	*Carex stipata* awl-fruited sedge	*Dryopteris carthusiana* spinulose wood fern
Aster novi-belgii New York aster	*Carex striata* Walter's sedge	*Dulichium arundinaceum* three-way sedge
Aster racemosus small white aster	*Carex stricta* tussock sedge	*Echinochloa muricata* American barnyard grass
Azolla sp. water fern	*Carex trisperma* three-fruited sedge	*Eleocharis acicularis* needle spike-rush
Bartonia paniculata twining bartonia	*Ceratophyllum echinatum* prickly hornwort	*Eleocharis flavescens var. olivacea* green spike-rush
Bidens connata purple-stemmed beggar ticks	*Chasmanthium laxum* slender spike-grass	*Eleocharis robbinsii* Robbin's spike-rush
Bidens coronata tickseed sunflower	*Chelone glabra* turtlehead	*Epilobium coloratum* purple-leaved willow-herb
Bidens frondosa beggar ticks	*Cinna arundinacea* wood-reed	*Equisetum arvense* field horsetail
Bidens laevis large bur marigold	*Cladium mariscoides* twig-rush	*Erechtites hieracifolia* pilewort
Bidens polylepis beggar ticks	*Commelina communis* Asiatic dayflower	*Eupatorium dubium* eastern joe-pye weed
Boehmeria cylindrica false nettle	*Cuscuta sp.* dodder	*Eupatorium perfoliatum* boneset

Scientific/Common Name	Scientific/Common Name	Scientific/Common Name
Eupatorium rugosum white snakeroot	*Lobelia cardinalis* cardinal flower	*Orontium aquaticum* golden club
Eupatorium serotinum late-flowering boneset	*Lobelia nuttallii* Nuttall's lobelia	*Osmunda cinnamomea* cinnamon fern
Euthamia tenuifolia slender-leaved goldenrod	*Ludwigia alternifolia* seedbox	*Osmunda regalis* royal fern
Galium tinctorium stiff marsh bedstraw	*Ludwigia palustris* water purslane	*Oxalis sp.* wood sorrel
Glechoma hederacea gill-over-the-ground	*Lycopodium obscurum* tree clubmoss	*Panicum clandestinum* deertongue grass
Glyceria obtusa blunt manna-grass	*Lycopus uniflorus* northern bugleweed	*Panicum longifolium* long-leaved panic-grass
Glyceria striata fowl manna-grass	*Lycopus virginicus* Virginia bugleweed	*Panicum verrucosum* warty panic-grass
Hypericum canadense Canada Saint John's-wort	*Lygodium palmatum* climbing fern	*Panicum virgatum* switchgrass
Hypericum mutilum dwarf Saint John's-wort	*Lysimachia terrestris* swamp loosestrife	*Peltandra virginica* arrow arum
Impatiens capensis spotted touch-me-not	*Lythrum salicaria* purple loosestrife	*Penthorum sedoides* ditch stonecrop
Iris versicolor larger blue flag	*Microstegium vimineum* stiltgrass	*Phalaris arundinacea* reed canary grass
Juncus acuminatus sharp-fruited rush	*Mikania scandens* climbing hempweed	*Phragmites australis* reed
Juncus caesariensis New Jersey rush	*Mimulus alatus* winged monkey flower	*Pilea pumila* clearweed
Juncus canadensis Canada rush	*Mimulus ringens* square-stemmed monkey-flower	*Polygonum arifolium* halberd-leaved tearthumb
Juncus effusus common rush	*Mitchella repens* partridge berry	*Polygonum cespitosum* cespitose knotweed
Juncus pelocarpus brown-fruited rush	*Morus alba* white mulberry	*Polygonum cuspidatum* Japanese knotweed
Lachnanthes caroliniana redroot	*Myosotis laxa* small forget-me-not	*Polygonum hydropiperoides* mild water pepper
Leersia oryzoides rice cut-grass	*Myriophyllum humile* low water milfoil	*Polygonum persicaria* lady's thumb
Lemna sp. duckweed	*Nuphar variegata* bullhead lily	*Polygonum punctatum* dotted smartweed
Lespedeza sp. bush-clover	*Nymphaea odorata* white water lily	*Polygonum sagittatum* arrow-leaved tearthumb
Lindernia dubia short-stalked false pimpernel	*Onoclea sensibilis* sensitive fern	*Pontederia cordata* pickerel-weed

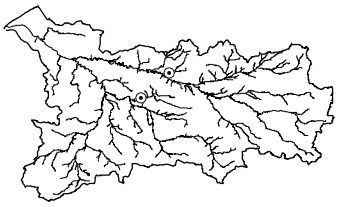
Scientific/Common Name	Scientific/Common Name	Scientific/Common Name
Potamogeton confervoides alga-like pondweed	*Sanicula canadensis* short-styled snakeroot	*Thelypteris palustris* marsh fern
Potamogeton crispus curly pondweed	*Saururus cernuus* lizard's-tail	*Thelypteris simulata* bog fern
Potamogeton diversifolius hair-like pondweed	*Scirpus cyperinus* wool-grass	*Triadenum virginicum* marsh Saint John's-wort
Potamogeton epihydrus Nuttall's pondweed	*Scirpus subterminalis* water club-rush	*Typha latifolia* broad-leaved cat-tail
Potamogeton pusillus small pondweed	*Scirpus validus* great bulrush	*Utricularia vulgaris* greater bladderwort
Pteridium aquilinum bracken	*Scutellaria lateriflora* mad-dog skullcap	*Viola lanceolata* lance-leaved violet
Rhexia virginica Virginia meadow beauty	*Solidago rugosa* rough-stemmed goldenrod	*Woodwardia areolata* netted chain fern
Rhynchospora capitellata small-headed beaked-rush	*Sparganium americanum* slender bur-reed	*Woodwardia virginica* Virginia chain fern
Rumex obtusifolius broad-leaved dock	*Symplocarpus foetidus* skunk cabbage	*Xyris difformis* yellow-eyed grass
Sagittaria engelmanniana Engelmann's arrowhead	*Thalictrum pubescens* tall meadow rue	
Woody plants:		
Acer negundo box elder	*Betula populifolia* gray birch	*Cornus amomum* silky dogwood
Acer platanoides Norway maple	*Campsis radicans* trumpet creeper	*Cornus florida* flowering dogwood
Acer rubrum red maple	*Carpinus caroliniana* ironwood	*Corylus americana* American hazelnut
Acer saccharinum silver maple	*Carya sp.* hickory	*Eubotrys racemosa* fetterbush
Ailanthus altissima tree-of-heaven	*Catalpa bignonioides* common catalpa	*Fagus grandifolia* American beech
Alnus serrulata smooth alder	*Celastrus orbiculatus* Asiatic bittersweet	*Fraxinus pennsylvanica* green ash
Amelanchier canadensis oblongleaf juneberry	*Cephalanthus occidentalis* buttonbush	*Gaylussacia frondosa* dangleberry
Amorpha fruticosa false indigo	*Chamaecyparis thyoides* Atlantic white cedar	*Hypericum densiflorum* bushy Saint John's-wort
Aronia arbutifolia red chokeberry	*Chamaedaphne calyculata* leatherleaf	*Ilex glabra* inkberry
Berberis thunbergii Japanese barberry	*Clematis terniflora* yam-leaved clematis	*Ilex opaca* American holly
Betula nigra river birch	*Clethra alnifolia* sweet pepperbush	*Ilex verticillata* winterberry

Scientific/Common Name	Scientific/Common Name	Scientific/Common Name
Itea virginica	*Parthenocissus quinquefolia*	*Sambucus canadensis*
Virginia willow	Virginia creeper	common elder
Juglans nigra	*Picea abies*	*Sassafras albidum*
black walnut	Norway spruce	sassafras
Juniperus virginiana	*Pinus rigida*	*Smilax glauca*
red cedar	pitch pine	glaucous greenbrier
Kalmia angustifolia	*Platanus occidentalis*	*Smilax rotundifolia*
sheep laurel	sycamore	common greenbrier
Kalmia latifolia	*Prunus serotina*	*Spiraea tomentosa*
mountain laurel	black cherry	steeplebush
Lindera benzoin	*Quercus alba*	*Toxicodendron radicans*
spicebush	white oak	poison ivy
Liquidambar styraciflua	*Quercus phellos*	*Ulmus rubra*
sweet gum	willow oak	slippery elm
Liriodendron tulipifera	*Quercus prinus*	*Vaccinium corymbosum*
tulip tree	chestnut oak	highbush blueberry
Lonicera japonica	*Quercus velutina*	*Vaccinium macrocarpon*
Japanese honeysuckle	black oak	large cranberry
Lyonia ligustrina	*Rhododendron viscosum*	*Viburnum dentatum*
maleberry	swamp azalea	southern arrowwood
Magnolia virginiana	*Rosa sp.*	*Viburnum nudum var. nudum*
sweet bay	rose	naked withe-rod
Morus rubra	*Rubus hispidus*	*Vitis labrusca*
red mulberry	swamp dewberry	fox grape
Myrica pensylvanica	*Rubus sp.*	*Wisteria sp.*
bayberry	blackberry	wisteria
Nyssa sylvatica	*Salix sp.*	
black gum	willow	

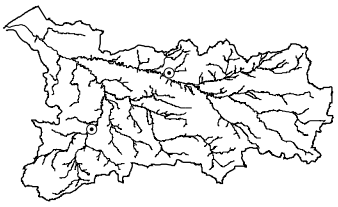
APPENDIX 2.3. PLANT-DISTRIBUTION MAPS



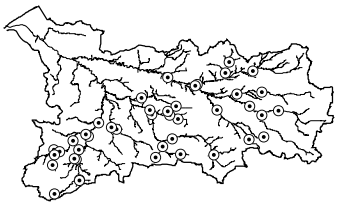
Location of 45 stream-vegetation survey sites. Distribution maps for plants found at two or more sites are on the following pages.



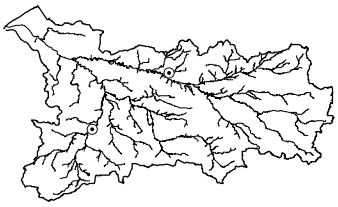
Acer negundo
box elder



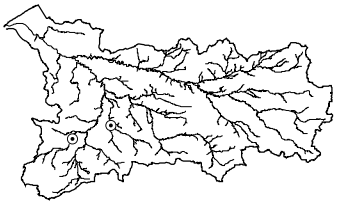
Acer platanoides
Norway maple



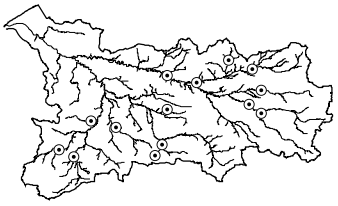
Acer rubrum
red maple



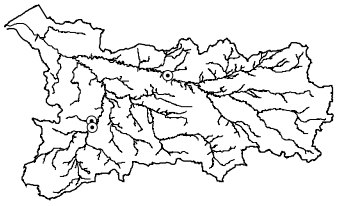
Acer saccharinum
silver maple



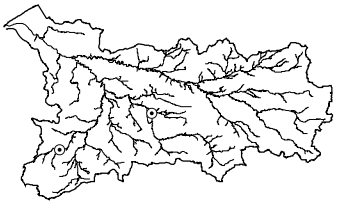
Ailanthus altissima
tree-of-heaven



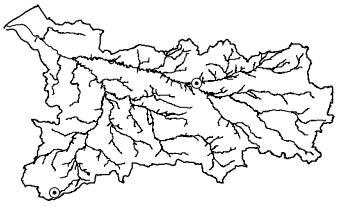
Alnus serrulata
smooth alder



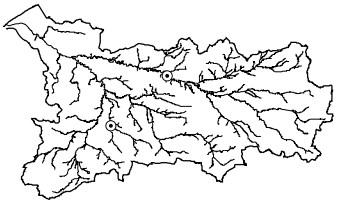
Ambrosia artemisiifolia
common ragweed



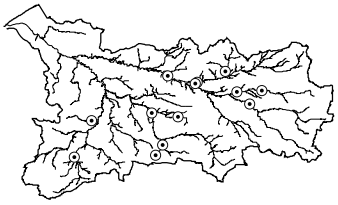
Amelanchier canadensis
oblongleaf juneberry



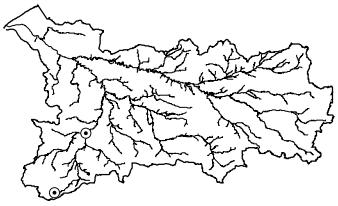
Andropogon virginicus var. abbreviatus
bushy beard-grass



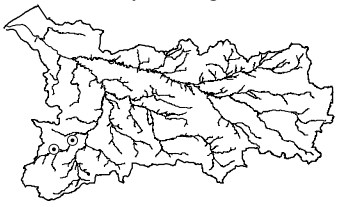
Andropogon virginicus var. virginicus
broomsedge



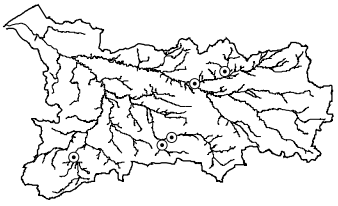
Apios americana
groundnut



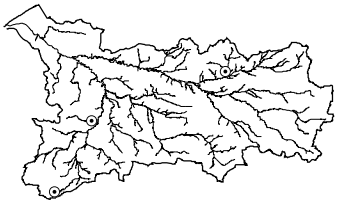
Apocynum cannabinum
Indian hemp



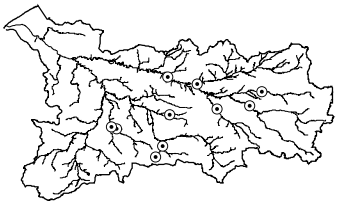
Arisaema triphyllum
Jack-in-the-pulpit



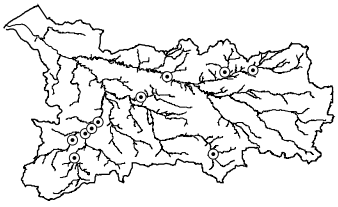
Aronia arbutifolia
red chokeberry



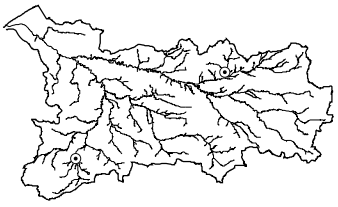
Asclepias incarnata
swamp milkweed



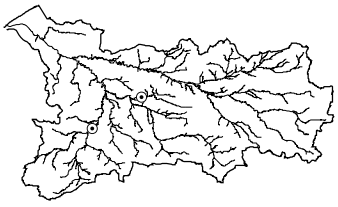
Aster novi-belgii
New York aster



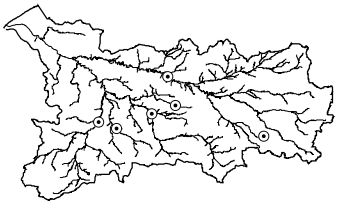
Aster racemosus
small white aster



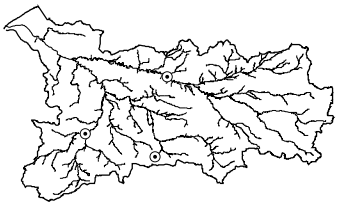
Berberis thunbergii
Japanese barberry



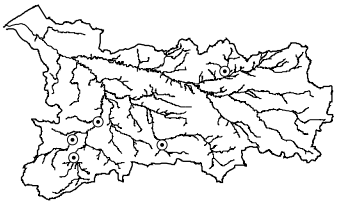
Betula nigra
river birch



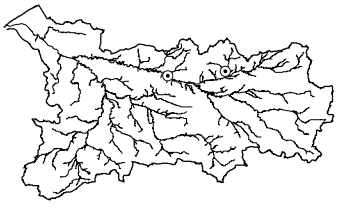
Betula populifolia
gray birch



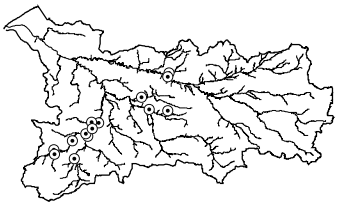
Bidens connata
purple-stemmed beggar ticks



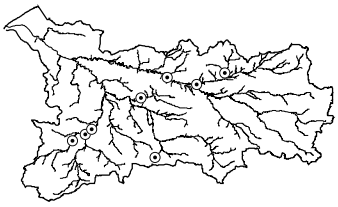
Bidens frondosa
beggar ticks



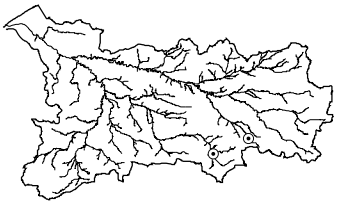
Bidens polylepis
beggar ticks



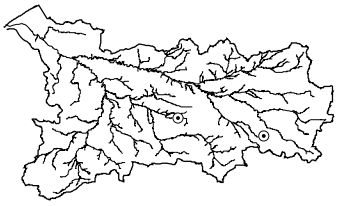
Boehmeria cylindrica
false nettle



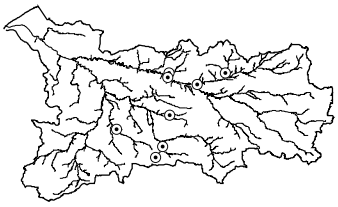
Callitriche heterophylla
larger water starwort



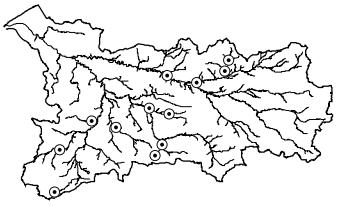
Carex bullata
button sedge



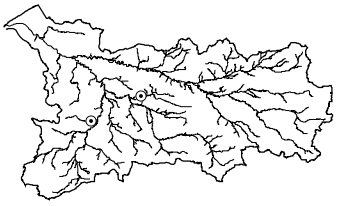
Carex collinsii
Collins' sedge



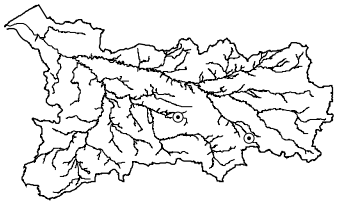
Carex crinita
fringed sedge



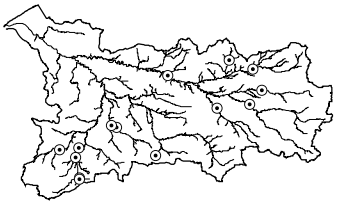
Carex lurida
sallow sedge



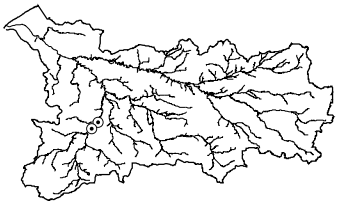
Carex stipata
awl-fruited sedge



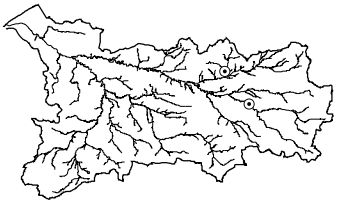
Carex striata
Walter's sedge



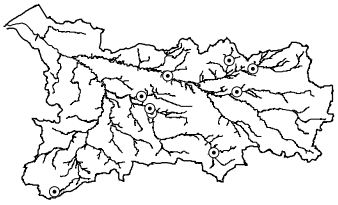
Carex stricta
tussock sedge



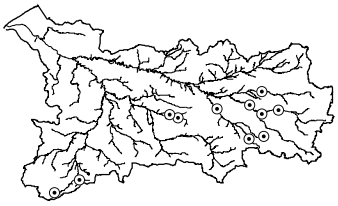
Carpinus caroliniana
ironwood



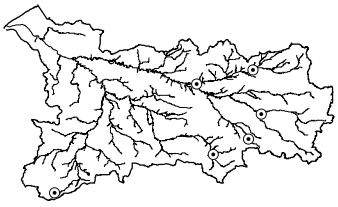
Celastrus orbiculatus
Asiatic bittersweet



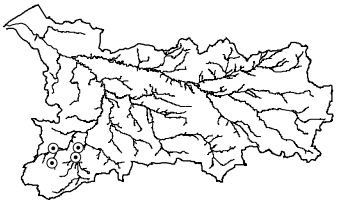
Cephalanthus occidentalis
buttonbush



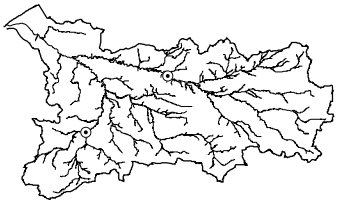
Chamaecyparis thyoides
Atlantic white cedar



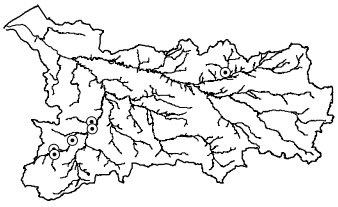
Chamaedaphne calyculata
leatherleaf



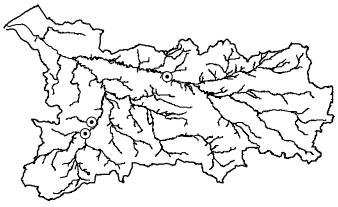
Chasmanthium laxum
slender spike-grass



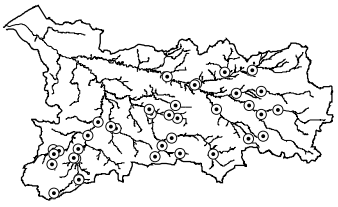
Chelone glabra
turtlehead



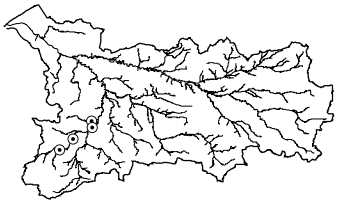
Cinna arundinacea
wood-reed



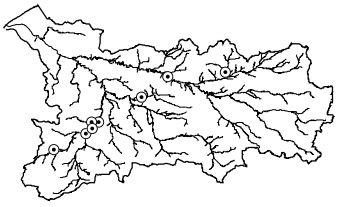
Clematis terniflora
yam-leaved clematis



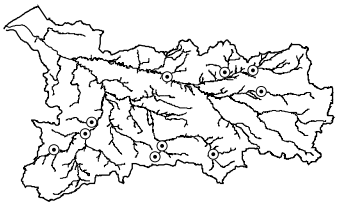
Clethra alnifolia
sweet pepperbush



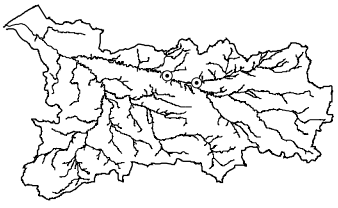
Commelina communis
Asiatic dayflower



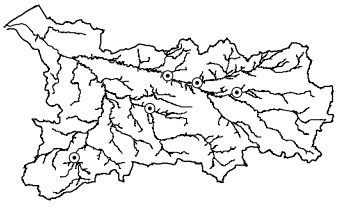
Cornus amomum
silky dogwood



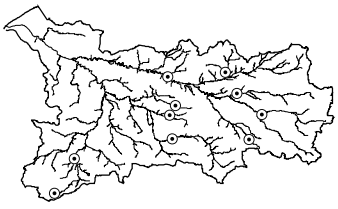
Cuscuta sp.
dodder



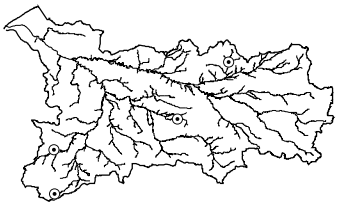
Cyperus dentatus
toothed cyperus



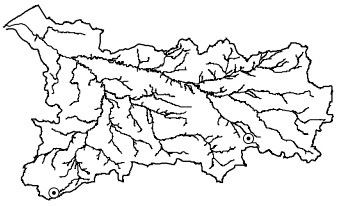
Cyperus strigosus
straw-colored cyperus



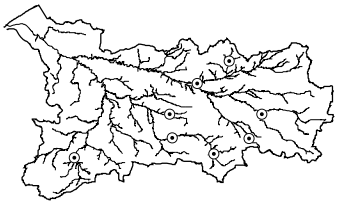
Decodon verticillatus
swamp loosestrife



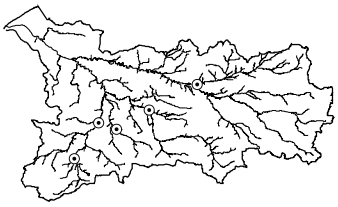
Dioscorea villosa
common wild yam



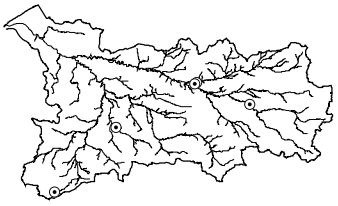
Drosera intermedia
spatulate-leaved sundew



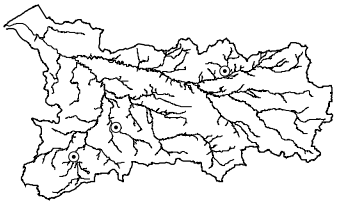
Dulichium arundinaceum
three-way sedge



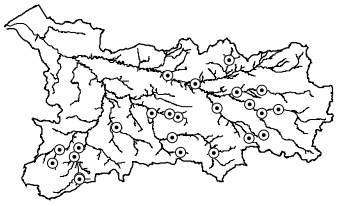
Echinochloa muricata
American barnyard grass



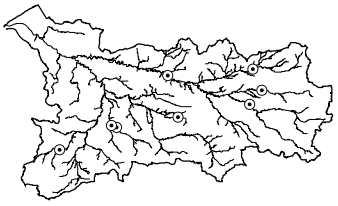
Eleocharis acicularis
needle spike-rush



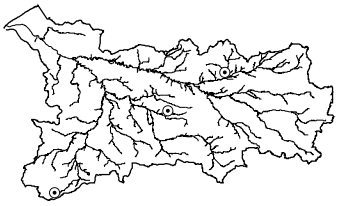
Erechtites hieracifolia
pilewort



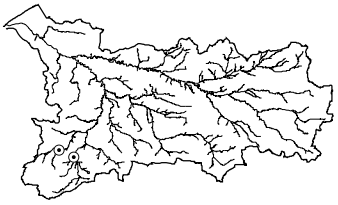
Eubotrys racemosa
fetterbush



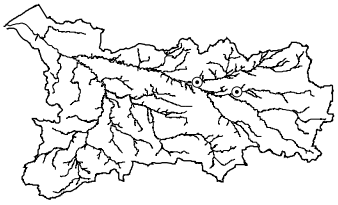
Eupatorium dubium
eastern joe-pye weed



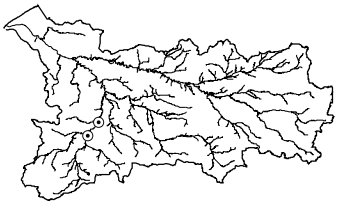
Eupatorium perfoliatum
boneset



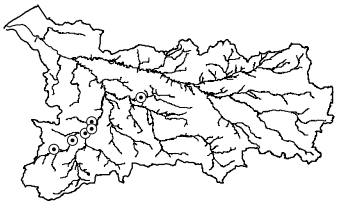
Eupatorium serotinum
late-flowering boneset



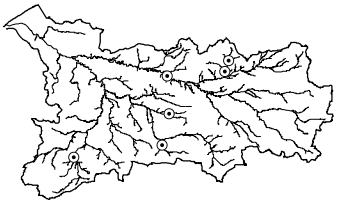
Euthamia tenuifolia
slender-leaved goldenrod



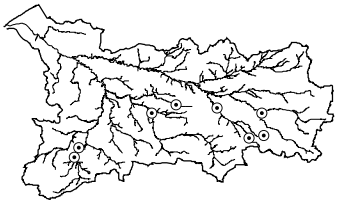
Fagus grandifolia
American beech



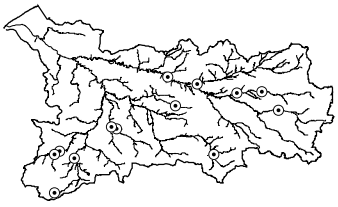
Fraxinus pennsylvanica
greeen ash



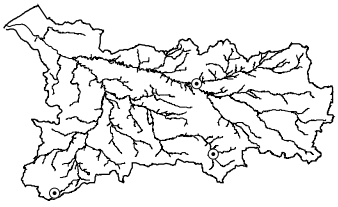
Galium tinctorium
stiff marsh bedstraw



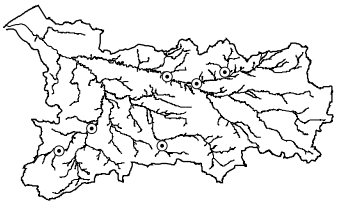
Gaylussacia frondosa
dangleberry



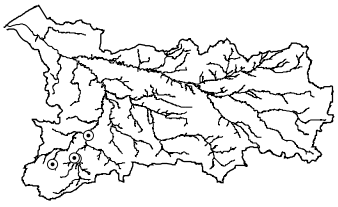
Glyceria obtusa
blunt manna-grass



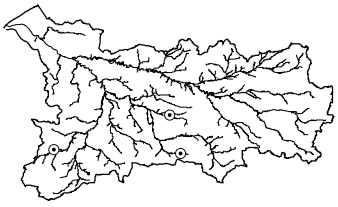
Hypericum canadense
Canada Saint John's-wort



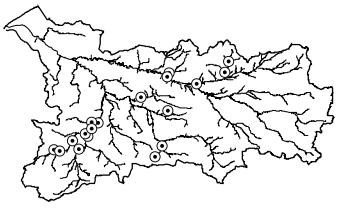
Hypericum mutilum
dwarf Saint John's-wort



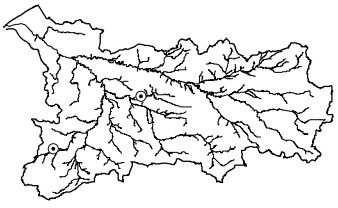
Ilex opaca
American holly



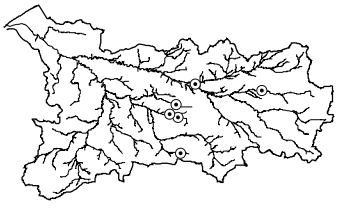
Ilex verticillata
winterberry



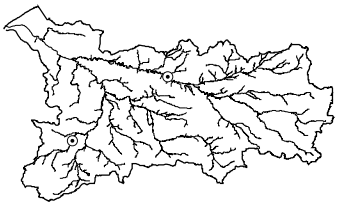
Impatiens capensis
spotted touch-me-not



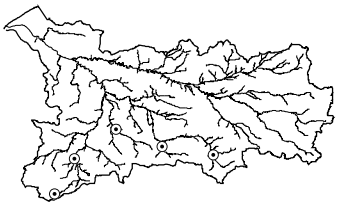
Iris versicolor
larger blue flag



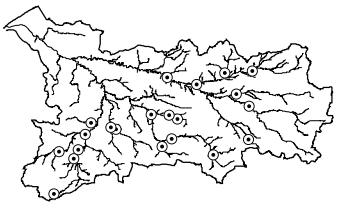
Itea virginica
Virginia willow



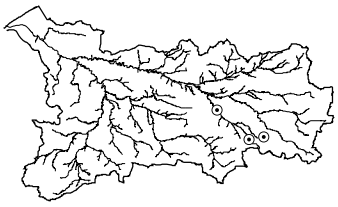
Juglans nigra
black walnut



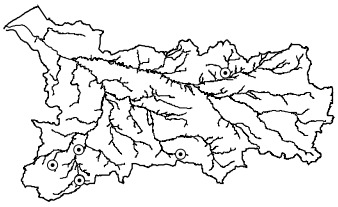
Juncus canadensis
Canada rush



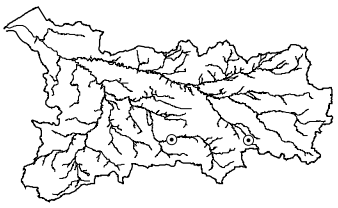
Juncus effusus
common rush



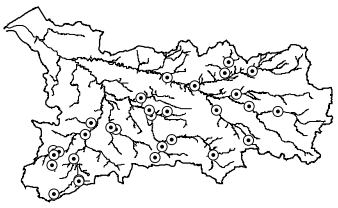
Kalmia angustifolia
sheep laurel



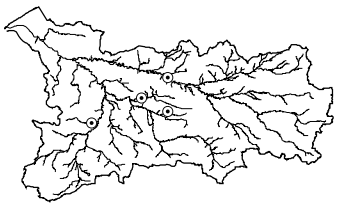
Kalmia latifolia
mountain laurel



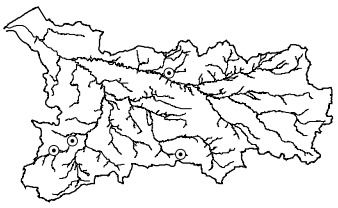
Lachnanthes caroliniana
redroot



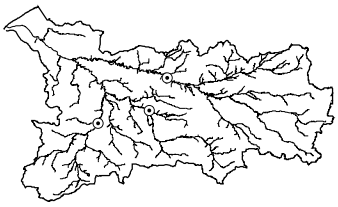
Leersia oryzoides
rice cut-grass



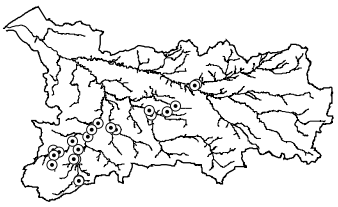
Lemna sp.
duckweed



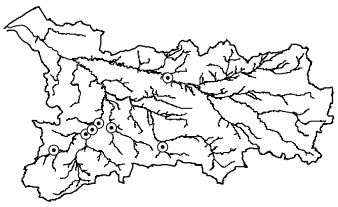
Lindera benzoin
spicebush



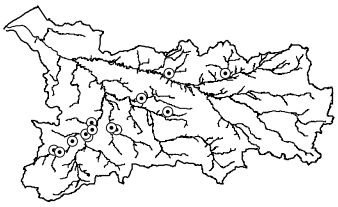
Lindernia dubia
short-stalked false pimpernel



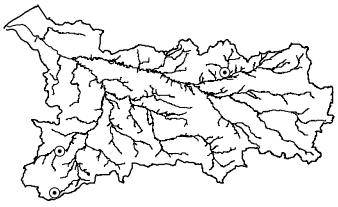
Liquidambar styraciflua
sweet gum



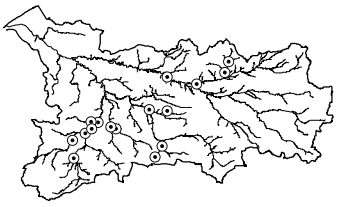
Lobelia cardinalis
cardinal flower



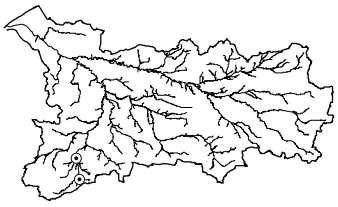
Lonicera japonica
Japanese honeysuckle



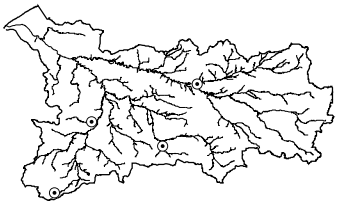
Ludwigia alternifolia
seedbox



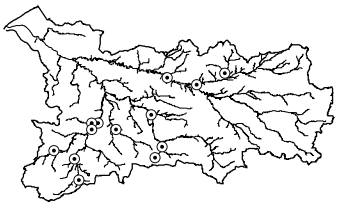
Ludwigia palustris
water purslane



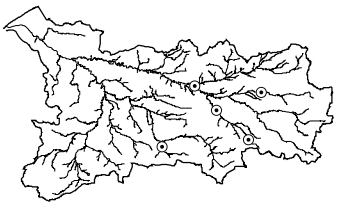
Lycopodium obscurum
tree clubmoss



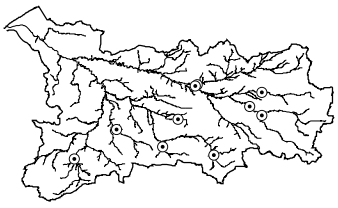
Lycopus uniflorus
northern bugleweed



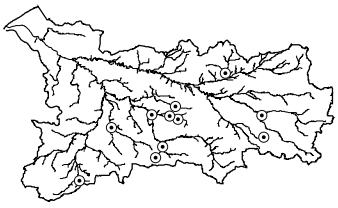
Lycopus virginicus
Virginia bugleweed



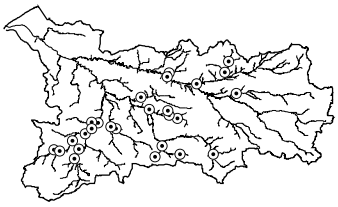
Lyonia ligustrina
maleberry



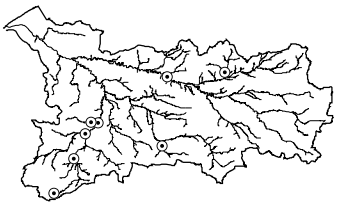
Lysimachia terrestris
swamp loosestrife



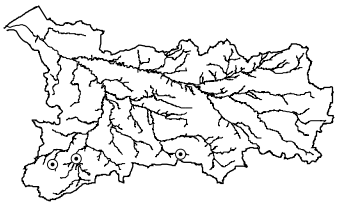
Magnolia virginiana
sweet bay



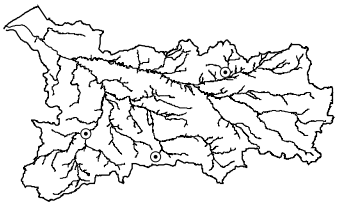
Microstegium vimineum
stiltgrass



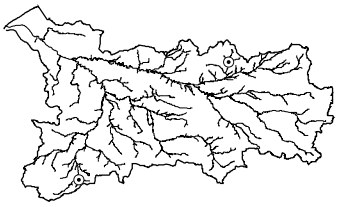
Mikania scandens
climbing hempweed



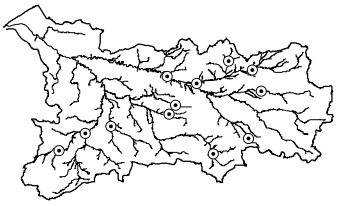
Mitchella repens
partridge berry



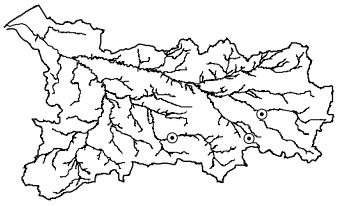
Myosotis laxa
small forget-me-not



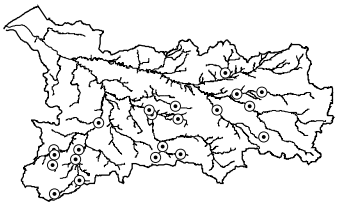
Myriophyllum humile
low water milfoil



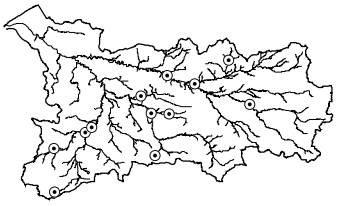
Nuphar variegata
bullhead lily



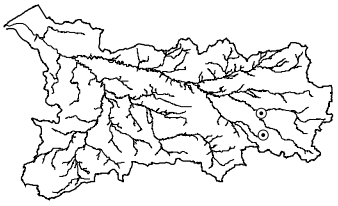
Nymphaea odorata
white water lily



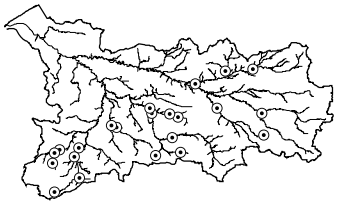
Nyssa sylvatica
black gum



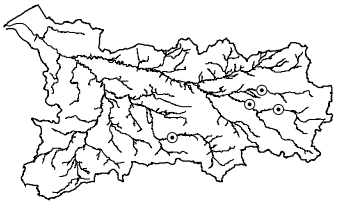
Onoclea sensibilis
sensitive fern



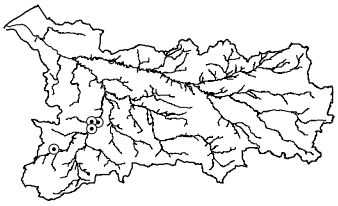
Orontium aquaticum
golden club



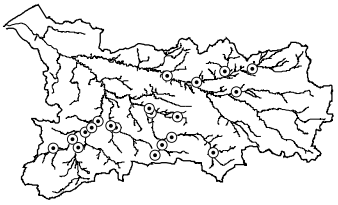
Osmunda cinnamomea
cinnamon fern



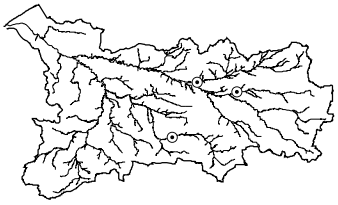
Osmunda regalis
royal fern



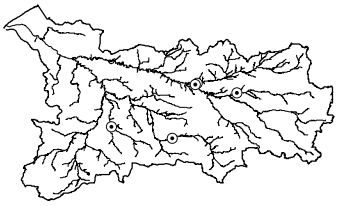
Oxalis sp.
wood sorrel



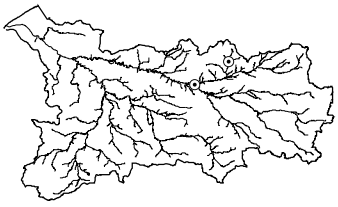
Panicum clandestinum
deertongue grass



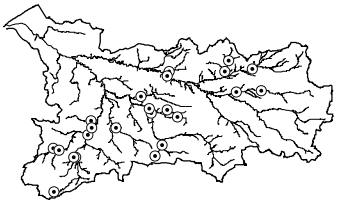
Panicum longifolium
long-leaved panic-grass



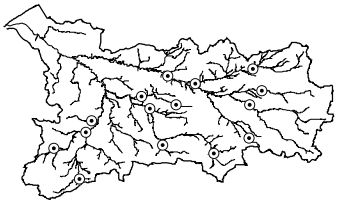
Panicum verrucosum
warty panic-grass



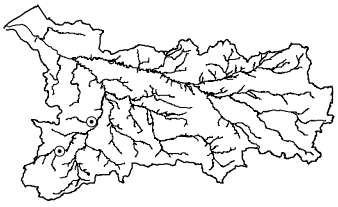
Panicum virgatum
switchgrass



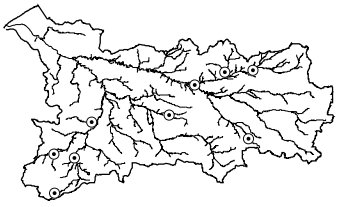
Parthenocissus quinquefolia
Virginia creeper



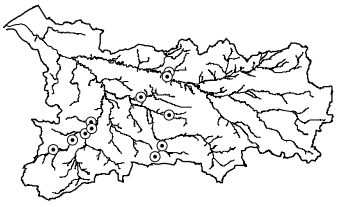
Peltandra virginica
arrow arum



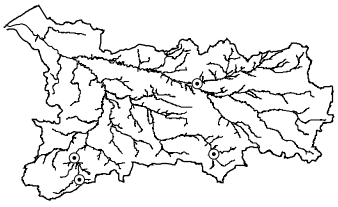
Phalaris arundinacea
reed canary grass



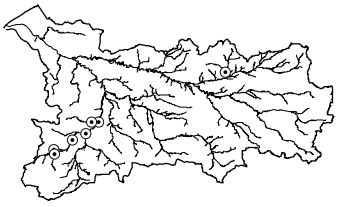
Phragmites australis
reed



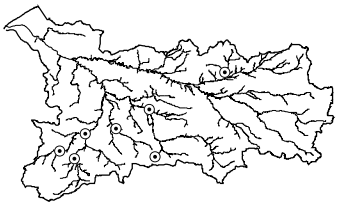
Pilea pumila
clearweed



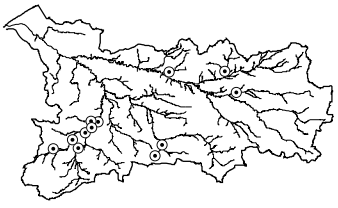
Pinus rigida
pitch pine



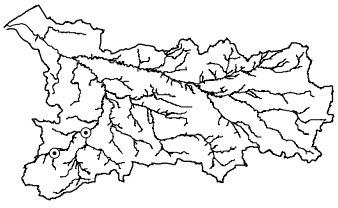
Platanus occidentalis
sycamore



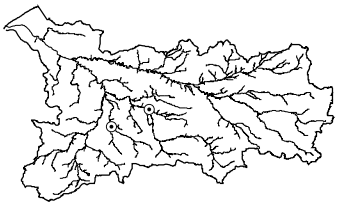
Polygonum arifolium
halberd-leaved tearthumb



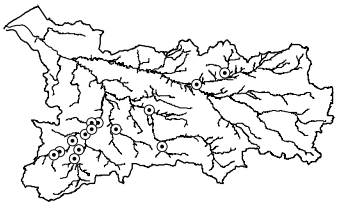
Polygonum cespitosum
cespitose knotweed



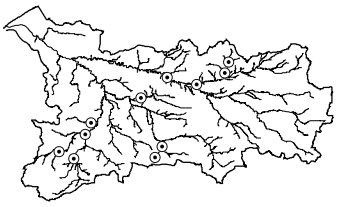
Polygonum cuspidatum
Japanese knotweed



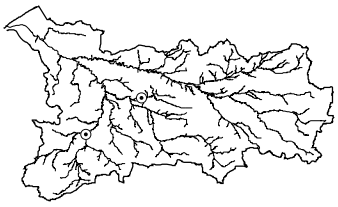
Polygonum hydropiperoides
mild water pepper



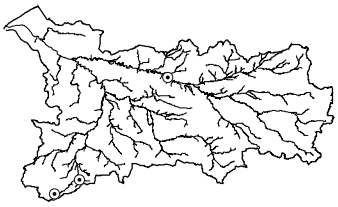
Polygonum punctatum
dotted smartweed



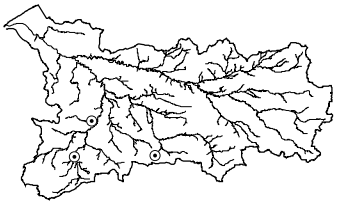
Polygonum sagittatum
arrow-leaved tearthumb



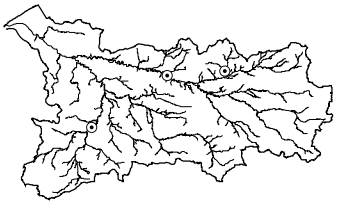
Pontederia cordata
pickerel-weed



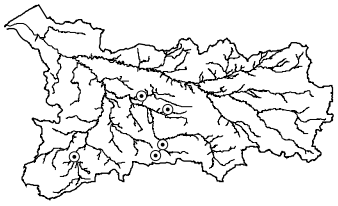
Potamogeton diversifolius
hair-like pondweed



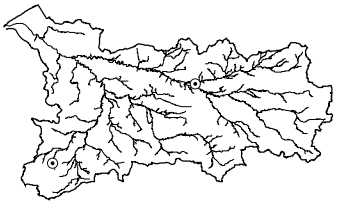
Potamogeton epihydrus
Nuttall's pondweed



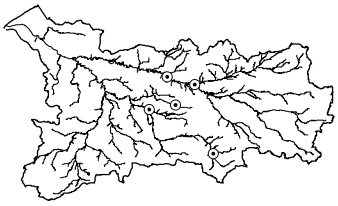
Potamogeton pusillus
small pondweed



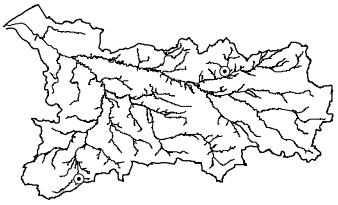
Prunus serotina
black cherry



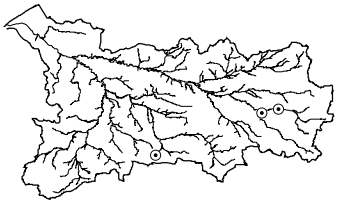
Quercus alba
white oak



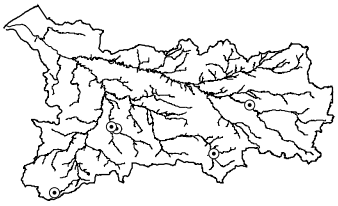
Quercus phellos
willow oak



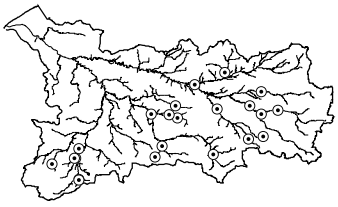
Quercus prinus
chestnut oak



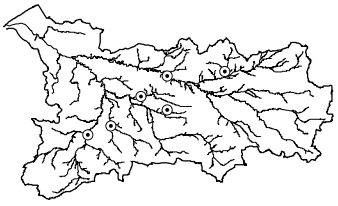
Quercus velutina
black oak



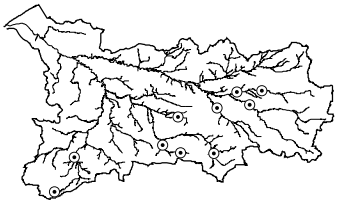
Rhexia virginica
Virginia meadow beauty



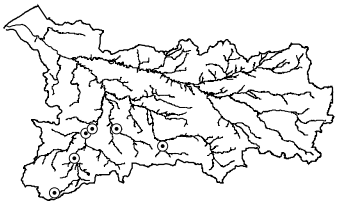
Rhododendron viscosum
swamp azalea



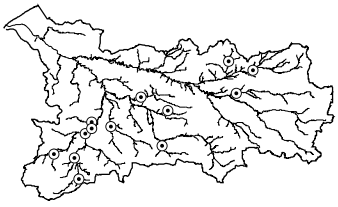
Rosa sp.
rose



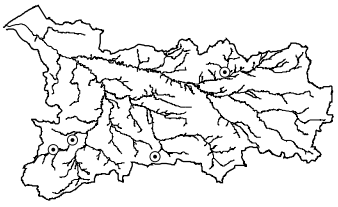
Rubus hispidus
swamp dewberry



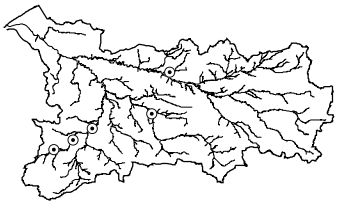
Rubus sp.
blackberry



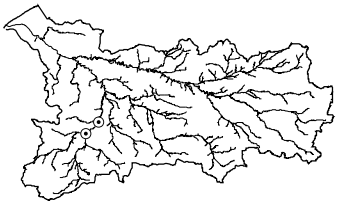
Salix sp.
willow



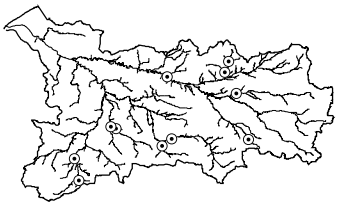
Sambucus canadensis
common elder



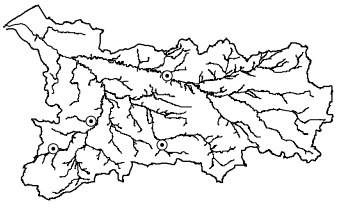
Sanicula canadensis
short-styled snakeroot



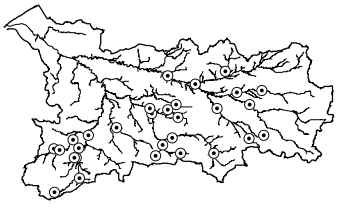
Saururus cernuus
lizard's-tail



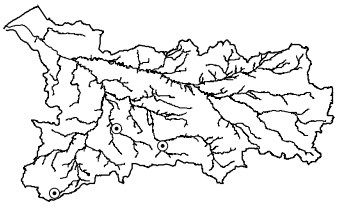
Scirpus cyperinus
wool-grass



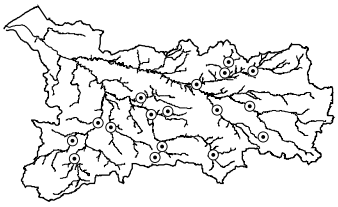
Scutellaria lateriflora
mad-dog skullcap



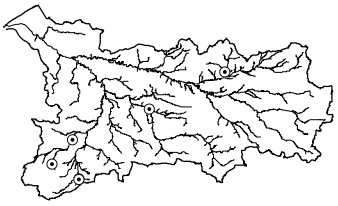
Smilax rotundifolia
common greenbrier



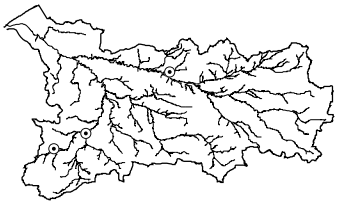
Solidago rugosa
rough-stemmed goldenrod



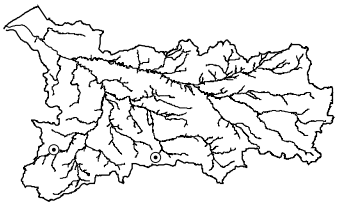
Sparganium americanum
slender bur-reed



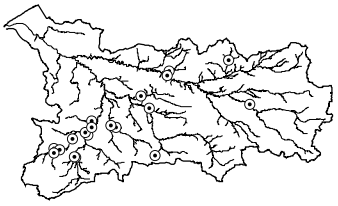
Symplocarpus foetidus
skunk cabbage



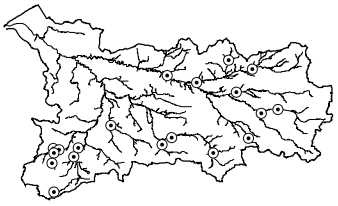
Thalictrum pubescens
tall meadow rue



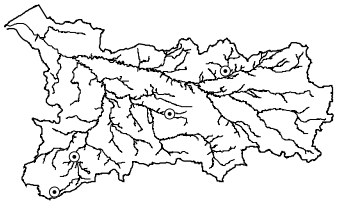
Thelypteris palustris
marsh fern



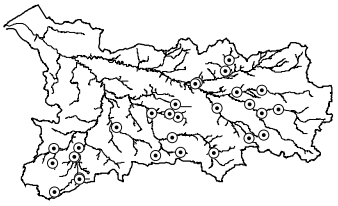
Toxicodendron radicans
poison ivy



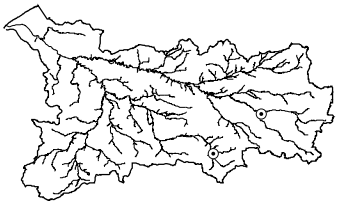
Triadenum virginicum
marsh Saint John's-wort



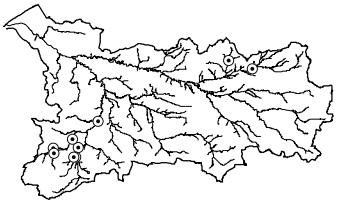
Typha latifolia
broad-leaved cat-tail



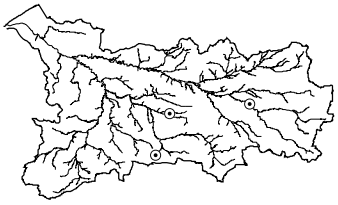
Vaccinium corymbosum
highbush blueberry



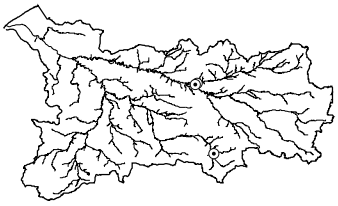
Vaccinium macrocarpon
large cranberry



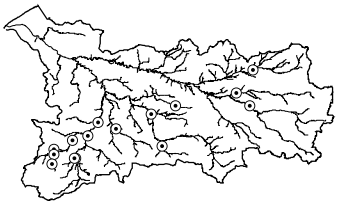
Viburnum dentatum
southern arrowwood



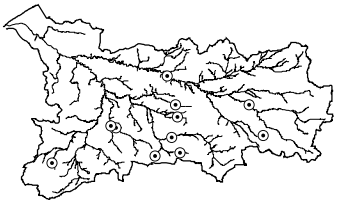
Viburnum nudum var. nudum
naked withe-rod



Viola lanceolata
lance-leaved violet



Vitis labrusca
fox grape



Woodwardia areolata
netted chain fern

APPENDIX 3. FISH-ASSEMBLAGE DATA

Appendix 3.0. Fish-monitoring sites (streams and impoundments) in the Rancocas Creek Basin. Two 10-m sections were sampled for each stream site. Sections were not assigned in impoundments. Latitude, longitude, and USGS 7.5 minute topographic quadrangle names are given in parentheses. Sites are ordered alphabetically by site code.

Site Name and Description	Site Code
Presidential Lakes Pemberton Twp., Burlington Co. (lat 39E54'32.47", long 74E34'25.29", Browns Mills quad). Impoundment on Bisphams Mill Creek, upstream from dike at end of New York Road.	GBIPRESU
Bisphams Mill Creek at Turkey Buzzard Bridge Road Pemberton Twp., Burlington Co. (lat 39E55'26.05", long 74E35'30.03", Browns Mills quad). Sections located upstream and downstream from Turkey Buzzard Bridge Road.	GBITURKE
Pakim Pond Woodland Twp., Burlington Co. (lat 39E52'51.98", long 74E31'56.83", Browns Mills quad). Impoundment on Cooper Branch, upstream from Batona Trail.	GCOPAKIM
Cooper Branch below Pakim Pond Woodland Twp., Burlington Co. (lat 39E52'51.98", long 74E31'56.83", Browns Mills quad). Both sections located downstream from Batona Trail, below Pakim Pond.	GCOPAKIS
Country Lake below Choctaw Road Pemberton Twp., Burlington Co. (lat 39E57'00.50", long 74E32'50.62", Browns Mills quad). Impoundment on Cranberry Branch, downstream from northern part of Choctaw Road.	GCRCOUND
Greenwood Branch impoundment above New Lisbon-Four Mile Road Pemberton Twp., Burlington Co. (lat 39E57'22.63", long 74E37'39.54", Pemberton quad). Impoundment upstream from New Lisbon-Four Mile Road.	GGRIMPNT
Greenwood Branch at Meadowview Lane Pemberton Twp., Burlington Co. (lat 39E57'30.75", long 74E37'59.16", Pemberton quad). Sections located upstream and downstream from Meadowview Lane.	GGRMEADO
McDonalds Branch at Butterworth Road Woodland Twp., Burlington Co. (lat 39E53'05.99", long 74E30'19.36", Whiting quad). Sections located upstream from USGS gaging station and downstream from Butterworth Road.	GMCBUTTE
Mount Misery Brook at Route 70 Pemberton Twp., Burlington Co. (lat 39E55'44.97", long 74E31'52.13", Browns Mills quad). Sections located upstream and downstream from Route 70.	GMORTE70
Mount Misery Brook impoundment at Mount Misery Pemberton Twp., Burlington Co. (lat 39E55'22.88", long 74E31'24.36", Browns Mills quad). Impoundment between Route 70 and Mount Misery.	GMOUCAMP
North Branch Mount Misery Brook impoundment Manchester Twp., Ocean Co. (lat 39E55'16.44", long 74E27'25.60", Whiting quad). Impoundment upstream from dike/sand road, downstream from Butler Place Road.	GNOMMBOG
North Branch Mount Misery Brook at unnamed sand road Pemberton and Woodland Twps., Burlington Co. (lat 39E55'20.42", long 74E28'42.11", Whiting quad). Sections located upstream and downstream from unnamed sand road.	GNOSANDR
Country Lake above Choctaw Road Pemberton Twp., Burlington Co. (lat 39E56'51.27", long 74E32'43.76", Browns Mills quad). Impoundment on Pole Bridge Branch, upstream from southern part of Choctaw Road.	GPOCOUNU
Pole Bridge Branch at Whites Bogs-Pasadena Road Pemberton Twp., Burlington Co. (lat 39E56'56.71", long 74E30'32.48", Browns Mills quad). Sections located upstream and downstream from Whites Bogs-Pasadena Road.	GPOWHITE
Pole Bridge Branch at Wissahickon Trail Pemberton Twp., Burlington Co. (lat 39E56'48.68", long 74E33'20.12", Browns Mills quad). Sections located upstream and downstream from Wissahickon Trail, below Country Lake.	GPOWISSA
South Branch Mount Misery Brook impoundment at sand road Woodland Twp., Burlington Co. (lat 39E53'44.54", long 74E29'27.24", Whiting quad). Impoundment upstream from unnamed sand road, downstream from Butler Place Road.	GSONORMA
Budds Run above Route 616 Pemberton Twp., Burlington Co. (lat 39E58'34.43", long 74E40'51.28", Pemberton quad). Both sections located upstream from Route 616 (Hanover Street).	NBURT616

Site Name and Description	Site Code
Jacks Run above Range Road New Hanover Twp., Burlington Co. (lat 39E59'30.80", long 74E34'12.00", Browns Mills quad). Both sections located upstream from Range Road. *Latitude and longitude values were obtained using ArcView software.	NJARANGE
Hanover Lake Pemberton Twp., Burlington Co. (lat 39E58'47.89", long 74E31'27.39", Browns Mills quad). Impoundment on North Branch Rancocas Creek, upstream from Military Road. *Latitude and longitude values were obtained using ArcView software.	NNOHANOV
North Branch Rancocas Creek at Military Road Pemberton Twp., Burlington Co. (lat 39E58'46.75", long 74E31'31.06", Browns Mills quad). Sections located upstream and downstream from Military Road.	NNOMILIT
North Branch Rancocas Creek above New Lisbon-Four Mile Road Pemberton Twp., Burlington Co. (lat 39E57'36.62", long 74E37'44.75", Pemberton quad). Both sections located approximately 250 m upstream from New Lisbon-Four Mile Road.	NNONEWLI
North Branch Rancocas Creek at Route 616 Pemberton Twp., Burlington Co. (lat 39E58'12.22", long 74E41'02.70", Pemberton quad). Sections located upstream and downstream from Hanover Street (Route 616).	NNORT616
North Branch Rancocas Creek tributary above Magnolia Road Pemberton Twp., Burlington Co. (lat 39E57'16.67", long 74E38'34.17", Pemberton quad). Both sections located upstream from Magnolia Road.	NNOTRMGU
Ong Run at West Lakeshore Drive Pemberton Twp., Burlington Co. (lat 39E58'35.83", long 74E34'35.90", Browns Mills quad). Sections located upstream and downstream from West Lakeshore Drive.	NONWLAKE
Bread and Cheese Run below New Road Tabernacle Twp., Burlington Co. (lat 39E51'20.96", long 74E42'21.17", Indian Mills quad). Both sections located downstream from New Road.	SBRNEWRD
Burrs Mill Brook at Sooy Place Road Southampton Twp., Burlington Co. (lat 39E52'54.97", long 74E40'30.51", Pemberton quad). Sections located upstream and downstream from Sooy Place Road.	SBUSOOYS
Friendship Creek impoundment at Camp Inawendiwin Tabernacle Twp., Burlington Co. (lat 39E51'50.18", long 74E41'17.86", Indian Mills quad). Impoundment upstream from confluence with Bread and Cheese Run at Camp Inawendiwin.	SFRCAMPI
Friendship Creek at Irick's Causeway Tabernacle Twp., Burlington Co. (lat 39E51'36.07", long 74E39'35.68", Indian Mills quad). Sections located upstream and downstream from Irick's Causeway.	SFRIRICK
Friendship Creek at Powell Place Road Tabernacle Twp., Burlington Co. (lat 39E52'15.73", long 74E41'35.06", Indian Mills quad). Sections located upstream and downstream from Powell Place Road.	SFRPOWEL
Friendship Creek at Retreat Road Southampton Twp., Burlington Co. (lat 39E54'59.64", long 74E42'49.85", Pemberton quad). Sections located upstream and downstream from Retreat Road.	SFRRETRE
Jade Run near Route 616 Southampton Twp., Burlington Co. (lat 39E56'26.45", long 74E43'57.45", Pemberton quad). Sections located upstream and downstream from unnamed sand road, south of Pemberton Road (Route 616), between Brace Road and Route 206.	SJART616
Jade Run at Stocktons Bridge Road Southampton Twp., Burlington Co. (lat 39E55'44.40", long 74E40'07.60", Pemberton quad). Sections located upstream and downstream from Stocktons Bridge Road.	SJASTOCK
South Branch Burrs Mill Brook at Sooy Place Road Woodland Twp., Burlington Co. (lat 39E51'34.09", long 74E35'53.34", Chatsworth quad). Sections located upstream and downstream from Sooy Place Road.	SSBSOOYS
South Branch Rancocas Creek at Ridge Road Southampton Twp., Burlington Co. (lat 39E55'23.68", long 74E43'03.18", Pemberton quad). Sections located upstream and downstream from Ridge Road (Buddtown-Beaverville Road).	SSORIDGE
Jennings Lake Evesham Twp., Burlington Co. (lat 39E51'55.68", long 74E53'42.19", Clementon quad). Impoundment on Barton Run upstream from Tomlinson Mill Road.	WBAJENNL

Site Name and Description	Site Code
Barton Run below Jennings Lake Evesham Twp., Burlington Co. (lat 39E51'56.45", long 74E53'40.96", Clementon quad). Both sections located downstream from Tomlinson Mill Road, below Jennings Lake.	WBAJENNS
Barton Run at Tuckerton Road Medford Twp., Burlington Co. (lat 39E52'43.75", long 74E51'36.28", Mount Holly quad). Sections located upstream and downstream from Tuckerton Road.	WBATUCKE
Bear Swamp River above Route 70 Southampton Twp., Burlington Co. (lat 39E53'44.02", long 74E46'44.61", Mount Holly quad). Both sections located upstream from Route 70.	WBERTE70
Black Run at Route 544 Evesham Twp., Burlington Co. (lat 39E51'48.21", long 74E53'01.95", Clementon quad). Sections located upstream and downstream from Tomlinson Mill Road (Route 544).	WBLRT544
Black Run bog Evesham Twp., Burlington Co. (lat 39E50'40.30", long 74E53'49.89", Clementon quad). Impoundment upstream from fourth dike above Kettle Run Road.	WBLSPBOG
Black Run below abandoned cranberry bog Evesham Twp., Burlington Co. (lat 39E50'40.30", long 74E53'49.89", Clementon quad). Both sections located downstream from abandoned cranberry bog.	WBLSPRAY
Black Run tributary at Kettle Run Road Evesham Twp., Burlington Co. (lat 39E51'31.28", long 74E53'37.38", Clementon quad). Sections located upstream and downstream from Kettle Run Road.	WBLTRKET
Cedar Run Lake Medford Twp., Burlington Co. (lat 39E49'19.25", long 74E50'50.35", Medford Lakes quad). Impoundment on Cedar Run, at Woodford Cedar Run Refuge.	WCEDARLK
Cedar Run below Cedar Run Lake Medford Twp., Burlington Co. (lat 39E49'19.25", long 74E50'50.35", Medford Lakes quad). Both sections located downstream from sand road, below Cedar Run Lake.	WCEREFUG
Haynes Creek below Falls Road Medford Twp., Burlington Co. (lat 39E51'59.41", long 74E50'53.73", Medford Lakes quad). Both sections located downstream from Falls Road, below Lake Pine.	WHAPINES
Haynes Creek at Route 623 Medford Twp., Burlington Co. (lat 39E53'06.86", long 74E49'53.66", Mount Holly quad). Sections located upstream and downstream from Himmelein Road (Route 623).	WHART623
Haynes Creek below Breakneck Avenue Medford Twp., Burlington Co. (lat 39E51'10.24", long 74E51'14.50", Medford Lakes quad). Both sections located downstream from Breakneck Avenue, below Taunton Lake.	WHATAUNT
Haynes Creek tributary at Hopewell Road Medford Twp., Burlington Co. (lat 39E51'11.52", long 74E51'23.53", Medford Lakes quad). Sections located upstream and downstream from Hopewell Road, near intersection with Breakneck Road.	WHATRBLU
Squaw Lake Medford Twp., Burlington Co. (lat 39E50'44.52", long 74E46'43.92", Medford Lakes quad). Impoundment on tributary of Haynes Creek, at Camp Matollionequay.	WHATRSQU
Lake Stockwell Medford Twp., Burlington Co. (lat 39E50'55.40", long 74E47'01.14", Medford Lakes quad). Impoundment on tributary of Haynes Creek, at Camp Ockanicken.	WHATRSTO
Kettle Run at camp Kettle Run Medford Twp., Burlington Co. (lat 39E49'02.61", long 74E51'35.73", Medford Lakes quad). Impoundment upstream from Braddocks Millpond, at Camp Kettle Run.	WKEGIRLS
Kettle Run below Hopewell Road Evesham Twp., Burlington Co. (lat 39E48'11.71", long 74E53'35.05", Clementon quad). Both sections located downstream from Hopewell Road.	WKEHOPEW
Kettle Run at Sawmill Road Medford Twp., Burlington Co. (lat 39E49'23.70", long 74E50'50.25", Medford Lakes quad). Sections located upstream and downstream from Sawmill Road.	WKESAWMI

Site Name and Description	Site Code
Little Creek below Hawkins Road Medford Twp., Burlington Co. (lat 39E53'04.03", long 74E47'03.98", Mount Holly quad). Both sections located downstream from Hawkins Road.	WLIHAWKI
Little Creek at Route 70 Medford and SouthamptonTwps., Burlington Co. (lat 39E53'54.29", long 74E47'17.18", Mount Holly quad). Sections located upstream and downstream from Route 70.	WLIRTE70
Sharps Run at Route 541 Medford Twp., Burlington Co. (lat 39E54'18.81", long 74E49'28.89", Mount Holly quad). Sections located upstream and downstream from Main Street (Stokes Road or Route 541).	WSHRT541
Southwest Branch Rancocas Creek at Hartford Road Medford Twp., Burlington Co. (lat 39E53'18.83", long 74E50'08.39", Mount Holly quad). Sections located upstream and downstream from Hartford Road.	WSOHARTF
Southwest Branch Rancocas Creek at Route 541 Medford Twp., Burlington Co. (lat 39E53'43.82", long 74E49'25.13", Mount Holly quad). Sections located upstream and downstream from Main Street (Stokes Road or Route 541).	WSORT541
Southwest Branch Rancocas Creek at Route 70 Medford Twp., Burlington Co. (lat 39E54'16.52", long 74E48'45.01", Mount Holly quad). Sections located upstream and downstream from Route 70.	WSORTE70

Appendix 3.1. Total number collected for each fish species at monitoring sites in the Rancocas Creek Basin. A dash (-) indicates that a species was not collected at a site. Surveys were completed by John F. Bunnell and Jason C. Shvanda. Refer to the Chapter 4 (Fish Assemblages) for survey methodology. Refer to Appendix 3.0 for detailed site information and Appendix 3.3 for common names for each species.

Species	Site Code and Date											
	GBIPRESU 10/25/01	GBITURKE 08/01/01	GCOPAKIM 10/05/01	GCOPAKIS 08/01/01	GCRCOUND 11/08/01	GGRIMPNT 10/05/01	GGRMEADO 09/21/01	GMCBUTTE 08/01/01	GMORTE70 08/01/01	GMOUCAMP 10/05/01	GNOMMBOG 10/25/01	GNOSANDR 08/01/01
Acantharchus pomotis	-	-	-	4	2	-	4	-	-	-	-	2
Ameiurus catus	-	-	-	-	-	-	-	-	-	-	-	-
Ameiurus natalis	-	-	-	-	-	3	4	-	-	-	-	1
Ameiurus nebulosus	-	-	-	-	-	-	-	-	-	-	-	-
Anguilla rostrata	-	-	-	-	-	-	-	-	-	-	-	-
Aphredoderus sayanus	-	-	-	-	1	19	2	-	-	6	-	5
Cyprinella analostana	-	-	-	-	-	-	-	-	-	-	-	-
Enneacanthus chaetodon	231	1	-	-	2	13	5	-	-	73	-	-
Enneacanthus gloriosus	-	-	-	-	-	20	-	-	-	-	-	-
Enneacanthus obesus	20	-	171	79	13	13	11	-	-	22	84	1
Enneacanthus species	-	-	4	11	-	20	-	-	-	-	-	1
Erimyzon oblongus	-	-	-	-	-	-	-	-	-	-	-	-
Esox americanus	-	-	-	3	1	-	-	-	-	-	-	-
Esox niger	4	2	3	6	1	-	-	-	1	5	6	-
Esox species	-	-	-	-	-	-	-	-	-	-	-	-
Etheostoma fusiforme	29	1	-	7	5	12	1	-	1	46	59	11
Etheostoma olmstedi	-	-	-	-	-	-	-	-	-	-	-	-
Lepomis auritus	-	-	-	-	-	-	-	-	-	-	-	-
Lepomis gibbosus	38	-	-	-	47	-	-	-	-	-	-	-
Lepomis macrochirus	20	-	-	-	-	-	-	-	-	-	-	-
Lepomis species	52	-	-	-	3	-	-	-	-	-	-	-
Micropterus salmoides	-	-	-	-	-	-	-	-	-	-	-	-
Notemigonus crysoleucas	-	-	-	-	-	-	-	-	-	-	-	-
Notropis procne	-	-	-	-	-	-	-	-	-	-	-	-
Noturus gyrinus	-	-	-	-	-	-	-	-	-	-	-	-
Perca flavescens	-	-	-	-	2	-	-	-	-	-	-	-
Pomoxis nigromaculatus	-	-	-	-	-	-	-	-	-	-	-	-
Semotilus corporalis	-	-	-	-	-	-	-	-	-	-	-	-
Umbra pygmaea	-	-	1	8	-	52	5	12	-	1	-	1

Species	Site Code and Date											
	GPOWISSA 08/02/01	GPOCOUNU 11/08/01	GPOWHITE 08/01/01	GSONORMA 10/05/01	NBURT616 08/02/01	NJARANGE 09/27/01	NNOHANOV 11/15/01	NNOMILIT 09/27/01	NNONEWLI 08/16/01	NNORT616 08/06/01	NNOTRMGU 10/25/01	NONWLAKE 08/02/01
Acantharchus pomotis	2	4	-	-	-	-	-	-	2	1	3	-
Ameiurus catus	-	-	-	-	-	-	-	-	-	-	-	-
Ameiurus natalis	-	14	-	-	-	1	-	-	6	1	-	-
Ameiurus nebulosus	99	-	-	-	-	-	-	-	6	2	-	-
Anguilla rostrata	-	-	-	-	1	-	-	-	-	-	-	-
Aphredoderus sayanus	-	13	-	3	-	3	-	-	-	-	-	-
Cyprinella analostana	-	-	-	-	-	-	-	-	-	-	-	-
Enneacanthus chaetodon	1	109	-	5	-	26	129	83	-	24	-	-
Enneacanthus gloriosus	-	-	-	-	-	20	21	-	-	32	-	2
Enneacanthus obesus	2	62	2	31	-	-	9	19	4	-	36	-
Enneacanthus species	-	5	1	1	-	7	6	-	-	5	-	-
Erimyzon oblongus	-	-	-	-	-	5	3	-	-	-	-	-
Esox americanus	-	-	-	-	-	-	-	-	-	1	2	-
Esox niger	-	-	-	1	-	5	-	2	-	5	-	2
Esox species	-	2	-	-	-	-	-	-	-	-	-	-
Etheostoma fusiforme	3	43	1	5	-	9	16	14	-	1	-	11
Etheostoma olmstedi	-	-	-	-	24	-	-	-	-	-	-	-
Lepomis auritus	-	-	-	-	2	-	-	-	-	-	-	-
Lepomis gibbosus	-	-	-	-	-	-	-	-	1	-	-	-
Lepomis macrochirus	6	-	-	-	-	4	-	7	10	-	-	-
Lepomis species	2	-	-	-	-	-	-	-	1	-	-	-
Micropterus salmoides	-	-	-	-	-	1	-	-	3	1	-	7
Notemigonus crysoleucas	-	-	-	-	-	-	-	-	-	-	-	-
Notropis procne	-	-	-	-	-	-	-	-	-	-	-	-
Noturus gyrinus	-	-	-	-	-	-	-	-	16	-	-	-
Perca flavescens	2	-	-	-	-	-	-	3	-	-	-	-
Pomoxis nigromaculatus	-	-	-	-	-	-	-	-	-	-	-	-
Semotilus corporalis	-	-	-	-	1	-	-	-	-	-	-	-
Umbra pygmaea	-	1	-	3	-	3	-	-	2	1	3	2

Species	Site Code and Date											
	SBRNEWRD 09/28/01	SBUSOOYS 08/06/01	SFRCAMPI 11/15/01	SFRIRICK 10/25/01	SFRPOWEL 09/26/01	SFRRETRE 08/06/01	SJART616 08/02/01	SJASTOCK 08/02/01	SSBSOOYS 09/28/01	SSORIDGE 08/06/01	WBAJENNL 10/01/01	WBAJENNS 08/15/01
Acantharchus pomotis	2	3	-	-	-	-	-	34	-	1	-	-
Ameiurus catus	-	-	-	-	-	-	-	-	-	-	-	-
Ameiurus natalis	-	-	-	-	5	1	-	-	-	1	-	-
Ameiurus nebulosus	-	-	-	-	-	-	-	-	-	-	1	-
Anguilla rostrata	-	-	-	-	-	-	6	-	-	-	-	-
Aphredoderus sayanus	13	1	-	-	-	1	21	40	-	9	1	-
Cyprinella analostana	-	-	-	-	-	-	-	-	-	-	-	-
Enneacanthus chaetodon	-	2	-	-	2	-	-	-	1	-	-	-
Enneacanthus gloriosus	-	-	-	-	-	-	6	-	-	-	57	-
Enneacanthus obesus	-	9	16	1	1	-	-	1	28	1	-	-
Enneacanthus species	-	-	5	-	-	-	4	-	-	-	13	-
Erimyzon oblongus	-	-	-	-	-	21	-	-	-	10	3	1
Esox americanus	-	-	-	-	-	-	-	1	-	-	-	-
Esox niger	12	5	7	2	-	1	1	1	1	1	17	-
Esox species	-	-	2	-	-	-	-	-	-	-	-	-
Etheostoma fusiforme	-	15	35	-	1	2	-	-	1	23	1	-
Etheostoma olmstedi	-	-	-	-	-	-	7	-	-	-	-	5
Lepomis auritus	-	-	-	-	-	-	-	-	-	-	2	4
Lepomis gibbosus	2	-	16	-	2	-	-	-	-	-	6	-
Lepomis macrochirus	-	-	-	-	-	-	-	-	-	-	13	-
Lepomis species	-	-	16	-	-	-	-	-	-	-	2	-
Micropterus salmoides	-	-	-	-	1	-	-	-	-	-	3	-
Notemigonus crysoleucas	-	-	-	-	-	-	4	-	-	-	2	-
Notropis procne	-	-	-	-	-	-	-	-	-	-	-	-
Noturus gyrinus	-	-	-	-	-	-	-	-	-	-	-	1
Perca flavescens	-	-	-	-	-	-	-	-	-	-	-	-
Pomoxis nigromaculatus	-	-	-	-	-	-	-	-	-	-	2	-
Semotilus corporalis	-	-	-	-	-	-	-	-	-	-	-	-
Umbra pygmaea	19	1	-	2	-	-	1	10	3	4	-	-

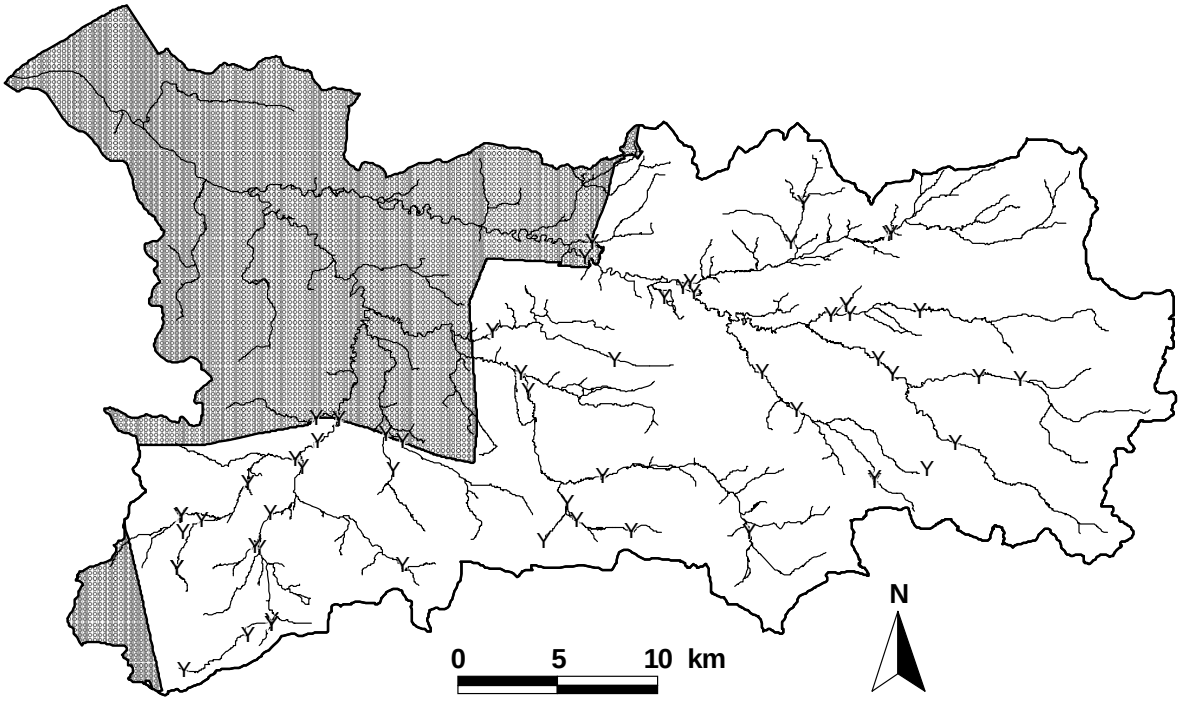
Species	Site Code and Date											
	WBATUCKE 08/15/01	WBERTE70 08/16/01	WBLABBOG 10/31/01	WBLSPRAY 08/15/01	WBLRT544 08/15/01	WBLTRKET 09/26/01	WCEDARLK 10/31/01	WCEREFUG 09/26/01	WHAPINES 08/10/01	WHART623 08/10/01	WHATAUNT 08/10/01	WHATRBLU 08/10/01
Acantharchus pomotis	-	4	-	3	4	1	-	3	-	-	-	-
Ameiurus catus	-	-	-	-	-	-	-	-	-	2	-	-
Ameiurus natalis	-	-	-	1	-	-	-	3	-	-	1	-
Ameiurus nebulosus	-	-	-	-	-	-	-	1	-	-	-	-
Anguilla rostrata	-	-	-	-	-	-	-	-	1	-	-	-
Aphredoderus sayanus	-	13	-	-	-	-	-	-	-	-	1	1
Cyprinella analostana	-	-	-	-	-	-	-	-	-	-	-	-
Enneacanthus chaetodon	-	-	-	-	-	-	-	-	-	-	2	-
Enneacanthus gloriosus	-	-	-	-	-	-	-	-	-	-	-	-
Enneacanthus obesus	-	-	204	31	13	2	96	11	-	-	-	-
Enneacanthus species	-	-	-	1	-	-	-	-	-	1	-	-
Erimyzon oblongus	-	-	-	-	-	-	-	-	-	-	-	-
Esox americanus	-	1	-	2	-	1	-	-	-	-	-	-
Esox niger	-	1	-	-	-	2	-	1	1	1	-	-
Esox species	-	-	-	-	-	-	1	-	-	-	-	-
Etheostoma fusiforme	-	-	-	-	5	2	-	6	3	-	5	4
Etheostoma olmstedi	6	-	-	-	-	-	-	-	-	8	-	-
Lepomis auritus	8	-	-	-	-	-	-	-	-	9	-	-
Lepomis gibbosus	2	-	-	-	-	-	-	-	-	-	-	2
Lepomis macrochirus	19	-	-	-	-	-	-	-	10	6	14	7
Lepomis species	90	-	-	-	-	-	-	-	-	-	22	-
Micropterus salmoides	1	-	-	-	-	-	-	-	6	3	2	2
Notemigonus crysoleucas	-	-	-	-	-	-	-	-	-	-	-	-
Notropis procne	-	-	-	-	-	-	-	-	-	-	-	-
Noturus gyrinus	-	-	-	-	-	-	-	-	-	18	-	-
Perca flavescens	-	-	-	-	-	-	-	-	-	-	-	-
Pomoxis nigromaculatus	8	-	-	-	-	-	-	-	1	2	-	-
Semotilus corporalis	-	-	-	-	-	-	-	-	-	-	-	-
Umbra pygmaea	-	8	-	-	18	14	-	1	-	-	-	-

Species	Site Code and Date									
	WHATRSQU 10/31/01	WKEGIRLS 10/01/01	WKEHOPEW 08/10/01	WKESAWMI 09/26/01	WLIHAWKI 09/26/01	WLIRTE70 08/06/01	WSHRT541 08/16/01	WSOHARTF 08/15/01	WSORT541 08/16/01	WSORTE70 08/16/01
Acantharchus pomotis	-	-	-	-	4	2	-	-	-	-
Ameiurus catus	-	-	-	-	-	-	-	-	-	-
Ameiurus natalis	-	1	14	5	-	5	-	-	-	-
Ameiurus nebulosus	-	-	1	-	-	-	-	-	-	-
Anguilla rostrata	-	-	-	-	1	2	1	-	4	-
Aphredoderus sayanus	-	-	-	-	1	-	12	-	-	-
Cyprinella analostana	-	-	-	-	-	-	-	-	12	-
Enneacanthus chaetodon	-	30	-	4	-	-	-	-	-	-
Enneacanthus gloriosus	-	-	-	-	-	-	-	-	-	-
Enneacanthus obesus	-	21	-	-	-	1	-	-	-	-
Enneacanthus species	-	-	-	-	-	-	-	-	-	-
Erimyzon oblongus	-	-	-	-	-	-	-	-	-	-
Esox americanus	-	-	-	-	-	-	-	-	-	-
Esox niger	2	2	3	1	-	-	8	1	1	2
Esox species	-	-	-	-	-	-	-	-	-	-
Etheostoma fusiforme	9	10	7	11	-	1	-	-	-	-
Etheostoma olmstedi	-	-	-	-	-	-	-	2	12	8
Lepomis auritus	-	-	-	-	-	-	-	15	7	2
Lepomis gibbosus	8	-	7	-	-	-	-	-	-	-
Lepomis macrochirus	35	12	-	2	-	-	12	4	1	2
Lepomis species	71	-	-	-	-	-	3	10	2	6
Micropterus salmoides	4	1	1	4	-	-	3	2	1	4
Notemigonus crysoleucas	-	-	-	-	-	-	-	1	-	-
Notropis procne	-	-	-	-	-	-	-	-	8	67
Noturus gyrinus	-	-	-	-	-	-	-	-	-	-
Perca flavescens	2	-	-	-	-	-	-	-	-	-
Pomoxis nigromaculatus	-	-	-	-	-	-	-	-	-	1
Semotilus corporalis	-	-	-	-	-	-	-	-	-	-
Umbra pygmaea	1	12	2	1	2	1	1	-	-	-

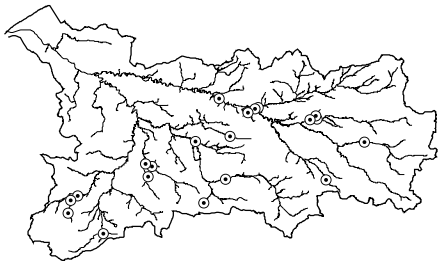
Appendix 3.2. Common and scientific names for 26 fish species collected in Rancocas Creek Basin streams and impoundments. Nomenclature follows Page and Burr (1991).

Scientific Name	Common Name
Acantharchus pomotis	mud sunfish
Ameiurus catus	white catfish
Ameiurus natalis	yellow bullhead
Ameiurus nebulosus	brown bullhead
Anguilla rostrata	American eel
Aphredoderus sayanus	pirate perch
Cyprinella analostana	satinfin shiner
Enneacanthus chaetodon	blackbanded sunfish
Enneacanthus gloriosus	bluespotted sunfish
Enneacanthus obesus	banded sunfish
Erimyzon oblongus	creek chubsucker
Esox niger	chain pickerel
Esox americanus	redfin pickerel
Etheostoma fusiforme	swamp darter
Etheostoma olmstedi	tesselated darter
Lepomis gibbosus	pumpkinseed
Lepomis auritus	redbreast sunfish
Lepomis macrochirus	bluegill
Micropterus salmoides	largemouth bass
Notemigonus crysoleucas	golden shiner
Notropis procne	swallowtail shiner
Noturus gyrinus	tadpole madtom
Perca flavescens	yellow perch
Pomoxis nigromaculatus	black crappie
Semotilus corporalis	fallfish
Umbra pygmaea	eastern mudminnow

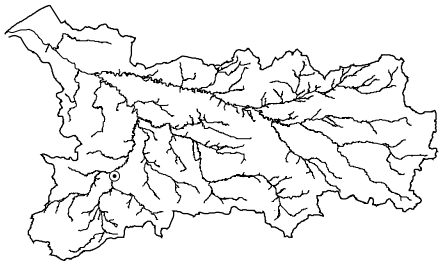
APPENDIX 3.3. FISH-DISTRIBUTION MAPS



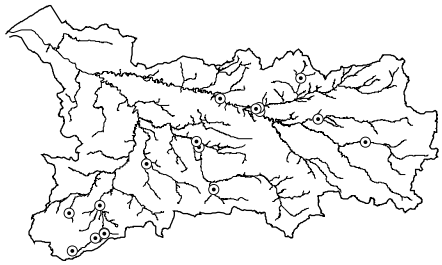
Location of 43 stream-fish and 15 impoundment-fish survey sites. Distribution maps on the following pages show where each fish species was present.



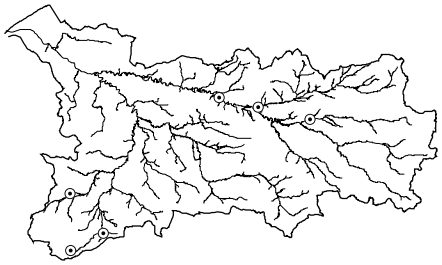
Acantharchus pomotis
mud sunfish



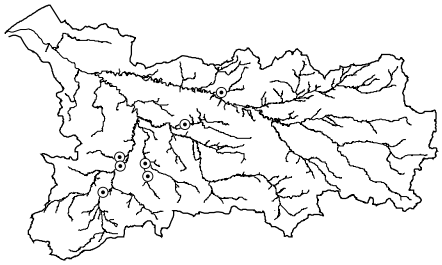
Ameiurus catus
white catfish



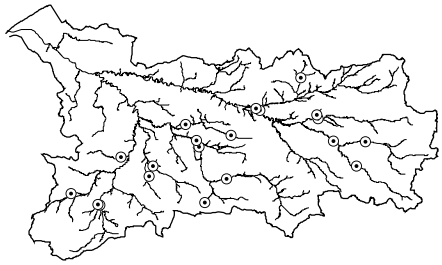
Ameiurus natalis
yellow bullhead



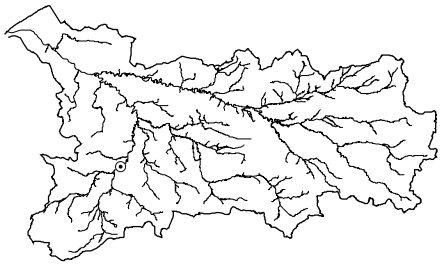
Ameiurus nebulosus
brown bullhead



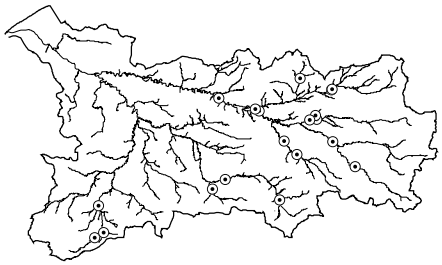
Anguilla rostrata
American eel



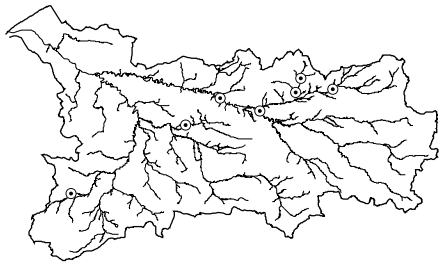
Aphredoderus sayanus
pirate perch



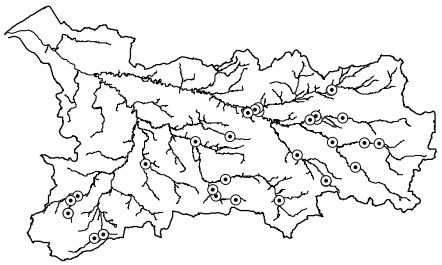
Cyprinella analostana
satinfin shiner



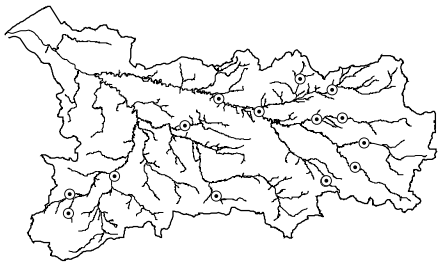
Enneacanthus chaetodon
blackbanded sunfish



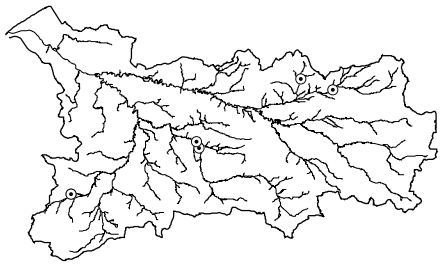
Enneacanthus gloriosus
bluespotted sunfish



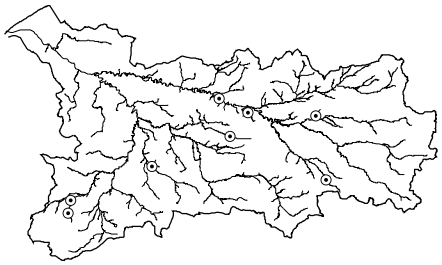
Enneacanthus obesus
banded sunfish



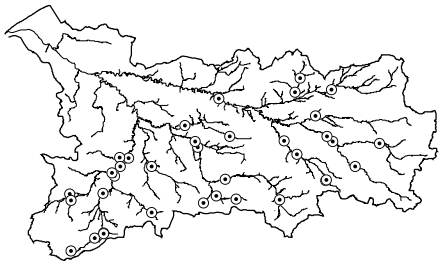
Enneacanthus species



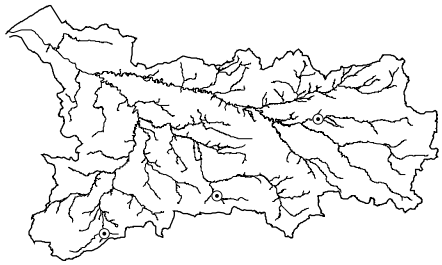
Erimyzon oblongus
creek chubsucker



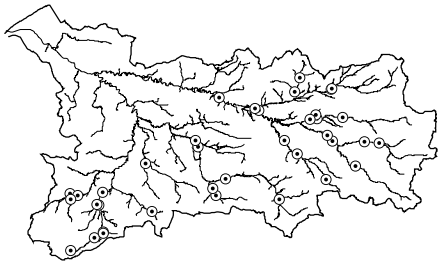
Esox americanus
redfin pickerel



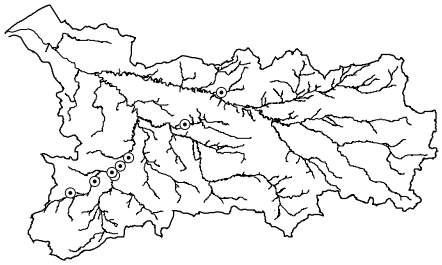
Esox niger
chain pickerel



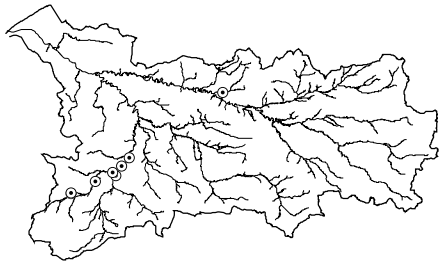
Esox species



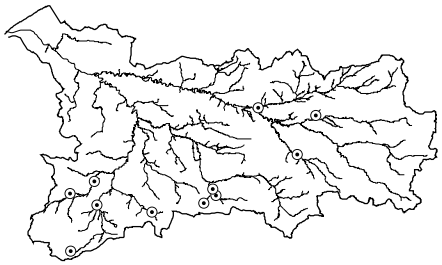
Etheostoma fusiforme
swamp darter



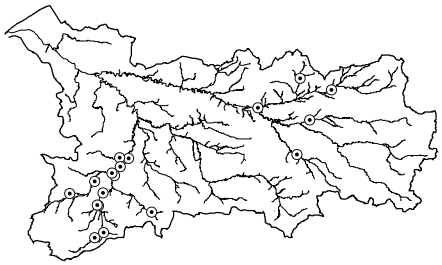
Etheostoma olmstedi
tessellated darter



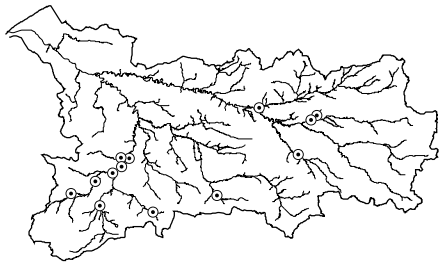
Lepomis auritus
redbreast sunfish



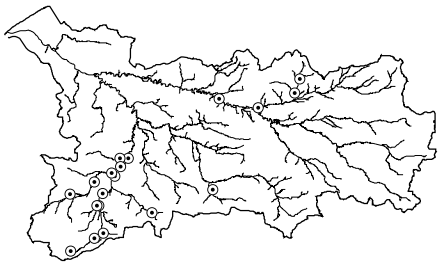
Lepomis gibbosus
pumpkinseed



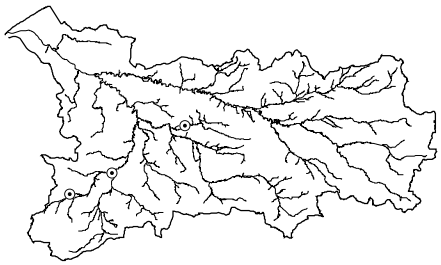
Lepomis macrochirus
bluegill



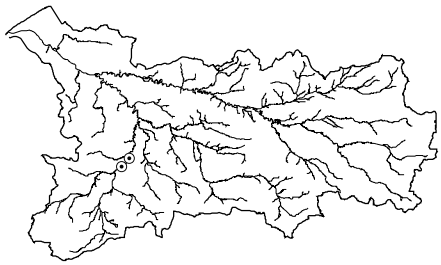
Lepomis species



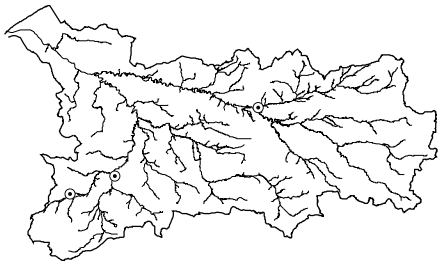
Micropterus salmoides
largemouth bass



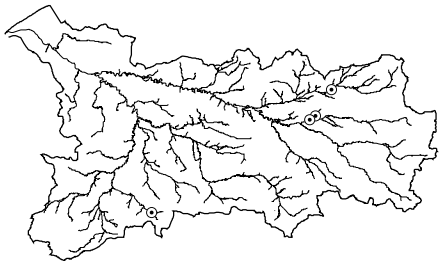
Notemigonus crysoleucas
golden shiner



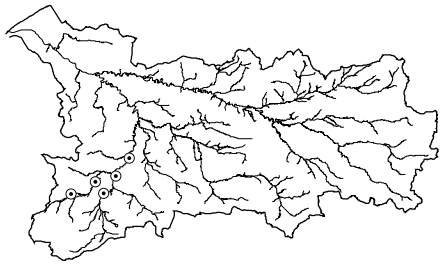
Notropis procne
swallowtail shiner



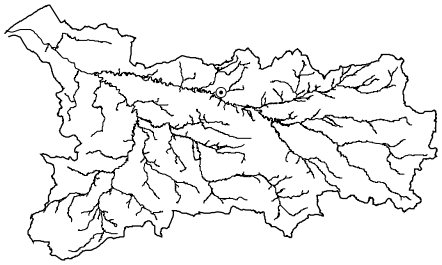
Noturus gyrinus
tadpole madtom



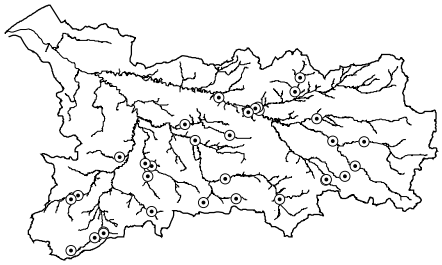
Perca flavescens
yellow perch



Pomoxis nigromaculatus
black crappie



Semotilus corporalis
fallfish



Umbra pygmaea
eastern mudminnow

APPENDIX 4. ANURAN-ASSEMBLAGE DATA

Appendix 4.0. Anuran-monitoring sites in the Rancocas Creek Basin. Latitude, longitude, and USGS 7.5 minute topographic quadrangle names are given in parentheses. The listening point is given in brackets after the site location. Sites are ordered alphabetically by site code.

Site Name and Description	Site Code
Presidential Lakes - lower	GBIPRESD
Pemberton Twp., Burlington Co. (lat 39E54'32.47", long 74E34'25.29", Browns Mills quad). Impoundment on Bisphams Mill Creek, downstream from dike at end of New York Road [northern end of dike].	
Presidential Lakes - upper	GBIPRESU
Pemberton Twp., Burlington Co. (lat 39E54'32.47", long 74E34'25.29", Browns Mills quad). Impoundment on Bisphams Mill Creek, upstream from dike at end of New York Road [northern end of dike].	
Bucks Cove Run below Route 530	GBUR530D
Pemberton Twp., Burlington Co. (lat 39E57'0.00", long 74E32'36.50", Browns Mills quad). Impoundment downstream from Route 530 (Lakehurst Road), northern lobe of Country Lake [Route 530].	
Bucks Cove Run above Route 530	GBUR530U
Pemberton Twp., Burlington Co. (lat 39E57'0.00", long 74E32'36.50", Browns Mills quad). Impoundment upstream from Route 530 (Lakehurst Road) [Route 530].	
Pakim Pond	GCOPAKIM
Woodland Twp., Burlington Co. (lat 39E52'49.51", long 74E31'58.37", Browns Mills quad). Impoundment on Cooper Branch, upstream from Batona Trail [western shoreline at beach].	
Country Lake north - below Choctaw Road	GCRCOUND
Pemberton Twp., Burlington Co. (lat 39E57'0.50", long 74E32'50.62", Browns Mills quad). Impoundment on Cranberry Branch, downstream from northern part of Choctaw Road [Choctaw Road].	
Country Lake north - above Choctaw Road	GCRCOUNU
Pemberton Twp., Burlington Co. (lat 39E57'0.50", long 74E32'50.62", Browns Mills quad). Impoundment on Cranberry Branch, upstream from northern part of Choctaw Road [Choctaw Road].	
Cranberry Branch impoundment at Whitesbog	GCRWHITE
Pemberton Twp., Burlington Co. (lat 39E57'46.62", long 74E30'7.20", Browns Mills and Whiting quads). Impoundment just northeast of Whitesbog Village [southern corner of bog].	
Greenwood Branch impoundment above New Lisbon-Four Mile Road	GGRIMPNT
Pemberton Twp., Burlington Co. (lat 39E57'22.63", long 74E37'39.54", Pemberton quad). Impoundment upstream from New Lisbon-Four Mile Road [southwestern shoreline].	
Gum Spring Run impoundment - lower	GGUMBOGD
Pemberton Twp., Burlington Co. (lat 39E55'22.39", long 74E33'53.23", Browns Mills quad). Impoundment downstream from dike at northern end of Presidential Lake Estates [southeastern corner of bog].	
Gum Spring Run impoundment - upper	GGUMBOGU
Pemberton Twp., Burlington Co. (lat 39E55'22.39", long 74E33'53.23", Browns Mills quad). Impoundment upstream from dike at northern end of Presidential Lake Estates [southwestern corner of bog].	
McDonalds Branch tributary impoundment above dike	GMCTRBOG
Woodland Twp., Burlington Co. (lat 39E54'18.16", long 74E32'34.61", Browns Mills quad). Impoundment upstream from dike at northeastern end of cranberry bog complex [dike]. *Latitude and longitude values were obtained using ArcView software.	
McDonalds Branch near gaging station	GMCWIDEN
Woodland Twp., Burlington Co. (lat 39E52'47.14", long 74E29'58.18", Whiting quad). Impoundment upstream from gaging station, near Butterworth Road [southwestern shoreline].	
Mount Misery Brook impoundment at Mount Misery	GMOUCAMP
Pemberton Twp., Burlington Co. (lat 39E55'22.88", long 74E31'24.36", Browns Mills quad). Impoundment between Route 70 and Mount Misery [southwestern shoreline].	
Route 70 borrow pit	GPO70BOR
Pemberton Twp., Burlington Co. (lat 39E56'15.70", long 74E31'10.10", Whiting quad). Northern borrow pit on southern side of Route 70, near Upton [northwestern shoreline].	
Country Lake at Chippewa Road	GPOCOUNB
Pemberton Twp., Burlington Co. (lat 39E56'43.53", long 74E32'35.27", Browns Mills quad). Impoundment on Pole Bridge Branch, at beach near intersection of Chippewa Road and Spring Lake Boulevard [southcentral shoreline at beach].	
Country Lake south - below Choctaw Road	GPOCOUND
Pemberton Twp., Burlington Co. (lat 39E56'51.27", long 74E32'43.76", Browns Mills quad). Impoundment on Pole Bridge Branch, downstream from southern part of Choctaw Road [Choctaw Road].	

Site Name and Description	Site Code
Country Lake south - above Choctaw Road	GPOCOUNU
Pemberton Twp., Burlington Co. (lat 39E56'51.27", long 74E32'43.76", Browns Mills quad). Impoundment on Pole Bridge Branch, upstream from southern part of Choctaw Road [Choctaw Road].	
Pole Bridge Branch impoundment below Route 70	GPORT70D
Pemberton Twp., Burlington Co. (lat 39E56'55.72", long 74E29'34.50", Whiting quad). Impoundment downstream from Route 70 [southeastern shoreline].	
South Branch Mount Misery Brook impoundment at sand road	GSONORMA
Woodland Twp., Burlington Co. (lat 39E53'44.54", long 74E29'27.24", Whiting quad). Impoundment upstream from unnamed sand road, downstream from Butler Place Road [sand road].	
Big Pine Lake below Bayberry Street	NJABPBAY
Pemberton Twp., Burlington Co. (lat 39E59'12.50", long 74E34'13.80", Browns Mills quad). Impoundment on Jacks Run, downstream from Bayberry Street [Bayberry Street].	
Big Pine Lake above Hanover Boulevard	NJABPHAN
Pemberton Twp., Burlington Co. (lat 39E58'45.43", long 74E34'24.85", Browns Mills quad). Impoundment on Jacks Run, upstream from Hanover Boulevard [Hanover Boulevard].	
Mirror Lake below Club House Road	NJACLUBD
Pemberton Twp., Burlington Co. (lat 39E58'27.40", long 74E34'24.19", Browns Mills quad). Impoundment on Jacks Run, downstream from Club House Road [Club House Road].	
Mirror Lake above Club House Road	NJACLUBU
Pemberton Twp., Burlington Co. (lat 39E58'27.40", long 74E34'24.19", Browns Mills quad). Impoundment on Jacks Run, upstream from Club House Road [Club House Road].	
Little Pine Lake above Bayberry Street	NJALPINE
Pemberton Twp., Burlington Co. (lat 39E59'12.50", long 74E34'13.80", Browns Mills quad). Impoundment on Jacks Run, upstream from Bayberry Street [Bayberry Street].	
North Branch Rancocas Creek above Route 616	NNORT616
Pemberton Twp., Burlington Co. (lat 39E58'12.22", long 74E41'02.70", Pemberton quad). Impoundment upstream from Hanover Street (Route 616) [southwestern shoreline].	
North Branch Rancocas Creek tributary below Magnolia Road	NNOTRMGD
Pemberton Twp., Burlington Co. (lat 39E57'16.67", long 74E38'34.17", Pemberton quad). Impoundment downstream from Magnolia Road [Magnolia Road].	
North Branch Rancocas Creek tributary above Magnolia Road	NNOTRMGU
Pemberton Twp., Burlington Co. (lat 39E57'16.67", long 74E38'34.17", Pemberton quad). Impoundment upstream from Magnolia Road [Magnolia Road].	
Bread and Cheese Run impoundment at Camp Inawendiwin	SBRCAMPI
Tabernacle Twp., Burlington Co. (lat 39E52'9.44", long 74E41'35.50", Indian Mills quad). Impoundment at confluence of Bread and Cheese Run and Friendship Creek, at Camp Inawendiwin [eastern end of dam breast].	
Burrs Mill Brook impoundment near Route 70	SBURNR70
Southampton Twp., Burlington Co. (lat 39E53'08.27", long 74E39'56.86", Pemberton quad). Impoundment midway between Sooy Place Road and Burrs Mill [sand road]. *Latitude and longitude values were obtained using ArcView software.	
Burrs Mill Brook bog above Sooy Place Road	SBUSOOYL
Southampton Twp., Burlington Co. (lat 39E52'54.97", long 74E40'30.51", Pemberton quad). Impoundment upstream from Sooy Place Road [Sooy Place Road].	
Friendship Creek impoundment at Camp Inawendiwin	SFRCAMPI
Tabernacle Twp., Burlington Co. (lat 39E51'50.18", long 74E41'17.86", Indian Mills quad). Impoundment upstream from confluence with Bread and Cheese Run at Camp Inawendiwin [eastern end of dam breast].	
Old Forge Lake	SFRHAMPT
Southampton Twp., Burlington Co. (lat 39E53'29.76", long 74E42'37.68", Pemberton quad). Impoundment on Friendship Creek, downstream from Route 70, in Hampton Lakes development [at park].	
Jade Run near Route 616 - downstream	SJAR616D
Southampton Twp., Burlington Co. (lat 39E56'26.45", long 74E43'57.45", Pemberton quad). Downstream from unnamed sand road, south of Pemberton Road (Route 616), between Brace Road and Route 206 [sand road].	
Jade Run impoundment at Route 616	SJAR616I
Southampton Twp., Burlington Co. (lat 39E56'34.68", long 74E43'43.37", Pemberton quad). Impoundment on south side of Pemberton Road (Route 616), between Brace Road and Route 206 [Route 616].	

Site Name and Description	Site Code
Jade Run near Route 616 - upstream	SJAR616U
Southampton Twp., Burlington Co. (lat 39E56'26.45", long 74E43'57.45", Pemberton quad). Upstream from unnamed sand road, south of Pemberton Road (Route 616), between Brace Road and Route 206 [sand road].	
South Branch Burrs Mill Brook impoundment above Sooy Place Road	SSBSOOYL
Woodland Twp., Burlington Co. (lat 39E51'32.50", long 74E35'49.40", Chatsworth quad). Impoundment upstream from Sooy Place Road [Sooy Place Road].	
Vincentown Millpond	SSOVINCE
Southampton Twp., Burlington Co. (lat 39E56'6.41", long 74E45'6.52", Mount Holly quad). Impoundment on South Branch Rancocas Creek, upstream from Race Street [northwestern shoreline].	
Barton Run impoundment above Tuckerton Road	WBACONDO
Medford Twp., Burlington Co. (lat 39E51'57.67", long 74E52'3.77", Mount Holly quad). Impoundment upstream from Tuckerton Road, in Barton Run development [southeastern end of impoundment]	
Jennings Lake	WBAJENNL
Evesham Twp., Burlington Co. (lat 39E51'55.68", long 74E53'42.19", Clementon quad). Impoundment on Barton Run upstream from Tomlinson Mill Road [northwestern shoreline].	
Black Run bog	WBLABBOG
Evesham Twp., Burlington Co. (lat 39E50'22.64", long 74E53'36.73", Clementon quad). Impoundment upstream from fourth dike above Kettle Run Road [dike/sand road].	
Black Run tributary impoundment at Kings Grant development	WBLKINGS
Evesham Twp., Burlington Co. (lat 39E51'35.47", long 74E52'29.40", Clementon and Medford Lakes quads). Impoundment upstream from Tomlinson Mill Road (Route 544) [northern shoreline].	
Cedar Run Lake	WCEDARLK
Medford Twp., Burlington Co. (lat 39E49'19.25", long 74E50'50.35", Medford Lakes quad). Impoundment on Cedar Run, at Woodford Cedar Run Refuge [lake outlet].	
Haynes Creek at Cedar Trail	WHACEDAR
Medford Twp., Burlingt on Co. (lat 39E52'36.90", long 74E50'6.65", Mount Holly quad). At beach on Cedar Trail, between Tuckerton Road and Himmelein Road (Route 623) [at park].	
Centennial Lake	WHACENTL
Medford Twp., Burlington Co. (lat 39E50'31.91", long 74E50'58.25", Medford Lakes quad). Impoundment on Haynes Creek, upstream from Centennial Dam Road [lake outlet].	
Lake Pine	WHAPINEL
Medford Twp., Burlington Co. (lat 39E51'59.41", long 74E50'53.73", Medford Lakes quad). Impoundment on Haynes Creek, upstream from Falls Road [lake outlet].	
Taunton Lake at beach	WHATAUNB
Medford Twp., Burlington Co. (lat 39E51'8.91", long 74E51'18.30", Medford Lakes quad). Impoundment on Haynes Creek, upstream from Breakneck Road [northwestern corner at beach].	
Taunton Lake	WHATAUNL
Medford Twp., Burlington Co. (lat 39E50'31.91", long 74E50'58.25", Medford Lakes quad). Impoundment on Haynes Creek, downstream from Centennial Dam Road [lake inlet].	
Lower Aetna Lake	WHATRAET
Medford Twp.,Burlington Co. (lat 39E51'48.10", long 74E48'8.97", Medford Lakes quad). Impoundment on tributary of Haynes Creek, upstream from Tabernacle Road (Route 532) [northeastern corner at beach].	
Haynes Creek tributary impoundment above Jackson - Medford Road	WHATRBIR
Medford Twp., Burlington Co. (lat 39E52'04.01", long 74E49'14.85", Medford Lakes quad). Impoundment upstream from Jackson - Medford Road [Jackson - Medford Road].	
Haynes Creek tributary at McKendimen and Bear Head Roads	WHATRMCK
Medford Twp., Burlington Co. (lat 39E50'50.62", long 74E45'39.32", Medford Lakes quad). Impoundment southwest of intersection of McKendimen and Bear Head Roads [McKendimen Road].	
Lake Mishe-Mokwa	WHATRMIS
Medford Twp., Burlington Co. (lat 39E51'29.41", long 74E48'30.13", Medford Lakes quad). Impoundment on tributary of Haynes Creek, upstream from Hiawatha Drive [northeastern corner at beach].	
Haynes Creek tributary impoundment below Jackson - Medford Road	WHATROAK
Medford Twp., Burlington Co. (lat 39E52'04.01", long 74E49'14.85", Medford Lakes quad). Impoundment downstream from Jackson - Medford Road [Jackson - Medford Road].	

Site Name and Description	Site Code
Lake Stockwell at tributary	WHATROCD
Medford Twp., Burlington Co. (lat 39E51'09.37", long 74E47'23.60", Medford Lakes quad). Impoundment on tributary of Haynes Creek, at tributary entering lake from north, between Camp Matollionequay and Ockanicken [sand road].	
Haynes Creek tributary above Lake Stockwell	WHATROCU
Medford Twp., Burlington Co. (lat 39E51'09.37", long 74E47'23.60", Medford Lakes quad). Impoundment on northern tributary of Lake Stockwell, upstream from sand road, between Camp Matollionequay and Ockanicken [sand road].	
Squaw Lake	WHATRSQU
Medford Twp., Burlington Co. (lat 39E50'44.52", long 74E46'43.92", Medford Lakes quad). Impoundment on tributary of Haynes Creek, at Camp Matollionequay [eastern end of dam breast].	
Lake Stockwell near outlet	WHATRSTO
Medford Twp., Burlington Co. (lat 39E50'55.40", long 74E47'01.14", Medford Lakes quad). Impoundment on tributary of Haynes Creek, at Camp Ockanicken [northeastern end of dam breast].	
Haynes Creek tributary above Kettle Run Road	WHATRYMC
Evesham Twp., Burlington Co. (lat 39E49'03.88", long 74E53'55.99", Clementon quad). Impoundment upstream from Kettle Run Road, at Moore YMCA Camp [Kettle Run Road].	
Braddocks Millpond	WKEBRADD
Medford Twp., Burlington Co. (lat 39E49'19.73", long 74E50'56.36", Medford Lakes quad). Impoundment on Kettle Run, upstream from Sawmill Road [southeastern shoreline at Sawmill Road].	
Kettle Run at camp Kettle Run	WKEGIRLS
Medford Twp., Burlington Co. (lat 39E49'02.61", long 74E51'35.73", Medford Lakes quad). Impoundment upstream from Braddocks Millpond, at Camp Kettle Run [eastern end of dam breast].	
Kettle Run above Hopewell Road	WKEMARLT
Evesham Twp., Burlington Co. (lat 39E48'11.71", long 74E53'35.05", Clementon quad). Impoundment upstream from Hopewell Road, at Marlton Lakes development [Hopewell Road].	
Kettle Run impoundment above Georgia O'Keefe Way	WKESANCT
Evesham Twp., Burlington Co. (lat 39E48'27.15", long 74E52'41.70", Clementon quad). Impoundment upstream from Georgia O'Keefe Way, at Sanctuary development [northeastern shoreline].	
Little Creek at Church Road	WLICHURC
Medford and Southampton Twps., Burlington Co. (lat 39E55'22.98", long 74E47'16.68", Mount Holly quad). Downstream from Church Road [Church Road].	
Little Creek at Shawnee Pass - downstream	WLISHAWD
Medford Twp., Burlington Co. (lat 39E51'41.76", long 74E47'01.24", Medford Lakes quad). Impoundment downstream from Shawnee Pass, at Shawnee Country development [Shawnee Pass].	
Little Creek at Shawnee Pass - upstream	WLISHAWU
Medford Twp., Burlington Co. (lat 39E51'41.76", long 74E47'01.24", Medford Lakes quad). Impoundment upstream from Shawnee Pass, at Shawnee Country development [Shawnee Pass].	
Lake Cotoxen	WSOCOTOX
Medford Twp., Burlington Co. (lat 39E55'0.24", long 74E48'19.52", Mount Holly quad). Impoundment on Southwest Branch Rancocas Creek, upstream from Church Road, at Kirbys Mill [Church Road].	
Southwest Branch Rancocas Creek impoundment at Medford Park	WSOMEDPK
Medford Twp., Burlington Co. (lat 39E53'36.95", long 74E49'36.89", Mount Holly quad). Impoundment at Medford Park, upstream from Main Street (Stokes Road or Route 541) [northern shoreline]. *Latitude and longitude values were obtained using ArcView software.	

Appendix 4.1. Maximum-calling ranks for seven anuran species at monitoring sites in the Rancocas Creek Basin. Observers are JFB = John F. Bunnell and DMG = Dennis M. Gray. Weather codes are 0 = clear, 1 = cloudy, 2 = overcast, 3 = fog/haze, 4 = breezy, 5 = drizzle, 6 = constant rain, 7 = showers, 8 = thunder storm occurred within one hour, and 9 = thunderstorm. Maximum calling ranks are 1 = 1, 2 = 2-5, 3 = 6-10, and 4 > 10 individuals calling. The letter " v " refers to the visual observation of a species that was not calling. A dash (-) indicates that a species was not heard or observed at a site. Refer to Chapter 5 (Anuran Assemblages) for survey methodology. Refer to Appendix 4.0 for detailed site information and Appendix 4.2 for full scientific and common names.

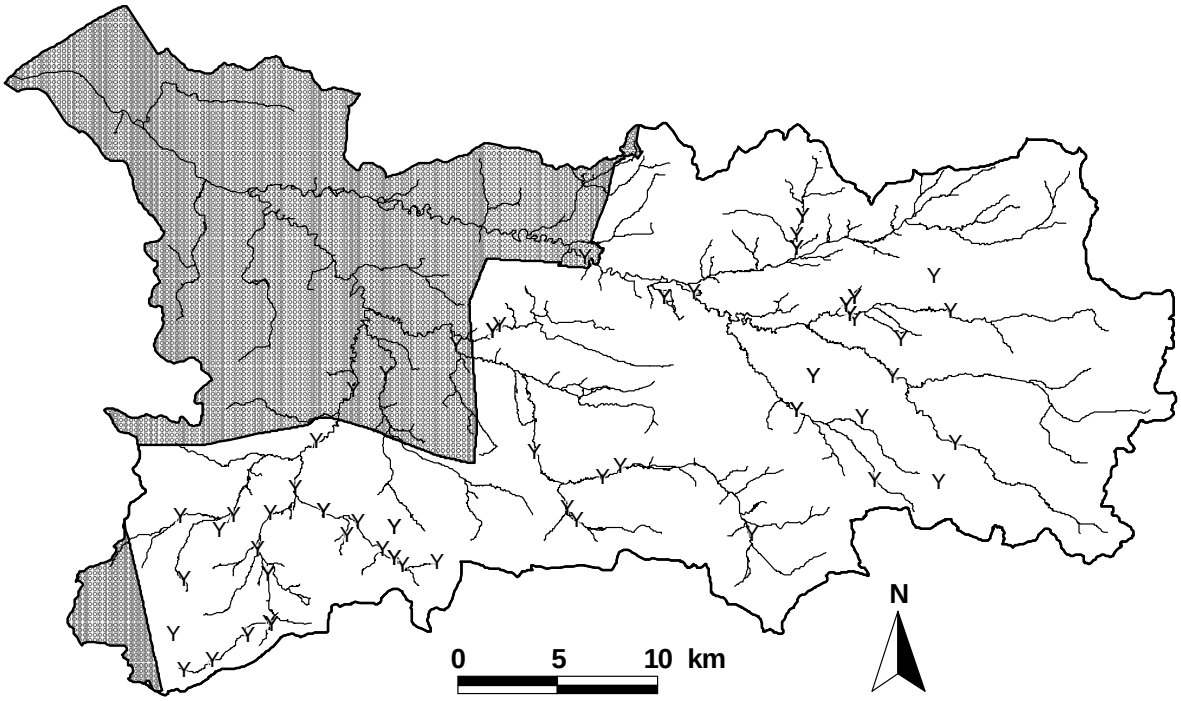
Survey Information				Conditions			Species						
Site Code	Observer(s) Initials	Date	Time	Weather Code	Air Temp. (EC)	Rel. Hum. (%)	*B. w. fowleri*	*H. andersonii*	*H. versicolor*	*R. catesbeiana*	*R. c. melanota*	*R. utricularia*	*R. virgatipes*
GBIPRESD	JFB	06/15/01	10:29 PM	2,4	23.0	92	3	-	-	2	-	-	2
GBIPRESU	JFB	06/15/01	10:29 PM	2,4	23.0	92	3	-	-	2	-	-	1
GBUR530D	JFB	06/15/01	09:18 PM	2	24.0	92	-	-	-	-	2	-	2
GBUR530U	JFB	06/15/01	09:18 PM	2	24.0	92	-	-	-	-	2	-	2
GCOPAKIM	JFB	06/15/01	11:02 PM	2,4	23.5	96	-	-	-	-	1	-	4
GCRCOUND	JFB	06/11/01	11:04 PM	2,4,5	23.5	84	4	-	-	-	-	-	-
GCRCOUNU	JFB	06/11/01	11:04 PM	2,4,5	23.5	84	-	-	-	-	-	-	-
GCRWHITE	JFB	06/11/01	11:17 PM	2,4,5	23.0	84	-	-	-	-	-	-	4
GGRIMPNT	JFB	06/11/01	09:39 PM	2	23.5	84	-	-	-	-	-	-	-
GGUMBOGD	JFB	06/15/01	10:42 PM	2	23.0	92	2	-	-	-	1	2	4
GGUMBOGU	JFB	06/15/01	10:42 PM	2	23.0	92	-	-	-	-	1	-	4
GMCTRBOG	JFB	06/15/01	11:26 PM	2,4	23.5	96	1	1	-	-	1	3	3
GMCWIDEN	JFB	06/15/01	11:46 PM	2	23.0	96	-	1	-	-	-	-	1
GMOUCAMP	JFB	06/15/01	10:06 PM	0,4	22.0	100	-	3	-	-	2	-	4
GPO70BOR	JFB	06/15/01	09:48 PM	2,4	23.5	92	3	-	-	-	2	-	2
GPOCOUNB	JFB	06/15/01	09:08 PM	0,4	24.5	96	3	-	-	-	-	-	-
GPOCOUND	JFB	06/11/01	10:55 PM	2,4,5	23.5	84	4	-	-	-	-	-	-
GPOCOUNU	JFB	06/11/01	10:55 PM	2,4,5	23.5	84	-	-	-	-	-	-	-
GPORT70D	JFB	06/15/01	09:27 PM	0	23.5	92	2	-	-	-	1	-	2
GSONORMA	JFB	06/15/01	12:07 AM	2	23.0	96	-	-	-	-	1	-	2
NJABPBAY	JFB	06/11/01	10:16 PM	2,4	24.0	76	2	-	-	2	-	-	-
NJABPHAN	JFB	06/11/01	10:10 PM	2	24.0	76	2	-	-	-	-	-	-
NJACLUBD	JFB	06/11/01	09:59 PM	2	24.0	76	2	-	-	2	-	-	-
NJACLUBU	JFB	06/11/01	09:59 PM	2	24.0	76	-	-	-	1	-	-	-
NJALPINE	JFB	06/11/01	10:16 PM	2,4	24.0	76	-	-	-	-	-	-	-
NNORT616	JFB	06/11/01	09:06 PM	0	24.0	76	2	-	-	2	2	-	-
NNOTRMGD	JFB	06/11/01	09:28 PM	0,4	24.0	76	-	-	-	2	4	1	2
NNOTRMGU	JFB	06/11/01	09:28 PM	0,4	24.0	76	-	-	-	-	2	-	2
SBRCAMPI	JFB	06/19/01	11:30 PM	0,4	20.5	84	2	-	-	2	1	-	-
SBURNR70	JFB	06/19/01	10:21 PM	0,4	21.0	84	2	-	-	-	-	-	2
SBUSOOYL	JFB	06/19/01	10:47 PM	0	21.0	78	1	-	-	2	2	2	3
SFRCAMPI	JFB	06/19/01	11:38 PM	0,4	20.5	84	2	-	-	-	1	-	2
SFRHAMPT	JFB	06/19/01	10:04 PM	0,4	21.5	72	2	-	-	1	-	-	-
SJAR616D	JFB	06/19/01	09:18 PM	0	23.5	84	-	-	-	2	2	-	-
SJAR616I	JFB	06/19/01	09:08 AM	0	23.5	68	-	-	-	-	-	-	-

Survey Information				Conditions			Species						
Site Code	Observer(s) Initials	Date	Time	Weather Code	Air Temp. (EC)	Rel. Hum. (%)	*B. w. fowleri*	*H. andersonii*	*H. versicolor*	*R. catesbeiana*	*R. c. melanota*	*R. utricularia*	*R. virgatipes*
SJAR616U	JFB	06/19/01	09:18 PM	0	23.5	84	-	-	-	-	2	-	-
SSBSOOYL	JFB	06/19/01	11:05 PM	0	21.0	78	-	-	-	-	1	-	4
SSOVINCE	JFB	06/19/01	09:33 PM	0	23.0	68	2	-	-	2	2	-	-
WBACONDO	JFB	06/08/01	09:03 PM	0	18.5	64	-	-	-	2	-	-	-
WBAJENNL	JFB/DMG	06/05/01	10:08 PM	0	16.5	86	-	-	-	3	2	-	-
WBLABBOG	JFB/DMG	06/05/01	10:36 PM	0	17.0	96	-	-	-	1	2	-	4
WBLKINGS	JFB/DMG	06/05/01	09:53 PM	0	19.5	76	-	-	-	-	-	-	-
WCEDARLK	JFB	06/08/01	09:47 PM	0	16.0	80	-	-	-	-	2	-	-
WHACEDAR	JFB/DMG	06/05/01	09:10 PM	0	19.5	86	3	-	-	1	-	-	-
WHACENTL	JFB/DMG	06/05/01	11:21 PM	0	17.0	90	-	-	-	-	-	-	-
WHAPINEL	JFB/DMG	06/05/01	09:39 PM	0	20.0	82	1	-	-	1	-	-	-
WHATAUNB	JFB	06/08/01	09:37 PM	0	19.0	72	-	-	-	-	-	-	-
WHATAUNL	JFB/DMG	06/05/01	11:21 PM	0	17.0	90	-	-	-	2	-	-	-
WHATRAET	JFB	06/08/01	10:59 PM	0	16.0	90	-	-	-	-	-	-	-
WHATRBIR	JFB	06/08/01	10:25 PM	0	15.0	86	-	-	-	-	-	-	-
WHATRMCK	JFB	07/17/01	09:30 PM	2	25.5	70	-	-	4	-	2	-	-
WHATRMIS	JFB	06/08/01	10:48 PM	0	16.0	76	-	-	-	3	-	-	-
WHATROAK	JFB	06/08/01	10:25 PM	0	15.0	86	-	-	-	2	-	-	-
WHATROCD	JFB	07/17/01	10:11 PM	2	25.5	70	-	-	-	-	2	-	-
WHATROCU	JFB	07/17/01	10:11 PM	2	25.5	70	-	-	-	-	4	-	-
WHATRSQU	JFB	07/17/01	10:04 PM	2	25.5	78	-	-	-	-	-	-	-
WHATRSTO	JFB	07/17/01	09:48 PM	0,2	25.5	78	-	-	-	-	-	-	-
WHATRYMC	JFB/DMG	06/05/01	10:45 PM	0	17.0	80	2	-	-	1	2	-	-
WKEBRADD	JFB	06/08/01	09:53 PM	0	16.0	80	-	-	-	-	-	-	-
WKEGIRLS	JFB	07/17/01	10:50 PM	2,4	25.0	76	-	-	-	2	2	-	1
WKEMARLT	JFB/DMG	06/05/01	10:59 PM	0	19.5	80	2	-	-	2	1	-	-
WKESANCT	JFB	07/17/01	11:25 PM	2	24.5	76	v	-	-	-	2	-	-
WLICHURC	JFB	06/08/01	11:25 PM	0	16.0	90	-	-	-	-	1	-	-
WLISHAWD	JFB	07/17/01	09:18 PM	2	25.5	70	-	-	-	v	-	-	-
WLISHAWU	JFB	07/17/01	09:18 PM	2	25.5	70	1	-	-	-	1	-	-
WSOCOTOX	JFB/DMG	06/05/01	11:53 PM	0	17.0	90	1	-	-	-	-	-	-
WSOMEDPK	JFB/DMG	06/05/01	08:55 PM	0	20.0	66	-	-	-	2	-	-	-

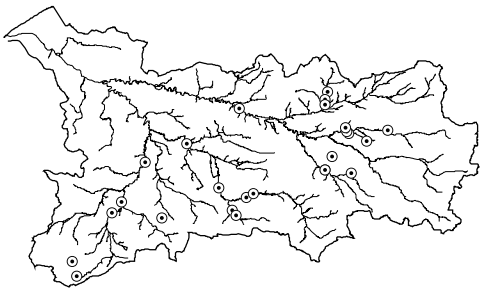
Appendix 4.2. Common and scientific names for seven anuran species heard during vocalization surveys in the Rancocas Creek Basin. Nomenclature follows Conant and Collins (1998).

Scientific Name	Common Name
Bufo woodhousii fowleri	Fowler's toad
Hyla andersonii	Pine Barrens treefrog
Hyla versicolor	northern gray treefrog
Rana virgatipes	carpenter frog
Rana clamitans melanota	green frog
Rana utricularia	southern leopard frog
Rana catesbeiana	bullfrog

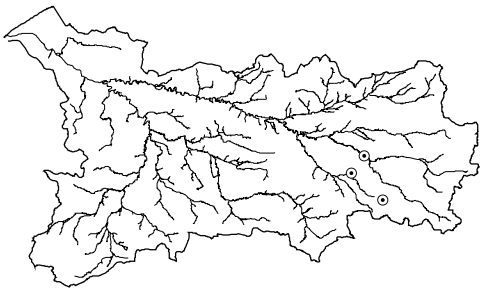
APPENDIX 4.3. ANURAN-DISTRIBUTION MAPS



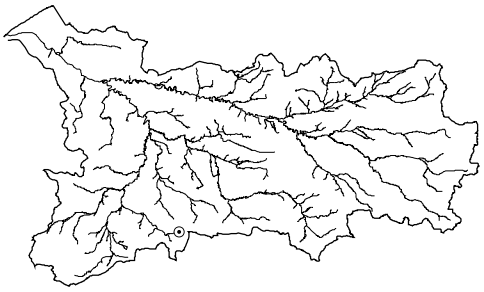
Location of 67 anuran (frog and toad) survey sites. Distribution maps on the following pages show where each anuran species was found.



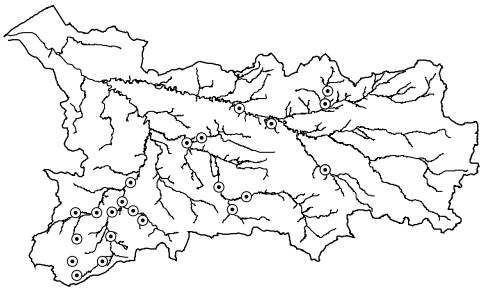
Bufo woodhousii fowleri
Fowler's toad



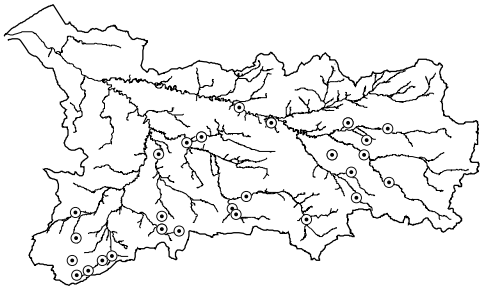
Hyla andersonii
Pine Barrens treefrog



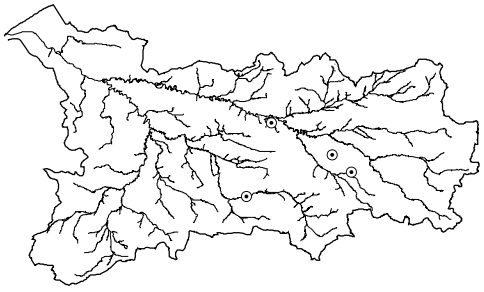
Hyla versicolor
northern gray treefrog



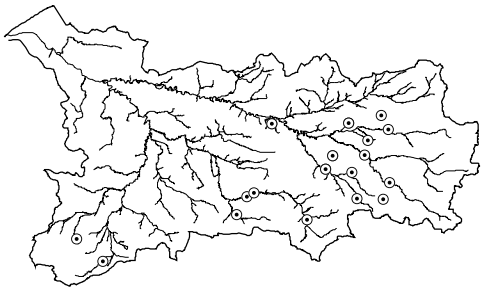
Rana catesbeiana
bullfrog



Rana clamitans melanota
green frog



Rana utricularia
southern leopard frog



Rana virgatipes
carpenter frog