

Upper Rock Creek

3.22 Stream Valley Drive Stream Restoration

3.22.1 Introduction

The Stream Valley Drive Stream Restoration Project was completed in 2004. The primary restoration objective for the project was to protect stream quality of an important headwater tributary to Rock Creek, located in a County Special Protection Area (SPA). The goal of the project was to restore the tributary to good biological and aquatic habitat conditions as defined in the *Countywide Stream Protection Strategy* (CSPS 1998, updated 2003), published by the Department of Environmental Protection.

Subwatershed facts

Subwatershed Drainage Area: 142 acres

Subwatershed Imperviousness: 6 percent

Property Ownership: Maryland-National Capitol Park and Planning Commission

Project facts

Project Area: The Rock Creek Watershed, tributary of the Potomac River, includes a drainage area of 60 square miles. Rock Creek flows 21 miles through central Montgomery County, east of I-270, then continues into the District of Columbia.

Project Length: 2,380 feet

Costs: Structural (\$170,000), Reforestation (\$60,000), funded in part through a grant from the Maryland Department of Natural Resources

Completion Date: September 2004

Project Selection

Montgomery County has a continuing commitment to protecting its water resources. The CSPS, published by the Department of Environmental Protection, evaluated biological, chemical, and habitat conditions of streams in the county, and identified impaired “priority” subwatersheds for restoration. Following the CSPS, *The Rock Creek Watershed Feasibility Study* (April 2001) evaluated more than 14 miles of Rock Creek and its tributaries to identify specific stream restoration and stormwater management opportunities. The study identified 23 priority stream restoration sites, including the Stream Valley Drive tributary, a Use Class III headwater tributary of Rock Creek (**Figure 3.22.1**).

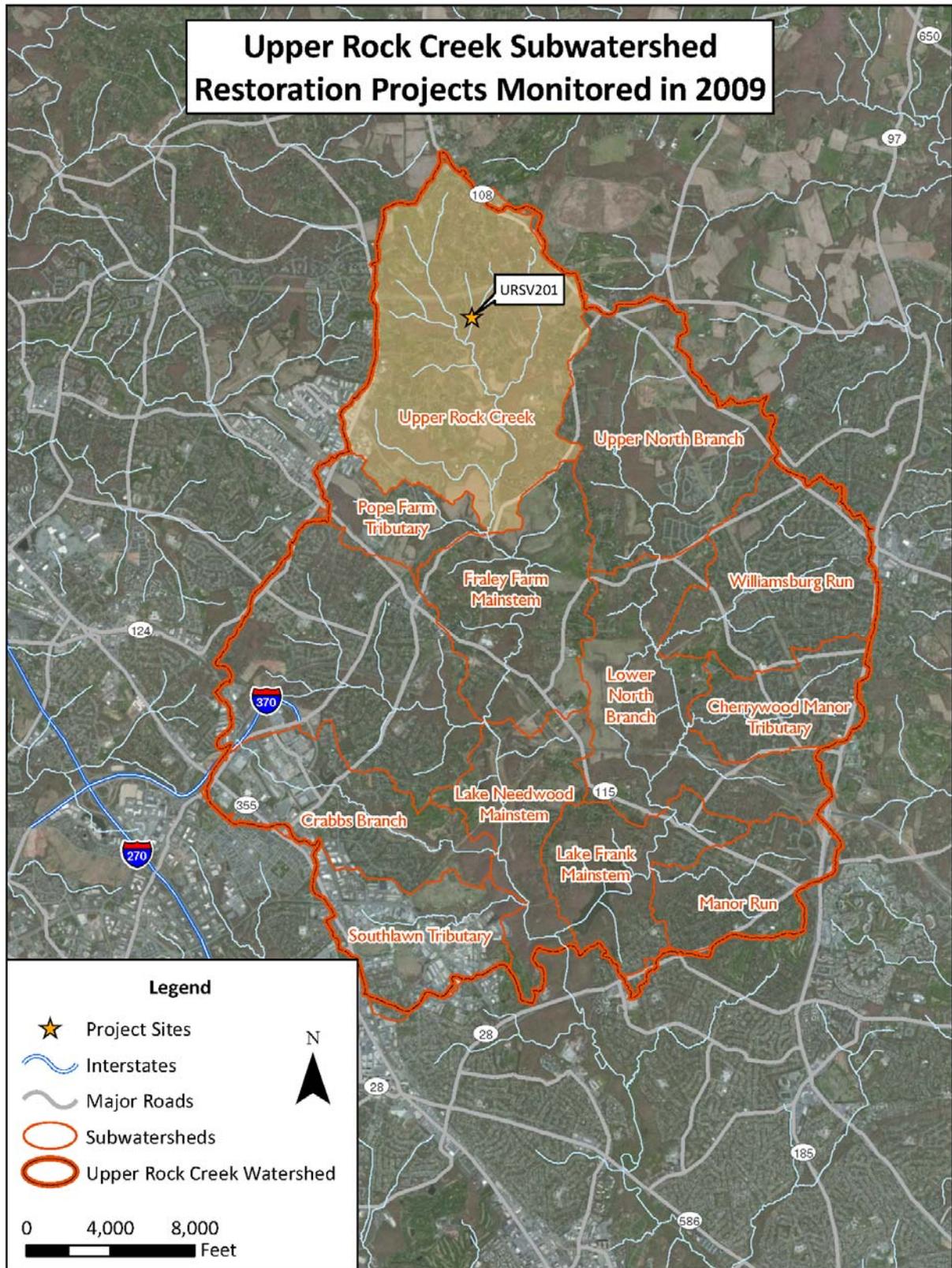


Figure 3.22.1 – Upper Rock Creek Watershed Restoration Projects, Including Stream Valley Drive Stream Restoration

Pre-Restoration Conditions

Generally, the Upper Rock Creek Watershed was categorized by the *CSPS* as having excellent to good stream conditions. In the Stream Valley Drive tributary, however, land use impacts such as residential development, historic agricultural practices, a power line crossing, and road crossings increased stormwater flow velocities, which in turn created erosion, high sedimentation, incised channels and degraded instream habitat (**Figure 3.22.2**).



Figure 3.22.2 – Pre-Restoration Conditions at Site URSV201 in 2002, Picturing Eroded Stream Bank and Undercut Trees

Restoration Actions Taken

The Stream Valley Drive stream project used in-stream restoration techniques to stabilize stream banks and enhance aquatic and riparian habitat. Newly built instream structures included log cross vanes, which direct water away from unstable stream banks and form downstream scour pools, providing habitat for fish. Log cross vanes also function as grade control structures, which slow the erosive process of stream down-cutting. Rock was also installed at the toe of the streambank slope, stabilizing the area of the stream channel subject to the greatest erosive energy, or “shear” stress. The slopes above the reinforced toes were graded back to create new floodplain terraces, which allow high flows to lose erosive energy by escaping the confined stream bank (**Figure 3.22.3**).



Figure 3.22.3 – Example of the Stream Restoration at Site URSV201 in 2005, Picturing Stabilized Stream Bank and Graded Banks

Diverse species of shade tolerant native trees and shrubs were planted to further stabilize the streambanks. Log sills were constructed to add grade control and additional floodplain access. The project attempted to save undercut stream bank trees with supportive “rock packing.” More seriously damaged trees were flush cut, allowing the root systems to remain in the bank for stabilization. The original stream below Fieldcrest Road had been diverted away from its natural channel into a straightened, entrenched ditch during road construction. The restoration project returned the stream to its original, gently meandering path, and left the straightened channel in place for storm overflow, with installed rock weirs, which created pools for additional wetland habitat. Four shallow wetland pools were constructed throughout the stream floodplain, and planted with native wetland plant species. These wetlands were created to enhance aquatic communities, adding additional aesthetic and habitat benefits, including natural mosquito control. The riparian forest was also enhanced by planting more than 730 native trees, shrubs and wetland plants in the riparian zone. The goal of the Stream Valley Drive project was to restore the tributary to good biological and habitat conditions as defined in the *CSPS*.

3.22.2 Restoration goals

Restoration goals were defined during the planning and implementation of the Stream Valley Stream Restoration project. Pre- and post-restoration monitoring was conducted within the stream and floodplain to evaluate each goal’s degree of success. **Table 3.22.1** below presents the restoration goals, monitoring performed to evaluate the success of the goals, and when and where the monitoring occurred.

Table 3.22.1 – Summary of Restoration Project Goals and Associated Monitoring

Why: Restoration Goals	What: Monitoring Done to Evaluate Goal	When: Years Monitored	Where: Station or Location Monitored
<ul style="list-style-type: none"> • Improve aquatic habitat conditions in Upper Rock Creek • Improve fish passage • Improve water quality in the Upper Rock Creek 	<ul style="list-style-type: none"> • Aquatic Communities: <ul style="list-style-type: none"> ▪ Benthic macroinvertebrates ▪ Fish • Qualitative Habitat • In-situ Water Chemistry 	2002 (pre) 2005, 2007, and 2009 (post)	URSV201
<ul style="list-style-type: none"> • Reduce stream erosion and sedimentation • Stabilized stream banks 	<ul style="list-style-type: none"> • Quantitative habitat (stream morphology surveys) 	2010 ¹ , 2011 (post)	URSV201
<ul style="list-style-type: none"> • Create amphibian habitat • Create wetlands 	<ul style="list-style-type: none"> • Vernal pool or wetland • Wetland vegetation 	2005, 2007, and 2009 (post)	URSV201
<ul style="list-style-type: none"> • Enhance riparian zone 	<ul style="list-style-type: none"> • Botanical survey 	2007 and 2009	URSV201

¹ Quantitative habitat surveys were scheduled for 2009, but were delayed due to missing benchmarks. These benchmarks were located and survey work was performed in 2010 and 2011. 2010 and 2011 reports will include updates for this monitoring.

3.22.3 Methods to Measure Project Goals

The basic sampling design for most of the monitoring tasks was pre-restoration (before) and post-restoration (after) monitoring, located within stream restoration reaches, at the created wetlands/vernal pools, and in the floodplain of the Stream Valley Drive site. The County monitored the biological communities (benthic macroinvertebrates and fish), performed rapid habitat assessments (RHAB), and took in-situ water chemistry measurements to evaluate the aquatic habitat conditions and water quality during the pre- and post-restoration periods (*Figure 3.22.4*). The County also performed wetland and herpetofauna surveys of the created vernal pools and botanical surveys of the planted riparian areas. All data collected in 2002 are considered pre-restoration data and all data collected in 2005 and beyond are considered post-restoration.



Figure 3.22.4 – Map of 2009 Monitoring Locations at the Stream Valley Restoration Site

3.22.4 Results and Analysis

Benthic Macroinvertebrates

BIBI (Benthic Index of Biological Integrity) Scores

Pre-restoration benthic macroinvertebrate assessments were conducted by the County at URSV201 in 2002 and post-restoration assessments were performed in 2005 and 2009. The Benthic Index of Biological Integrity (BIBI) percentages at this site were in the Good range in all years (*Figure 3.22.5*). In 2005, the first year post-restoration, the BIBI percent score increased from 70 to 80 and in 2009 declined back down to 70 percent. The increase in 2005 was due to an increase in the percentage of scrapers and a decrease in the percentage of dominant taxa. The decline in 2009 was due to an increase in the percentage of dominant taxa back to the pre-restoration range and a decrease in the proportion of individuals from the group Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (collectively abbreviated as EPT). Seven out of 20 taxa collected, or 42 percent of individuals, were from the EPT group in 2002, 49 percent of the individuals collected were from the EPT group in 2005, and 37 percent were EPT in 2009. Two genera of mayflies, a sensitive order of macroinvertebrates, were collected in 2005 and four mayfly genera were collected in 2009. Field data sheets for this task are included in *Appendix D*.

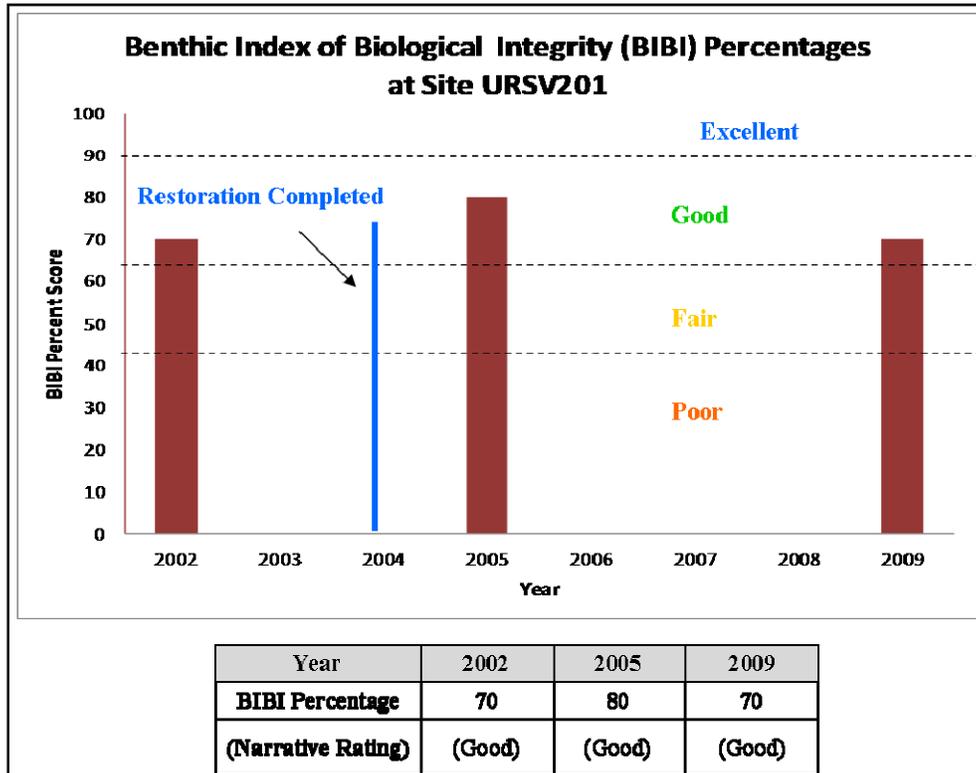


Figure 3.22.5 - Pre- and Post-Restoration Benthic Index of Biological Integrity (BIBI) Percentages at URSV201

Dominant Taxa

Both prior to and after restoration, the community was dominated by the same two taxa, Chironomidae (midges) and *Amphinemura* sp. (a genus of spring stonefly). Chironomidae comprised 35 percent of the community prior to restoration and 38 percent after restoration. Chironomidae are a generally tolerant family of benthic macroinvertebrate. Percentages of spring stonefly increased from the pre- to post-restoration period from 16 to 18 percent, this genus is considered sensitive to urbanization. However, this genus was only collected in 2005 and not in 2009. A diversity of other benthic macroinvertebrates was found at this site in all years, many of which are considered sensitive to disturbance. Overall, the percentage of the two most dominant taxa increased from 51 prior to restoration to 56 after restoration.

Tolerance Values

Individuals sensitive to disturbance were dominant in the pre-restoration period comprising 40 percent of the community (*Figures 3.22.6 and 3.22.7*). In the post-restoration period, the composition of tolerances shifted to a community dominated by tolerant individuals (47 percent); however, the percentage of sensitive individuals still comprised 36 percent of the community, declining only slightly from the pre-restoration period.

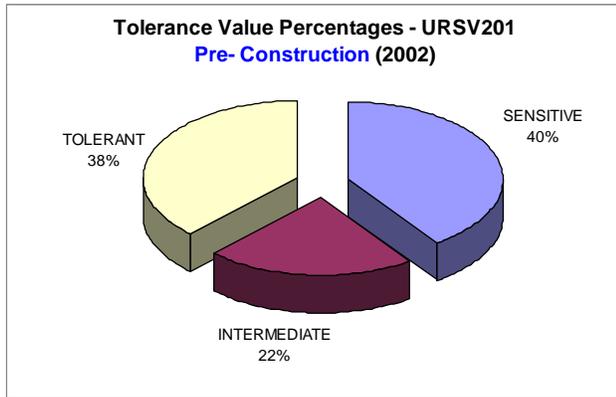


Figure 3.22.6 – Benthic Macroinvertebrate Tolerance Composition at URSV201 Prior to Restoration

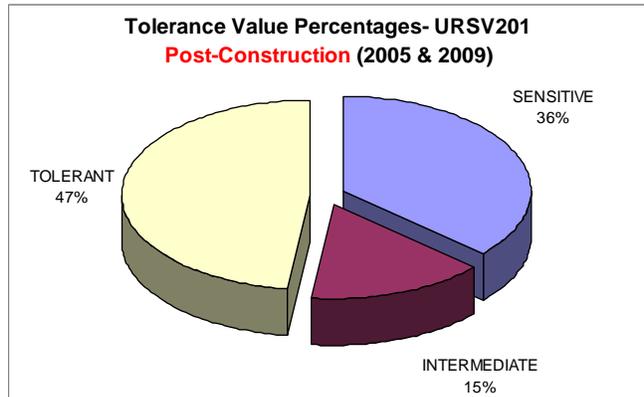


Figure 3.22.7 – Benthic Macroinvertebrate Tolerance Composition at URSV201 After Restoration

Functional Feeding Groups

More specialized feeders, including scrapers and shredders, often require less degraded stream conditions or specific habitat features. Benthic macroinvertebrates classified as generalist feeders, such as collectors and filterers, can often persist in more impacted streams (EPA 2010). Prior to restoration at URSV201, generalist feeders comprised 64 percent of the community and specialized feeders occupied 27 percent (*Figures 3.22.8 – 3.22.9*). After restoration, the percentage of generalist feeders declined to 44 percent and the percentage of specialized feeders increased to 33 percent. The percentage of predators also increased in the post-restoration period, which was mostly due to an increase in several genera of stoneflies. In 2002, identification of Chironomids was limited to the family level (Chironomidae), possibly due to damaged specimens. The

Chironomidae family is classified as collectors, whereas finer taxonomic identification may have revealed more predators, such as the tribe Tanypodinae. Since Chironomidae was the most dominant taxon in both the pre- and post-restoration period, the difference in laboratory identification resolution may have artificially changed the proportion of feeding groups between the pre- and post-restoration periods. This also could account for the decline in the percentage of collectors in the post-restoration period.

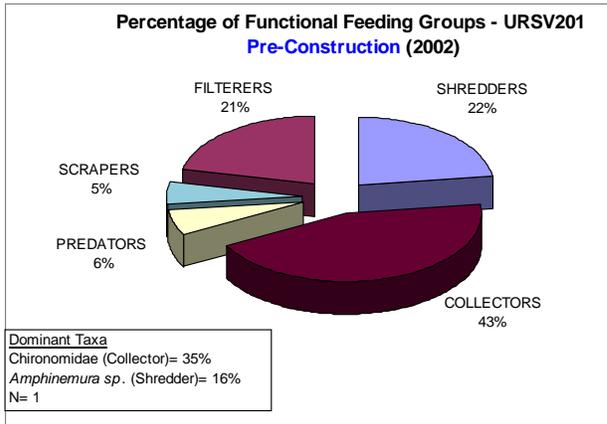


Figure 3.22.8 – Benthic Macroinvertebrate Functional Feeding Group Composition at URSV201 Prior to Restoration

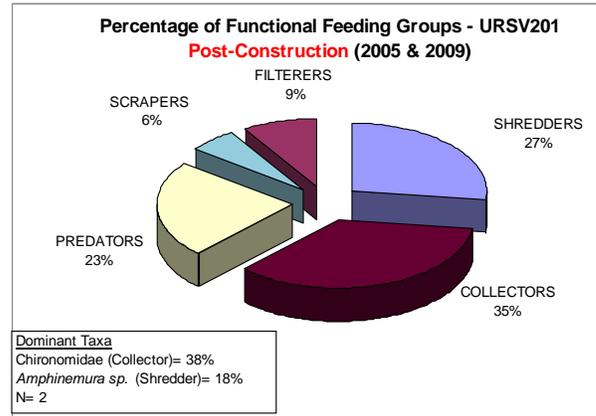


Figure 3.22.9 – Benthic Macroinvertebrate Functional Feeding Group Composition at URSV201 After Restoration

Fish

FIBI (Fish Index of Biological Integrity) Scores

In both the pre- and post-restoration periods, the fish community at this site was consistently rated as Poor (34 percent) by the MCDEP Fish Index of Biological Integrity (FIBI) (**Figure 3.22.10**). Prior to restoration, three species were collected, with *Rhinichthys atratulus* (blacknose dace) dominating the community and *Semotilus atromaculatus* (creek chub) and *Clinostomus funduloides* (rosyside dace) collected in lesser amounts. The fish community remained similar after restoration activities occurred, with blacknose dace dominating the community and creek chub and rosyside dace also collected in lesser amounts in both years. Additionally, one white sucker was collected in 2009. Overall, the fish community at this site was represented by a low diversity of tolerant fish species. Conditions in the fish community have neither improved nor declined since the stream restoration occurred at this site. 2009 field data sheets for this task are included in **Appendix D**.

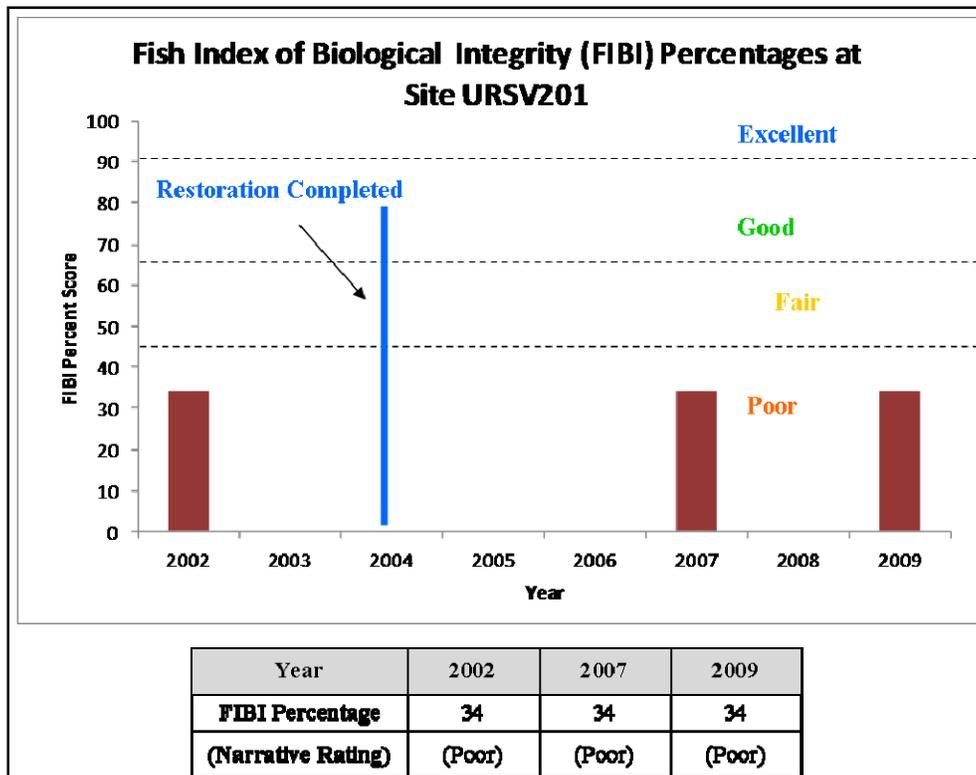


Figure 3.22.10 - Pre- and Post-Restoration Fish Index of Biological Integrity (FIBI) Percentages at URSV201

Dominant and Pioneering Species

As stated above, the most dominant species both prior to and after restoration was blacknose dace, followed by creek chub, both of which are pioneering species. The percentage of dominance of these two species increased from comprising 94 percent of the community before restoration to occupying 96 percent of the community after restoration. The percentage of pioneering individuals also increased from the pre- to post-restoration period (*Figures 3.22.11 – 3.22.12*).

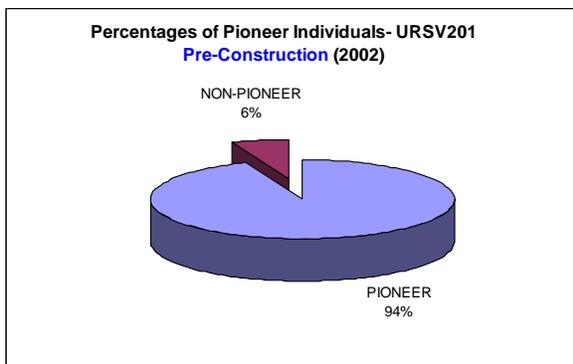


Figure 3.22.11 – Pioneer Fish Composition at URSV201 Prior to Restoration

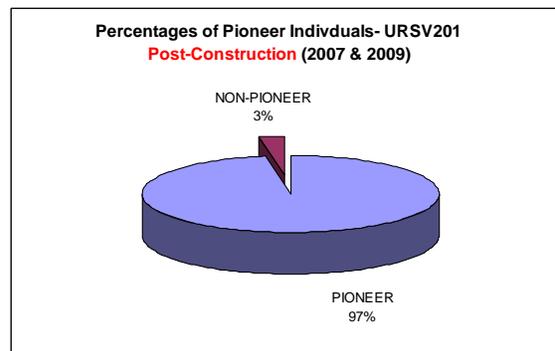


Figure 3.22.12 – Pioneer Fish at URSV201 After Restoration

Tolerance Values

Tolerant fish species dominated the fish community both prior to and after restoration at URSV201 (**Figures 3.22.13 – 3.22.14**). In the pre-restoration period, fish intermediate in sensitivity comprised six percent of the community and in the post-restoration period, the proportion of intermediate individuals declined to three percent and the proportion of tolerant individuals increased.

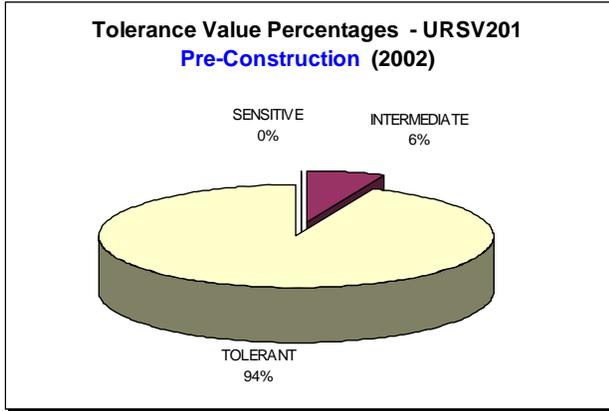


Figure 3.22.13 – Fish Tolerance Composition at URSV201 Prior to Restoration

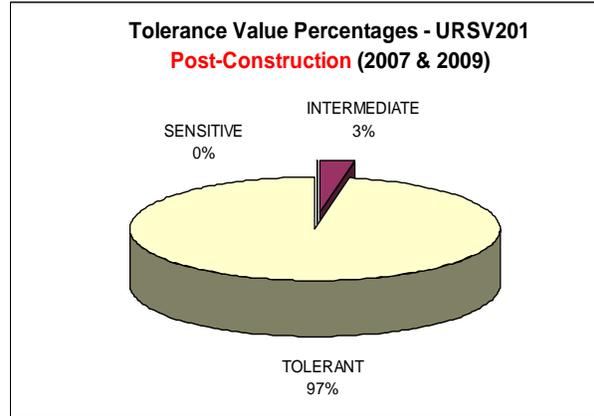


Figure 3.22.14 – Fish Tolerance Composition at URSV201 After Restoration

Functional Feeding Groups

Omnivores and generalists were the dominant feeding groups at URSV201 both prior to and after restoration (**Figures 3.22.15 – 3.22.16**). Invertivores were the only specialized feeding group present at this site, comprising six percent of the community before restoration and three percent after restoration. The decline in the percentage of invertivores was due to a decline in the proportion of roside dace at the Stream Valley site.

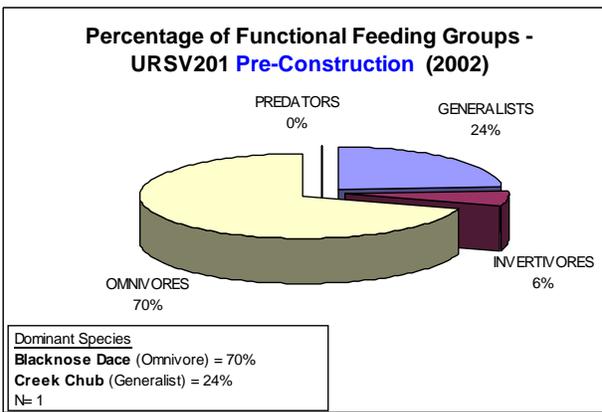


Figure 3.22.15 – Fish Functional Feeding Group Composition at URSV201 Prior to Restoration

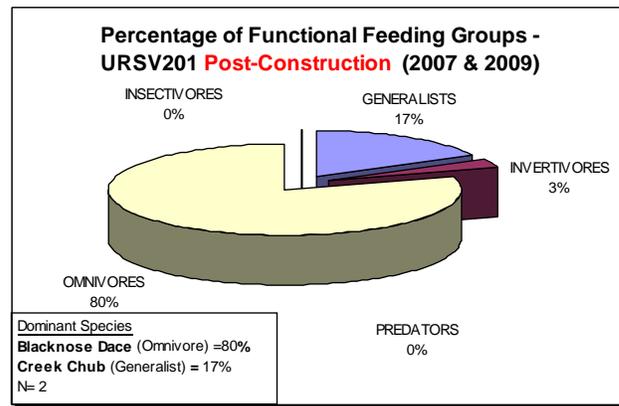


Figure 3.22.16 – Fish Functional Feeding Group Composition at URSV201 After Restoration

Qualitative Habitat

Aquatic habitat assessed by the EPA Rapid Bioassessment Protocol (RHAB) scored in the Excellent/Good and Good ranges in the spring and summer of 2002, respectively (*Figure 3.22.17*). Habitat percentages were generally in the suboptimal and optimal ranges with sediment deposition and embeddedness values consistently scoring lowest of all assessed parameters during this time and epifaunal substrate values and channel alteration consistently scoring the highest.

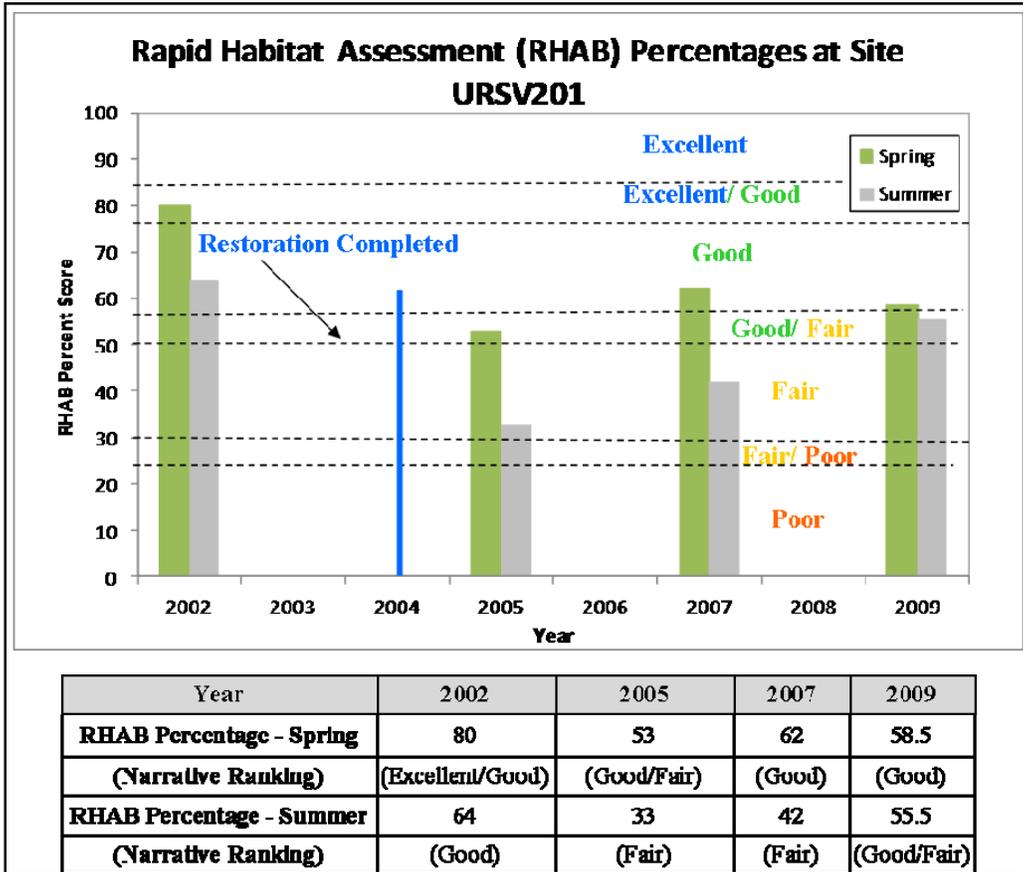


Figure 3.22.17 - Pre- and Post-Restoration Rapid Habitat Assessment (RHAB) Percentages at URSV201

Overall, post-restoration aquatic habitat percentages declined from the pre-restoration period but were variable over time, with several of the individual habitat scores ranging from poor to suboptimal. Spring aquatic habitat percentages were consistently rated higher than summer percentages, scoring in the Good and Good/Fair ranges. Summer aquatic habitat percentages scored in the Fair and Good/Fair ranges. The lowest habitat percentages were noted in 2005, a very dry year, when the stream was dry, with the exception of pools that were filled with water. After 2005, aquatic habitat scores improved, but were still below pre-restoration ranges.

No one habitat parameter decreased the most, but bank vegetative protection had a clear decline from the pre-restoration conditions, as did instream cover for fish, and epifaunal substrates for benthic macroinvertebrates. Additionally, some of the stream structures

did not appear to be stable, were being undermined by the stream flow, and in some cases constricting the natural stream flow and causing siltation upstream of the structures (*Figure 3.22.18*). Native vegetation covered more than 90 percent of both banks in 2002, prior to restoration, and declined to between 50 to 60 percent after restoration. An increase in the percentage of invasive plants on the banks may also have contributed to the lower bank vegetation scores. Embeddedness, sediment deposition, and bank stability conditions were similar to those recorded prior to restoration. 2009 field data sheets for this task are included in *Appendix D*.



Figure 3.22.18 – Cross vein and Rock Stabilization Creating Constriction and Upstream Siltation at URSV201 (2009)



Figure 3.22.19 – Rip Rap at URSV201 Being Slightly Undermined (2009)

Quantitative Habitat

Quantitative monitoring was scheduled to occur at URSV201 in 2009 but was delayed due to problems locating the benchmarks. Data were collected in 2010 and will be presented in the subsequent 2010 report.

Water Chemistry

Water chemistry monitoring prior to restoration at URSV201 resulted in two parameters exceeding COMAR’s Use III standards. In the summer of 2002, pH, being documented as 6.20, fell below the allowable lower limit of 6.5 and water temperature was above the acceptable upper limit of 68°F. **Table 3.22.2** below shows the pre-construction water chemistry data collected at URSV201.

Table 3.22.2 – Pre-Construction in-situ Water Chemistry at URSV201

Year	2002	
	spring	summer
Dissolved oxygen (mg/L)	9.65	5.23
Dissolved oxygen (% saturation)	92	61
pH	6.54	6.20
Conductivity (µmhos)	94	131
Water temperature (°F)	57.2	73.2

After restoration, dissolved oxygen concentrations fell below the lower COMAR limit of 5.0mg/L in the summer of 2005 and fall of 2007, with concentrations at 2.4, and 4.67, respectively (**Table 3.22.3**). In the summer of 2005, the stream was nearly dry, with water present only in pools, which is a likely cause of the very low dissolved oxygen conditions during this time. In 2007, pH was documented as 8.52, which exceeded the COMAR criteria for this parameter. The stream temperature also exceeded the 68°F COMAR upper limit during the summer of 2007. All other water quality parameters were within the COMAR water quality criteria for this use III stream.

Table 3.22.3 – Post-Construction in-situ Water Chemistry at URSV201

Parameter	2005			2007			2009	
	spring	summer	fall	spring	summer	fall	spring	summer
Dissolved oxygen (mg/L)	11.85	2.4	13.97	13.02	7.37	4.67	11.12	7.14
Dissolved oxygen (% saturation)	101	24	107	137	83.8	42.2	97	75.8
pH	7.99	7.25	7.9	8.36	8.52	7.19	7.08	6.93
Conductivity (µmhos)	135	236	145	139	201	270	139	176
Water temperature (°F)	48.6	63.0	39.7	63.9	70	50.7	50.4	64.9

Vernal Pool

Pre-restoration vernal pool data are not available for this site since the vernal pool was created for the restoration project.

The vernal pool was constructed in 2004 and monitored post-restoration in 2005, 2007, and 2009. In 2005, the pool dimensions were 65 by 65 feet and depth was approximately 1.8 feet. This constructed vernal pool was circular with an island in the middle of it. The diameter of the island was approximately 16 feet. Emergent vegetation was present but sparse. One *Lithobates sylvaticusi* (wood frog) egg mass comprised of approximately 50 eggs was found and eight *Ambystoma maculatum* (spotted salamander) egg masses were found, each with approximately five eggs. In 2007, the dimensions of the pool were very similar to the 2005 estimates. One adult *Lithobates palustris* (pickerel frog) and 2 spotted salamander egg masses were observed in the vernal pool during the 2007 site visit.

In 2009, the vernal pool dimensions were the same as they were in previous years. During the 2009 site visit, the vernal pool appeared to be full when monitored, the depth of the water in the pool was approximately 1 foot, and the temperature within the vernal pool was 45°F. Emergent and submerged herbaceous vegetation was found growing in the vernal pool. Additionally, a large fallen tree branch and many smaller pieces of downed woody debris were observed in the pool creating a natural vernal pool condition (**Figure 3.22.20**). Spring peepers were heard calling from the pool, more than 1,000 *Bufo* sp. (toad) tadpoles were seen swimming in the pool, and four spotted salamander egg masses were observed (**Figure 2.22.21**). The egg masses were submerged and attached to the woody debris. Several invertebrate taxa were also observed including: Culicidae (mosquito larvae), Dytiscidae (diving beetles), copepods, and Gerridae (water striders). No crayfish burrows or fish were seen in or around the pool. Field data sheets for the 2009 vernal pool monitoring task are included in **Appendix D**.



Figure 3.22.20 – Created Vernal Pool at Site URSV201 in 2009



Figure 3.22.21 – Created Vernal Pool at Site URSV201 in 2009, Picturing *Anaxyrus* sp. (unknown toad) tadpoles

Wetland Vegetation

Pre-restoration wetland vegetation data are not available for this site, as the wetlands were created as part of the restoration. Four wetland areas were created for this restoration project. All of these areas were monitored in 2005 and 2009; in 2007, only wetland Area 10, the created vernal pool, was monitored for wetland vegetation (**Figure 3.22.4**). Methodologies differed between years; in 2005 and 2007, a point-intercept sampling procedure (Federal Interagency Committee for Wetland Delineation 1989) was performed and in 2009, the *MDE Mitigation Site Scoring Method* (2007) was used.

The method used in 2009 gives each wetland a total score out of 100 points based on vegetation, soils, hydrology, and wetland functional gains. Each wetland area is described separately and will correspond with the planting area numbers on the *Site Plan*. The four sites have also been combined to yield a total wetland score for the entire restoration site. Each wetland was weighted, based on area, and then multiplied by its score to give a site sub-score. The sum of each sub-score yielded a total wetland score for the site (**Table 3.22.4**). The total wetland score for the Stream Valley Drive project was 77. The largest wetland, Area 10, also had the highest score onsite and the second largest site, Area 9, had the lowest score at this restoration site. Each wetland and associated scores are described below. 2009 field data sheets for this task are included in **Appendix D**.

Table 3.22.4 – Post-Restoration Wetland Vegetation Assessment (2009)

Area #	Area Score	Portion of Total Credit (based on Sub-Area)	Sub-Score
10	92	0.53	48.8
9	53	0.36	19.1
8	78	0.07	5.5
7	89	0.04	3.6
Total		1.0	77.0

Area 10

Area 10 is the same area described above as the vernal pool. It is a created pond in the floodplain of the Stream Valley Tributary to Upper Rock Creek. The pool was dry when visited on September 29, 2005. The following are the plant species found in 2005: *Microstegium vimineum* (Nepalese browntop), *Liriodendron tulipifera* (tulip poplar), *Saururus cernuus* (lizard’s tail), *Acorus calamus* (sweetflag), and *Carex crinita* (fringed sedge). In July 2007, wetland vegetation was only present in a narrow ring around the wetland. Common species included Nepalese browntop and fringed sedge. Monitoring in 2007 indicated this area was a wetland.

In October 2009, on the day the monitoring occurred, the pool was dry and the areas inundated in the spring completely lacked vegetation. The periphery of the pool was vegetated, as was the center island (**Figure 3.22.22**). Lizard’s tail, *Polygnum sp.* (smartweed), and *Boehmeria cylindrical* (smallspike false nettle) were the dominant plants in the assessed emergent wetland. Sweetflag, fringed sedge, and *Calamagrostis sp.* (reedgrass) were also present in lesser amounts. No woody plants were observed in the wetland. Nepalese browntop and *Polygonum perfoliatum* (Asiatic tearthumb) were prevalent throughout the floodplain. These species may be a concern for future wetland success as they are invasive species that are known to take over other native vegetation. This wetland scored a 92 out of a total possible score of 100. Overall, the emergent wetland that fringes the vernal pool in area 10 appears to be functioning as a wetland. In addition to supporting wetland vegetation, this area has hydric soils, and appears to have groundwater and surface water inputs that will support wetland hydrology. **Table 3.22.5** below shows the individual scores for the wetland vegetation monitoring for each wetland monitored at URSV201.



Figure 3.22.22 – Wetland Area 10 at Site URSV201 (October 2009)

Table 3.22.5 – Post-restoration Wetland Vegetation Assessment (2009)

Area	Vegetation Score (out of 30)	Soil Score (out of 20)	Hydrology Score (out of 30)	Wetland Functional Gains Score (out of 20)	Area Total Score (out of 100)
10	25.3	18	29	20	92
9	17	10	14	12	53
8	21	18	23	16	78
7	24	20	29	16	89

Area 9

Area 9 is about 60 feet north of area 10 and is another created wetland with rip rap on the edge closest to the stream. This wetland consists of an open water area with a palustrine emergent fringe. In 2005, the dominant species found in the wetland fringe were Nepalese browntop, lizard’s tail, sweetflag, and fringed sedge. In 2009, dominant species in the emergent portion of the wetland included: smartweed, Nepalese browntop, and *Carex* sp (**Figure 3.22.23**). No woody species were present. Similar to Area 10, the invasive species Nepalese browntop and Asiatic tearthumb are a concern for future success of the native wetland vegetation in this wetland. This area had the lowest score of all wetlands at URSV201, with a score of 52. Overall, the vegetation lacked diversity and had a high percentage of invasive coverage. In addition, bare ground was present in some areas where plant potential existed. Hydric soils existed at the site, however, high amounts of gravel and clay were present in the soil profile, which may limit plant growth. Wetland hydrology is supported at this site from groundwater and surface water sources, however, most of the planned vegetated area is often inundated and too wet to support wetland vegetation.



Figure 3.22.23 – Wetland Area 9 at Site URSV201 (October 2009)

Area 8

Area 8 is a remnant stream channel, long and narrow in shape, and has been reinforced with rip rap to maintain an emergent wetland adjacent to the existing streambank. The wetland is hydrologically connected to the adjacent stream. In 2005, the wetland was mostly dry with a small pool of water in the center. Dominant vegetation included Nepalese browntop, lizard's tail, sweetflag, and fringed sedge. In 2009, the wetland contained standing water (**Figure 3.22.24**). The dominant emergent plants at the site were lizard's tail, Nepalese browntop, and *Leersia oryzoides* (rice cutgrass). Fringed sedge was also present at the site in lesser amounts. Nepalese browntop accounted for seven percent of the vegetative cover in the wetland. This area scored a 78 out of a total possible 100. Hydric soils were present in the wetland, as was wetland hydrology, however, about 45 percent of the wetland was too wet to support wetland vegetation, which lowered the vegetation portion of the score (21 out of 30). It was also assessed as adequately providing several wetland functions, scoring 16 out of 20 for functional gains. Generally this area is successfully supporting wetland vegetation and providing some wetland functions; however Nepalese browntop may be a concern for the future success of this wetland.



Figure 3.22.24 – Wetland Area 8 at Site URSV201 (October 2009)

Area 7

Area 7, similar to Area 8, is a remnant stream channel. It is a long and slender emergent wetland, which is hydrologically connected to the adjacent stream. In 2005, the wetland was dry when it was monitored. Dominant vegetation in 2005 included Nepalese browntop, lizard’s tail, and fringed sedge. In 2009, lizard’s tail, *Ludwigia palustris* (marsh seedbox), rice cutgrass, and Nepalese browntop were the dominant emergent species (**Figure 3.22.25**). Several other less dominant species also occupied the wetland. This wetland area scored 89 out of 100. Hydric soils were present in the area, as was wetland hydrology. Most of the planned vegetated area was occupied by wetland vegetation. The wetland also provided several biological, water quality, and hydrologic functions. Overall, this area appears to support wetland vegetation and provide functional benefits.



Figure 3.22.25 – Wetland Area 7 at Site URSV201 (October 2009)

Botanical Reforestation

Overall planting survival and growth throughout the project area was good, with 63 percent of the planted trees surviving to 2009, and an additional 15 percent increase from volunteer trees, resulting in an overall percent survival of 78 (**Table 3.22.6**). Black gum, eastern redcedar, American holly, pin oak, and white oak were the volunteer species that were found growing at this restoration site. Success of planted shrubs was much lower, with only two percent survival; *Cornus racemosa* (gray dogwood) was the only planted shrub that was observed in 2009 (**Table 3.22.7**). Additionally, nearly all of the planted trees have grown since they were planted, with some growing up to five inches in diameter (**Table 3.22.8**).

Table 3.22.6 - 2009 Botanical Reforestation Summary for Trees at Site URSV201

Common Name	Scientific Name	Number Planted (2004)	Number Observed (2009)	Percent Survival¹
Red maple	<i>Acer rubrum</i>	38	38	100
River birch	<i>Betula nigra</i>	27	22	81
Tuliptree	<i>Liriodendron tulipifera</i>	29	7	24
American sycamore	<i>Platanus occidentalis</i>	29	18	62
Flowering dogwood	<i>Cornus florida</i>	21	9	43
Eastern redbud	<i>Cercis canadensis</i>	14	9	64
Sweet gum	<i>Liquidambar styraciflua</i>	6	0	0
Black gum	<i>Nyssa sylvatica</i>	3	7	233
Eastern redcedar	<i>Juniperus virginiana</i>	20	24	120
Red oak	<i>Quercus rubra</i>	12	0	0
Pin oak	<i>Quercus palustris</i>	50	52	104
Green ash	<i>Fraxinus pensylvanica</i>	22	11	50
American holly	<i>Ilex opaca</i>	20	26	130
White oak	<i>Quercus alba</i>	0	5	100
Total		291	223	78

¹Percent survival = (number observed + number of volunteers observed/total number planted (2005+2009))*100

Table 3.22.7 - 2009 Botanical Reforestation Summary for Shrubs at Site URSV201

Common Name	Scientific Name	Number Planted (2004)	Number Observed (2009)	Percent Survival
Northern spicebush	<i>Lindera benzoin</i>	123	0	0
Southern arrowwood	<i>Viburnum dentatum</i>	145	0	0
Elderberry	<i>Sambucus nigra</i> ssp. <i>canadensis</i>	98	0	0
Northern bayberry	<i>Morella pensylvanica</i>	5	0	0
American holly	<i>Ilex opaca</i>	25	0	0
Sweetbay	<i>Magnolia virginiana</i>	17	0	0
Gray dogwood	<i>Cornus racemosa</i>	25	4	16
Blackhaw	<i>Viburnum prunifolium</i>	0	6	-
Total		438	10	2

Overall, the planted trees have grown up to five inches in diameter in the past five years. **Table 3.22.8** depicts the overall growth of the trees. American sycamore, sweet gum, river birch, and red maple have grown the most and flowering dogwood and American holly have grown the least in the past five years.

Table 3.22.8 – Site URSV201 2004 Botanical Planting Sizes versus 2009 Observed Sizes

Common name	Scientific Name	Planting Size 2006/2007 (inch diameter)	Observed Size 2009 (inch diameter)
Red maple	<i>Acer rubrum</i>	1-1.5	1 – 4.5
River birch	<i>Betula nigra</i>	1-1.5	2.5 – 5.25
Tuliptree	<i>Liriodendron tulipifera</i>	1-1.5	1.5 – 3.75
American sycamore	<i>Platanus occidentalis</i>	1-1.5	1.75 – 6
Flowering dogwood	<i>Cornus florida</i>	1-1.5	1.25 – 2
Eastern redbud	<i>Cercis canadensis</i>	1-1.5	2.5 – 4.75
Sweet gum	<i>Liquidambar styraciflua</i>	1-1.5	4.75 – 5.25
Black gum	<i>Nyssa sylvatica</i>	1-1.5	2.5 – 3.25
Eastern redcedar	<i>Juniperus virginiana</i>	1-1.5	3 – 3.75
Pin oak	<i>Quercus palustris</i>	1-1.5	1.5 – 4
Green ash	<i>Fraxinus pensylvanica</i>	1-1.5	1.25 – 3.25
American holly	<i>Ilex opaca</i>	< 1	0.5 – 2.5

Several different zones were planted for the Stream Valley restoration project. Generally, each planting zone corresponded to a different enhanced habitat type (e.g. wetland, streambank, or upland forest), stream access areas, or haul roads that were planted after construction. This section will describe the success of the plantings observed at the site in 2009, beginning at the northern end at Fieldcrest Road and proceeding south, to the end of the project limits on the tributary near the end of Falling Spring Court (**Figure 3.22.4**). 2009 field data sheets for this task are included in **Appendix D**.

Botanical Zone A includes the planted haul road, upland reforestation areas, and riparian plantings from Fieldcrest Road to the created vernal pool, on the northern portion of the project (**Figure 3.22.4**). This planting zone was fairly successful, with 81 percent of the trees determined to be healthy and six percent dead. Most of the tree species planted in these areas were found growing and most individual trees were healthy (**Figure 3.22.26**). Red maples were the exception; most red maple individuals had been damaged by deer rub and did not appear to be growing as well as the other species. Very few shrubs were observed in these areas; only 25 percent were assessed as healthy and 38 percent were dead. Some shrub species were planted according to the planting plan, but were not found onsite. These species included *Cornus florida* (flowering dogwood), *Lindera benzoin* (spicebush), *Viburnum dentatum* (arrowwood), and *Sambucus canadensis* (elderberry). No woody trees or shrubs were observed in or around the wetland or streambank (terraced) zones even though several were planted in these areas.



Figure 3.22.26 – Botanical Plantings at Zone A (2004 versus 2009) Showing Planted Eastern Redcedar

Botanical Zone B is located south of Zone A, along the floodplain of the Stream Valley Tributary, from the constructed vernal pool to the southern end of the project. These floodplain plantings were slightly more successful than the Zone A plantings (**Figure 3.22.27**). Ninety percent of the observed trees were healthy and ten percent were dead. Only two shrubs were noted in this area, one of which was dead. Invasive plants were found throughout most planting zones, with Nepalese browntop and Asiatic tearthumb being the two most dominant. Generally, these species were not impeding tree or shrub growth, but in some areas Asiatic tearthumb was found climbing on native vegetation.



Figure 3.22.27 – Botanical Zone B in the Floodplain at Site URSV201 Showing Red Maple and Other Plantings (2009)

The plantings at Zone C, on the Falling Spring access area, parallel to Falling Spring Court, were determined to be growing successfully (**Figure 3.22.28**). Ten tree species were found within the zone. Ninety-seven percent of the trees were assessed as healthy and three percent were dead. However, many of the trees had been rubbed by deer. Two shrubs were observed in this zone, both of which showed signs of tip dieback.



Figure 3.22.28 – Botanical Reforestation Zone C Along Falling Spring Court at Site URSV201 Showing American sycamore Plantings (2004 versus 2009)

3.22.5 Discussion

Table 3.22.9 below provides a summary of project goals, the results of post-restoration monitoring, and whether each project goal has been met by the restoration actions in the fifth year of monitoring post-restoration. Three of the project goals were successfully

met, one goal was partially met, one project goal was not met by restoration actions, and one goal will be determined in 2010.

Table 3.22.9 – Summary of Project Goal Results

Goal	Result
Improving aquatic habitat conditions in Upper Rock Creek	Unsuccessful – declines in aquatic habitat within the Stream Valley project area, some restoration structures appeared to be failing
Improving water quality in Upper Rock Creek	Partially successful – general improvement in the benthic macroinvertebrate community; decreasing trend in the fish community
Reducing stream erosion and sedimentation	Unable to determine – physical survey data from 2010 will suggest if these goals have been met
Creating wetlands	Successful – open water and emergent wetlands now exist in portions of the restoration area that were previously upland
Creating amphibian habitat	Successful – several species of obligate and facultative vernal pool species were observed in the created vernal pool
Riparian reforestation	Successful – planted trees had a 78% survival rate (includes both planted and volunteer individuals) in 2009 and provide riparian vegetation and enhanced habitat in a formerly sparsely vegetated area

Successful – Wetland Creation, Amphibian Habitat, and Riparian Reforestation

The Stream Valley Drive Restoration project has met several of the project goals including the creation of wetlands and amphibian habitat, and riparian reforestation (**Figures 3.22.29**). The wetlands created in the restoration area supported several species of wetland vegetation. They were also determined to provide several biological, hydrologic, and water quality functions such as providing habitat for amphibians, and other wetland dependent wildlife; filtering sediments, pollutants, and toxins; furnishing organic material to aquatic food webs; floodwater and headwater storage; and several other important wetland functions. Collectively, the wetlands created for this restoration project scored 77 out of 100 using the *MDE Mitigation Site Scoring Method*. The lowest scoring wetland, Wetland 9, had areas of bare ground where wetland plant potential existed. Replanting of wetland vegetation is recommended at Wetland 9 to improve wetland function. In addition, Nepalese browntop, an invasive plant species, was found growing at all four wetland sites, and Asiatic tearthumb, another invasive plant, was present at two of the wetlands. In 2009, the invasive species were not affecting plant growth but they may be a concern for native plant growth and survival in the future. It is recommended that Asiatic tearthumb is controlled at Wetland 10 to ensure survival of native, planted material. Asiatic tearthumb is an invasive species of concern because it can climb on herbaceous vegetation and outcompete it for light and other resources.

The highest scoring wetland at URSV201 was also constructed as a vernal pool. Over the post-restoration period, this wetland supported two obligate vernal pool species, spotted salamander and wood frog, and several facultative species. Therefore, the wetland appeared to be successfully functioning as a vernal pool. The presence of the woody debris in the pool helped to create a natural vernal pool condition. This woody debris fell naturally into the pool after construction and was not part of the engineered design.



Figure 3.22.29 – Created Vernal Pool at Site URSV201 in 2007

Overall, botanical reforestation was successful at this site, with 63 percent of the trees planted in 2004 found growing in 2009, and an additional 15 percent increase due to volunteer trees. Red maple, black gum, eastern redcedar, pin oak, and American Holly were observed to be thriving, with all planted individuals surviving, and additional volunteers observed growing. Additionally, nearly all of the caliper sizes of the individuals observed in 2009 were larger than those that were planted in 2004. The increase in size of the planted individuals is a measure of successful growth and a sign that these trees are well established. Planted sycamore individuals showed the greatest increase in growth followed by river birch, sweet gum, eastern red bud and red maple. Planted shrubs were not successful; only two percent of the planted shrubs were observed in 2009.

Partially Successful – Water Quality

The benthic macroinvertebrate community at site URSV201 showed a slight improvement after restoration by certain community measures, but also reflected slight declines. BIBI percentages improved in 2005, one year after restoration, and then declined in 2009 to pre-restoration conditions, but overall remained Good over time. The proportion of specialist feeders increased after restoration, which is another indication of community improvement. However, the benthic macroinvertebrate community shifted from one dominated by sensitive individuals in the pre-restoration period, to one

dominated by tolerant individuals in the post-restoration period. The increase in tolerant individuals suggests a more degraded stream condition in the post-restoration period over time. Overall, the benthic macroinvertebrate community showed mixed results with both small improvements and declines after restoration.

Fish communities remained similar before and after restoration, scoring in the Poor FIBI range in all years with pioneer species dominating. However, some of the measures used to evaluate the fish community indicated a slight decline in its quality. Dominance of the two most abundant fish species increased after restoration, as did the proportion of tolerant individuals, and the proportion of pioneering individuals. This was due to an increase in the percentage of blacknose dace, the most abundant fish collected at this site. The only notable change in the fish community over time was the addition of one species, white sucker, in 2009. This may be due to improved fish habitat from the restoration activities. However, it is most likely that this stream is limited to low flow conditions during drier periods resulting in a lack of stable fish habitat. Therefore a fish community comprised of a high diversity of fish species and individuals with low tolerance values may never occur in this area.

The qualitative habitat assessments do not indicate that overall fish habitat improved after restoration. In-situ water chemistry taken at the site after restoration had several parameters that were out of compliance with COMAR Use III streams including two dissolved oxygen readings, one pH value, and one temperature reading. These appeared to have been related primarily to low or standing water conditions at the time of monitoring.

Unsuccessful – Aquatic Habitat

Aquatic habitat conditions declined from the pre- to post-restoration periods from Excellent and Good, to Good and Fair, respectively. Bank vegetative protection showed the clearest decline of all habitat parameters, mostly due to an increase of invasive species on the stream bank after restoration. Additionally, epifaunal substrates for benthic macroinvertebrates and instream cover for fish evidently declined after restoration. Also, some of the instream structures appear to be failing, creating upstream sedimentation and potential fish blockages (*Figure 3.22.30*) Sediment deposition and bank stability, however, remained similar from the pre- to post-restoration periods.



Figure 3.22.30 – Log Vein and Rip Rap at URSV201 Constricting Stream Flow and Creating Upstream Sedimentation (2009)

3.22.6 Conclusions

Overall, the Stream Valley Drive stream restoration project has met or partially met most of the project goals. The restoration has created wetlands and amphibian habitat as well as helped reforest the riparian zone. The vernal pool that contained downed woody debris was more successful than the others. It is recommended that future vernal pool designs incorporate the use of woody material to improve pool shading and provide surfaces to which egg masses can be attached.

The stream restoration has maintained Good benthic macroinvertebrate conditions, with some minor improvements noted in 2005. However, fish communities remained Poor over time and some measures of the fish community quality indicated a slight decline. Aquatic habitat conditions also declined after restoration activities occurred. Within the stream restoration reach and in the vicinity of the created wetlands, invasive plants were common including Asiatic tearthumb, *Rosa multiflora* (multiflora rose), and *Berberis thunbergii* (Japanese barberry), with some species considered dominant, including Nepalese browntop. Control of these invasive species, especially in the wetlands and vernal pool, is recommended to prevent further proliferation.