Acknowledgements

Fairfax County is extremely grateful to the many individuals and groups who continue to support and dedicated their time and knowledge in assisting the Department of Public Works and Environmental Services with the 2005 Annual Report on Fairfax County's Streams.

Thanks to the following individuals for providing data to be incorporated in this report:

Joanna Cornell	*Northern Virginia Soil and Water Conservation District*
Cliff Fairweather	*Audubon Naturalist Society*

Thanks to the following who rendered special assistance:

Prince William Forest Park	*Allowing us to sample the reference sites*
Volunteer Stream Monitors	*Supplemental data*
Versar	*Technical assistance*
Fairfax County Health Department	*Processing of bacteria, nitrate, and phosphate samples*

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Executive Summary

Fairfax County's Stream Protection Strategy Baseline Study report documented conditions in the county's streams based on biological communities observed at 114 targeted monitoring sites. The abundance and diversity of fish and benthic macroinvertebrates (aquatic bugs) provides an indicator of the overall health of streams and a way to evaluate the effectiveness of measures to protect and restore this natural resource. The results of the baseline study suggested that three-quarters of the county's streams were in "fair" to "very poor" condition and that approximately 70 percent of streams needed some degree of restoration.

The baseline study set the foundation for implementing a watershed management program to protect and restore streams, the riparian corridors (stream valleys) and associated resources such as the county's drinking water supply and to help reverse impaired conditions of the Chesapeake Bay. Currently, watershed plans have been initiated or completed for approximately 50 percent (200 square miles) of the county. The development of watershed management plans are scheduled for completion by 2009.

In 2004 the county's biological sampling strategy was re-evaluated and long-term goals established. It was determined that annual countywide conditions and trends were best determined from a probability-based sampling procedure, rather than the targeted sampling approach employed in the baseline study. Various volunteer biological monitoring activities were identified as valuable data sources for site-specific trend evaluations. In addition, the bacteria monitoring program previously administered by the Health Department for over 30 years was integrated into the biological monitoring program to provide a more comprehensive report on water quality from both a biological and human health perspective.

This annual report documents the results from a probability-based sampling procedure conducted in 2004. It includes several new items that were not part of the original baseline study including:

- the findings of volunteer monitors that routinely monitor streams through the Northern Virginia Soil and Water Conservation District and Audubon Naturalist Society volunteer monitoring programs,
- the results and analysis of the bacteria monitoring that was formally conducted by the Health Department,
- a Fish Index of Biotic Integrity, a multimetric index for fish community analysis,
- a countywide stream quality index that will be calculated annually to report the overall condition of streams, and to help determine the progress of future restoration efforts.

The biological monitoring program is intended to serve many needs including requirements under the Virginia Pollution Discharge Elimination System (VPDES) or Municipal Separate Storm Sewer System (MS4) stormwater permit issued by the state.

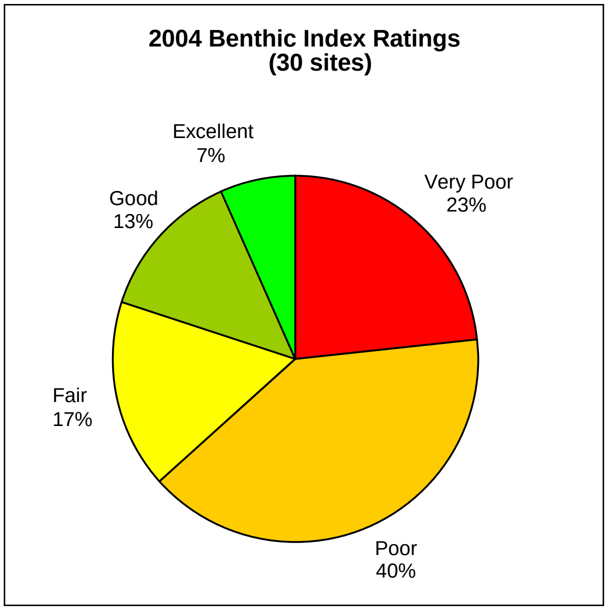


Figure E1. Ratings of 2004 biomonitoring sites based on benthic macroinvertebrate data.

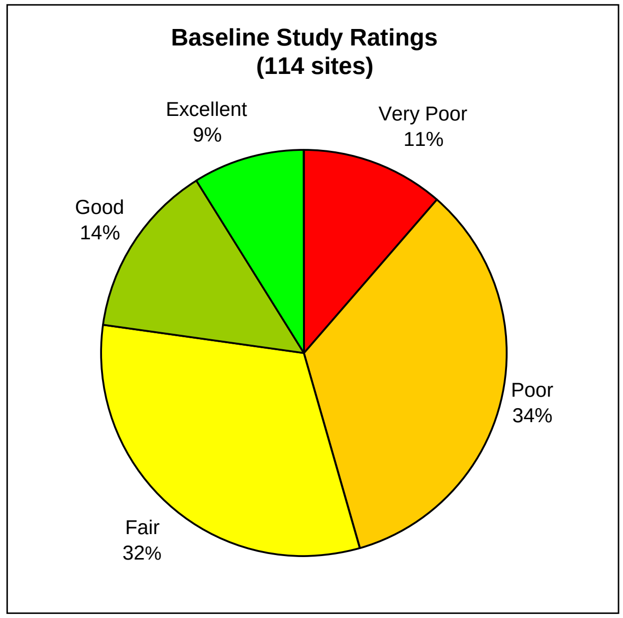


Figure E2. Ratings of benthic macroinvertebrate data from the baseline study. Data was collected in 1999 and the baseline report was published in 2001.

Results

Biological Monitoring: The results of the 2004 benthic macroinvertebrate monitoring are simliar to the results of the baseline study (Figures E1 and E2). The 2004 data suggest that more than 60 percent of the county's streams are in "poor" to "very poor" condition and 80 percent are now "fair" to "very poor" based on a five category rating scale (Figures E1). The five category scale is: excellent; good; fair; poor; and very poor. Forty-five percent were in "poor" to "very poor" condition based on the baseline study (Figures E2). The benthic macroinvertebrate community lacks enough sensitive species that are indictors of good water quality and is dominated by tolerant species that are characteristic of degraded streams. According to fish index all sites received a rating of less than "good" (Figure E3). The fish community is dominated by habitat generalists, omnivores, and non-native species.

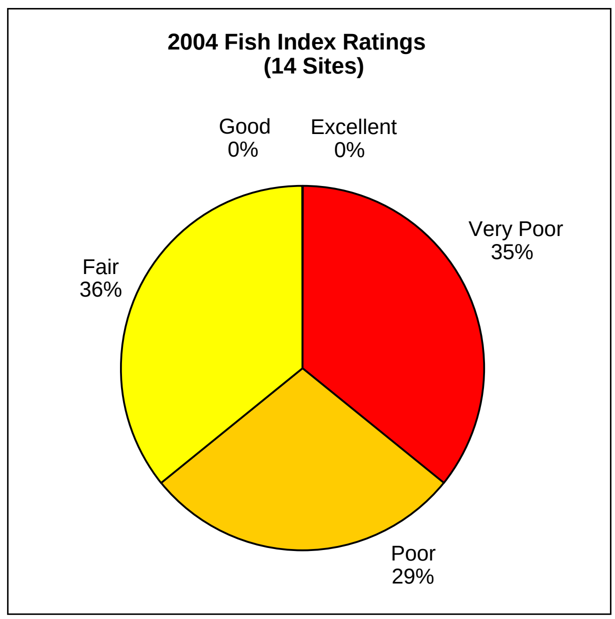


Figure E3. Ratings of 2004 biomonitoring based on fish data.

Volunteer monitoring programs such as those conducted by the Northern Virginia Soil and Water Conservation District and the Audubon Naturalist Society also show similar signs of poor water quality. For example, 81 percent of Northern Virginia Soil and Water Conservation District sites reported “unacceptable” conditions.

Bacteria Monitoring: All sites sampled in 2004 for bacteria violated the state’s water quality standard for fecal coliform bacteria (400 f.c./100 ml) on at least one occasion. Of the 67 sites that were sampled four times (seasonally) during 2004, 20 percent of the sites exceeded the water quality standard for bacteria levels on all sampling occasions (Figure E4).

Based on historical bacteria monitoring data, the Fairfax County Health Department issued the following statement related to the use of streams for contact recreation:

> *“In summary, any open, unprotected body of water is subject to pollution from indiscriminate dumping of litter and waste products, sewer line breaks and contamination from runoff pesticides, herbicides, and waste from domestic and wildlife animals. Therefore, the use of streams for contact recreational purposes, such as swimming, wading, etc., which could cause ingestion of stream water or possible contamination of an open wound by stream water, should be avoided.”*

Additional information related to use of streams for contact recreation is available on the Health Department’s web site at:

http://www.fairfaxcounty.gov/service/hd/resourcewater.htm

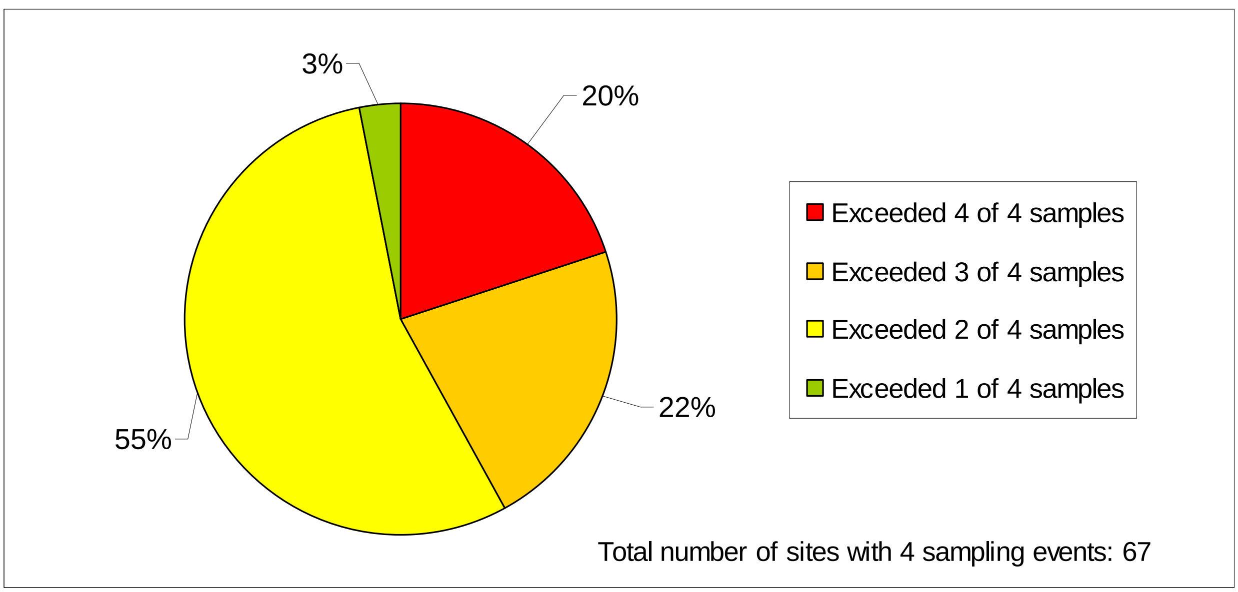


Figure E4. Percentage of sites with exceedences of the state’s water quality standard (400 f.c./100ml) for fecal coliform bacteria.

Countywide Stream Quality Index: A stream quality index was developed to establish a performance measure for a key natural resource (streams) which are visible and of great interest to the public. The index which is based on benthic macroinvertebrate data suggests a small decline in overall stream quality from data collected in 2004 compared to data collected for the baseline study (from 2.76 to 2.41, over a possible range or scale of 1 to 5). However, it is difficult to make any broad statements about trends based on data from two sampling years. This index will be reported annually to evaluate trends in the overall health of streams countywide.

1. Introduction

Fairfax County is located in the northeastern part of the state of Virginia, bordering the Potomac River. The county is bordered by Arlington County, and the Cities of Falls Church and Alexandria to the east. The Potomac River borders the county to the northeast and southeast. The land border with Loudon County lies to the north, and the Bull Run/Occoquan rivers form the southern border with Prince William County. Within the borders of Fairfax County are three incorporated towns (Vienna, Herndon, and Clifton) and one city (Fairfax City).

Fairfax County today is highly urbanized and approaching ultimate build-out conditions, as envisioned in the county's Comprehensive Plan. The total land area of Fairfax County, including incorporated towns is 395 mi^2. It is the most populous jurisdiction in Virginia as well the Washington D.C. metropolitan area, with the 2005 population estimated to be 1,047,500 with 387,700 households. Most land in the county is devoted to residential, commercial, recreational, and open-land uses, with heavy industry essentially nonexistent.

1.1 Watersheds and Physiographic Setting

There are approximately 850 miles of stream channels (with perennial streamflow) draining 30 designated major watersheds (drainage basins) in the county, with 23 watersheds falling entirely within the county's borders (Figure 1). The 30 watersheds drain either to the north and east to the Potomac River, or to the south into the Bull Run/Occoquan rivers (which eventually outlets into the Potomac). The 30 major watersheds within the county range in size from the two square mile Turkey Run drainage to the 58 square mile Difficult Run basin. The mouths of the streams draining the far southeastern portion of the county are influenced by the tidal rhythm of the Lower Potomac. The major lakes throughout the county are all man-made impoundments and were designed primarily for stormwater control, recreational, or aesthetic purposes. The Occoquan River is impounded just upstream of where it passes under Route 123. The reservoir was created when the river was dammed in 1950, and then enlarged in 1957 by the county to provide a source of drinking water for residents within the region. In July 1982, the Fairfax County Board of Supervisors voted to restrict development on 41,000 of the 64,500 acres within Fairfax County draining to the reservoir. The resultant "down-zoning" limited the number of residences to one home per five acres in an effort to improve the quality of stream water draining into the drinking water reservoir.

Fairfax County lies within two major physiographic provinces, the Coastal Plain and Piedmont (Figure 1). Physiographic provinces are areas that have common geology, surface processes, and landscape history having characteristic landforms and environments. Each province comprises areas with similar terrestrial and aquatic floral and faunal ecosystems, including certain communities which may be unique to those provinces. These provinces are the basic landscape units by which biological communities can be evaluated and compared. The Piedmont province covers 60% of the county (243 mi^2) and is typified by gently rolling landscapes, deeply weathered bedrock/soils and a relatively low occurrence of solid outcrop. The Triassic basin occupying the far western portion of Fairfax County is a subset of the larger Piedmont province, and covers 17% of the county (69 mi^2). The Triassic basin is actually the remains of a huge prehistoric lake bottom that covered portions of western Northern Virginia

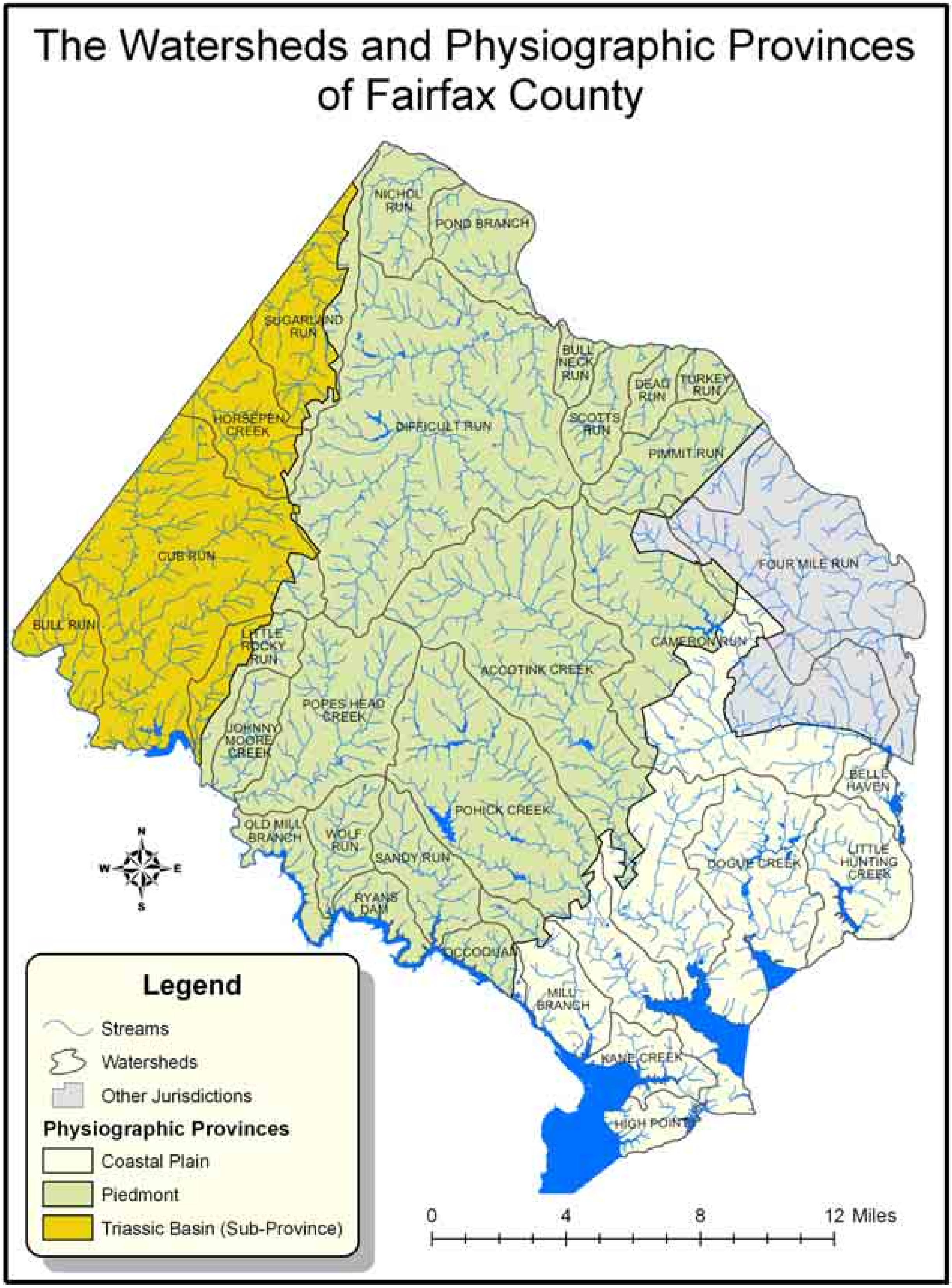


Figure 1: The 30 watersheds and two physiographic provinces and sub-province in Fairfax County, Virginia.

and Maryland. It is typically much flatter and has unique lake sediment-type soils as compared to the encompassing Piedmont province. The Coastal Plain province spans the eastern portion of the county and bounds the Piedmont along the fall line. The fall line is a low east-facing cliff paralleling the Atlantic coastline from New Jersey to the Carolinas. It marks the boundary between the hard Paleozoic metamorphic rocks of the Piedmont (to the West) from the softer, flatter Mesozoic and Tertiary sedimentary rocks of the Coastal Plain. To the west of this line, the streams are typified by greater-sloping channel bottoms and the resultant higher velocity riffle-run habitats. East of this line, in the Coastal Plain, the stream channels (and landscapes), have much gentler slopes, and as a result much more flat water areas dominated more by lower velocity pool and glide habitats. Historically, this fall line presented an obstacle to further upstream navigation to early European settlers in boats and thus is the location of many major mid-Atlantic cities such as Philadelphia, Baltimore, Washington DC, and Richmond. Interstate 95 generally traverses this geologic feature through Northern Virginia.

1.2 Monitoring Efforts

1.2.1 Stream Protection Strategy

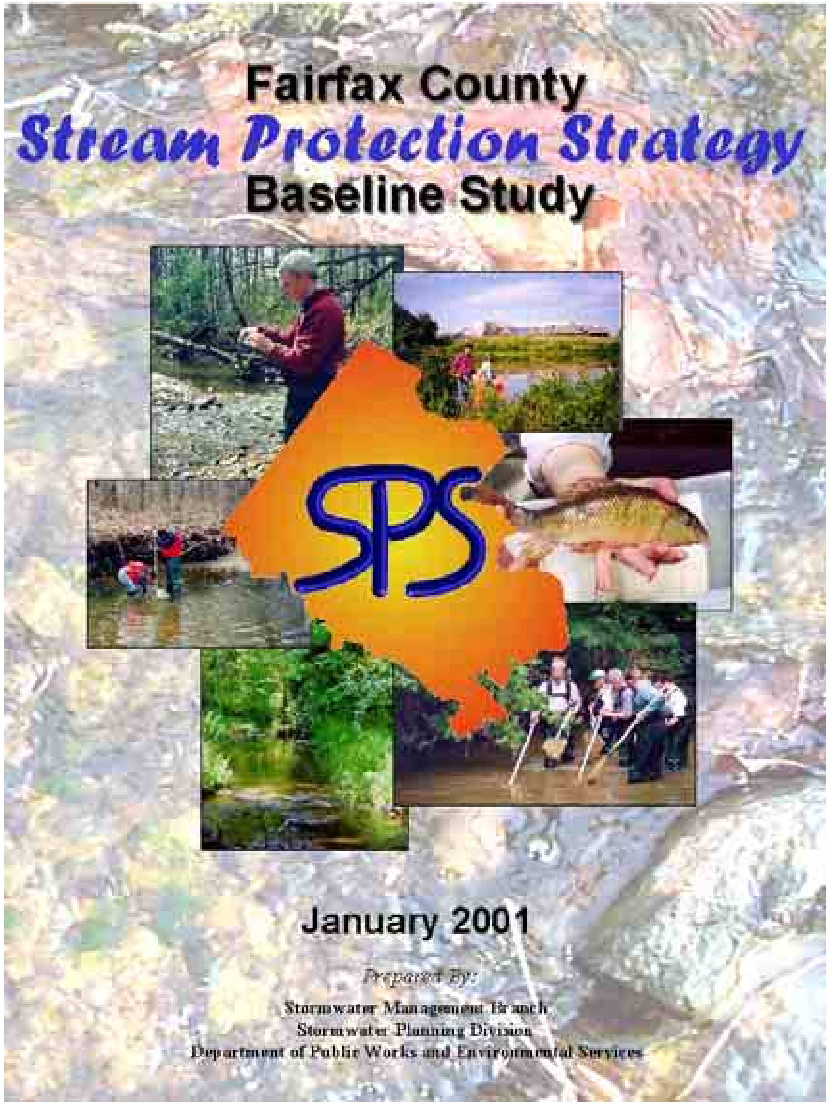
The Stream Protection Strategy Baseline Study on the biological condition of Fairfax County's streams was published in January 2001. This study evaluated the physical, chemical, and biological conditions of 114 sites located along the major streams and tributaries in each of the county's 30 watersheds based on data collected in 1999. Modified versions of the Environmental Protection Agency's (EPA) Rapid Bioassessment Protocol (RBP) were applied along with a Quality Assurance/Quality Control (QA/QC) methodology. Eleven reference sites, located in the Prince William Forest National Park, were used for comparison.

The results of the baseline study were used to identify, rank, and prioritize county streams and create broad management categories and strategies for future restoration and/or preservation efforts on a sub-watershed basis. The baseline study set the framework for developing comprehensive management programs for the county's watersheds.

Major recommendations from the baseline study and their status are summarized below:

Recommendations	Status
Continue a five-year rotational sampling scheme for the county's streams.	A probability-based sampling scheme has been developed. This report summarizes the methodology and results of monitoring during 2004.
Complete a countywide stream physical assessment survey on ALL streams	A Countywide Stream Physical Assessment was completed in 2003
Develop and implement a countywide watershed management program.	Currently, watershed plans have been initiated or completed for over 50 percent (200 square miles) of the county. All watershed management plans are scheduled to be completed by 2009. These plans will be updated periodically.
Pursue a dedicated source of funding for implementing the proposed improvements in county streams and the stormwater infrastructure system.	A Stormwater Needs Assessment Program was completed in 2005 that identified program needs and alternative funding sources. Approximately $18 million in new funds was dedicated from tax revenues in the fiscal year 2006 budget to supplement funds for the stormwater program.
Encourage the use of Best Management Practices (BMP) and Low Impact Development (LID) techniques in all new construction and retrofit activities.	In 2001, a letter to industry (#01-11) was published to facilitate the use of innovative Best Management Practices (BMP). Currently, DPWES is working on amendments to the Public Facilities Manual (PFM) to include additional Best Management Practices (BMP) and Low Impact Development (LID).

The data and the report are being used as part of a long-term database, as well as to guide future activities as they relate to the development and implementation of Watershed Management Plans.



http://www.fairfaxcounty.gov/dpwes/environmental/sps_main.htm

1.2.2 Post-Baseline Study Sampling

Under the original recommendation of the baseline study, trend data was to be collected at each of the 114 sites on a five year rotational basis, where 20 percent of the total sites would be collected annually. Staff began this process in the spring of 2001. Biological and habitat data was collected at approximately 20 percent of the original monitoring locations. Specifically, assessments were made at 23 sites, randomly selected from the original site list, and at the 11 reference locations within Prince William Forest Park. An additional seven sites were established on streams whose watersheds were designated as Priority Assessment Areas in the baseline study.

Unlike the monitoring conducted in 1999, the 2001 effort also included an additional fish sampling event in the spring. This was done in an effort to understand possible seasonal variations in fish distribution patterns and overall abundance, and their subsequent influence on metric development and scoring. Specifically, large numbers of young-of-year fish were collected and enumerated in the original assessments—which may have led to inflated population measures relative to habitat quality—and it was hoped that early season sampling, prior to emergence and development of fry, would eliminate this potential problem.

1999 – Monitoring efforts initiated in the county as part of the Stream Protection Strategy Baseline Study. One hundred and fourteen sites were established and sampled in the county for benthic macroinvertebrates and fish.

2000 – Sampling continued in support of the baseline study. A portion of the sites were resurveyed for fish, under relatively normal drought conditions.

2001 – Baseline study was released in January. As recommended, 20 percent of the original 114 sites were resurveyed for the benthic macroinvertebrate and fish community composition. Seven additional sites were established in Priority Assessment Areas. A spring fish sampling event occurred, to understand any possible seasonal variations in distribution and abundance.

2002 – 2003 – Fieldwork conducted as part of the Perennial Streams Identification and Mapping project.

2004 – Biological monitoring sites were randomly selected based on stream order. Benthic macroinvertebrates were collected and identified from all sites. Fish were collected at higher order sites (greater than 2nd order).

Results from the 2001 sampling event may be found in Appendix A.

Fieldwork for the Perennial Stream Identification and Mapping project initiated with a pilot study in October-December 2001. Formal field identifications commenced in March 2002 and continued through October 2003. The 2003 RPA maps were adopted by the Fairfax County Board of Supervisors on November 18, 2003. This fieldwork was rechecked and validated with a 10 percent quality control re-survey in the spring and summer of 2004. Following data analysis, map production, and Planning Commission hearings, the final Chesapeake Bay Preservation Area (RPA) maps were adopted by the Board of Supervisors on July 11, 2005. Further information can be found at www.fairfaxcounty.gov/dpwes/stormwater.

1.2.3 Bacteria Monitoring

The bacteria monitoring program was initiated in 1969 by the Department of Health's Division of Environmental Health to generate a baseline for bacterial levels in the waterways of Fairfax County. This bacteria baseline allowed the Health Department to monitor the water quality of the streams by establishing a "normal" level of bacteria for different sections of our waterways. By establishing a baseline, it enabled the Health Department to determine when a spike in the bacteria concentration occurred for a particular waterway and facilitated staff to locate pollution sources and to initiate corrective action or refer to the appropriate agency for corrective action. Fecal coliform has been used as an indicator of possible bacteria contamination because it is commonly found in human and animal feces. Although fecal coliform is generally not harmful itself, the occurrence indicates the possible presence of pathogenic (disease-causing) bacteria, viruses, and protozoans which are correlated with swimming-associated gastroenteritis. In 2003, the Fairfax County Health Department transferred the bacteria monitoring program to the county's Stormwater Planning Division in an effort to consolidate all stream monitoring functions in the county. At the time of transfer, 80 sites were divided into nine zones and were visited at a frequency of once to twice per month by the Health Department. The monitoring program has been modified by Stormwater Planning Division, the routine sampling was reduced to visiting each zone four times per year. The Stormwater Planning Division has continued this monitoring effort and took over 300 samples from 25 watersheds in 2004.

1.2.4 Volunteer Biomonitoring

Data that is generated by volunteer stream monitors supplement the county program by providing greater coverage of the county's streams and information on general trends. Audubon Naturalist Society monitors six sites in Fairfax County. Northern Virginia Soil and Water Conservation District has several years' worth of data for 35 sites in the county, and sometimes monitors as many as 50 sites in a given year. In working together with these volunteer monitoring organizations, the county effectively doubles the number of sites visited in a particular year.

In addition to learning about stream monitoring, many volunteers also become involved in watershed groups, clean-up programs, and educational programs. Newsletters and calendars are sent to about 700 people and forwarded to hundreds more, a very effective way to reach large numbers of existing and potential monitors.

Several newsletters and other information can be found on the NVSWCD monitoring Web site at www.fairfaxcounty.gov/nvswcd/monitoring.htm or by contacting Joanna Cornell, NVSWCD Watershed Specialist, at jcornell@gmu.edu or 703-324-1425.

1.2.5 Other Monitoring Efforts

There are many agencies and groups that regularly monitoring water quality in the county. A listing of these can be found in Appendix G.

1.3 Goals

The goal of this report is to present the results of Fairfax County's annual surface water quality monitoring efforts. The results are used to help determine the county's Stream Quality Index as an indicator of the overall condition of Fairfax County's waterways. It is envisaged that future reports will serve as a clearinghouse for information and data related to the biological, chemical and physical conditions of the county's waterways, collected through various county agencies and local organizations.

The long-term biological and bacteriological monitoring program supports the Board of Supervisor's Environmental Excellence for Fairfax County, a 20-year Vision by providing a comprehensive analysis of stream conditions throughout the county, while simultaneously meeting the requirements set forth in local, state, and federal regulations, including:

- Chesapeake Bay Act;
- Municipal Separate Storm Sewer System (MS4) Permit;
- Virginia Pollutant Discharge Elimination System (VPDES); and
- Clean Water Act.

While supporting these requirements, the program will also develop a substantial dataset, which over time will provide essential data to determine the overall rate of change or trends in the conditions of Fairfax County's streams and provide a basis for prioritization of watershed implementation measures to restore watersheds.

2. Methods

Fairfax County uses various methods to collect data for surface water quality monitoring and analyze it for useable results. The monitoring and analysis methods of the county and volunteer organizations are described below in detail.

2.1 History

In the Stream Protection Strategy Baseline Study, a targeted site selection method was employed. The basic goal was to locate sites that (incrementally) drained two to five square miles and were distributed relatively evenly within the county's watersheds. Most sites were located on second and third order streams (determined from 1:24,000 scale USGS topographic maps).

Fairfax County staff collect aquatic insects in Pohick Creek in March 2004. The samples are used to determine the health of the watershed.

It had been the original intent to continue sampling 20 percent of the targeted sites from the baseline study on an annual, rotating basis, so that an assessment of countywide conditions could be performed after five years. This was initiated in 2001 with a resample of 23 of the baseline study sampling locations (Appendix A). The 2001 sampling also included seven new sites to fill in data gaps identified in the baseline study.

In 2004, the county's biological sampling strategy was re-evaluated and long-term goals established. To meet the long-term goals, it was felt that rather than the 20 percent annual resampling of the baseline study monitoring sites on a rotating basis, it would be more meaningful to infer annual countywide conditions and trends from a probability-based sampling procedure. In addition, various volunteer biological monitoring activities were identified as valuable data sources for site-specific trend evaluations (see Section IV and Appendix B).

2.2 Probability-Based Site Selection

Sampling based on probability survey designs are generally acknowledged to be the best way of obtaining statistically defensible estimates of a variable of interest when a full census is impractical or cost prohibitive. The basic disadvantage with targeted sampling approaches is that it is essentially impossible to establish that the sites targeted are representative of the target population of interest. In probability-based sampling, because sites are randomly selected, every possible sampling unit has a non-zero probability of being selected. This eliminates any site selection bias and provides the basis for making statistical inferences about characteristics of the target population being sampled.

Probability sampling can be implemented in a number of ways, including simple random sampling and stratified random sampling. While simple random sampling is straightforward to implement and results can be easily analyzed, it does not incorporate any information about the target population that could potentially provide more precise results, and it does not allow inferences to be made about any sub-populations of interest. Stratified random sampling, which is probably the most common probability sampling technique in aquatic resource surveys, overcomes the disadvantages of simple random sampling. In stratified random sampling, the target population is divided into a number of mutually exclusive subgroups, called strata, based on some characteristic that results in less variability within each subgroup than the overall variability. Each stratum is then sampled by simple random sampling, and the results from different strata may be combined to give more precise results than if the population had not been stratified.

A key task in developing a probability-based sampling methodology is to establish the sampling frame, which refers to the collection of all possible sampling locations. It is also necessary to uniquely identify every sampling location, and incorporate these locations into a randomization scheme to allow probability-based selection of sampling locations. Additionally, for stratified random sampling, the sampling frame must clearly demarcate the different strata.

A high-resolution Digital Elevation Model of the county, created from over 1.1 million spot elevations, was used to create a synthetic stream network at a threshold of 50 acres*. All stream segments were assigned a Strahler stream order. The synthetic stream network was utilized as the basic sampling frame. A stratified random sampling procedure was employed based on Strahler stream order, with samples allocated in a proportional manner according to the total stream length in each stratum (Table 1).

An example of a first order stream in Occoquan.

A two-stage procedure was employed to determine sampling locations. Within each stratum, a stream segment was first selected at random. A sampling location was then randomly selected within each segment. The final sampling locations used for the 2004 monitoring campaign for all strata are shown in Figure 2. (for more information see Appendix G)

Table 1. Number of sampling sites per stream order.

Stream Order	Total length (mi)	Percentage of total (%)	Number of sampling locations
1	526.5	52.9	16
2	221.8	22.3	7
3	144.1	14.5	4
4	85.4	8.6	2
5	17.0	1.7	1

* The 'threshold' refers to the drainage area that must be equaled or exceeded to initiate a starting point of the synthetic stream network.

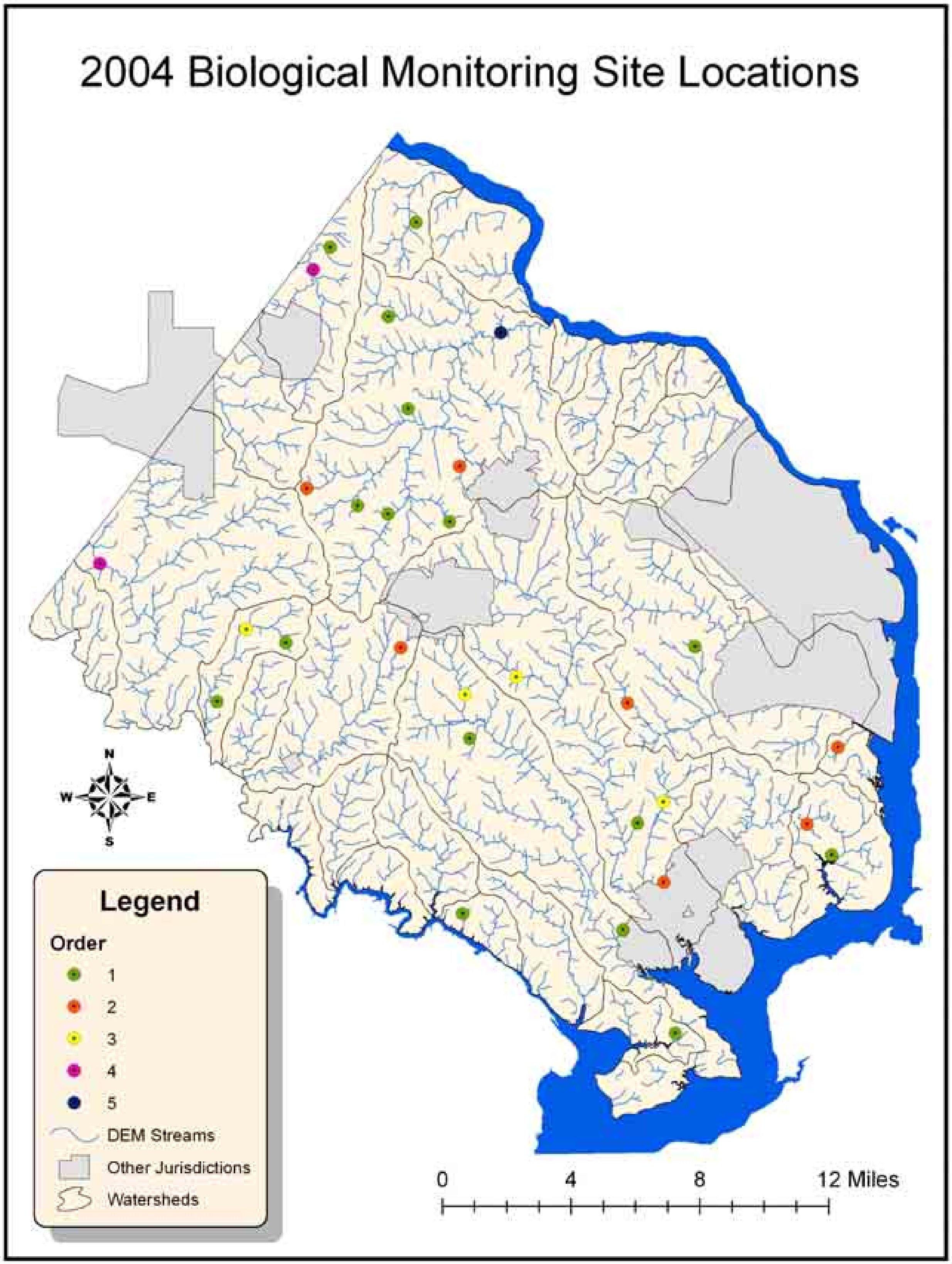


Figure 2: Location of 2004 biological sampling sites.

2.3 Bacteria

Fairfax County conducts bacteria sampling throughout the county to determine the concentration of fecal coliform and *E. coli* in the streams which can be harmful to humans.

The first full year that the Stormwater Planning Division assumed bacteria monitoring activities from the Health Department was 2004. The 80 original sampling sites were sectioned into nine separate zones (Figure 3). Each zone was sampled four times in 2004, for a total of more than 300 bacteria samples.

2.3.1 Procedures

Bacteria sampling involved taking grab samples from the stream to determine the concentration of fecal coliform and *E. coli* in the water. In addition to the assessment of bacteria, sterile bottles were used to collect samples to assess Nitrate (NO_3^-) and Phosphate (PO_4^{-3}) as a secondary test for possible human inputs. Finally, chemical parameters, such as pH, water temperature, dissolved oxygen, and specific conductance were recorded during bacteria sampling using a combination of YSI 85, YSI 556, and Accument Portable pH meters. The sampling techniques, the sample site locations, the parameters sampled for, as well as the chemical data collected for each site was identical to the previous Health Department monitoring program (Appendix D).

Fairfax County staff collecting a bacteria sample in February 2004. Results from the samples indicate that Fairfax County streams are not safe for recreational contact.

2.3.2 Analysis

Beginning in May of 2004, the concentration of *E. coli* in water samples was determined in addition to fecal coliform concentrations. This was in response to the EPA recommendation to use concentrations of *E. coli* and enterococci rather than concentrations of fecal coliform to better determine possible health issues associated with surface waters. Virginia's Department of Environmental Quality has also adopted new *E. coli* standards for water quality.

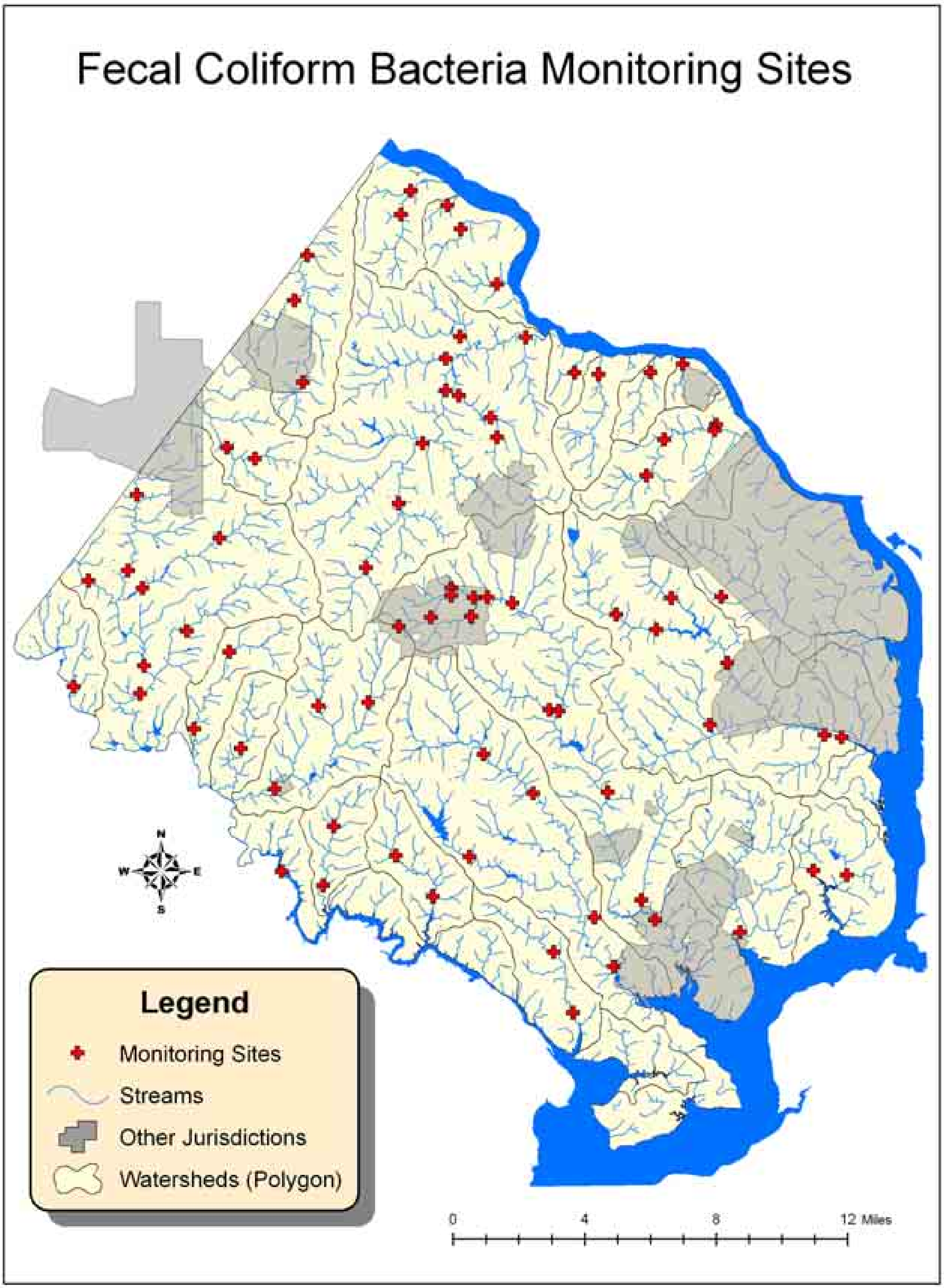


Figure 3: Locations of bacteria monitoring sites.

2.4 Fish

Fish sampling is done by the county because a collection of fish represents the apex of most stream communities. Fish typically are at the top of the food web and are sensitive to both natural and anthropogenic changes within a given system and are, therefore, useful indicators of stream ecosystem health.

Fairfax County staff sampling fish in Pohick Creek in August 2004. Samples are taken to determine stream ecosystem health.

2.4.1 Sampling

Fairfax County conducts fish sampling every summer using the U.S. Environmental Protection Agency's (EPA) Rapid Bioassessment Protocol (RBP) for Use in Wadeable Streams and Rivers (Barbour et al. 1999) to determine stream ecosystem health. Samples were collected in the field using electrofishing equipment that temporarily stuns fish, allowing them to be netted with relative ease. The fish were then identified and released back into the stream. See Appendix C for more detailed information on sampling and laboratory methods.

2.4.2 Analysis

In the baseline study an attempt was made to quantify the health of each of the 30 watersheds using an index based on the fish community data. The data collected at that time was not used to create a Fish Index of Biotic Integrity (F-IBI), similar to index that was developed for the benthic macroinvertebrate data, which is described later in this document. The development of a fish index is an additional useful tool because fish communities are sensitive to different stressors, such as blockages, compared with benthic macroinvertebrates.

Fairfax County staff evaluated an extensive suite of candidate metrics and each metric was evaluated based on trophic characteristics, tolerance, and community structure. The county assessed each metric for its usefulness in developing a fish index. Metrics tested were similar to those tested by Dr. Billy Teels whose work was completed in the Occoquan watershed in 2001. Metrics used by the statewide Maryland Biological Stream Survey (MBSS) were also tested. Metrics were chosen on their ability to correlate with imperviousness, ability to distinguish most disturbed sites from least disturbed sites and frequency of appearance in literature (Table 2).

Fairfax County staff identifying fish species in a sample in August 2004. The number and type of species are used to determine a Fish Index of Biotic Integrity (F-IBI).

There are two physiographic provinces in the county, Coastal Plain and Piedmont. Studies have shown that there is a significant difference in fish communities in the Coastal Plain versus the Piedmont (Smogor 1999, Roth et. al 2005). A small portion of Fairfax County is in the Coastal Plain, but there are few reference areas available in this small portion. The fish index for the Coastal Plain will be based on metrics and scoring criteria used by Roth et al. in Maryland Coastal Plain streams. Metrics used for Piedmont streams are similar to those used by Teels. Metrics for the Piedmont were chosen based on their ability to correlate with imperviousness and ability to distinguish most disturbed sites from least disturbed sites. Scoring criteria was determined using the tri-sectioning method as detailed by Fausch et al. (1984) and Karr (1986) and results are similar to Teels. Further refinement of the metrics and/or scoring criteria could occur in the future as more data is collected, particularly for the Coastal Plain.

Table 2: Metrics chosen for the Piedmont Fish Index of Biotic Integrity.

METRIC	DESCRIPTION
1. Number of Native Species	Number of species in sample that are native to the Potomac Drainage.
2. Number of Darter Species	Number of species in sample that are darters.
3. Percent Tolerant	Percent of individuals in the sample that are classified as being tolerant.
4. Number of Intolerant Species	Number of species in sample that are classified as being intolerant.
5. Percent Omnivores	Percent of individuals whose functional feeding group is omnivores.
6. Percent Benthic Invertivores	Percent of individuals whose primary functional feeding group is benthic invertivores.
7. Percent Carnivores	Percent of individuals whose primary functional feeding group is carnivores.
8. Percent Lithophils	Percent of individuals that spawn on clean gravel.
9. Percent Anomalies	Percent of individuals in the sample that have wounds, diseases, or parasites.

Table 3: Metrics chosen for the Coastal Plain Fish Index of Biotic Integrity.

METRIC	DESCRIPTION
1. Percent Tolerant	Percent of individuals in the sample that are classified as being tolerant.
2. Percent Omnivores and Invertivores	Number of species whose functional feeding group is omnivores and/or invertivores.
3. Percent Non-tolerant Suckers	Percent of individuals in that sample that are suckers not classified as tolerant.
4. Percent Dominance	Percent of sample that is the most abundant species.

Measures of fish community richness typically increase with increasing stream discharge or order, and the values were adjusted accordingly to generate an ultimate rating of: excellent; good; fair; poor; and very poor (Table 4).

Table 4: Classification rating for the Fish Index of Biotic Integrity.

Fish Index Score		RATING
Piedmont	Coastal Plain	
> 34	-	Excellent
30 to 34	>17	Good
25 to 29	14 – 17	Fair
20 to 24	10 - 13	Poor
< 20	< 10	Very Poor

See Appendix C for a more in-depth explanation on the creation and use of the fish index.

2.5 Benthic Macroinvertebrates

Benthic macroinvertebrate samples are collected by county ecologists to help determine the water quality of streams. Benthic macroinvertebrates are important indicators of water quality of their varying tolerances to chemical, nutrient, and sediment pollution in waterbodies. Benthics are also an important link in any aquatic food web by forming the core diet of many stream fishes.

2.5.1 Sampling

The county conducts benthic macroinvertebrate sampling at all sites in late winter to early spring using the 20 jab multi-habitat sampling protocol of the U.S. Environmental Protection Agency's (EPA) Rapid Bioassessment Protocol (RBP) for Use in Wadeable Streams and Rivers (Barbour et al. 1999). The "20 jab" method involves taking 20 separate "jabs" or collections from representative habitat types in the reach including undercut banks, aquatic vegetation, riffles and snags. The benthics that are collected are brought back a county lab where they are subsampled which means that 200 individual benthic macroinvertebrates (plus/minus 20 percent) are picked. The subsample is then identified to the

Fairfax County staff sampling benthic macroinvertebrates in Kane Creek in April 2004. Samples are taken to determine the stream ecosystem health based on an Index of Biotic Integrity (IBI).

genus level where possible with all others categorized at a higher taxonomic level due to time constraints. See Appendix B for more detailed information on sampling and laboratory methods.

2.5.2 Analysis

The data obtained from the identification of the benthic macroinvertebrate samples was then used within a framework of pre-established metrics. Each metric is a numerical valuation reflecting the tolerance or trophic structure variables of the benthic macroinvertebrate community. The metrics are combined into a Benthic Index of Biotic Integrity. A metric set that was developed for use within the Northern Virginia Piedmont areas (Jones 2000, personal communication) was used for sites located within the Piedmont physiographic region of Fairfax County (Table 5). The metrics used in the benthic index for sites in the Coastal Plain region were based on a metric set (Table 6) created by Maxted et al. (1999).

Table 5: Metrics for the Piedmont Benthic Index of Biotic Integrity.

METRIC	DESCRIPTION
1. Taxa Richness	Number of different taxa at a site.
2. EPT Taxa	Number of Mayfly, Stonefly, and Caddisfly taxa at a site.
3. Percent EPT	Percent of Mayfly, Stonefly, and Caddisfly taxa at a site excluding the Net-Spinning Caddisfly (Hydropsychidae).
4. Percent Trichoptera without Hydropsychidae	Percent of sample that are Caddisflies excluding the tolerant Net-Spinning Caddisflies (Hydropsychidae).
5. Percent Coleoptera	Percent of sample that are beetles.
6. Family Biotic Index (FBI)	General tolerance/intolerance of the sample.
7. Percent Dominance	Percent of sample that is the most abundant taxa.
8. Percent Clingers + Percent Plecoptera	Percent of individuals whose habitat type is clingers plus percent of sample that are stoneflies but are not clingers.
9. Percent Shredders	Percent of individuals whose primary functional feeding group is shredders.
10. Percent Predators	Percent of individuals whose primary functional feeding group is predators.

Table 6: Metrics for the Coastal Plain Benthic Index of Biotic Integrity.

METRIC	DESCRIPTION
1. Taxa Richness	Number of different taxa at a site
2. EPT Taxa	Number of Mayfly, Stonefly and Caddisfly taxa at a site
3. Percent Ephemeroptera	Percent of sample that are Mayflies
4. Hilsenhoff Biotic Index (HBI)	General tolerance/intolerance of the sample
5. Percent Clingers	Percent of individuals whose habitat type is clingers.

For each individual metric, sites were scored on a scale of 0 (low correspondence) to 10 (high correspondence) relative to the reference condition. For Piedmont sites, comparisons were made to reference sites sampled in Prince William Forest Park, while Coastal Plain sites where compared to Kane Creek in southeastern Fairfax County based on the use of least impaired sites approach recommended by Karr et al. (1986). Values from each suite of metrics (10 for the Piedmont region and 5 for the Coastal Plain region) were then added together to develop a single benthic index measured on a 0 to 100 scale. In the Coastal Plain, values were doubled to produce a comparable 0 to 100 scale. Based on this value, individual sites were given a qualitative rating within one of the following five categories: excellent; good; fair; poor; and very poor (Table 7).

Table 7: Benthic Index of Biotic Integrity scoring and equivalent rating system.

BENTHIC INDEX SCORE	RATING	DESCRIPTION
80 to 100	Excellent	Equivalent to reference conditions; high biodiversity and balanced community.
60 to 80	Good	Increased number of intolerant species; balanced community
40 to 60	Fair	Marked decrease in intolerant species; shift to an unbalanced community.
20 to 40	Poor	Intolerant species rare or absent, decreased diversity.
0 to 20	Very Poor	Degraded site dominated by a small number of tolerant species.

See Appendix B for a more in-depth explanation on the creation and use of the benthic index.

2.6 Volunteer Monitoring

2.6.1 Audubon Naturalist Society

The Audubon Naturalist Society water quality monitoring program recruits, trains, equips, and organizes volunteers to assess the health of streams throughout the Washington, D.C., region. The program uses a modified version of the EPA's Rapid Bioassessment Protocols (RBP) to perform habitat assessments and benthic macroinvertebrate surveys (see Appendix E). All monitoring equipment is provided. There are six permanent sites within Fairfax County that are covered by 20 to 30 volunteers each year (Figure 5). The data collected by the society volunteers are currently shared with the Department of Environmental Quality, Prince William County, Fairfax County, National Park Service, and Department of Game and Inland Fisheries.

Volunteers assess habitat conditions and macroinvertebrate community composition (usually to family level) at specific points throughout the year (May, July, and September, with an optional winter sample). Macroinvertebrates are collected using a "hand-scrubbing" sampling technique whereby the volunteers pick up rocks from the stream and rub them in a bucket filled with stream water to detach any macroinvertebrates on the rocks. All benthics that are collected using this method are visually identified to the family taxonomic level where possible. Multiple samples are collected from riffle and pool areas.

Monitors gauge overall habitat condition by visually assessing parameters such as substrate composition, embeddedness, turbidity, bank cover and canopy cover. Four other components of the EPA's habitat assessment—channel flow status, bank stability, sediment deposition and riparian zone width—are also scored using a visual assessment. Readings of pH and water temperature are taken concurrently.

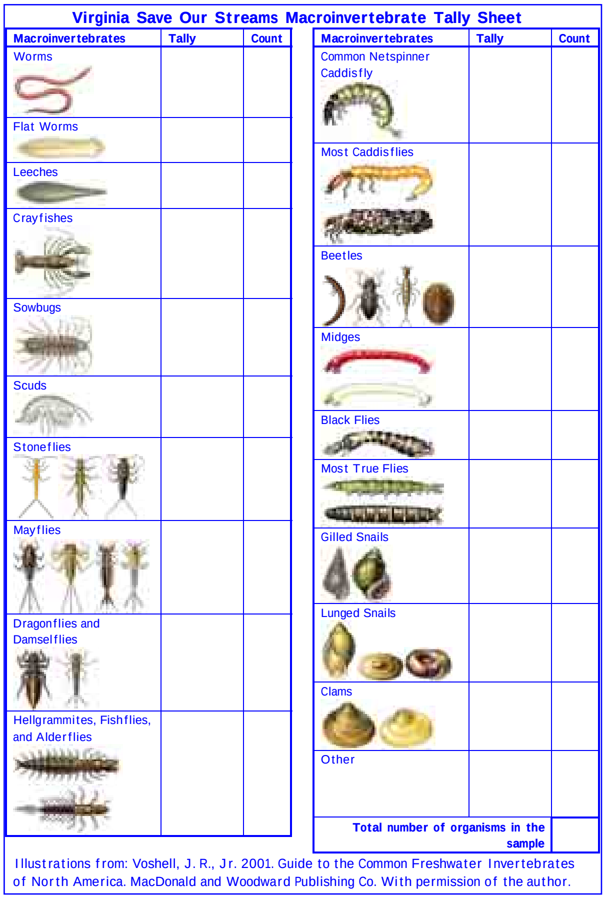
2.6.2 Northern Virginia Soil and Water Conservation District

The Northern Virginia Soil and Water Conservation District coordinates a volunteer stream monitoring program first established in 1997 that is open to all individuals interested in water quality issues. Training includes indoor and field workshops and mentoring by experienced monitors. Volunteers commit to monitoring their chosen stream four times a year or assist other monitors at their sites. Sites are located throughout the county and in the City of Fairfax.

Blythe Merritt, Northern Virginia Soil and Water Conservation District and Audubon Naturalist Society volunteer monitor, sorting a sample in Cub Run in December 2003. Volunteer data supplements the county's data. (photo NVSWSD)

The conservation district initially used the Izaak Walton League Save Our Streams (SOS) protocol for biological monitoring. The protocol classified stream condition based on the absence or presence of organisms. In 2001, the conservation district adopted the use of a new, modified Virginia Save Our Streams protocol (Figure 4). The new protocol was the result of graduate research at Virginia Polytechnic Institute and State University. The new method takes both abundance and diversity into account when calculating six metrics and using a multi-metric for the final score (see Appendix E).

Monitors sample riffles by disturbing the stream bottom and collecting dislodged insects with the use of a three foot-square net. At least 200 organisms are collected and identified. Monitors calculate six metrics, and then use a multi-metric approach to score the site as having an acceptable or unacceptable ecological condition. The final score ranges from zero to twelve. Volunteers also conduct chemical analyses of turbidity and nitrate/nitrite and make physical observations. The conservation district provides all monitoring equipment.



Virginia Save Our Streams Macroinvertebrate Tally Sheet

Macroinvertebrates	Tally	Count	Macroinvertebrates	Tally	Count
Worms			Common Netspinner Caddisfly		
Flat Worms			Most Caddisflies		
Leeches			Beetles		
Crayfishes			Midges		
Sowbugs			Black Flies		
Scuds			Most True Flies		
Stoneflies			Gilled Snails		
Mayflies			Lunged Snails		
Dragonflies and Damselflies			Clams		
Hellgrammites, Fishflies, and Alderflies			Other		
			Total number of organisms in the sample		

Illustrations from: Voshell, J. R., Jr. 2001. Guide to the Common Freshwater Invertebrates of North America. MacDonald and Woodward Publishing Co. With permission of the author.

Individual Metrics

Metric	Number		Total number of organisms in the sample		Percent
Mayflies + Stoneflies + Most Caddisflies		Divide by		Multiply by 100	
Common Netspinners		Divide by		Multiply by 100	
Lunged Snails		Divide by		Multiply by 100	
Beetles		Divide by		Multiply by 100	

% Tolerant

Taxon	Number
Worms	
Flatworms	
Leeches	
Sowbugs	
Scuds	
Dragonflies and Damselflies	
Midges	
Black Flies	
Lunged Snails	
Clams	
Total Tolerant	
Total Tolerant divided by the total number of organisms in the sample	
Multiply by 100	

% Non-Insects

Taxon	Number
Worms	
Flatworms	
Leeches	
Crayfish	
Sowbugs	
Scuds	
Gilled Snails	
Lunged Snails	
Clams	
Other non-insects (organisms without 6 jointed legs)	
Total Non-Insects	
Total Non-Insects divided by the total number of organisms in the sample	
Multiply by 100	

Figure 4: Example field data sheets for the Virginia Save Our Streams Protocol.

There are between 40 and 50 sites that are monitored during a typical year, with 35 sites that currently have several years' worth of data (Figure 5).

More than 700 volunteers have participated in collecting data. Certified data is forwarded to Fairfax County, the Department of Environmental Quality, Virginia Save Our Streams, and other interested organizations or individuals.

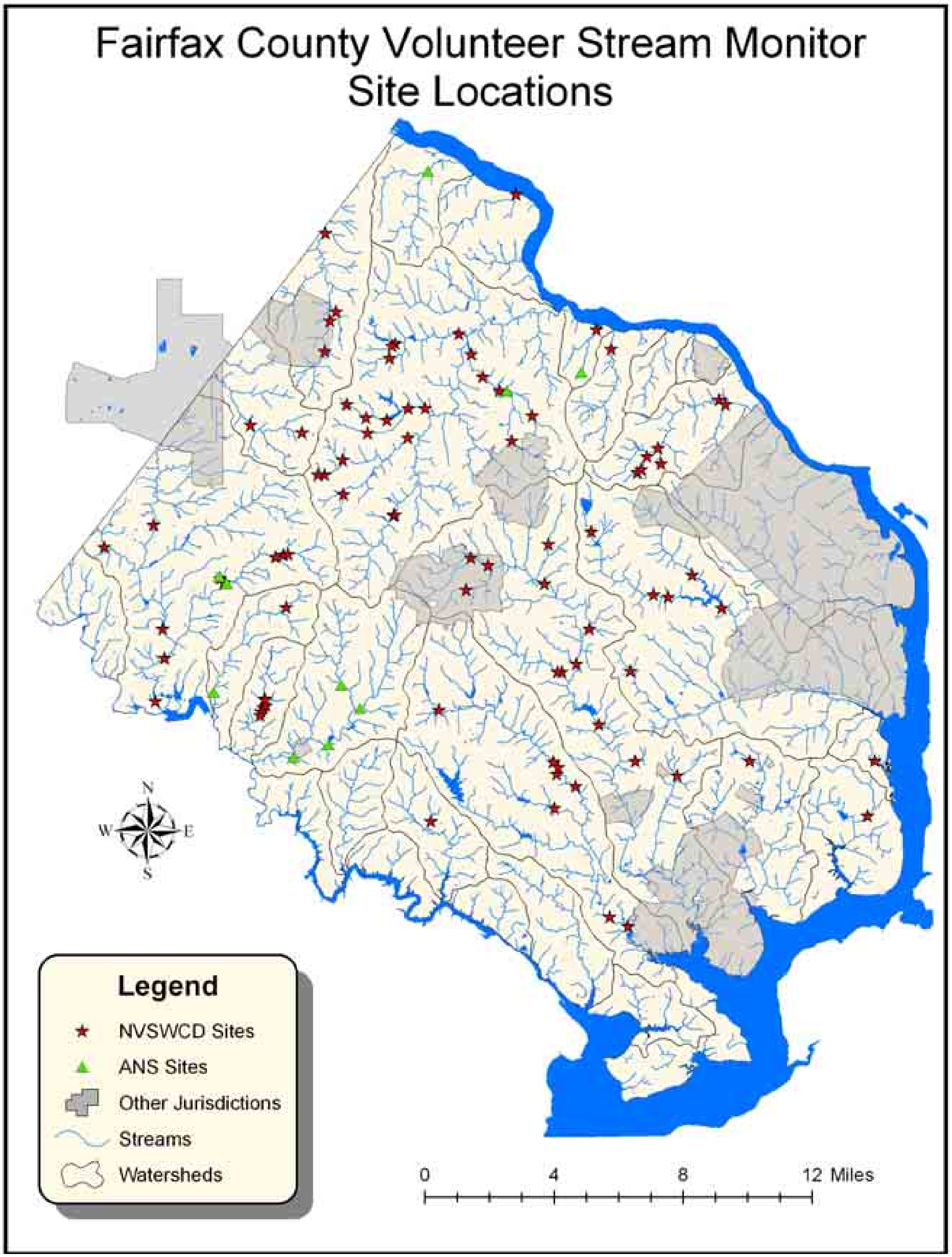


Figure 5: Location of volunteer monitoring site locations.

3. Results

In general, bacteria levels found in a majority of streams make them unsafe for recreational contact (swimming and wading). The benthic macroinvertebrate community lacks sensitive species that are indictors of good water quality and is dominated by tolerant species that are characteristic of degraded streams. The fish community is dominated by habitat generalists, omnivores, and non-native species.

3.1 Bacteria Monitoring Data

In 2003, the Department of Environmental Quality adopted a more stringent bacteria standard for primary contact recreation to all surface water of the state. This action was taken as part of Virginia's commitment to attain the national goal of water quality of surface water for all types of recreation. According to these standards, the following standards now apply:

- Fecal coliform bacteria shall not exceed a geometric mean of 200 fecal coliform bacteria per 100 ml of water for two or more samples over a calendar month
- No more than 10 percent of the total samples taken during any calendar month can exceed 400 fecal coliform bacteria per 100 ml of water
- *E. coli* shall not exceed a geometric mean of 126 bacteria per 100 ml of water or exceed an instantaneous value of 235 bacteria per 100 ml of water.

Since bacteria sampling in the county is only conducted on a quarterly basis, the geometric mean standard cannot really be applied to the data. Comparisons with the 400 f.c./100 ml standard are more meaningful. In 2004, the percentage of samples with fecal concentration less than 400 f.c./100ml decreased to 28 percent from 32 percent in 2002 (Figure 6). However, since the Health Department has historically used 200 f.c./100ml as the cutoff for "good" water quality, the percentage of samples with fecal concentrations less than 200 f.c./100ml are also shown in Figure 6. This percentage, actually showed an increase from 17 percent to 24 percent.

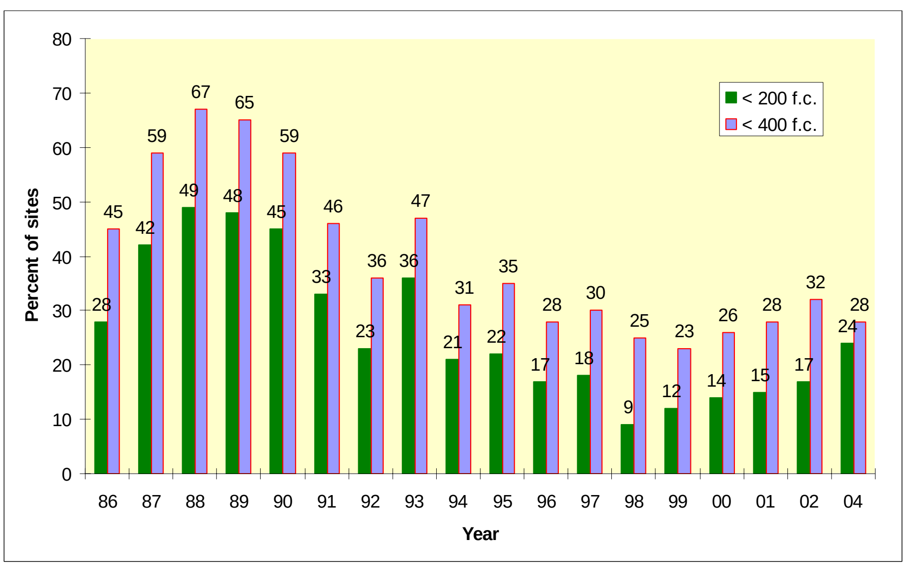


Figure 6: Percent of sites with less than 200 and 400 fecal coliform bacteria per 100ml.

Factors affecting the increase or decrease in the amount of fecal coliform in stream waters include, rainfall and the sample water temperature. Both of these factors are noted in past Health Department stream water quality reports as environmental conditions affecting the fecal coliform results. Plots of fecal concentration counts versus temperature (Figure 7) and fecal concentration geometric means versus 5-day antecedent rainfall (Figure 8) suggests a closer association to temperature.

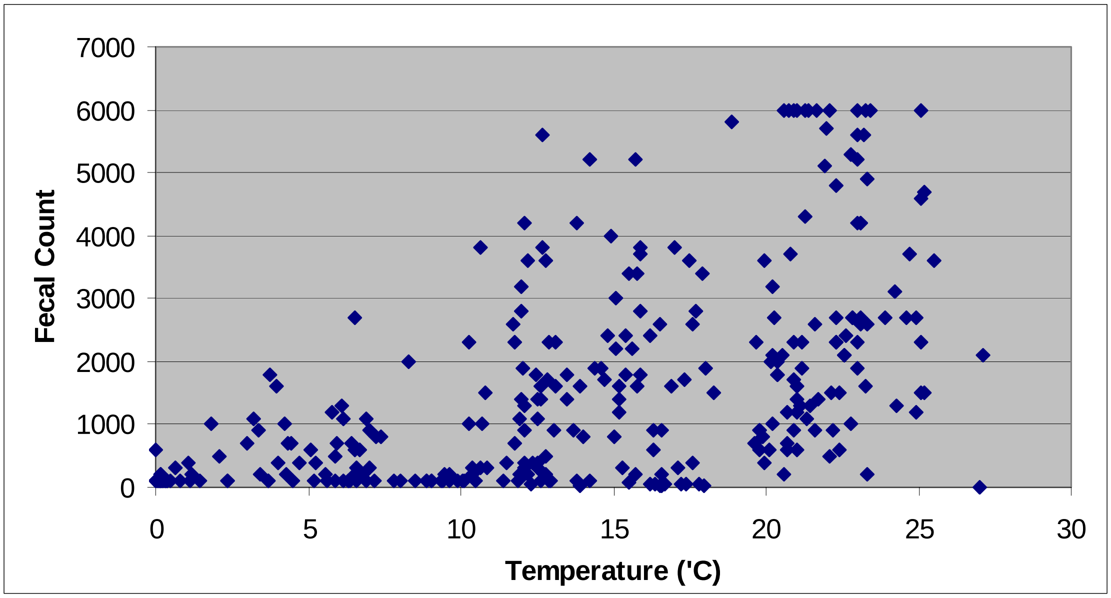


Figure 7: Fecal coliform concentrations versus water temperature.

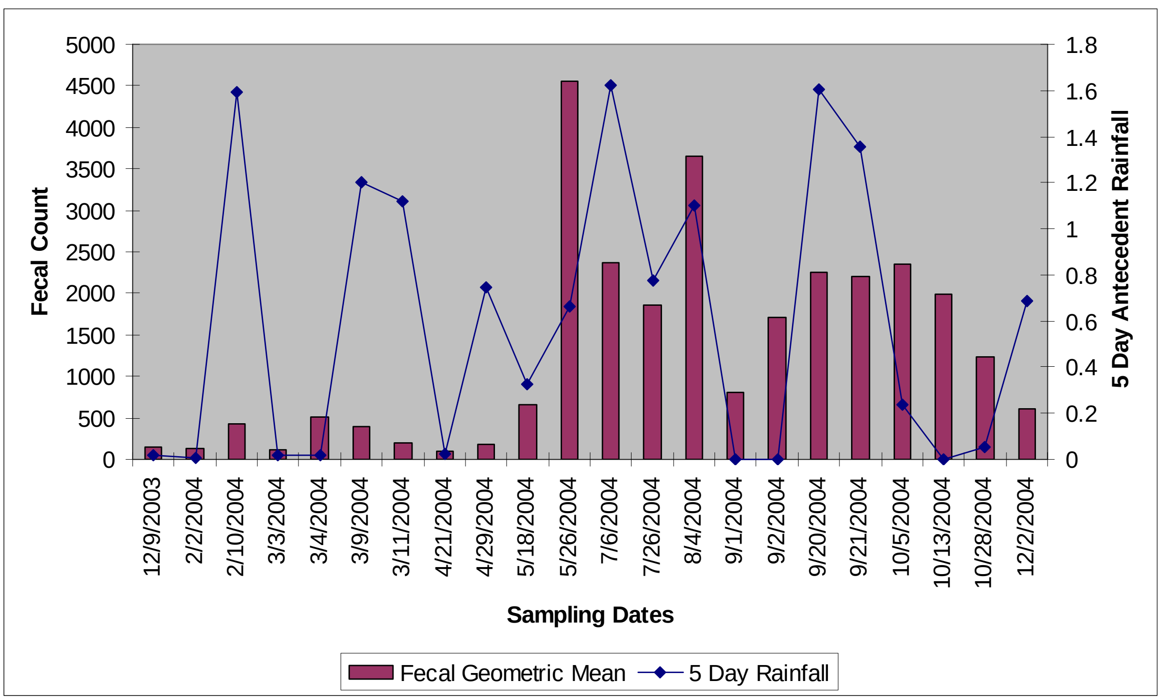


Figure 8: Geometric mean of fecal coliform concentrations versus 5-day antecedent rainfall.

All sites in Fairfax County where at least 4 samples were taken exceeded concentrations of 400 f.c./100ml at least once. The distribution of the number of exceedences in shown in Figure 9, it can be seen that the vast majority of sites (97%) exceeded 400 f.c./100ml two or more times. This would imply that in all areas of the county whether intensely developed or sparsely developed are experiencing a problem with fecal coliform contamination in our waterways. *At any time, any stream in Fairfax County may exceed the level of fecal coliform that the Department of Environmental Quality deems appropriate for recreational contact.*

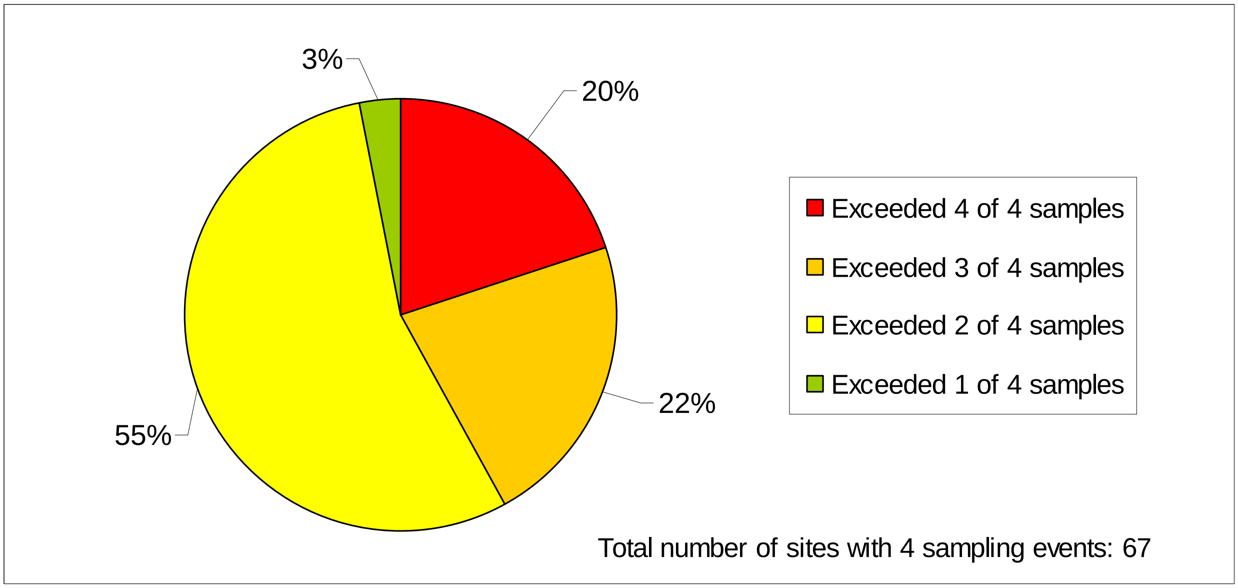


Figure 9: Percentage of sites with exceedences of the state's water quality standard (400 f.c./100ml) for fecal coliform bacteria.

Eighty sites were sampled four times throughout 2004 for a total of 320 samples. The original Health Department sample sites are located on major streams and their tributaries and were picked on ease of access. Only 25 of the 30 watersheds were sampled using the original Health Department bacteria monitoring program locations (Figure 9). Four of these five watersheds are located in downzoned areas of Fairfax County. By disregarding these watersheds, the percent of sites within the acceptable fecal coliform range may be skewed. Future bacteria monitoring efforts will utilize sites selected using stratified random sampling and will provide more representative data.

3.2 Fish Sampling Data

A total of 14 streams within the county were sampled for fish during 2004. All sites were rated in the “fair” to “very poor” range according to the fish community (Figure 10) meaning most streams were dominated by habitat generalists, omnivores, and species that are tolerant of poor water quality. Sixty-four percent of all streams assessed for fish received a “poor” or “very poor” rating and the remaining 36 percent fell into the “fair” rating.

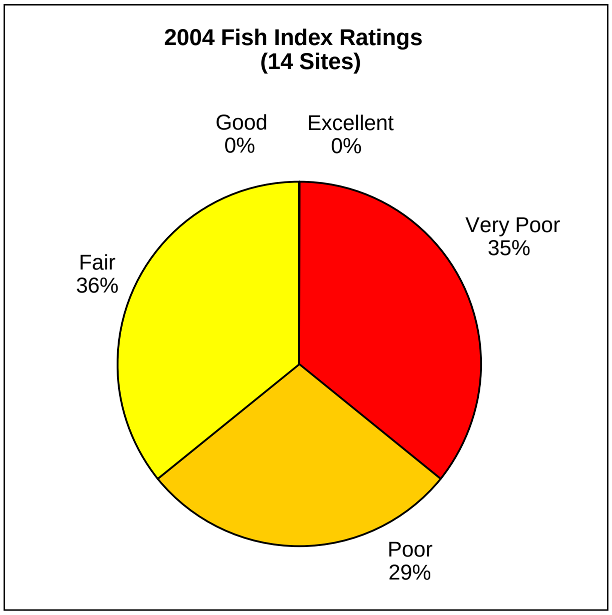


Figure 10: Ratings of 2004 biomonitoring sites based on the Fish Index of Biotic Integrity.

The Blacknose dace, Rhinichthys atratulus, is tolerant of poor water quality. The Blacknose dace is common in streams throughout Fairfax County.

The White Sucker, Catostomus commersoni, is an omnivore. This species is also found throughout Fairfax County.

Larger streams (3, 4, and 5 order) had a higher rating (“fair” to “poor”) compared with second order streams based on the mean (Table 8). Second order streams have a higher standard deviation compared with the larger streams meaning there was high variability in the rating scores of second order streams.

Table 8: Fish Index of Biotic Integrity statistics by stream order.

Stream Order	Number of samples	Mean Fish Index	Rating	Standard Deviation
2	7	14.5	Very Poor	9.8
3, 4, and 5	7	24.9	Fair to Poor	5.4

3.3 Benthic Macroinvertebrates

A total of 30 sites within the county were sampled for benthic macroinvertebrates. Consistent with what was reported in the baseline study, a majority of streams within the county are in "fair" to "very poor" condition (80 percent) based on the Benthic Index of Biotic Integrity (Figure 11). For the 2004 sampling season, 6 sites were rated in the "excellent" to "good" range while 24 sites were rated in the "fair" to "very poor" range. Volunteer sampling data from the Northern Virginia Soil and Water Conservation District also shows that 81 percent of the sites that they sampled were rated as "unacceptable" (Figure 12).

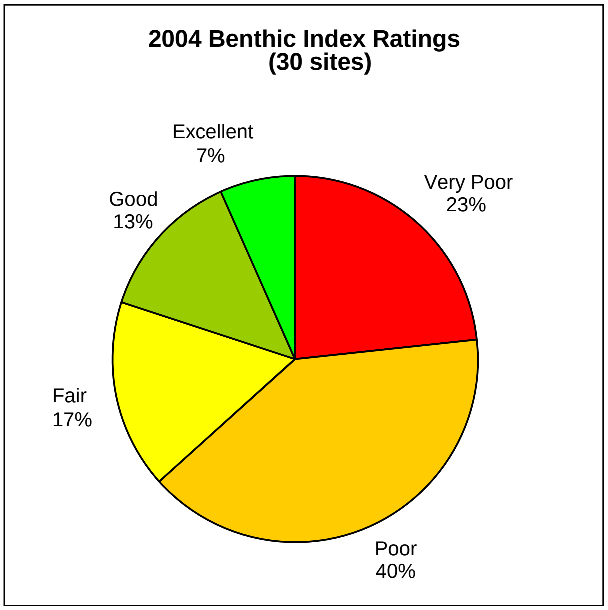


Figure 11: Ratings of 2004 biomonitoring sites based on the Benthic Index of Biotic Integrity.

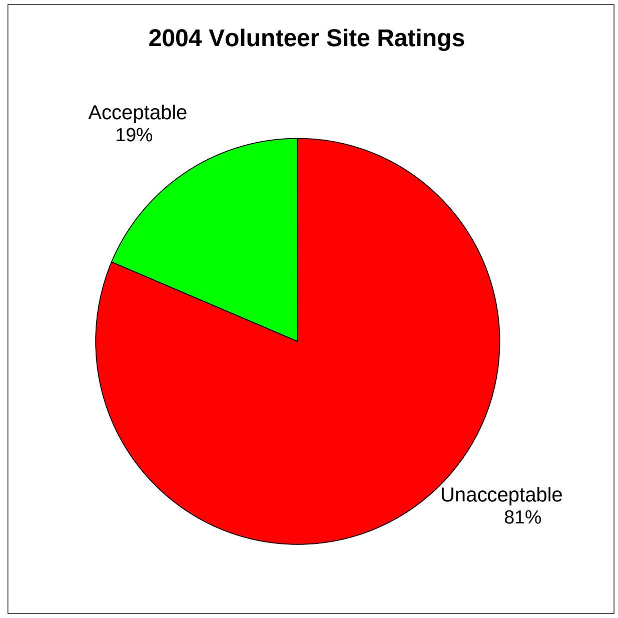


Figure 12: Results from the 48 Northern Virginia Soil and Water Conservation District volunteer monitoring sites.

First order streams and large streams (3, 4, and 5 order) have similar means corresponding to a rating of "fair" (Figure 12). First order streams have a higher standard deviation compared with the other sized streams meaning there was high variability in the rating scores of second order streams, with one stream rated "excellent" and four rated "good".

Table 9: Benthic Index of Biotic Integrity statistics by stream order.

Stream Order	Number of samples	Mean Benthic Index	Rating	Standard Deviation
1	16	40.8	Fair	19.1
2	7	27.3	Poor	11.8
3, 4, and 5	7	40.1	Fair	5.1

3.4 Stream Quality Index

Fairfax County's vision is to protect and enrich the quality of life for the people, neighborhoods, and diverse communities of Fairfax County. An important aspect of achieving this vision is through the practice of environmental stewardship. This includes the wise use of resources, and the protection and enhancement of the county's natural environment and open space.

A number of key indicators have been developed to support the environmental component of Fairfax County's vision. Indicators include one related to watersheds/stream quality. Benthic macroinvertebrate data from the biological monitoring program was used to develop a watersheds/stream quality indicator.

A segment of stream in Accotink Creek Watershed shows eroding banks and inadequate riparian buffer. This segment of stream is rated "poor" and is representative of streams in Fairfax County.

The number of sites placed in each of the five rating categories (excellent; good; fair; poor; and very poor based on the benthic macroinvertebrate monitoring data) was used to develop a stream quality index of overall watershed/stream conditions countywide. The index is computed by multiplying the fraction of total sites rated "excellent" by 5, those rated "good" by 4, those rated "fair" by 3, those rated "poor" by 2, and those rated "very poor" by 1. These values are then summed, resulting in an index ranging from 1 to 5, with a higher value indicating better stream biological conditions. Thus, an index value of 5 would correspond to "excellent", 2.5 would indicate conditions intermediate between "fair" and "poor", and an index of 1 corresponds to "poor". This watershed/stream quality indicator meets a number of criteria including:

- A measurable index, data for which can be collected annually.
- Derived primarily from direct measurement of a key natural resource, the county's receiving waters, which is visible and of great interest to the public.
- Supports the long-term trend analysis of stream conditions.

The stream quality index values for the baseline study and the 2004 stratified random sampling is shown in Table 10. The stream quality index suggests a small decline in overall stream quality from in 2004 compared to 1999. However, it is difficult to make any broad statements about trends based on data from two sampling years. This index will be reported annually to evaluate trends in the overall health of streams countywide.

Table 10: Stream quality index values for sampling completed in 1999 and 2004.

Sampling Year	Fraction of total sites					Index Value
	Very Poor	Poor	Fair	Good	Excellent	
1999	0.11	0.34	0.32	0.14	0.09	2.76
2004	0.23	0.40	0.17	0.13	0.07	2.41

4. Future Efforts

A summary of proposed future efforts in the county's comprehensive monitoring program are presented here. It is anticipated that these efforts will result in more representative countywide data, improved identification of bacteria hotspots, more comprehensive evaluation of trends, and help the prioritization of capital improvement projects to have the most potential to benefit stream biological communities.

Revised Site Selection: In future sampling efforts, a single-stage sampling procedure will be implemented within each stratum to eliminate the need to use correction factors based on sampled stream segment lengths (see Appendix G) when computing stratum means and variances. In addition, a more extensive stratification strategy will be explored, taking into account factors such as physiographic province, and land use within the watershed.

Future Bacteria Sampling: Starting in 2005, the Health Department will drop fecal coliform altogether as an indicator of bacteria contamination, and switch to EPA recommended and the state's standard of enterococci and *E. coli*. Additionally, in 2005 the original Health Department bacteria sampling stations will be dropped. New locations will correspond with the 2005 benthic macroinvertebrate and fish sampling locations. This coordination with the Stormwater Planning Division randomized sampling locations will give provide comprehensive countywide assessment of bacteria levels in the waterways. Each of the new 2005 sites will be sampled four times a year, once per quarter, in order to examine how seasonal conditions affect the level of E. coli and enterococci in the waterways. In the future, "hot spots" or areas with consistently elevated bacteria counts will be tracked and the location(s) of the problem will be investigated with coordinated efforts of Stormwater Management, Wastewater Management, and the Health Department. To isolate these "hot spots" new techniques may be used including Optical Brighteners Monitoring.

Optical Brighteners Monitoring is a technique used to identify potential illicit waste water discharges into the storm drainage network. Optical brighteners are found in most household and industrial laundry detergents and fluoresce or glow under a UV light. To aid in narrowing down the area where potential cross-connections (between the sanitary and storm sewer systems) may be occurring, these techniques may be applied in the upper sections of the site's sub-watershed where streams regularly have bacteria concentrations well above the state standard.

Volunteer Data and Trend Stations: Fairfax County continues to use volunteer data to supplement county data in evaluating general trends. Possible additional volunteer sites will be identified on a yearly basis after random selection of county sites is completed. In working together with volunteer monitoring organizations such as Audubon Naturalist Society and Northern Virginia Soil and Water Conservation District, the county effectively doubles the number of sites it monitors in a given year.

Volunteer data will be standardized to be compatible with county data and data collection will be centralized. Volunteer data will eventually be collected online in an Access database utilizing the same format as the county's data. Land use in each subwatershed will be characterized to aid in trend analysis. Information and photos of all volunteer sites will be available in the county's GIS-based Stream Assessment Tool.

Project-Specific Monitoring: Currently there are several stream restoration projects that are in the design stages in the Stormwater Planning Division. As projects like these are identified in the watershed management plans, the Stormwater Planning Division, with the help of others, will monitor these locations to assess how quickly biological communities recover and differ from the original community.

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6. Glossary

A

Anthropogenic - Effects or processes that are derived from human activity.
Anomalies – abnormalities

B

Baseline Monitoring - Data collection intended to define existing biological conditions and to set up a framework for long-term study.
Benthic - That portion of the aquatic environment inhabited by organisms which live permanently in or on the bottom.
Benthic Invertivore – An animal that feeds primarily on stream bottom dwelling invertebrates.
Benthic Macroinvertebrate - An aquatic animal lacking a backbone and generally visible to the unaided eye.
Best Management Practice (BMP) - Structural or nonstructural practice that is designed to minimize the impacts of change in land use on surface and groundwater systems.
Biomonitoring - The use of living organisms to assess environmental conditions.

C

Canopy Cover – The amount of cover provided by trees.
Clean Water Act - A law enacted by the United States Congress in 1972 and enforced by the Environmental Protection Agency on the national level and the Georgia Environmental Protection Division on the local level. The Clean Water Act established three main goals: "zero discharge" or the elimination of polluting discharges to the nation's waters by 1985; "fishable and swimmable waters" or the restoration and protection of water quality and wildlife habitat; and "no toxins in toxic amounts" or the prohibition of the discharge of toxic pollutants in amounts that are toxic to the environment or life.
Clingers - An aquatic macroinvertebrate that is able to cling to substrates and maintain itself in fast flowing water.
Coastal Plain - The physiographic province that lies along the Atlantic coast and extends inland to the Piedmont physiographic province. This area is generally characterized by low gradient, meandering streams with mobile sand/silt or gravel substrates.
Community – a group of organisms living together.

D

Darter – Small bottom dwelling fishes belonging to the family Percidae.
Dissolved Oxygen - The amount of oxygen freely available in water and necessary for aquatic life and the oxidation of organic materials.

E

Ecosystem - All of the component organisms of a community and their environment that, together, form an interacting system.
Electrofishing - Fish sampling method using electrical currents to temporarily stun fish to facilitate capture.

Embeddedness - Refers to the extent to which stream substrate (gravel, cobble, boulders and snags) is filled and/or covered with silt, sand, or mud.

Enterococci - Members of two bacteria groups, coliforms and fecal streptococci, commonly found in human and animal feces.

EPT - A group of three orders of insects: mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) which are used to determine stream health based on their sensitivity to pollution.

F

Family Biotic Index (FBI) - The general tolerance/intolerance of a community that considers the numbers of individuals in each tolerance class at the family level taxonomic resolution.

Fecal Coliform Bacteria - A group of organisms common to the intestinal tracts of humans and of animals. The presence of fecal coliform bacteria in water is an indicator of pollution and of potentially dangerous bacterial contamination.

Fish Barrier - An obstacle in a stream or river, such as a dam or elevated culvert, that prevents the up and downstream movement of fish and other aquatic species.

Fish Index of Biotic Integrity (F-IBI) - A stream assessment tool that evaluates biological integrity based on characteristics of the fish community at a site.

Functional Feeding Group - A categorization of a biological community based on its trophic or feeding level within its environment (shredder, predator, scraper…).

G

Gastroenteritis - An infection caused by a variety of viruses that results in vomiting or diarrhea.

Genus - A taxonomic category.

Geographic Information System (GIS) - A method of overlaying spatial land and land use data of different kinds. The data are referenced to a set of geographical coordinates and encoded in a computer software system. GIS is used by many localities to map utilities and sewer lines and to delineate zoning areas.

Glide - Section of a stream with a relatively high velocity and with little or no turbulence on the surface of the water.

H

Habitat - The environment in which an organism lives.

Hilsenhoff Biotic Index (HBI) - The general tolerance/intolerance of the community which considers the number of individuals in each tolerance class.

I

Impervious Cover - A surface composed of any material that significantly impedes or prevents natural infiltration of water into soil (i.e. sidewalks, houses, parking lots...).

Imperviousness - The percentage of impervious cover within a defined area.

Impoundment - A body of water contained by a barrier, such as a dam.

Index of Biotic Integrity (IBI) - A stream assessment tool that evaluates biological integrity based on characteristics of the fish and benthic community at a site.

Infiltration - The portion of rainfall or surface runoff that moves downward into the subsurface rock and soil.

Insectivore - An animal that feeds primarily on insects.

Intermittent Streams - Streams flowing temporarily or periodically rather than continuously throughout the year.

Intolerant Species - Populations of animals and/or plants that are adversely affected even at low levels of degradation.

Invertivore - An animal that primarily feeds on invertebrates.

L

Lithophils – An animal that lays eggs on clean gravel.

M

Metric - A characteristic of a habitat or biological community structure that changes in some predictable way with increased disturbance or divergence from normal, natural conditions.

N

National Pollutant Discharge Elimination System (NPDES) - Mandated by Congress under the Clean Water Act, a two-phased national program to address nonagricultural sources of stormwater discharge and prevent harmful pollutants from being washed into local water bodies by stormwater runoff.

Native Species – a species that exists naturally in an area, not introduced.

Nitrate - A form of nitrogen, which is found in several different forms in terrestrial and aquatic ecosystems. Sources of nitrates include wastewater treatment plants, runoff from fertilized lawns and cropland, failing on-site septic systems, runoff from animal manure storage areas, and industrial discharges that contain corrosion inhibitors.

Nonpoint Source Pollution - Contaminants such as sediment, nitrogen and phosphorous, hydrocarbons, heavy metals, and toxins whose sources cannot be pinpointed but rather are washed from the land surface in a diffuse manner by stormwater runoff.

O

Omnivores – an animal that feeds on a variety of foods.

P

Peak Flow - Refers to a specific period of time when the discharge of a stream or river is at its highest point.

Perennial Streams - A body of water that normally flows year-round in a defined channel or bed, and is capable, in the absence of pollution or other manmade stream disturbances, of supporting bottom dwelling aquatic animals.

pH - A term used to indicate the alkalinity or acidity of a substance as ranked on a scale from 1.0 to 14.0. Acidity increases as the pH gets lower.

Phosphate - A form of phosphorus, which is found in terrestrial and aquatic systems.

Physiographic Provinces - A region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

Piedmont - This physiographic province bordered by the Atlantic Coastal Plain to the east and the Appalachian Mountains to the west and is generally characterized by rolling terrain with streams of moderate gradient and cobble/gravel substrates.

Q

Quality Assurance/Quality Control (QA/QC) - A system of procedures, checks, audits, and corrective actions to ensure that research design and performance, environmental monitoring and sampling, and other technical and reporting activities are of the highest achievable quality.

R

Rapid Bioassessment Protocol (RBP) - A synthesis of techniques and methodologies for quickly assessing habitat and biological conditions in stream systems.

Reference Conditions - Conditions (i.e. habitat, chemical, biological) that reflect least impaired or best attainable conditions in a given area.

Reference Streams - Streams which exhibit highest quality or least impaired habitat conditions that are used as a standard to which all other streams are compared.

Resource Protection Area (RPA) - That component of the Chesapeake Bay Preservation Area comprised of lands at or near the shoreline of water bodies that have an intrinsic value due to the ecological and biological processes they perform or are sensitive to impacts which may result in significant degradation to the quality of state waters. All other land outside RPAs within Fairfax County is considered RMAs.

Restoration - Improving conditions within a natural system so that its functional characteristics are comparable to its original, unaltered state.

Riffle - A reach of stream that is characterized by shallow, fast moving water broken by the presence of rocks and boulders.

Riparian Buffer - A transitional area around a stream, lake, or wetland left in a natural state to protect the waterbody from runoff pollution. Development is often restricted within such zones.

S

Shredder - Macroinvertebrate functional feeding group in which the individuals feed off of large pieces of plant material (i.e. leaves, twigs and bark) that have fallen into the stream.

Specific Conductance - The ability of water to pass an electrical current while taking into account both temperature and pressure, both factors which may affect the conductivity of a sample.

Stormwater - That portion of precipitation that is discharged across the land surface or through conveyances to one or more waterways.

Subwatershed - A defined land area within a watershed drained by a river, stream or drainage way, or system of connecting rivers, streams, or drainage ways such that all surface water within the area flows through a specific point.

T

Taxon (plural - Taxa) - A taxonomic category or group, such as a phylum, order, family, genus, or species

Tolerant Species - Animals and/or plants that can withstand high levels of degradation.

Total Maximum Daily Load (TMDL) - The maximum levels of a particular pollutant water body can receive in a given day without violating pre-established water quality standards. Total Maximum Daily Loads are the sum of point and nonpoint source loads.

Triassic Basin - This physiographic province is a subprovince of the Piedmont Upland. The geology consists largely of red sedimentary (sandstone, siltstone, shale, and conglomerate) rocks characterized by wide and gently rolling hilltops, with long gently sloping sideslopes and nearly level areas.

Trophic – related to an animal's feeding preferences.

Turbidity - A measure of the suspended solids in a liquid.

W

Watershed - A discrete unit of land drained by a river, stream, drainage way or system of connecting rivers, streams or drainage ways such that all surface water within the area flows through a single outlet.

Watershed Restoration - Improving current conditions of watersheds to restore degraded fish habitat and provide long-term protection to aquatic and riparian resources.

Wetland - Land that is saturated with water and which contains plants and animals that are adapted to living on, near, or in water. Wetlands have hydric soils and are usually located between a body of water and land.

Y

Young of year – juvenile fish hatched that year.