The Jackson Creek Streamwalk, 2007

Dedication – Jane Geisler

This work is dedicated to Jane Geisler for her many years of service to environmental causes. Shown here in a rare moment where she is sitting down during the Jackson Creek Streamwalk, she has spent many decades working to improve the environment. Jane, we wish you many more decades.

<u>The Jackson Creek Streamwalk, 2007</u>

An Assessment of the Creek with Findings and Recommendations

May 16, 2008

A joint project of
The Fishkill Creek Watershed Committee,
The Dutchess County Environmental Management Council,
The East Fishkill Conservation Advisory Commission
and others

Acknowledgements- We would like to thank all of the property owners along Jackson Creek that allowed access to their properties; thank the three Town Supervisors- Lisette Hitsman of Union Vale, Jon Wagner of LaGrange and John Hickman of East Fishkill; Dutchess County Legislator Bill McCabe was instrumental in contacting individual property owners and supporting this project; Margarete Fettes and Ed Hoxsie of the Dutchess County Soil and Water Conservation District provided valuable advice; the Lower Hudson Coalition of Conservation Districts and the Dutchess County Soil and Water Conservation District provided the Streamwalk protocol for this study and the study of Fishkill Creek; Trout Unlimited provided copies of their recent report on Jackson Creek; Craig Hoover, a student intern working with Cornell Cooperative Extension of Dutchess County provided valuable typing and database management skills to the project.

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Executive Summary

In recent years a variety of chronic problems have plagued Jackson Creek. These problems include increased flooding, excessive erosion and sedimentation and an infestation of Mile-a-Minute Vine. This study was undertaken to learn more about these problems, to determine where along the creek the problems exist and to provide recommendations to solve the probable causes of the problems.

The Jackson Creek Streamwalk, 2007 Report provides findings and recommendations to support the following goals-

- Reduce flooding
- Reduce erosion rates
- Reduce sedimentation
- Maintain stream water and well water levels
- Increase the areas where Trout can survive and breed
- Enhance the health of the creek and its streamside environment
- Reduce the area colonized by invasive species

The specific method used in this study was developed by the Lower Hudson Coalition of Conservation Districts (LHCCD). The method assesses the health of the stream through twelve different visual characteristics that determine its physical conditions. Almost the entire length of Jackson Creek was walked, measured, evaluated and photographed in late October and early November of 2007. The stream was divided into 11 segments, and the 12 characteristics were determined at several locations within each segment. The physical condition of each segment was determined by averaging the 12 characteristics in that segment. Segment results can range from excellent to poor. The results of the 11 segments of Jackson Creek are shown in Table 1 and Figure 1a. In Figure 1b are results from nearby Fishkill Creek. No segment in Jackson Creek was rated excellent, one was rated good, four were rated fair and six were rated poor. Members of the Fishkill Creek Watershed Committee, the Dutchess County Environmental Management Council and the Town of East Fishkill Conservation Advisory Commission and others participated in this project.

Many problems and problem areas were observed and documented during the Streamwalk. Flooding has been a persistent problem in recent years along the creek but did not occur during the field work portion of this project. Evidence of excessive erosion and sedimentation were observed at many locations. A lack of streamside shrubs and trees is also a common problem along Jackson Creek. Modifications to the stream channel, barriers to fish migration and trash in or near the stream were also observed. The extent of invasive plants along the creek including Mile-a-Minute Vine was observed and documented. Impairments along Jackson Creek are shown in Figure 2a. In Figure 2b are results from nearby Fishkill Creek.

The Urban Stream Syndrome is a term given to streams with a collection of symptoms often associated with urban or suburban settings. Symptoms include an increase in flooding, an increase in streambank erosion, and may include an increase in sedimentation and a lowering or drying up of stream water. These symptoms match many of the problems observed along Jackson Creek. Based on our understanding of the probable causes of Urban Stream Syndrome we make the following recommendations to reduce the problems along the creek.

Our recommendations are-

1) Any new development within the Jackson Creek Watershed should utilize “better site design” principles.

2) Man-made constrictions, such as culverts and bridges, that are too small to pass high flow events should be replaced with larger structures.

3) Wherever possible, retrofit existing piped drainage with swales, retention ponds, rain gardens, pervious pavers and other practices of “better site design”.

4) Protect existing trees and shrubs along the streambank, the so-called riparian zone.

5) Replant streambanks that have had their trees and shrubs removed.

6) Protect floodplains from development, filling, walling-off or alteration of the natural vegetation.

7) Where needed repair areas of extreme streambank erosion, using natural channel design and bioengineering techniques.

8) Clean up the trash in the few areas that it is abundant.

9) Monitor rainfall, stream level and well water levels to track changes in the watershed. Work to get a stream gauge station on Jackson Creek, possibly from the USGS.

10) Monitor and fight against invasive plants and animals, especially Mile-a-Minute Vine.

11) Monitor stream turbidity, temperature, conductivity and nutrient levels.

12) Monitor the aquatic biology of Jackson Creek to track its health, including fish and macroinvertebrates.

Some of these recommendations are designed to prevent problems along Jackson Creek from getting worse (# 1, 4, and 6). Other recommendations are designed to help reduce the problems along the creek (# 2, 3, 5, 7, and 8). Recommendations 9, 10, 11 and 12 are designed to monitor changes within the watershed. Many of these recommendations are similar to those made by others in recent studies of Jackson Creek or nearby areas. A glossary near the end of this report defines many of the terms used.

The most effective way to reduce flooding along Jackson Creek is to attack the root causes of the problem. The primary causes are an increase in the amount of stormwater runoff and an increase in the speed that runoff enters the creek. These are caused by land use changes such as increased impervious surfaces, and a reduction of forested areas and drainage pipes that transport the runoff quickly to the creek. Better Site Design Principles provide techniques for development without causing these problems. Plans to dredge sediment out of the streambed, to straighten or deepen the channel or to remove all vegetation that has fallen into the creek are often counterproductive and often very damaging to the local environment. These approaches do not address the root causes of flooding, often have little effect on the problem and can sometimes make the flooding worse. The root causes, increased stormwater runoff and the increased speed of runoff, must be corrected to attain permanent flood reduction.

Segment #	Location	Segment Condition	Segment Score
1	Property line of Rod & Gun Club to Waterbury Hill Road (1st crossing)	FAIR	7.3
2	Waterbury Hill Road (1st crossing) to Waterbury Hill Road (2nd crossing)	FAIR	6.2
3	Waterbury Hill Road (2nd crossing) to N. Parliman (Wisseman Road)	POOR	4.1
4	N. Parliman (Wisseman Road) to Route 55	POOR	5.1
5	Route 55 to Route 82	FAIR	6.6
6	Route 82 to Emans Road	POOR	5.5
7/8	Emans Road to trib. near downstream property line of Whortlekill Rod & Gun Club	FAIR	7.0
9	Near property line of Whortlekill Rod & Gun Club to Noxon Road (near Rymph Rd.)	POOR	5.8
10	Noxon Road (near Rymph Rd.) to Arthursburg Road	POOR	5.6
11	Arthursburg Road to near Hellmans Court	POOR	5.5
12	Near Hellmans Court to Robinson Lane Park/ Sprout Creek	GOOD	7.7

Table 1 - Overall Segment Condition and Segment Score for the Jackson Creek, 2007.

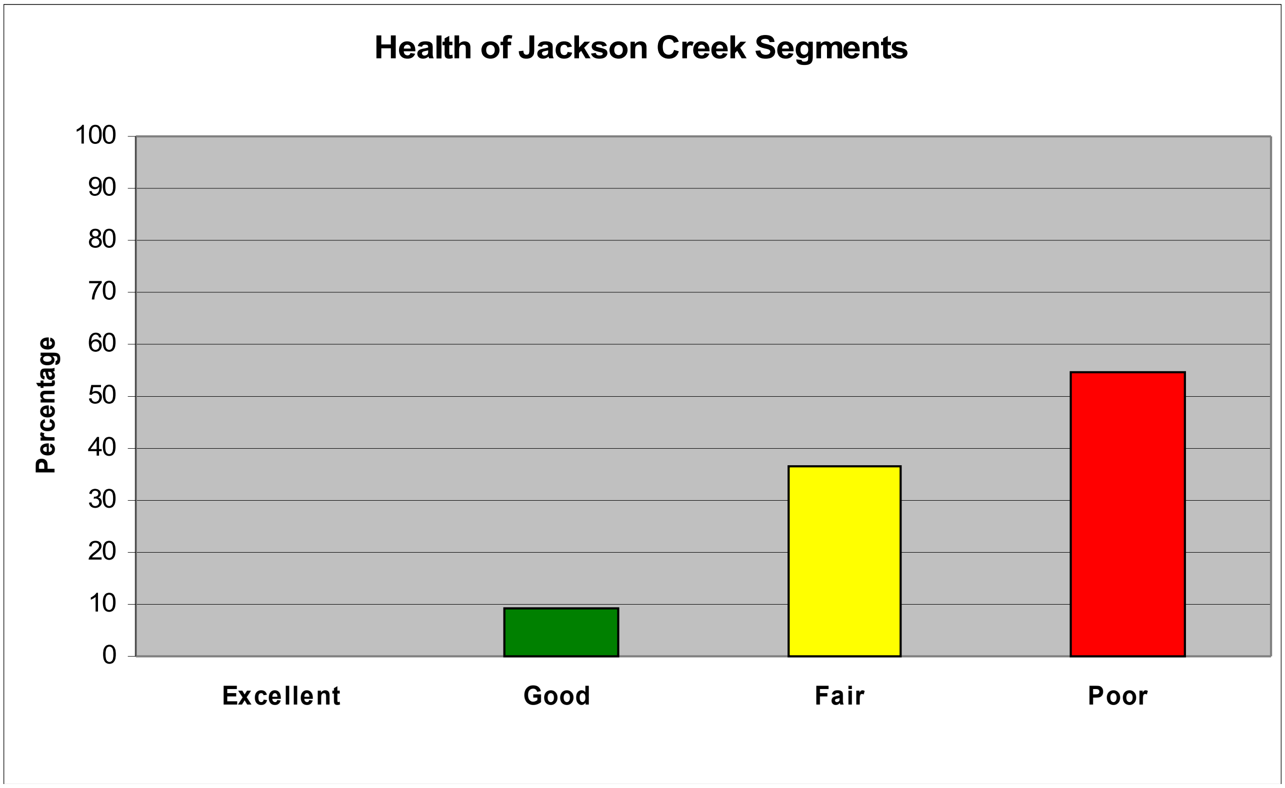

Figure 1a

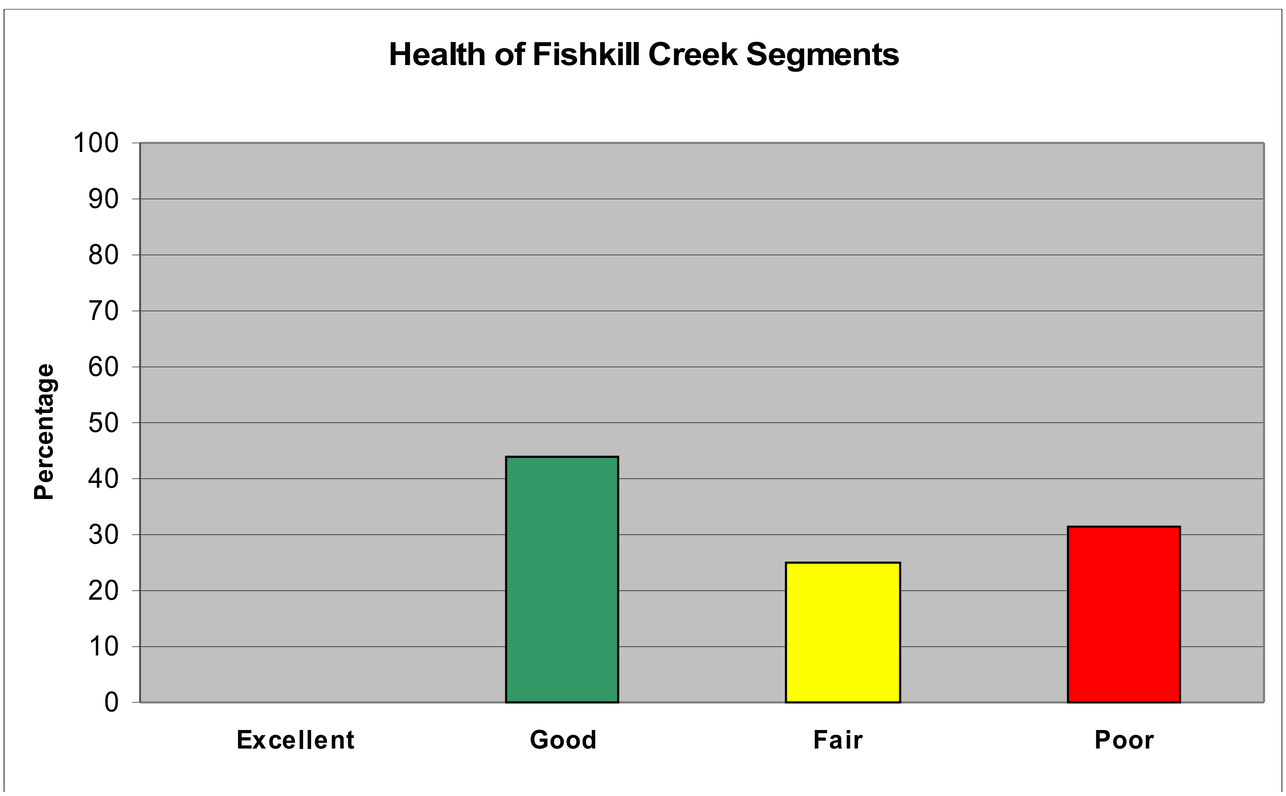

Figure 1b

Figure 1 – Physical condition or health of stream segments on Jackson Creek (Fig. 1a) and on Fishkill Creek (Fig. 1b).

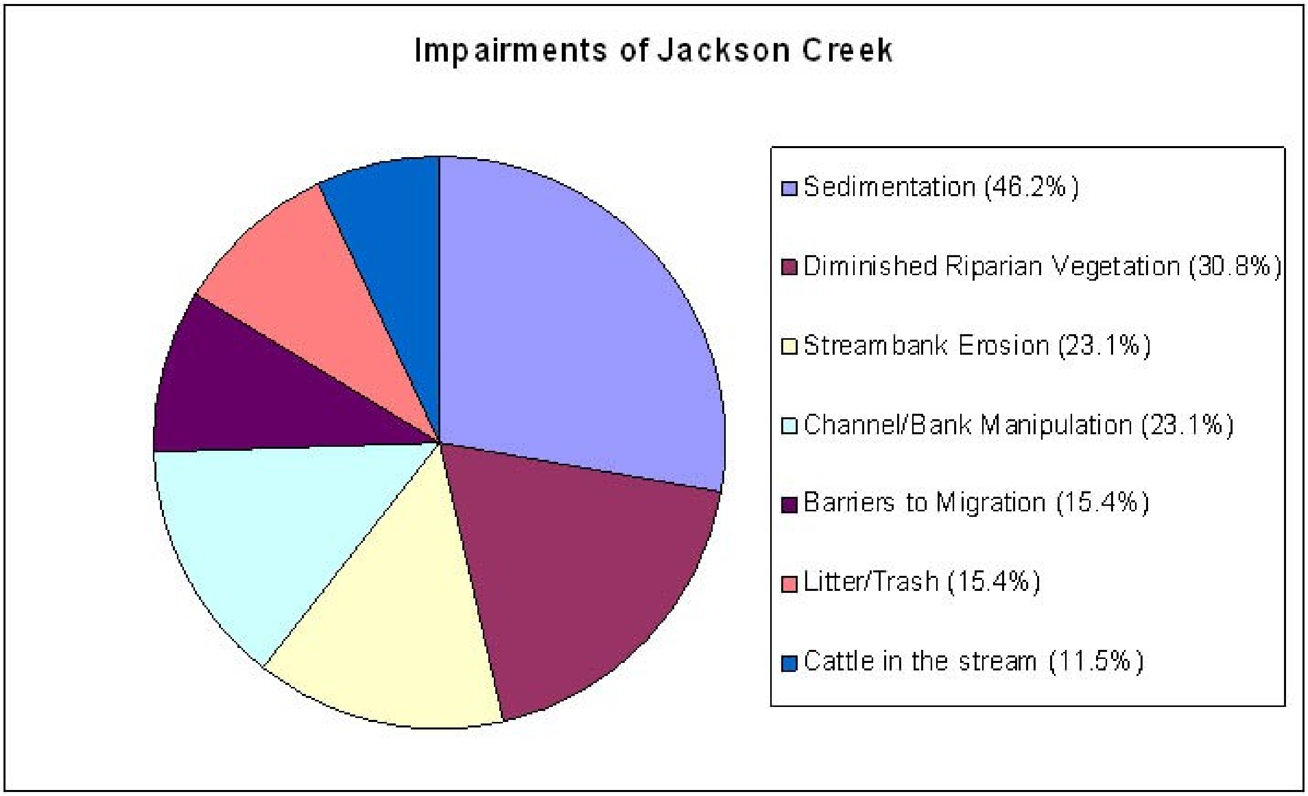

Figure 2a

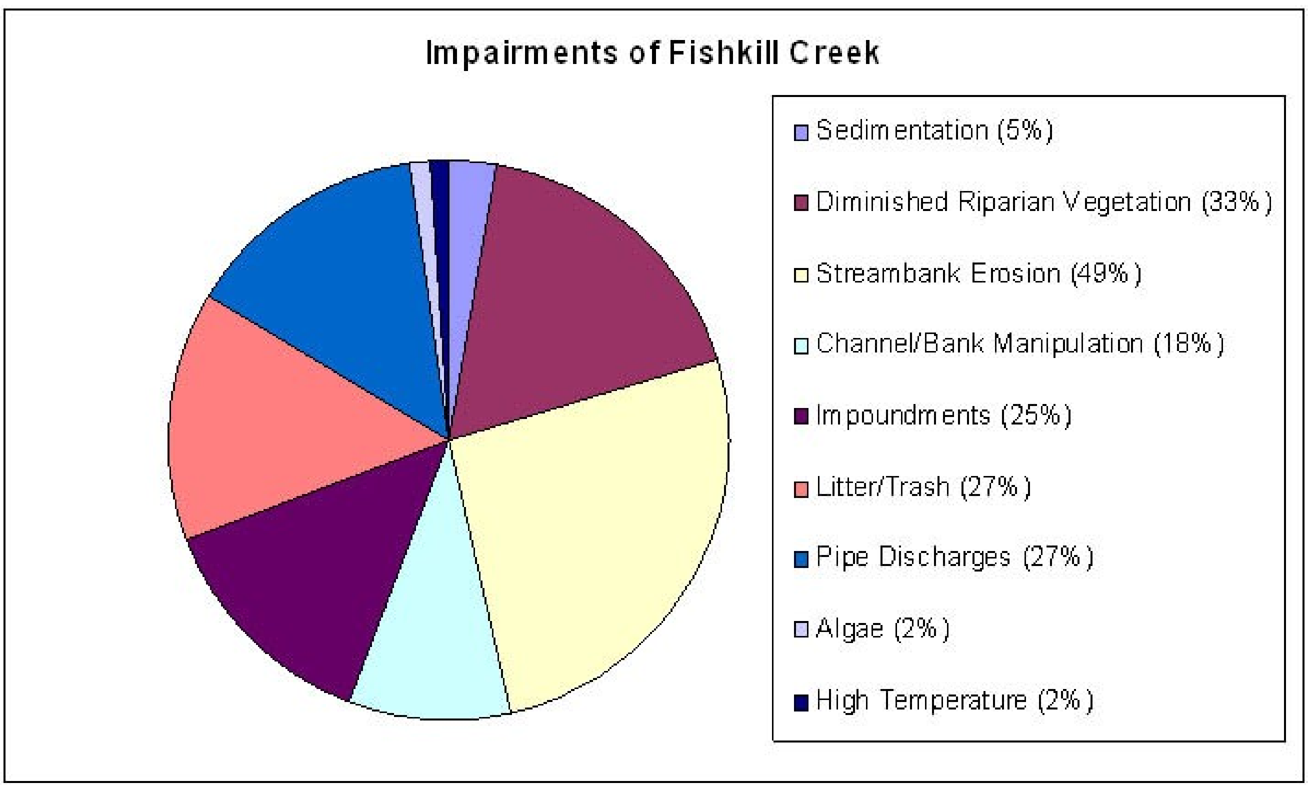

Figure 2b

Figure 2 – Impairments on Jackson Creek (Fig. 2a) and on Fishkill Creek (Fig 2b).

1. **Flooding April 2007** **2.**

3. **Streambank Erosion** **4.**

1. Flood damage to driveway off of Waterbury Hill Road.

2. Flooding along Noxon Road near Arthursburg Road.

3. Streambank erosion in Segment 10. Note the absence of shrubs and trees along the creek.

4. Streambank erosion in Segment 11. Note the roots of trees and shrubs slowing the erosion.

 

5. **Source of Sediments** **6.**

 

7. **Sedimentation** **8.**

5. A large sand and gravel bank in Segment 5. This is one major source of sediment in the creek.

6. An eroding streambank in Segment 3. Note that rocks and sand are entering the stream from this source.

7. A large island of sediment in Segment 5. The island is covered with leaves.

8. Several islands of sediment in Segment 10.


9. Lack of Riparian Vegetation 10.


11. Trash 12.

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9. The right side of the creek has a lack of trees and shrubs in this area of Segment 9.

10. In the background a large lawn comes down to the edge of the creek in Segment 10.

11. An old garbage dump in the woods near the creek in Segment 5.

12. A discarded tire, one of several, in this part of Segment 5.

13. Mile-a-Minute Vine 14.

15. Cattle in the Stream 16.

13. A close-up of Mile-a-Minute Vine in Segment 6 showing its blue berries.

14. Mile-a-Minute Vine draped over several shrubs in Segment 7. This photo was taken after most of the leaves had fallen in October.

15. Access point to Jackson Creek for cattle in Segment 9. Note the footprints and manure.

16. Cattle drinking directly from the Jackson Creek in Segment 9.

17. Dam **Culvert with Erosion 18.**

19. Box Culvert **Dry Streambed 20.**

17. This concrete dam exists in Segment 5. Dams and some culverts prevent fish from migrating along the creek.

18. Culvert with streambank erosion in Segment 2. The culvert appears too small to pass high flow events.

19. A box culvert with streambank erosion in Segment 2. This also appears too small to pass high flow events.

20. Jackson Creek was completely dry in this area of Segment 3. Note the lack of trees and shrubs along the creek bed.

21. **22.**

Some Streamwalk Participants

23. **24.**

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21. Carolyn Klocker

22. Carolyn Klocker and Lalita Malik

23. Rick Oestrike, Carolyn Klocker, and Jane Geisler

24. Richard Dennison

Introduction

Reasons For This Study

In recent years a variety of chronic problems have plagued Jackson Creek, including increased flood damage, excessive erosion and sedimentation and an infestation of the invasive plant called Mile-a-Minute Vine. The rains of October 2006 caused significant damage to the baseball fields of the Town of LaGrange. The playing fields, located on the floodplain of Jackson Creek, were inundated and strongly eroded disrupting the schedule of games for the season. At the same time flooding and erosion occurred in other areas of the creek. Several miles upstream, along Waterbury Hill Road, three driveways were washed away and extensive streambank erosion occurred. Repairs were made to the driveways and a berm was constructed between the baseball fields and the Jackson Creek to protect them. In April 2007, heavy storms again caused flooding along the Jackson Creek. The baseball fields, and nearby Noxon Road, was flooded again and the two back fields were again damaged by erosion. Once again flooding and erosion caused damage to several driveways along Waterbury Hill Road and the road was blocked by what one local resident called "a lake". The problems on Waterbury Hill Road blocked access to several homes for an extended period of time. Significant flooding also occurred on Wisseman Road, where the road crosses a floodplain. A second portion of Noxon Road, near Arthursburg Road, was flooded where Jackson Creek normally crosses under the road. Repairs were made once again and the berm protecting the ball fields was increased in height and length and reinforced with geotextile fabric and rip-rap. Rains in the winter of 2008 caused minor flooding and continued streambank erosion along the length of Jackson Creek. At the Town of LaGrange baseball fields floodwaters went around both ends of the berm, flooded the parking lot and again damaged the two back fields. Why is so much flooding and erosion occurring along Jackson Creek?

Meanwhile along tributaries of Jackson Creek similar problems were occurring. Flooding, erosion and sedimentation problems started on Clove Mountain, flowed down Robin Wood, Bloomer and Walsh Roads, through backyards and across driveways to Jackson Creek. Excessive erosion of streambanks carried silt, sand and gravel downstream and choked the streambed with these sediments further downstream.

Another problem was that certain areas of the creek known for good trout fishing, no longer have any trout. At the same time there are now trout in the tributary on Walsh Road where none existed before. What could be causing these changes?

In the summer of 2007, a fast growing invasive plant called Mile-a-Minute Vine was discovered near the Town of LaGrange baseball fields. Mile-a-Minute Vine grows and spreads very quickly, covering and killing the vegetation underneath it. It was known to be in the woods along the creek next to the ball fields. Soon it was understood that Mile-a-Minute Vine also occurred on neighboring properties. How far had it spread and what other invasive species were in the area?

This study was undertaken to determine exactly where along Jackson Creek these problems exist, to attempt to determine the causes of the problems, and to provide recommendations for solving these problems.

Goals Of This Study And Report

The purpose of the Jackson Creek Streamwalk was to identify major problem areas along the creek and to reverse recent adverse trends found along Jackson Creek. This report supports the following goals-

- Reduce flooding
- Reduce erosion rates
- Reduce sedimentation

- Maintain stream water and well water levels
- Increase the areas where Trout can survive and breed
- Enhance the health of the creek and its streamside environment
- Reduce the area colonized by invasive species

The Jackson Creek And Its Watershed

Every one of us lives within a watershed, whether we live on a rural farm in Pine Plains, a suburban home in the Town of Lagrange, or in an urban apartment complex in Poughkeepsie. A watershed is an area of land in which all of the water that falls onto the land drains into a single outlet, often a stream or river. The health of our streams is largely connected and dependent on its watershed. Aquifers in the watershed provide drinking water for local residents. Streams provide important ecosystem services besides supplying and carrying water through their systems. They can be homes to diverse and productive plants and animals, remove pollutants carried within them, as well as play a role as important social and cultural centers to the public.

The Jackson Creek is a tributary of Sprout Creek which drains into the larger Fishkill Creek, see Figure 3. The Jackson Creek watershed is 5,524 acres in size and drains a large portion of Union Vale and small portions of LaGrange and East Fishkill into the Sprout Creek (Burns et al. 2005). In 2000, the dominant land use in the Jackson Creek watershed was forested land (42%) followed by residential (27%) and agriculture (19%) (Burns et al 2005). Naturally reproducing trout populations were reported to be found in the Jackson Creek in 1985 (Schmidt and Kiviat) and since then both high brook and brown trout populations were documented in 2001 (Stainbrook 2004). Also in 2002, the DEC Rotating Integrated Basin Studies program documented that the Jackson Creek macroinvertebrate population was dominated by clean water mayflies suggesting nonimpacted water quality (Bode et al. 2004). Jackson Creek is classified by NYSDEC as a class C(T) stream in some areas and a class C(TS) stream in other areas. Class C streams are suitable for fishing and boating but not suitable for swimming or drinking.

Since 2000, the Jackson Creek Watershed has been subjected to very rapid, conventional development. This rapid change in land use probably resulted in significant increases in the percentage of rainfall that run off the land into local streams. The result is streams that flood more often, have more high water flow events causing significant erosion and the sediment removed by erosion is carried downstream and fills the stream channel with sediment.

A Growing Population

From 1990-2000, the population in Dutchess County increased by 8% (U.S. Census Bureau, 2001). Urban and suburban land use increased dramatically within the Fishkill Creek and Wappinger Creek watersheds from 1992-2001, with most of the increase occurring in the upper-mid portions of these watersheds (Limburg et al. 2005). In the Fishkill Creek watershed alone, percent urbanization in the upper portion of the watershed increased from 2.2% to 15.7% and from 7.4 to 25% in the middle portion of the watershed (Stainbrook et al. 2006). Much of this growth occurred along the Taconic Parkway (Limburg et al. 2005), which runs through the Jackson Creek watershed near the intersection of Noxon and Arthursburg Roads.

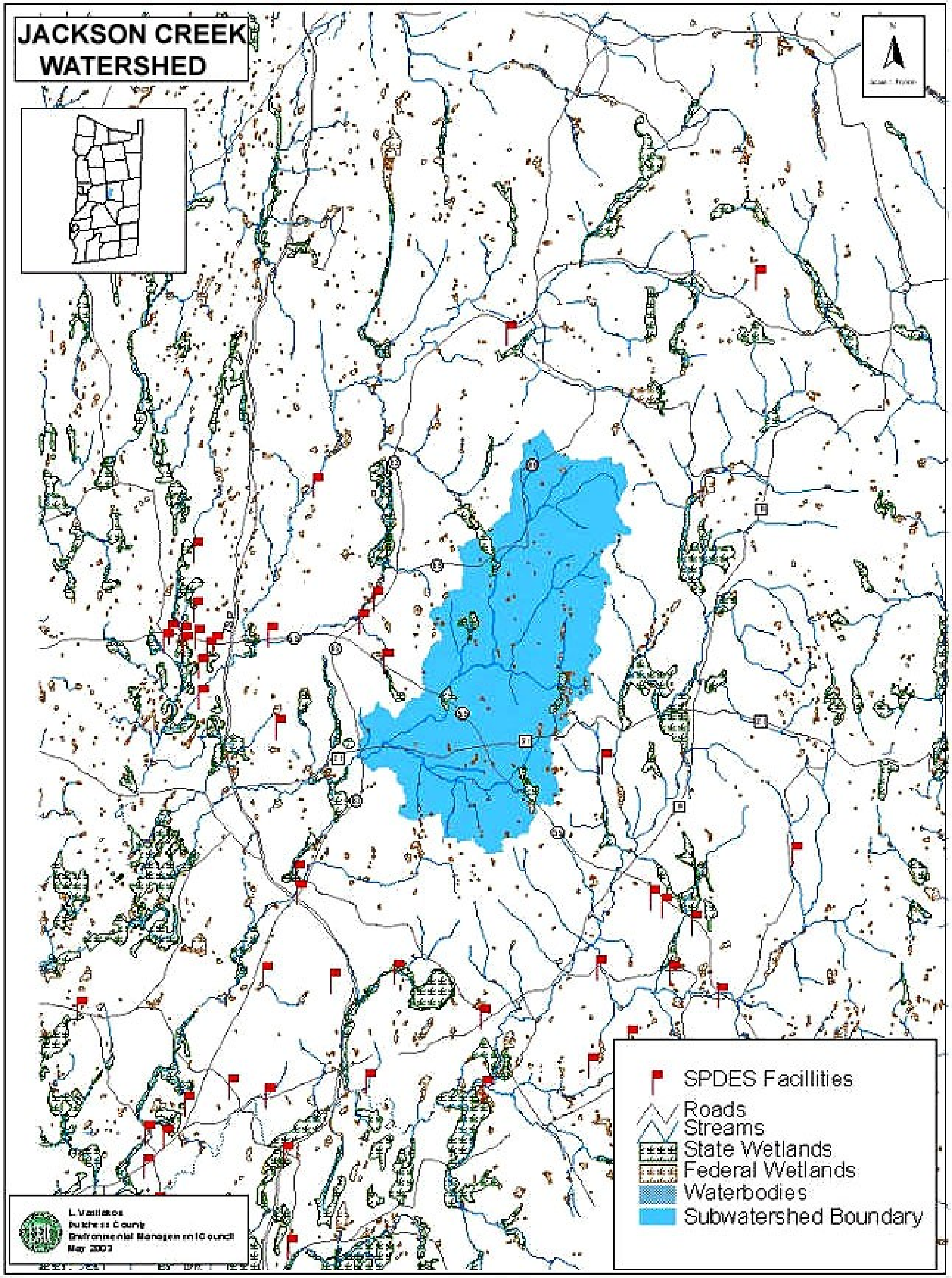

Figure 3 – Location of Jackson Creek Watershed (shown in blue). Map from the Fishkill Creek Watershed Management Plan, 2005.

Urbanization in the United States is second only to agriculture as a major cause of stream impairment (Paul and Meyer 2001). Agricultural practices often lead to loss of riparian vegetation near streams, increases in nutrients such as nitrogen and phosphorus, and the reduction of stream water level. The amount of agricultural land in Dutchess County though has declined drastically over the last 100 years. In 1880, 68% of the land in Dutchess County was agricultural land, 45% in 1935, and only 15-16% by the late 1990's (Stainbrook et al. 2006, NYNASS 1999). Much of this land converted to forest, but recently urban and suburban land uses account for most of the changes seen within Dutchess County over the past 20 years (Stainbrook et al. 2006, Stainbrook 2004, Limburg et al. 2005).

As urban/suburban centers continue to grow they bring with them new features of the landscape that are having profound effects on streams, rivers, and watersheds. The observed degradation of streams due to increasing development has been named by scientists the "urban stream syndrome" (Walsh et al. 2005). The EPA reports that over 130,000 km of waterways within the U.S. are degraded due to urbanization (USEPA 2000). With increasing urbanization many of these water ways can no longer support certain forms of life, process nutrients such as nitrogen and phosphorus as efficiently, or even hold all of the water that is now flowing through them.

Previous Work And Reports On The Jackson Creek

In 2005 the Natural Resources Management Plan for the Fishkill Creek Watershed, a comprehensive review of the existing Fishkill Creek and its watershed characteristics, was completed. The purpose of the management plan was to "assist the fourteen watershed municipalities in planning for a sustainable future for their water and biological resources". In regards to Jackson Creek the plan recommended that "the geomorphic stability of the stream (Jackson Creek) needs to be assessed to determine the impact of an increasing number of stream crossings and land contour changes due to development, particularly in the steep sloped areas upstream of the Route 55 crossing."

In June of 2007 an overview survey of the Jackson Creek was conducted by the Mid-Hudson Chapter of Trout Unlimited (TU). The study examined ten sites along the Jackson Creek between Waterbury Hill Road and Montfort Bridge (near the Taconic Parkway). Sites were visually assessed using the New York State Council of Trout Unlimited (NYSCTU) Stream Visual Assessment method which evaluates the geomorphic conditions, water quality, riparian buffers, presence of invertebrates and their habitat, and fish habitat of a stream. The TU study determined that increased residential development in the upper reaches of the watershed, possibly combined with increasing intensity of precipitation events, "have resulted in greater rates of runoff producing larger and more frequent high water events." Their study suggests that this has led to more frequent flooding, increased movement of coarse to fine sediments, decreased bank and channel stability, impacts on infrastructure (roads, culverts & bridges) and loss of biological value. The results of the TU study, combined with accounts from residents of the Jackson Creek watershed in regards to recent flooding problems, led members of the Fishkill Creek Watershed Committee to believe that an assessment in which the entire length of the Jackson Creek was walked and evaluated was prudent and necessary.

Methods

To determine the general health and the condition of the Jackson Creek a visual assessment of the creek was conducted from October 25 to early November of 2007 using the assessment method developed by the Lower Hudson Coalition of Conservation Districts (LHCCD 2004). This method is very similar to both the NRCS Stream Visual Assessment Protocol (NRCS 1998) and NYSCTU Stream Visual Assessment Protocol and was designed to facilitate the use of volunteers in stream assessments. Users of the method do not require scientific expertise to gain useful information about the state and health of the stream. Like the USDA Stream Visual Assessment Protocol the LHCCD method uses metrics, or "assessment elements", to provide an overall assessment score of the stream based primarily on physical conditions. In 2004 the LHCCD method was used to study 16 miles of the Fishkill Creek mainstem. Since Jackson Creek is in the Fishkill Creek watershed, the use of the same protocol will allow for comparisons of the two streams to be made.

The LHCCD Streamwalk assessment method looks at 12 different characteristics: Channel condition, hydrology, riparian zone, bank stability, water appearance, nutrient enrichment, barriers to fish movement, instream fish cover, pools, insect/invertebrate habitat, canopy cover, and embeddedness. Each characteristic was rated with a value of 1 to 10, with 10 implying the healthiest score and 1 being the poorest score. If a score varied within a segment, the lowest score observed was assigned to that segment.

Jackson Creek was originally divided into a total of 12 segments. During the field work it was decided to merge segments 7 and 8, so data from 11 segments exist in our data (Table 1). Segments were determined and assigned based on accessibility, distance, and having a clear starting and ending location. Therefore segments often begin and end at major road crossings. Segments were approximately one-half mile to one mile in length. A score was determined for each characteristic in several locations of each segment referred to as sites. A total of 43 sites were assessed along Jackson Creek. These site scores, of each characteristic, were collected in each segment at approximately equal distances from each other along the segment. The overall score for each of the 12 characteristics measured within the segment was determined by taking the lowest of the scores recorded in that segment. An overall segment score was then calculated by averaging the characteristic scores for that segment. Segments with scores of 9.0 or higher are then classified as excellent, 7.5-8.9 as good, 6.1-7.4 as fair, and less than 6.0 are classified as poor.

Segments with overall scores under 3 for Channel Condition, Riparian Zone, Bank Stability, or Barriers to Fish Movement were classified as impaired sites. In addition if there was excessive sedimentation, algae or litter, or if significant pipe discharges, high water temperature, or other obvious impairments (such as cattle present in the stream) were present at a site it was considered impaired. When a site is considered impaired, the LHCCD visual stream assessment method gathers further details on the assessment elements through additional assessments of the impaired sites. Due to time constraints the more detailed assessments of impaired sites will be conducted in spring of 2008 and reported on shortly thereafter. At each location that scores were collected, a measurement of water depth and wetted width were collected using a meter tape and meter stick. A latitude and longitude reading, was also collected at each of these sites using a GPS unit. In addition measurements of air temperature, water temperature, and pH were collected at each segments upstream end. Air and water temperatures were measured using an alcohol thermometer and pH was measured using pH paper.

The Jackson Creek streamwalk was conducted by members of the Fishkill Creek Watershed Committee, the Dutchess County Environmental Management Council, the Cornell Cooperative Extension Environmental Educator, the East Fishkill Conservation Advisory Commission (CAC) and other volunteers. Members of the streamwalk team were selected due to their previous experience in using the LHCCD Streamwalk assessment method and/or their training in aquatic ecology and stream assessment methods. All scores were determined as a group in order to reduce subjective discrepancies. Therefore members were consistently determining scores for each characteristic in the same manner. Most of the length of the Jackson Creek was walked and assessed by team members. The Streamwalk extended from just downstream property line of the Mid County Rod and Gun Club in UnionVale, NY (parcel 085671) near the headwaters, to the mouth of the Jackson Creek where it enters Sprout Creek. The only areas not walked were properties where permission was not obtained.

Results

General Results

Table 1 shows the segment #, the location of the segment, the overall segment health (based on physical characteristics) and the segment score. In the LHCCD protocol, stream condition can score as excellent, good, fair or poor. None of the Jackson Creek segments were found to be in excellent condition and only one segment was considered to be good. Four stream segments were scored as fair and six segments were in poor condition. These assessments were very similar to the results of the recent Trout Unlimited study of Jackson Creek. The study of Fishkill Creek in 2004 also did not find any segments in excellent health, but the study showed a considerable number of segments in good condition. Also, the study of Fishkill Creek found a distinct geographic pattern to stream health. The segments of the Fishkill Creek found to be in good condition were located in the upstream areas of the creek, while the downstream segments of the creek were those found to be in fair to poor health. No such simple geographic pattern was observed along Jackson Creek. Instead the portions of Jackson Creek in better condition seem to correspond to portions of the creek that are heavily forested and have few residents near the creek. In both the Fishkill Creek and the Jackson Creek there is a correlation between low population density and better stream health. The segments in better condition along Jackson Creek are associated with forested areas including segments near both Rod and Gun Clubs, the forest near the Union Vale Middle School property and the forest near the mouth of the stream.

Figure 2 is a "pie chart" showing which impairments were most commonly found along the Jackson Creek, based on our preliminary work. A final determination of impaired sites must wait for more detailed work in the future. Tentatively, we found 26 impaired sites having 43 total impairments. The most common impairment recorded was excessive sedimentation, which was found at 12 locations. The second most common impairment recorded was diminished riparian zone vegetation, found at 8 locations. The next most common impairment is excessive erosion or poor bank stability, found at 6 locations. Poor channel condition, including channel bank modifications, also occurred at 6 locations. Barriers to fish migration, including culverts and dams, were found at 4 locations. Also found at 4 locations were excessive trash. At 3 locations along the creek cattle had direct access to Jackson Creek. This pattern of problems is different from that associated with the Fishkill Creek. In both streams streambank erosion and diminished riparian vegetation are common problems. However, there is much more sedimentation along the Jackson Creek and less litter, fewer dams and fewer pipe discharges causing gully erosion than along the Fishkill Creek.

Segment #	Location	Segment Condition	Segment Score
1	Property line of Rod & Gun Club to Waterbury Hill Road (1st crossing)	**FAIR**	7.3
2	Waterbury Hill Road (1st crossing) to Waterbury Hill Road (2nd crossing)	**FAIR**	6.2
3	Waterbury Hill Road (2nd crossing) to N. Parliman (Wisseman Road)	**POOR**	4.1
4	N. Parliman (Wisseman Road) to Route 55	**POOR**	5.1
5	Route 55 to Route 82	**FAIR**	6.6
6	Route 82 to Emans Road	**POOR**	5.5
7/8	Emans Road to trib. near downstream property line of Whortlekill Rod & Gun Club	**FAIR**	7.0
9	Near property line of Whortlekill Rod & Gun Club to Noxon Road (near Rymph Rd.)	**POOR**	5.8
10	Noxon Road (near Rymph Rd.) to Arthursburg Road	**POOR**	5.6
11	Arthursburg Road to near Hellmans Court	**POOR**	5.5
12	Near Hellmans Court to Robinson Lane Park/ Sprout Creek	**GOOD**	7.7

Table 1 - Overall Segment Condition and Segment Score for the Jackson Creek, 2007.

Summary of Data

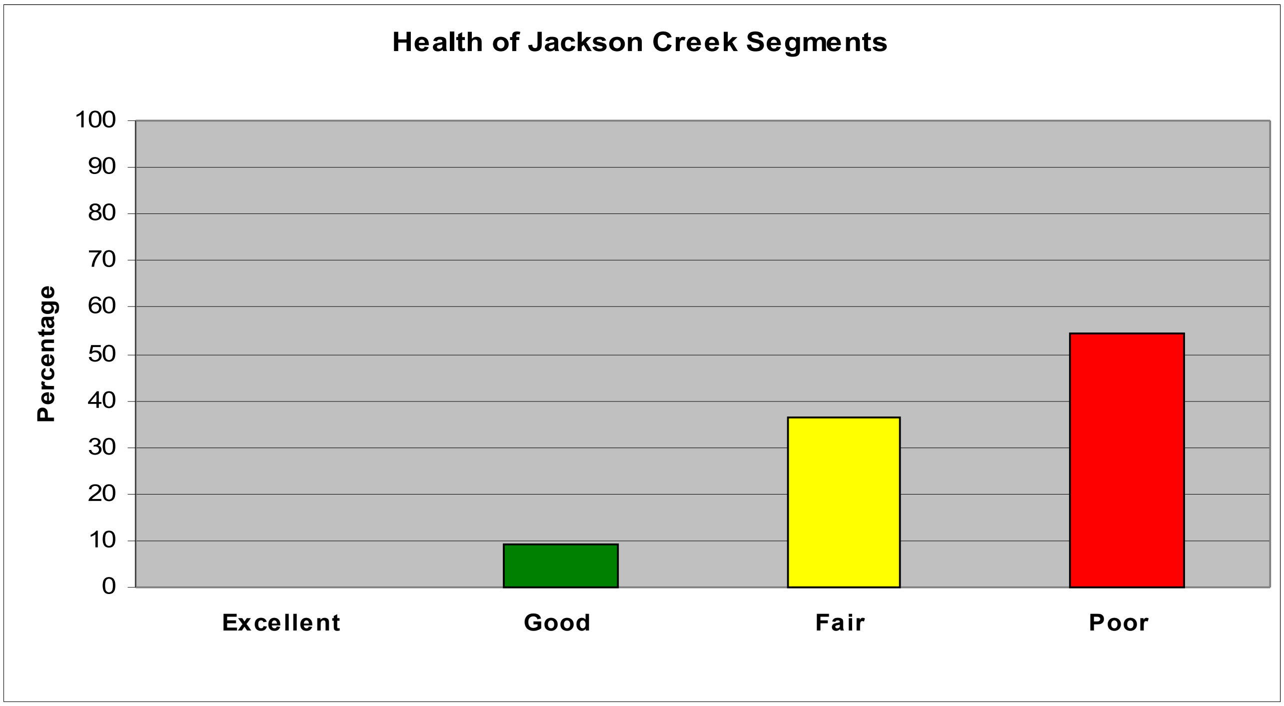

Figure 1a

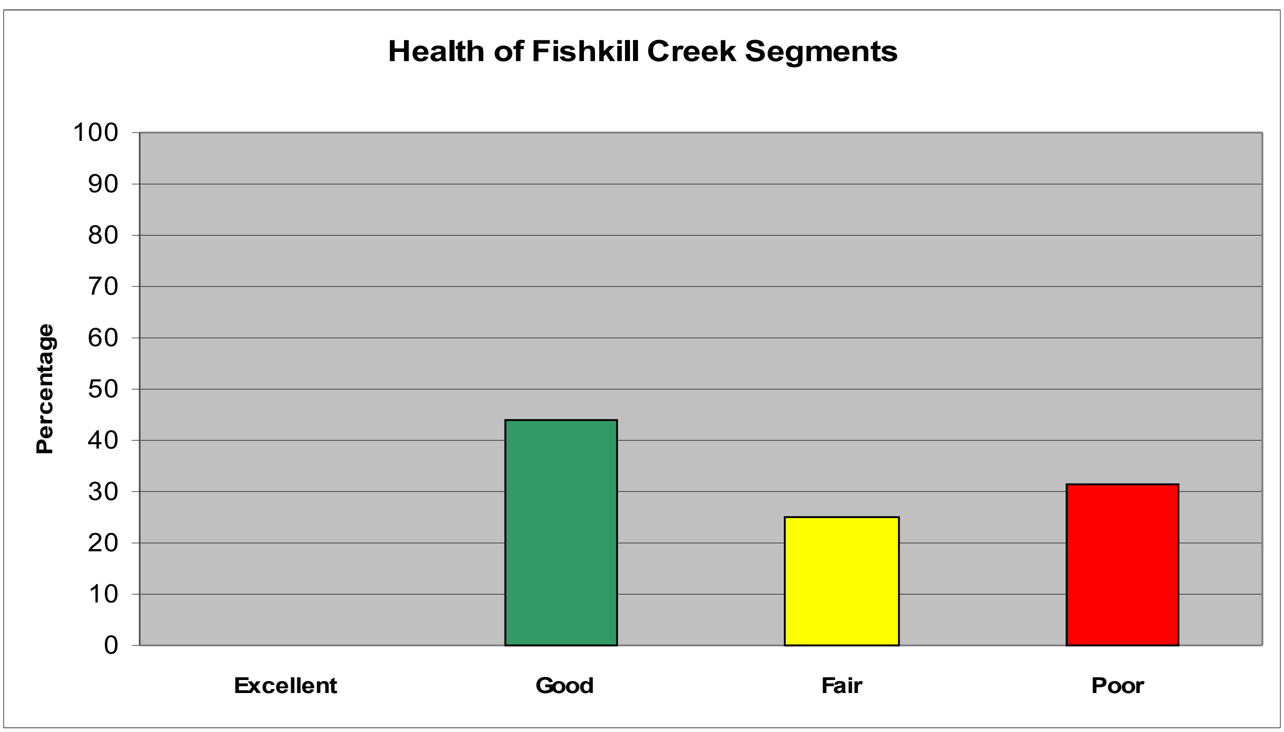

Figure 1b

Figure 1 – Physical condition or health of stream segments on Jackson Creek (Fig. 1a) and on Fishkill Creek (Fig. 1b).

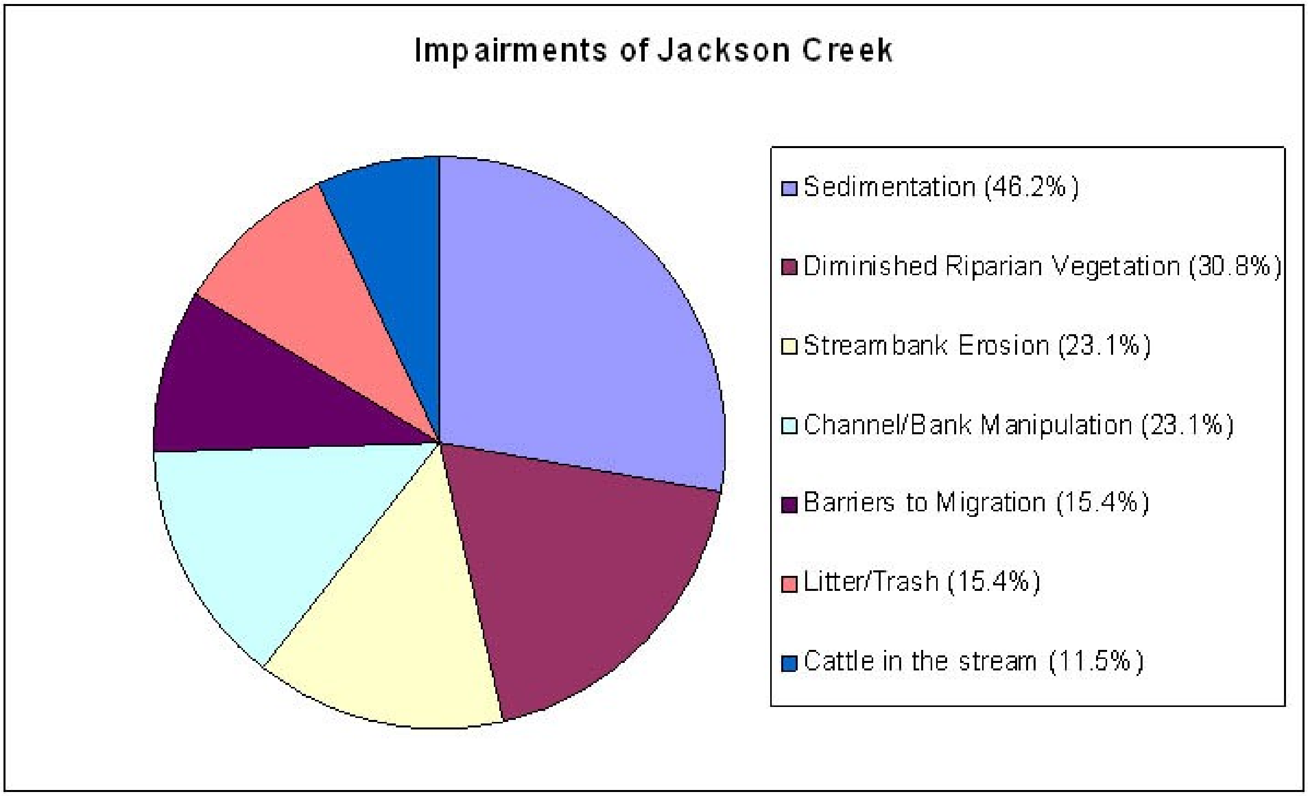

Figure 2a

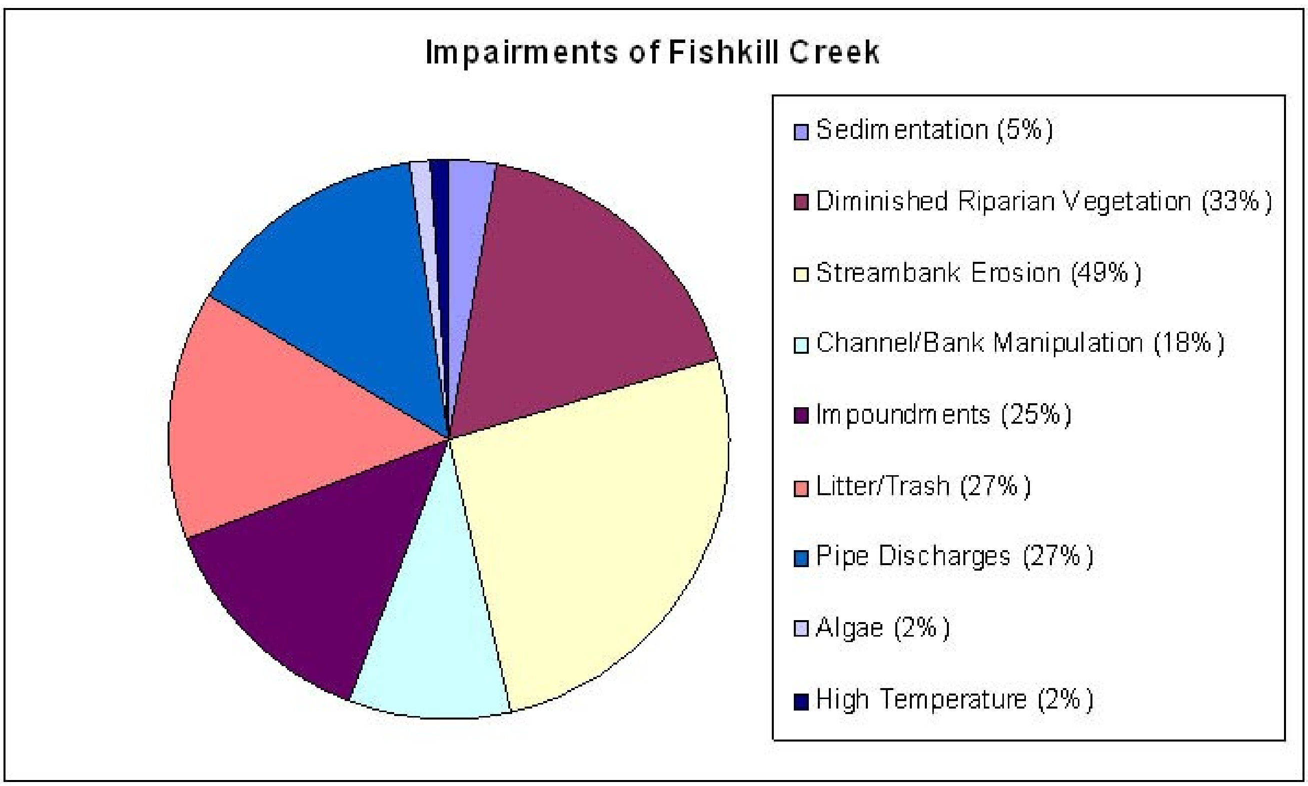

Figure 2b

Figure 2 – Impairments on Jackson Creek (Fig. 2a) and on Fishkill Creek (Fig 2b).

Specific Results

Flooding- During the field work phase of this project, in October 2007, no flooding was observed. However, significant flooding occurred the previous spring at several locations along the creek. Photos 1 and 2 show some examples of flooding along Jackson Creek in April 2007. Significant flooding occurred near where Jackson Creek crosses under Waterbury Hill Road. A nearby resident described the area as "a lake" in the spring of 2007, which blocked the road and several driveways. Significant flooding also occurred on Wisseman Road, where the road crosses a floodplain. The area around the Town of LaGrange Park on Noxon Road, another floodplain, was also inundated blocking the road. A second portion of Noxon Road, near Arthursburg Road, was flooded where Jackson Creek crosses the road. The perception of many local residents seems to be that flooding has increased in recent years.

Sedimentation- Photos 7 and 8 show examples of excessive deposition of sediments along Jackson Creek. Sediment deposition, or aggradation, is a significant problem in some localized areas. It can be recognized by the formation on islands of sand, gravel or cobbles within the stream channel. In more serious instances multiple islands of sediment surrounded by multiple stream channels occur. This pattern is called a braided stream and indicates that the stream bed has much more sediment than the water can transport. Braided streams indicate that the stream is out of equilibrium. Areas of excessive sediment deposition tend to occur a short distance downstream of areas with excessive erosion. Removing the excess sediment without solving the erosion problem will simply cause more sediment to be deposited in that location and may lead to additional down-cutting nearby.

Segment 2 has major erosion and deposition problems. Significant aggradation was also observed in segment 3. At site 3 of segment 4 sediment accumulated just downstream of Wisseman Road bridge. Multiple islands of sediment were observed in segment 5 and segment 6 indicating severe sedimentation. The recent Trout Unlimited study pointed out that Jackson Creek has a major change of slope in its center. In other words, the creek upstream of segment 5 is much steeper, and therefore has faster moving water, than the creek downstream of segment 5. The sudden reduction of water velocity in segments 5 and 6 may help to explain the excessive deposition of sediment there.

Lack of Riparian Vegetation- Significant areas with severely damaged riparian vegetation occur in segments 9 and 10, between the Whortlekill Rod & Gun Club and Arthursburg Road. Smaller, more isolated areas of severely damaged riparian vegetation occur in segments 3, 4 and 11. Less severely damaged areas occur in segments 1 and 2. Segments with riparian vegetation in excellent condition are segments 5, 7/8 and 12. These areas tend to be heavily forested with few residences near the creek. Photos 9, 10 and 20 show examples of damaged riparian vegetation along Jackson Creek.

Erosion- The amount of bank instability, or streambank erosion, is highly variable along the creek. It may be significant in one area and be almost absent a short distance away. Photos 3 and 4 show some examples of severely eroded banks along Jackson Creek. However, the data clearly show a concentration of areas with significant streambank erosion along and near Waterbury Hill Road. The Parliman Road crossing culvert appears too small to accommodate high water volumes, thus causing erosion downstream of the culvert. Smaller pockets of significant erosion occur on segments 5, 10 and 11. Erosion in one area will often lead to excessive sediment deposition a short distance downstream. Very little erosion was observed on segments 6, 7 and 12.

Several patterns of streambank erosion were observed. Meandering streams often have erosion along the outside curve of each bend and deposition of sand and gravel on the inside of each bend. This pattern is expected and normal. In some areas of Jackson Creek this pattern is exaggerated with unusually high eroding banks on the outside curve of the bend and smaller eroding banks on the inside of the curve. This pattern is not normal and suggests that the stream is out of equilibrium. In other areas the stream has incised downward by 4 to 8 feet, which also indicates disequilibrium. Other areas with excessive erosion occur where the stream is forced to flow through a constriction, such as a culvert or bridge that is too small. During flood events these constrictions cause the velocity and turbulence of the water to increase greatly, leading to very rapid erosion of the streambanks. Photos 5 and 6 show areas of erosion that yield significant amounts of sediment into the streambed. This sediment can be deposited further downstream causing additional problems.

Channel Manipulation- In a few places the streambanks have been modified by the use of rip rap, gabions, or stone walls or the streambed has been straightened and deepened (channelized). However, these occur in small localized areas along the creek. Rip-rap has been used in segments 2, 3, and 9, while a wall is utilized in segment 9 and the stream was channelized in segments 6 and 11. In a total of 22 locations a road or driveway was observed to cross Jackson Creek, with 5 of these in segment four alone. Some of these road crossings appear to be too small to pass flood waters causing unnatural changes in stream flow during floods that may result in severe streambank erosion.

Barriers to Fish Migration- Certain man-made objects including dams and some culverts block fish migration along Jackson Creek. Some of the culverts used to pass the creek under roads and driveways act as barriers the one concrete dam observed along the creek also acts as a barrier to fish migration. In addition the areas of the stream that were dry in the fall of 2007 act as barriers to migration.

Trash- Photos 11 and 12 show examples of litter along Jackson Creek. In general this is not a serious problem, although a few isolated parts of Jackson Creek have enough litter to warrant a clean-up effort. Two small dumps were observed, one in segment 5 and the other in segment 11, which should be removed. A small pile of asphalt was dumped on the streambank in section 4. Random trash was also observed in segments 5 and 10. The study of Fishkill Creek in 2004 found much more litter including more illegal dumps in many more places along that creek.

Invasive Plants- Photos 13 and 14 show Mile-a-Minute Vine, from eastern Asia, along Jackson Creek. The invasive plant species Japanese Barberry was observed within segment 1. In all areas downstream of site 2 of segment 1, including Union Vale, LaGrange and East Fishkill, both Barberry and Multiflora Rose, native to Japan, Korea and eastern China, were found. This is probably due to the fact that the high deer population in the area browses on other plants but avoid these prickly shrubs. Both Norway Maple, native to eastern and central Europe and southwest Asia, and Garlic Mustard, native to Europe, western and central Asia, and northwestern Africa, occurred sporadically along Jackson Creek.

Mile-A-Minute (MAM) vine, which first appears in site 4 of segment 5 south of Route 82, is a significant threat to the environment (Kumar and DiTommaso 2005). Mile-A-Minute Vine covers pre-existing vegetation and kills it and may lower the property values of parcels that are infested. A large continuous patch of MAM extends from the vicinity of the Town of LaGrange Park on Noxon Road, across Emans Road, onto the property owned by the Whortlekill Rod and Gun Club. Small discontinuous patches of MAM occur further downstream, continue beyond Arthursburg Road, but end before Jackson Creek empties into Sprout Creek.

Other Problems- Other problems include portions of Jackson Creek that dried up in 2007, pipe discharges, man-made obstacles to water flow and cattle in the creek. Summer and early fall of 2007 was an unusually dry period of time (See Table 2). While the flooding in April 2007 occurred after 6.10 inches of rainfall above average, by October the rainfall total had dropped to 2.72 inches above average. In other words between May and October rainfall was 3.38 inches below average for the normally lower summer totals. Despite the dry conditions, we were surprised to find two long portions of Jackson Creek that had no water at all, rather than simply finding low stream levels. One of these areas is in segment 3, see photo 20, while the other is in segment 6. Presumably, this phenomenon is caused by the lowering of the local water table during dry weather conditions, the deposition of sediment in the streambed or both. An important question is whether the falling water table is part of a long-term trend or is simply the result of the dry conditions in the summer of 2007. More information is needed to answer this question. A total of 16 drainage pipes were observed discharging into Jackson Creek, all of these appeared to be for stormwater runoff. In addition some of these culverts and bridges appear to be too small to pass high-flow events. This causes localized flooding and erosion and may lead to significant sedimentation downstream. In three different areas of Jackson Creek herds of cattle have direct access to the creek. Cattle may break down streambanks, when they drink stream water, and may produce significant pollution of the stream through urine and manure. No studies of bacteria levels or pollutant levels near the cattle herds have been completed at this time.

Correlations- The data collected was plotted on graphs of each of the twelve characteristics measured versus measures of the streams health. This was done to investigate the Streamwalk method itself. Table 3 shows the equation of the best fit line for each plot using the least-squares regression method. Also included is the R-squared value for each plot. Only three characteristics produced good correlations- Canopy Cover, Channel Condition and Riparian Zone. Sample graphs are shown in Figures 4, 5 and 6.The good correlation of only three characteristics suggests that the overall score of stream health was primarily due to these characteristics while the other nine characteristics have little effect. For each of these three characteristics, the better the characteristic the better the health of the stream in that area, in other words, there is a positive correlation. Correlations using three different methods were investigated- the standard Streamwalk protocol using lowest values of the characteristics in each segment, a revised protocol using segment averages for the characteristics and a third protocol using a site by site correlation, not using segments. Each of the modified protocols have slightly better correlations for some characteristics but slightly worse correlations for others. There does not seem to be a clear way to choose one protocol over the others based on this data.

The correlations of Canopy Cover and Riparian Zone with stream health suggest that heavily forested areas of the stream are in better health. Bad Channel Condition is often a sign of human modification of the stream channel and usually occurs in more populated areas, suggesting that more populated areas of the stream are in worse health.

Relatively Good Areas- Several areas along Jackson Creek are in relatively good condition. These areas are in the segments that are in either fair or good condition, are heavily forested and have few buildings near the creek. An example of such an area can be seen in the cover photo. The headwaters region is one such area. Other such areas are the forest on and near the Union Vale Middle School property, and the forest on the Whortlekill Rod and Gun Club property. The area in best condition is a forested floodplain near the mouth of Jackson Creek.

Previous 12 Months

Month	Temperature				Precipitation				
	Min. Temp. (F)	Max. Temp. (F)	Avg. Temp. (F)	Avg. Departure from Normal (F)	Monthly Total (inches)	Year to Date Total (inches)*	Monthly Total Snowfall (inches)	Seasonal Total Snowfall (inches)**	Yearly Total Departure from Normal (inches)
Mar 2007	1	75	35	-0.8	4.86	10.30	14.5	32.0	1.56
Apr 2007	19	89	45	-1.0	7.94	18.24	0.0	32.0	6.10
May 2007	30	89	61	3.4	1.66	19.90	-	-	3.42
Jun 2007	38	97	68	2.5	2.64	22.54	-	-	2.10
Jul 2007	43	95	71	0.7	6.01	28.55	-	-	3.74
Aug 2007	46	93	70	1.9	4.28	32.83	-	-	3.78
Sep 2007	34	92	64	3.6	1.80	34.63	-	-	1.76
Oct 2007	25	87	57	8.0	4.57	39.20	0.0	0.0	2.72
Nov 2007	13	65	39	-0.2	3.71	42.91	0.0	0.0	3.31
Dec 2007	4	56	30	0.7	5.03	47.94	15.0	15.0	5.35
Jan 2008	-1	64	30	5.6	1.69	1.69	7.5	22.5	-1.36
Feb 2008	-2	61	29	1.7	9.45	11.14	13.0	35.5	5.37
Mar 2008	14	61	36	0.7	5.83	16.97	1.0	36.5	8.23

Last updated April 7, 2008, 11:00 a.m.

Notes:
*Year to Date Total is from January.
**Seasonal Total Snowfall is for October-April.
Temperatures are 24-hour average, maximum and minimum temperatures.

Tr.=trace amount
NA = not yet available
ND = no data

QNS=quantity not sufficient

Table 2 – Precipitation in Millbrook, NY, in 2007 and part of 2008.
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Stream Characteristic	Best Fit Formula	Goodness of fit (R^2)
Riparian Zone	y = 0.255x + 5.5031	R^2 = 0.5848
Canopy Cover	y = 0.1998x + 6.1645	R^2 = 0.5139
Nutrient Enrichment	y = 0.4475x + 4.0437	R^2 = 0.391
Channel Condition	y = 0.3177x + 4.9705	R^2 = 0.3749
In Stream Fish Cover	y = 0.2473x + 6.359	R^2 = 0.1808
Hydrology	y = 0.3356x + 4.6229	R^2 = 0.1775
Embeddedness	y = 0.1994x + 6.0389	R^2 = 0.1717
Bank Stability	y = 0.1783x + 6.3383	R^2 = 0.1413
Barriers to Fish Movement	y = 0.1355x + 6.3679	R^2 = 0.1256
Pools	y = 0.2491x + 6.292	R^2 = 0.0774
Water Appearance	y = 0.258x + 5.2642	R^2 = 0.0657
Insect / Invertebrate Habitat	y = 0.064x + 6.9938	R^2 = 0.0091

Table 3a – All Sites Score Method

Stream Characteristic	Best Fit Formula	Goodness of fit (R^2)
Riparian Zone	y = 0.1902x + 6.0685	R^2 = 0.4047
Canopy Cover	y = 0.178x + 6.3538	R^2 = 0.8501
Nutrient Enrichment	y = 0.3809x + 4.5115	R^2 = 0.2926
Channel Condition	y = 0.2115x + 5.8701	R^2 = 0.2728
In Stream Fish Cover	y = 0.0546x + 7.3331	R^2 = 0.0151
Hydrology	y = 0.2728x + 5.2192	R^2 = 0.1634
Embeddedness	y = 0.1658x + 6.2963	R^2 = 0.2045
Bank Stability	y = 0.0064x + 7.5528	R^2 = 0.0003
Barriers to Fish Movement	y = 0.0026x + 7.5737	R^2 = 0.00005
Pools	y = 0.1721x + 6.7278	R^2 = 0.0479
Water Appearance	y = 0.1235x + 6.4484	R^2 = 0.0148
Insect / Invertebrate Habitat	y = 0.0949x + 6.7696	R^2 = 0.0435

Table 3b – Average Segment Score Method

Stream Characteristic	Best Fit Formula	Goodness of fit (R^2)
Riparian Zone	y = 0.2022x + 5.0484	R^2 = 0.5259
Canopy Cover	y = 0.2327x + 4.9228	R^2 = 0.6699
Nutrient Enrichment	y = 0.4042x + 3.1936	R^2 = 0.2925
Channel Condition	y = 0.2837x + 4.2171	R^2 = 0.3788
In Stream Fish Cover	y = 0.2889x + 3.8167	R^2 = 0.1834
Hydrology	y = 0.1463x + 4.9189	R^2 = 0.0321
Embeddedness	y = 0.1433x + 5.1109	R^2 = 0.0929
Bank Stability	y = 0.1275x + 5.4202	R^2 = 0.0759
Barriers to Fish Movement	y = 0.1081x + 5.3446	R^2 = 0.176
Pools	y = 0.067x + 5.7366	R^2 = 0.0041
Water Appearance	y = 0.201x + 4.25	R^2 = 0.0638
Insect / Invertebrate Habitat	y = 0.1974x + 5.2868	R^2 = 0.0705

Table 3c – Lowest Segment Score Method

Table 3 – Least square regression equations for Jackson Creek data.

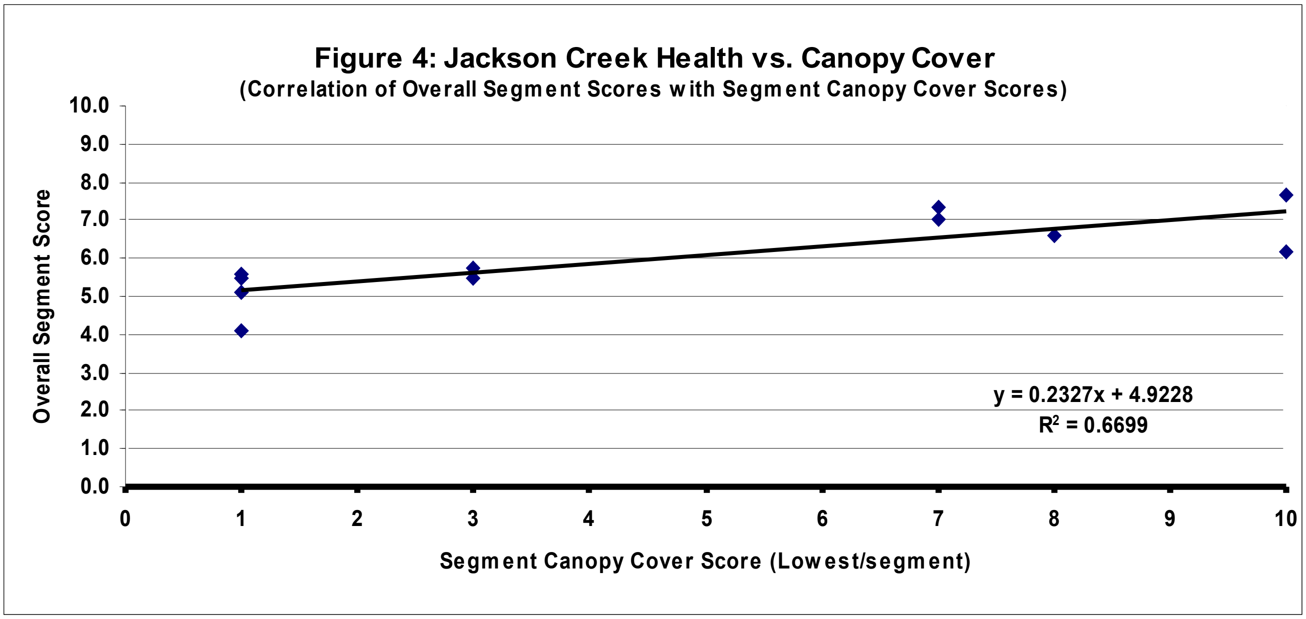
Figure 4: Jackson Creek Health vs. Canopy Cover
(Correlation of Overall Segment Scores with Segment Canopy Cover Scores)
Overall Segment Score
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
1
2
3
4
5
6
7
8
9
10
y = 0.2327x + 4.9228
R2 = 0.6699
Segment Canopy Cover Score (Lowest/segment)

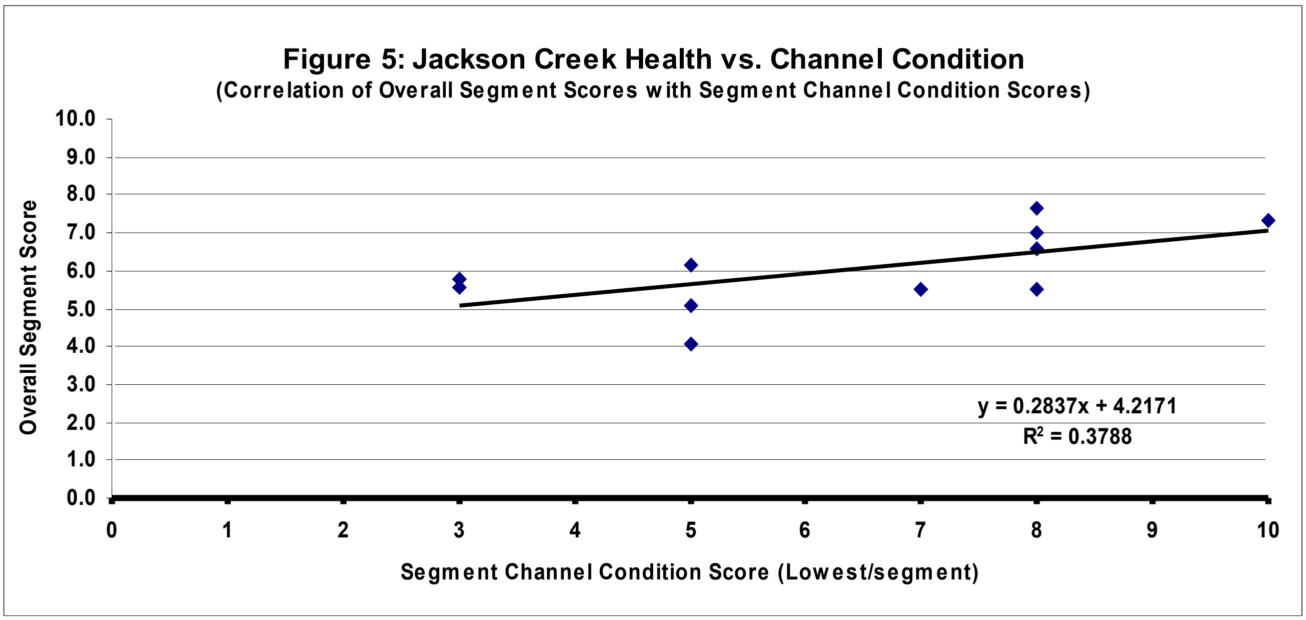
Figure 5: Jackson Creek Health vs. Channel Condition
(Correlation of Overall Segment Scores with Segment Channel Condition Scores)
Overall Segment Score
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
1
2
3
4
5
6
7
8
9
10
y = 0.2837x + 4.2171
R2 = 0.3788
Segment Channel Condition Score (Lowest/segment)

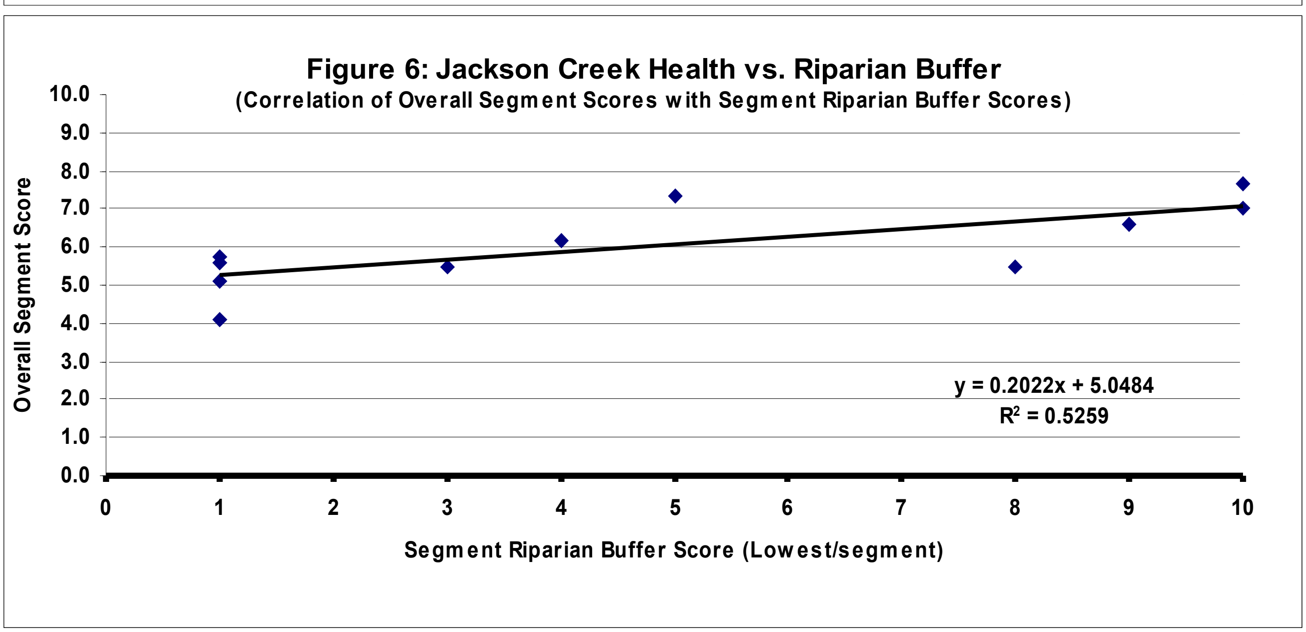
Figure 6: Jackson Creek Health vs. Riparian Buffer
(Correlation of Overall Segment Scores with Segment Riparian Buffer Scores)
Overall Segment Score
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
1
2
3
4
5
6
7
8
9
10
y = 0.2022x + 5.0484
R2 = 0.5259
Segment Riparian Buffer Score (Lowest/segment)

Interpretation

Problems And Probable Causes

Flooding- There are several factors that can lead to increased flooding along the Jackson Creek: (a) an increase in the quantity of water in rainfall/precipitation events, (b) increasing the percentage of rainfall/snowmelt that runs off the land, (c) increasing the speed or efficiency that runoff moves into the creek, (d) filling-in or walling-off portions of the floodplain, (e) increasing sedimentation in the creek bed and by (f) increasing the number of natural or man-made obstacles in the streambed. Flooding associated with the Urban Stream Syndrome is largely due to increased stormwater runoff and the increased speed of runoff as it moves to the creek (Walsh et al. 2005).

Computer models of Global Climate Change suggest that in the Northeastern US rainfall events will be much larger in the future. Currently most rainfall events deposit less than half an inch of rain in this region. If the computer models are correct, it will be much more common to have two, three or even four inch rainfall events in the future. This would greatly increase flooding along many streams including Jackson Creek. However, at this time it is not certain that the size of rainfall events have increased in recent years.

Rainfall striking the ground can take several different paths, see Figure 7. Some of this water evaporates back into the air, some is utilized by plants, some infiltrates into the ground and the remainder runs off the ground surface into streams and wetlands. This "runoff" causes stream levels to rise after it rains and may result in flooding. If the percentage of rain water that runs off increases, the result will be higher stream levels and more flooding. Changes in land use often cause the percentage of runoff to change and can therefore lead to more flooding, see Figures 7. Standard development techniques increase the percentage of runoff and contribute to flooding in nearby streams, see Figures 8 and 9. However, the use of "better site design principles" in developments can prevent these problems from occurring, as demonstrated in the Jordan Cove Project in Connecticut. Traditional development style greatly increases the amount of impervious surfaces including roads, sidewalks, parking lots, driveways, roofs, etc. which prevent infiltration and increase runoff. Also, traditionally these impervious surfaces connect to drainage pipes that quickly transport runoff into local streams. This increased runoff arriving quickly at the stream causes stream levels to rise abnormally fast and abnormally high and result in increased flooding and erosion, see Figures 8 and 9. During the Streamwalk many stormwater drainage pipes were observed emptying into Jackson Creek. A total of 16 drainage pipes were observed, with 11 of them in segment four.

Removal of the natural trees and shrubs along streambanks, the so-called Riparian Zone, increases flooding by increasing both the amount of runoff reaching the creek and by increasing the speed that runoff reaches the stream (Schneider 1998a, 1998b). Studies indicate that a wide forested Riparian Zone on both sides of the creek is best for reducing flooding, however a narrower forested zone does have some benefit for flood reduction. Lawns along the stream may also contribute to the flooding problem although the effects of lawns vary from place to place (Groffman, pers. comm. 2008). The replacement of forested hillsides within the watershed with large manicured lawns may increase the percentage of runoff and promote flooding. We suggest in the Next Steps Section further studies to determine if this is a significant problem in the Jackson Creek Watershed. The forests remaining have had their understories thinned out by large numbers of browsing deer. Although data on the effects of deer browse is rare, these changes may also increase the percentage of runoff and contribute to flooding. More data is needed to determine if deer overpopulation contributes significantly to flooding along Jackson Creek.

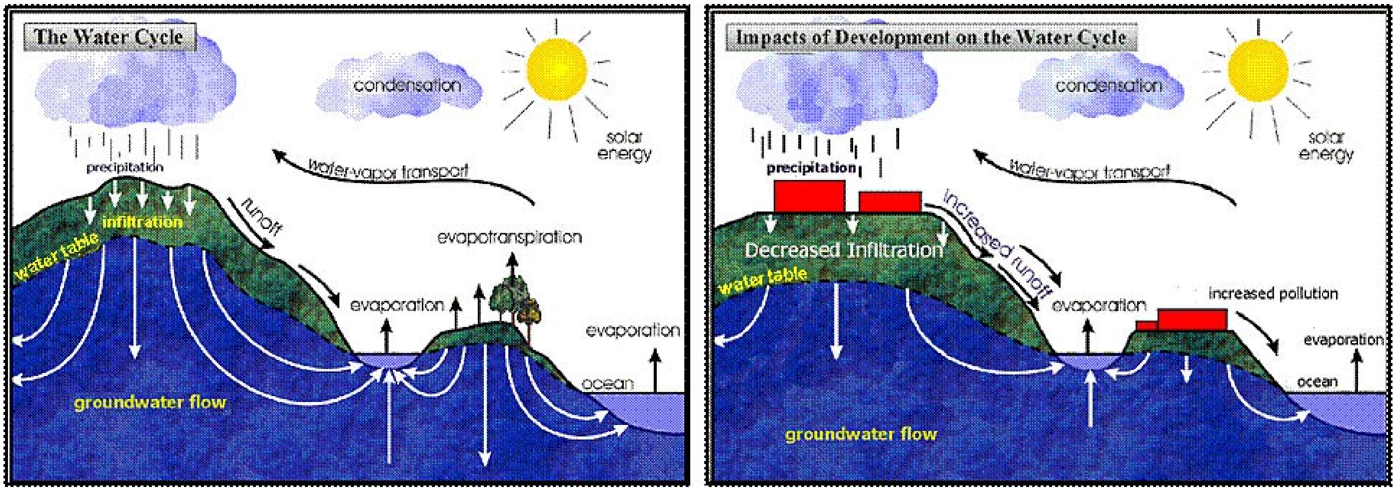

Figure 7- Development changes the local water cycle. Image from The Center for Watershed Protection slideshow "The Impacts of Urbanization".

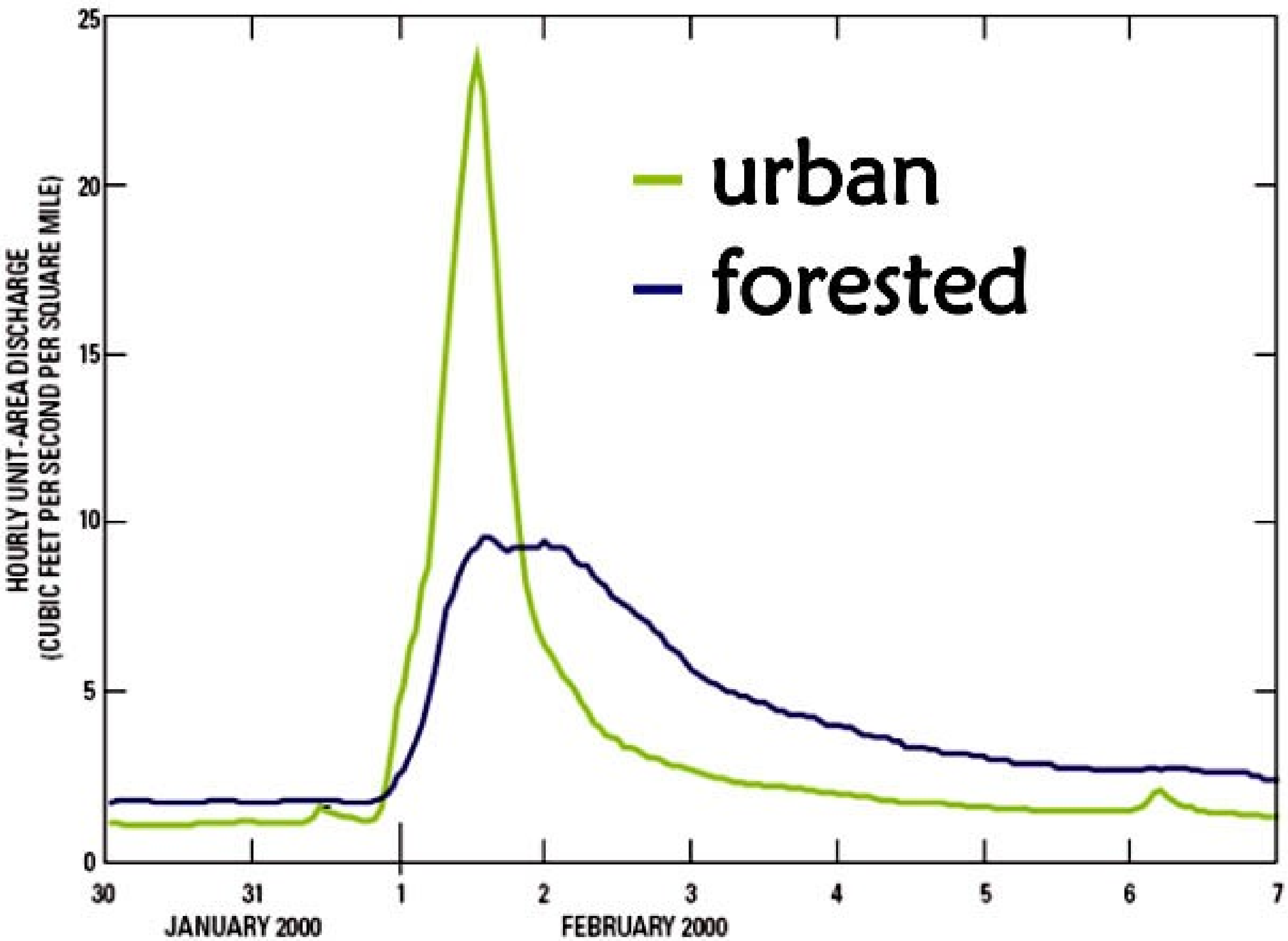

Figure 8 – The difference in stream water volume (discharge) for urban areas and forested areas after a rainfall event. Urban areas have increased stormwater runoff which may cause increased flooding.

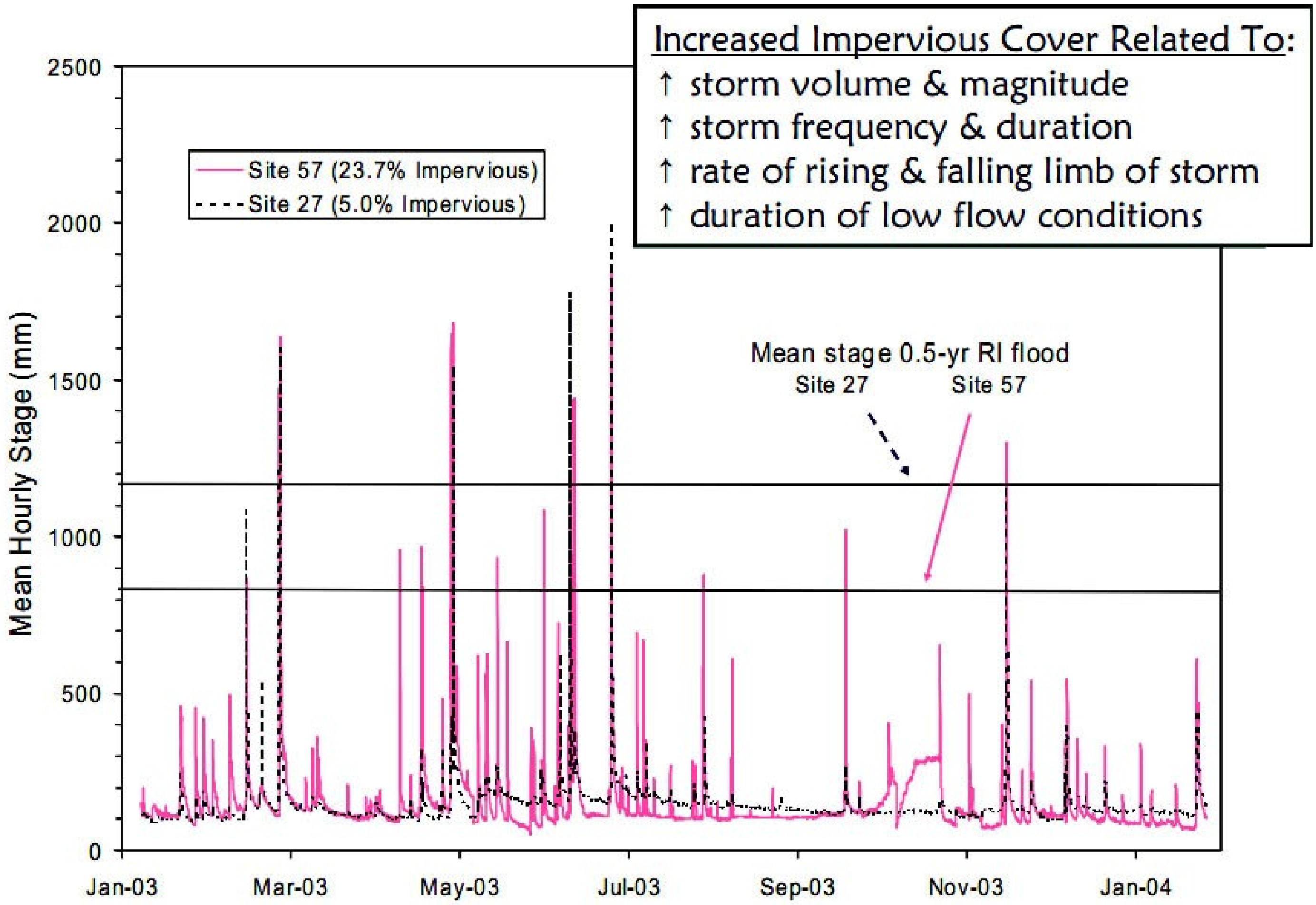

Figure 9 – Stream water height in two different watersheds in Ohio, one with 23.7% impervious surfaces and the other with 5.0% impervious surfaces. Note that the watershed with more impervious surfaces has higher stream levels and therefore increased flooding after almost every rainfall. From Roy et al. 2005.

Riparian zones, the area of land adjacent to streams, are often referred to as “hot spots” of interaction between plants, soils, water, microbes, and humans (Groffman et al. 2003). These zones remove contaminants from ground water and slow runoff before it enters the stream (Gold et al. 2001). Loss of vegetation in riparian zones can decrease bank stability increasing erosion (Allan 2004) and result in a loss of the zone’s pollutant removal functions (Allan 2004, Groffman et al. 2003, Schneider 1998a). Loss of riparian vegetation also reduces the amount of shade and increases light penetration to streams. The effect of this loss is seen by an increase in stream temperatures (Allan 2004) which is often harmful to trout populations. Riparian Zones trees and shrubs also reduce flooding of the creek (Schneider 1998a, 1998b).

Enhanced erosion in one area may lead to enhanced sediment deposition in a downstream area. While it is normal and expected for sediment to exist in streambeds, excessive sediment will reduce the volume available for stream water and make flooding somewhat more frequent. Excessive sedimentation is usually apparent when islands of sediment (sand, gravel, cobbles, etc.) form in the channel. In extreme cases, the stream becomes “braided” with multiple channels winding around many islands of sediment. However, removal of sediment without fixing the cause of sedimentation usually has little benefit and may make conditions worse.

Natural or man-made obstacles in the streambed can slow the stream water and cause localized flooding. Natural obstacles, such as downed trees, generally have a minor impact but can cause increased flooding and erosion locally. Removal of downed trees produces only a small local reduction in flooding while destroying natural habitat for aquatic organisms and possibly making flooding worse downstream. Man-made obstacles that create constrictions to stream flow, including culverts and bridges that are too small to pass high-flow events, can cause substantial local flooding and severe local erosion. Severe erosion in one spot may lead to excessive sedimentation downstream.

Projects to straighten and deepen stream beds, or to remove all fallen vegetation in the stream bed often have limited success because they do not address the root cause of the flooding. Increased flooding in urban and suburban areas is due to an increase in stormwater runoff and an increase in the runoff speed as it moves into the stream. These approaches can also be extremely damaging to the stream environment. Attempts to channelize a stream may reduce flooding in that particular area but will cause flooding to worsen downstream. The modified stream channel may trigger enhanced sedimentation to occur and fill in the new channel, or enhanced erosion to occur creating sedimentation problems downstream.

Sedimentation- Sediment is always part of stream systems. Fine-grained sediment (silt) in stream water makes it appear a muddy brown color. This fine-grained sediment can kill trout, choke trout eggs and kill other aquatic species. Excessive sediment in the stream is usually the result of excessive erosion upstream. This erosion could occur at construction sites near the stream if improper or inadequate sediment control measures are used. In addition, streambank erosion can yield abundant sediment into the stream channel under certain conditions, including high volume flow, high velocity flow or turbulence (see photos 7 and 8).

Diminished Riparian Vegetation- The removal of trees and shrubs adjacent to streams creates several problems including the removal of habitat for small animals, the removal of shade resulting in high stream water temperatures in the summer, increases in flooding, increases in streambank erosion and increases in certain pollutants entering the stream (Schneider 1998a, 1998b). In developed areas people will often remove streamside trees and shrubs and replace them with a lawn extending to the waters edge. This removes all of the beneficial effects of those plants and results in the degradation of the stream.

Erosion- While erosion is normal in stream systems, excessive erosion can endanger man-made structures, disconnect the floodplain ecosystem from the stream and may enhance sediment deposition downstream. Excessive erosion can be triggered by increased stream water volume, by increased stream water velocity, by increasing the turbulence of the stream water or by a combination of these factors. Increasing the percentage of rainfall that runs off a landscape into a stream will increase the volume of water in the stream and may also increase erosion. The velocity of stream water increases when a streambed is "channelized", straightened and deepened, often resulting in faster rates of erosion. In addition, the removal of natural overhanging vegetation and fallen trees will increase water velocity and may increase erosion. Man-made constrictions to water flow can greatly increase both the velocity and turbulence of stream water during peak flow events and typically severe erosion can be observed just downstream of these constrictions.

Channel Manipulation- Channel manipulation includes lining streambanks with walls, gabions, or crushed stone called rip-rap or may occur by mechanically altering the streambed. Channelizing a stream involves mechanically digging the streambed deeper and straighter. These types of stream manipulation are often counterproductive and may result in further degradation of the stream, greater flooding and/or erosion downstream and loss of habitats. Modern bioengineering techniques are less expensive and have superior results compared to older channel manipulation techniques.

Barriers to Fish Migration- Dams and some culverts act as barriers to migration of fish along a stream. Trout can not jump over obstacles or swim with their bellies touching the bottom of a culvert. Of course, the areas of Jackson Creek that dry up in the summer also act as barriers to migration. Trout can only survive in shaded cold water areas. Portions of the stream with damaged riparian vegetation tend to heat up in the summer due to lack of shade. In response the trout will attempt to migrate to cooler areas of the stream. However, if their path is blocked by a culvert or dam the trout will simply die.

Trash- Several small trash dumps were observed along Jackson Creek consisting of a pile of used appliances. In other areas were discarded used tires and other trash. In one location excess asphalt, which was used to pave a nearby driveway, was dumped on the streambank. Much of this trash will release pollutants into the environment, and the stream, over time. Cleaning up this trash should help improve water quality and the local environment in general.

Areas Colonized by Invasive Plants- Although Barberry and Multiflora Rose are commonplace along Jackson Creek and Phragmites and Garlic Mustard occur locally, the invasive plant of most concern is Mile-a-Minute (MAM) Vine. MAM occurs from site 4 of segment 5 through section 11, with a large patch of heavy infestation from the vicinity of the Town of LaGrange Park downstream through most of the Whortlekill Rod and Gun Club property. Preliminary attempts to control MAM occurred during the summer of 2007 met with only limited success.

Drop In Stream Water/Water Table Levels- During the Jackson Creek Streamwalk in October of 2007, two long portions of the creek were completely dry in segments 3 and 6. This indicates that the local water table had dropped below the level of the creekbed. October of 2007 was at the end of an unusually long dry period. Therefore it isn't clear whether the lower water table was only due to the dry conditions or if the water table in these areas has been dropping for many years. Local water tables can fall because land use changes cause less rainfall to infiltrate the ground, because new wells have been drilled or because existing wells use more groundwater than in the past. Also, the water table will drop if less rainfall occurs due to climate change. More information is needed to determine why this problem occurs along Jackson Creek.

Trout Survival and Breeding- Jackson Creek has been known for some time as a creek that supports breeding trout populations. The NYSDEC water quality designation is C(T) or C(TS) depending on location. This indicates a best use of fishing or boating (Class C) and the fact that it is a trout stream (T) and in some areas a trout spawning stream (TS). A study by Schmidt and Kiviat in 1985 reported a naturally reproducing trout population in Jackson Creek. Stainbrook, 2004 reported that in 2001 there were healthy brook and brown trout populations in the creek, but also mentioned the poor stream conditions due to low stream flow. More recently there have been verbal reports that areas known to support trout in the past no longer do. However, this information isn't based on any systematic study.

Urban Stream Syndrome

Urban Stream Syndrome is a collection of symptoms often associated with streams in urban or suburban settings. The causes of USS primarily include, 1) an increase in the amount of stormwater runoff, 2) an increase in the efficiency that runoff travels to the creek, 3) an increase in the input of certain pollutants, especially nutrients and 4) a decrease in the stream systems ability to remove certain pollutants, especially nitrate. The symptoms of USS are outlined in Walsh et al. 2005, Table 1. These symptoms include- (a) an increase in high water flow events, (b) an increase in the frequency of erosive flow events, (c) an increase in streambank erosion, (d) may include a change in the streams baseflow water level and (e) may include an increase in sedimentation. These symptoms correspond well to observations of Jackson Creek in recent years. Thus understanding USS should help us to understand the problems along Jackson Creek and help us to find solutions. Efforts to decrease the amount of runoff, decrease the speed that runoff reaches the creek and decrease the input of nutrients and other pollutants should help to alleviate many problems along the creek.

With increased development the amount of impervious surfaces, including roads, parking lots, sidewalks and roof tops, increase. Impervious surfaces prevent water from seeping, or infiltrating, into the ground which then increases the amount of surface water runoff. One acre of impervious surface can create 16 times more runoff then one acre of meadow (Schueler and Holland 2000). Thus instead of infiltrating into the earth and recharging the groundwater, precipitation in developed areas often flows directly into streams as overland flow and becomes stormwater runoff. As precipitation travels across impervious services into stormwater drainage pipes it brings with it anything that has collected on that surface such as leaf litter, human derived litter (aka trash), and various pollutants. The stormwater runoff is usually delivered directly into streams via pipe systems. These pipe systems completely bypass pervious soils and stream riparian zones so that anything carried in the water will enter directly into the stream. This leads to a more rapid delivery of water to stream channels after precipitation events, which often leads to faster and higher flows. This faster water carries with it enough energy to move larger amounts of sediments leading to erosion problems within the stream. Many scientific studies have found that degradation of streams and rivers occur at ≥ 10% impervious surface area of a watershed and sometimes with as little as 5% (Booth and Jackson 1997, Beach 2002).

Even in watersheds with low levels of urbanization, an increase in the amount and concentration of pollutants can be seen in urban streams (Walsh et al. 2005). Sources of pollution to streams include the precipitation itself, runoff, soil erosion, atmospheric deposition, fertilizers and pesticides, and direct discharge of pollutants into storm sewers (Novotny and Olem 1994). Urban runoff can also transport nutrients, such as nitrogen and phosphorous, organic carbon, trace metals such as copper, zinc, and lead and petroleum hydrocarbons (Scheuler and Holland 2000) as well as the heavy metals platinum, rhodium, palladium (derived from catalytic converters on cars) and ethylene glycol (antifreeze).

Recommendations

Our Recommendations

1) Any new development within the Jackson Creek Watershed should utilize "better site design" principles.

2) Replace man-made constrictions, such as culverts and bridges that are too small to pass high flow events with larger structures.

3) Wherever possible, retrofit existing piped drainage with swales, retention ponds, rain gardens, pervious pavers and other practices of "better site design".

4) Protect existing trees and shrubs along the streambank, the so-called riparian zone.

5) Replant streambanks that have had their trees and shrubs removed.

6) Protect floodplains from development, filling, walling-off or alteration of the natural vegetation.

7) Where needed repair areas of extreme streambank erosion, using natural channel design and bioengineering techniques.

8) Clean up the trash in the few areas that it is abundant.

9) Monitor rainfall, stream level and well water levels to track changes in the watershed. Possibly try to get a USGS stream gauge station on Jackson Creek.

10) Monitor and fight against invasive plants and animals, especially Mile-a-Minute Vine.

11) Monitor stream turbidity, temperature, conductivity and nutrient levels.

12) Monitor the aquatic biology of Jackson Creek to track its health, including fish and macroinvertebrates.

Explanation of Recommendations

Recommendation # 1 - Following recommendation #1, utilizing better site design principles, should help prevent flooding, erosion, sedimentation and water pollution along Jackson Creek from getting worse. Also referred to as "Smart Growth" or "Low Impact Development", Better Site Design refers to site development and storm water management approaches designed to decrease the amount of impact development has on the land, water, and air in an effort to conserve natural systems and hydrologic functions at a site. Techniques include reducing the amount of impervious surfaces, channeling runoff into raingardens, open swales and infiltration areas and using pervious paving techniques. A major study of these techniques in the Jordan Cove project in Connecticut demonstrated that both the amount of runoff and the pollutants in the runoff were reduced by 90%. Some available resources on Better Site Design are listed as follows:

Barbara Kendall, NYSDEC – blkendal@gw.dec.state.ny.us (845) 256-3163

"Protecting Water Resources with Smart Growth." EPA 231-R-04-002, May 2004.
Found online at: http://www.epa.gov/dced/pdf/waterresources_with_sg.pdf

Center for Watershed Protection "Better Site Design: A Handbook for Changing Development Rules in Your Community." Available at www.cwp.org for $35 for a hard copy or downloadable as a pdf for free.

The Low Impact Development Center: Sustainable Design and Water Quality Research, www.lowimpactdevelopment.org

The University of New Hampshire Stormwater Center,
www.unh.edu/erg/cstev/

Recommendation # 2 - Following recommendation #2, replacing constrictions with larger culverts or bridges, should reduce flooding, erosion, and sedimentation in specific areas along Jackson Creek. It is important that a system-wide approach is implemented by utilizing many recommendations, since implementing this recommendation by alone could cause conditions to worsen in some areas. During high flow events smaller culverts and bridges can quickly exceed their maximum capacity. When this maximum capacity is reached the remaining water that is trying to move downstream will begin to back up and flood the area. Eventually, the backed up water becomes deep enough to travel over and around these structures and can lead to serious damage to the culverts and bridges. This can also lead to extreme erosion problems immediately downstream of the bridge or culvert and to areas around the bridge or culvert where the water has found alternative paths of travel. This occurs because the water around the obstacle is more turbulent and moving faster than ordinary. Larger culverts and bridges, big enough to allow all of the water to pass through or under them during high flow events, can prevent these problems, prevent serious property damage to these structures and prevent serious erosion along the stream. According to Dr. Ann Riley, Executive Director of the Waterways Restoration Institute, replacing these man made constrictions will yield the "biggest bang for your buck" when working to remediate increased flooding. See section titled "Recommendations by others" for more information about Dr. Riley's recommendation.

Recommendation # 3 - Recommendation #3, retrofitting existing piped drainage, should help to reduce, erosion, sedimentation and water pollution along Jackson Creek. When water is piped directly into a stream instead of slowly infiltrating into the ground or running off the ground, the water rapidly makes its way to the stream. This causes more frequent and higher high flow events and can cause major problems for the properties downstream, leading to increases in flooding, erosion, sedimentation and pollution. The use of swales, retention ponds, rain gardens, and pervious pavement are all "better site design" practices that collect water and allow it to infiltrate into the ground, thus reducing the amount and velocity of runoff. When these techniques were utilized in the Jordan Cove project stormwater runoff was 90% less than that in traditional developments. For more information see –

www.jordancove.uconn.edu

Recommendation # 4 - Following recommendation #4, protecting streambank trees and shrubs, should help prevent flooding, erosion, sedimentation and water pollution from getting worse along Jackson Creek. As mentioned earlier in this document riparian buffers are extremely important to the health of a stream. By protecting the vegetation in these areas you can protect streams from erosion, excess nutrients and pollution, and keep temperatures cool for fish populations. The roots of trees and shrubs help hold sediment in place and protect stream banks from eroding. Forested buffers slow the movement of runoff moving toward a stream, reducing the "flashiness" of the stream. The root system of plants can also function to remove excess nutrients and other pollutants from water. Vegetation along stream banks also provides shade for streams keeping water temperatures cooler which is very important for many fish populations including trout.

Recommendation # 5 - Following recommendation #5, replanting streambanks with trees and shrubs, should help to reduce flooding, erosion, sedimentation and water pollution along Jackson Creek. Damaged riparian zones can often be easily remediated by once again planting trees and shrubs along stream banks. In some instances other work may need to be done to stabilize stream banks so that plants can survive and thrive in these areas. There are many programs currently available to residents and municipalities in the Hudson Valley that assist in the planting of riparian buffers.

The "Trees For Tribs" Initiative is sponsored by the Hudson River Estuary Program of NYSDEC. The program offers free native seedlings and saplings both in the spring and the fall for projects that qualify. The "Trees For Tribs" program is administered by Kevin Greiser of the NYSDEC – kagriese@gw.dec.state.ny.us

Recommendation # 6 - This recommendation, protecting floodplains, should help prevent flooding along Jackson Creek from getting worse and enhance the health of Jackson Creek and its Riparian Zone. A floodplain is the flat or nearly flat area adjacent to a stream where flooding occurs periodically during high flow events. It is normal for these areas to flood, in fact floodplains are created with flood deposited sediments. By trying to prevent streams from naturally spilling out onto their floodplains we ultimately cause ecological damage to the stream and nearby ecosystems and also increase flooding severity. Water needs someplace to go during heavy precipitation and high flow events. Floodplains and wetlands help by absorbing and slowly releasing water downstream instead of allowing water to travel in a large fast moving, destructive pulse. If areas of the floodplain have been filled in, walled off or covered with impervious surfaces, water will quickly rush downstream, creating more severe flooding in downstream areas. Also, if you exclude flood waters from part of the floodplain it must go somewhere else, possibly into basements and buildings causing massive property damage.

Recommendation # 7 - Following recommendation #7, repairing areas of severe streambank erosion, should help reduce erosion and sedimentation along Jackson Creek. In addition this recommendation may help protect specific private property that is now in jeopardy. The increased flooding along Jackson Creek in recent years has produced severe erosion in some places. Repair of these areas using vegetative or bioengineering techniques will reduce future erosion and sedimentation problems and enhance the stream environment.

Recommendation #8 - Following recommendation #8, cleaning up the trash, should help enhance the health of Jackson Creek and reduce water pollution. Although trash is not a major problem along Jackson Creek, there are local spots with significant trash. Not only is it unsightly, it can also yield pollutants into the creek and the environment. The removal of this trash will prevent further contamination of the creek and restore the beauty of the area.

Recommendation #9 - Following recommendation #9, monitoring rainfall, stream levels and well levels, should help us keep track of changes in flooding patterns and water levels. This would help to determine if changes being made in the watershed are having a positive or negative impact on conditions in the watershed. A USGS stream gauge station is preferred since identical stations exist in many locations around the nation. However, a USGS station costs at least $30,000 so other less expensive stations should also be considered. Dutchess County Water and Wastewater Authority currently monitors well water levels across the county. We should find out if this data is available to the public. If not a well monitoring program within the Jackson Creek Watershed would be advisable.

Recommendation #10 - Following recommendation #10, monitoring and fighting invasive species, should help to enhance the health of the creek and it's Riparian Zone. The reduction of invasive species, especially Mile-a-Minute Vine, will allow native species to thrive enhancing the local environment.

Recommendation #11 - Following recommendation #11 should help to track changes in physical parameters within the watershed. Monitoring turbidity, water temperature and nutrient levels in the creek will help to determine if trout and other aquatic species can thrive in Jackson Creek.

Recommendation #12 - Following recommendation #12, monitoring aquatic biology, should help to directly track changes in the watershed that affect aquatic organisms and the health of the Jackson Creek ecosystem.

<u>Recommendations Of Others</u>

Ann L. Riley, Ph.D.- On July 13, 2007 the Dutchess County Cornell Cooperative Extension hosted a conference entitled "Preventing and Minimizing Floods and Erosion" at the Farm and Home Center in Millbrook, New York. A presentation was given by Ann L. Riley, Ph.D., Executive Director of the Waterways Restoration Institute and a nationally recognized expert in river restoration. Dr. Riley was asked by a local official what should be done first, in light of the limited financial resources of local Towns. Dr. Riley responded that the most important thing is to replace man-made constrictions to water flow, such as culverts or bridges that are too small to pass high flow events. She continued that this approach would yield the "biggest bang for your buck". During the Stream Walk many such man-made constrictions that were too small were observed.

Trout Unlimited Study- Trout Unlimited conducted a study of Jackson Creek during the summer of 2007. The Trout Unlimited study examined 10 locations along the creek using visual methods similar to this study. Their recommendations included the following-

- Reduce runoff in the watershed by improving water interception and ground infiltration.
- Restore forested riparian buffers of adequate width throughout the watershed.
- Restore natural channel complexity by re-establishing stable dimension, pattern, profile and boundary roughness in degraded channel segments.

- Obtain a full analysis of the watershed before considering any action.
- Avoid quick fixes (check dams, channel "improvements", etc.).
- Seek to stop channel incision through grade control measures compatible with natural channel processes.
- Consider using flow diversion devices to reduce bank erosion in combination with rapid revegetation techniques.
- Seek to restore stable natural channels

Fishkill Creek Management Plan- In the Natural Resources Management Plan For The Fishkill Creek Watershed, published in 2005 there are many recommendations and suggestions. Some of these are for the entire Fishkill Creek Watershed, which includes the Jackson Creek watershed, and others are only for the smaller Jackson Creek sub-watershed. The recommendations for the entire Fishkill Creek Watershed include-

- Establish effective forested stream buffers.
- Protect in-stream water flows by considering the effect of increased groundwater withdrawals.
- Stormwater runoff should be treated before being discharged into local streams.
- Investment should be made into alternatives to impervious surfaces.
- Water quality monitoring should continue.
- Remote sensing-based maps of land use should be done every 5 years.
- Annual stream clean-up of litter should occur along with regular roadside clean ups.
- Old drain pipe infrastructure should be upgraded using the five New York State Stormwater design practices (ponds, wetlands, infiltration, filtering practices and open channels).
- A humane way to reduce deer populations must be found to reduce the damage of excessive deer browse to forest understories.
- Determine the amount of regulated discharges that can occur during low-flow stream conditions without degrading the stream.
- Evaluate and remove old, unused dams.
- Map riparian and in-channel habitats.
- Identify streams routinely used for swimming, and then make sure they are designated by NYSDEC as class B streams.
- Best Management Practices (BMPs) should always be followed.
- A watershed-wide evaluation of ordinances and zoning laws should be done. This evaluation should seek to identify regulatory gaps and determine if current laws adequately protect the watershed.
- All projects and procedures used by any entity should be re-evaluated to determine their effectiveness.
- Determine which municipal plans (master plans, build-out analyses, land-use studies, etc.) need to be updated, and then do so.

The recommendations specifically for the Jackson Creek Watershed include-

- Further chemical water quality analysis is warranted to establish base line parameters for Jackson Creek.
- Water quality and quantity issues must be considered during the approval of development projects.
- The impact of an increasing number of stream crossings and land contour changes due to development must be determined, particularly in the area upstream of Route 55.

David Burns' Masters Thesis, 2006 -

- Routinely collecting conductivity readings in local streams would be an easy and cost effective means of tracking the impacts of increasing urbanization on in-stream chloride concentration.
- All SPDES Discharges should be mapped & eventually quantified by the amount discharged.
- Remote sensing based tracking of land uses/covers and their associated impervious surfaces on a regular schedule would provide valuable data, model inputs and prediction and tracking capability.
- The 10% impervious surface threshold value identified by the Center for Watershed Protection (1998) seems to be a good goal below which impervious surfaces should be held to preserve healthy aquatic systems.
- Maintaining or increasing the amount of watershed forested land cover would also assist in obtaining/maintaining good water quality.
- Conductivity readings taken on a longitudinal profile during base flow conditions in the streams identified in this study as containing high chloride concentrations could help to identify the sources of the chloride contamination. This type of analysis would be particularly valuable for the Casper Kill, HR 99, HR 98 and possibly in the Muddler Kill, Maritje Kill, Fall Kill and Fishkill Creek.

Next Steps

A variety of follow-on studies, listed here, would enhance the usefulness of the Jackson Creek Streamwalk 2007 study.

1) More detailed study of each impaired site along the creek is part of the LHCCD protocol. This wasn't done due to time constraints, but could be done in 2008.

2) Another useful study would be to interview residents along the creek and record their memories of flooding and how it has changed over time.

3) The use of other stream assessment techniques, including aquatic macroinvertebrates and water chemistry, would also be useful. Analyses of waterborne bacteria, nitrate and optical brighteners would help determine whether local septic systems, farm animals or other sources are polluting the creek.

4) A Land Use Analysis of the Jackson Creek Watershed has been done using aerial photos from 2000. It would be very useful to do another Land Use Analysis based on more recent aerial photos.

5) It would be useful to construct an accurate graph showing stream elevation over the length of Jackson Creek. This would allow for the determination of stream gradient and where any abrupt changes in gradient occur along the creek. Changes in gradient could explain erosion in some areas and deposition in others.

6) A study of soil textures and infiltration rates in the Jackson Creek Watershed would be useful. A comparison of published data from soil maps with direct measurement of both disturbed and undisturbed soil may help to explain the increase in flooding observed. If lawns in the area are compacted, resulting in increased runoff, further steps should be taken to reduce the runoff.

7) The feasibility of reducing local deer populations should be investigated. While it is presumed that deer overpopulation reduce forest understories and therefore increase runoff, little data has been gathered to support this belief. An investigation to study the effect of deer browse on runoff would be useful.

8) It would be useful to map the damaged Riparian Zones along Jackson Creek and its tributaries. This map would help efforts to comply with recommendation # 5.

9) It would be useful to return to the property owners along Jackson Creek that have specific, localized problems and make sure they get adequate professional advice.

10) A detailed study of local rainfall patterns would be useful to determine whether or not rainfall events have increased in size in recent years.
11) It would be useful to create a list of incentive programs and grants available to help implement the recommendations in this report. A good starting point would be the list of incentive programs near the end of the Fishkill Creek Management Plan. That list should be checked and expanded.

Conclusions

A variety of chronic problems have plagued Jackson Creek in recent years. This study was undertaken to try to determine the causes of the problems, to find where along the creek the problems occur and to provide recommendations for reducing the problems along Jackson Creek. This report contains our findings about what the problems are, where the problems exist and what is known about their causes. Implementing the recommendations and next steps contained in this report should produce a noticeable improvement in conditions along the creek. Failure to implement these recommendations will probably result in conditions that continue to worsen on Jackson Creek.

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Glossary

aggradation- the process of building up the land surface by depositing more and more sediment.

aquifer- an underground deposit of water containing a useable amount of water. Aquifers are resupplied by rainfall soaking in, or infiltrating, the ground.

atmospheric deposition- the act of pollutants falling to the earth out of the air, either as dust particles or through rain or snow.

bank stability- how stable a streambank is. Low bank stability is caused by streambank erosion.

Barberry- a troublesome, invasive plant originally from Japan.

baseflow- a low water condition in a stream during dry periods. During baseflow conditions the stream water comes from an underground water source, not from stormwater runoff.

bioengineering- Using living things as engineering materials. For example, using live trees and shrubs along a streambank to reduce erosion rates.

braided stream- a stream consisting of multiple channels weaving around many islands composed of sediment (sand, gravel, cobbles, etc.). Braided streams form when more sediment exists in the channel than the stream water can move.

browse- the removal of short vegetation by many deer feeding upon it.

buffer zone- the region adjacent to a stream that separates and helps to protect it from the harmful effects of nearby residential, commercial or agricultural land uses.

canopy- the solid layer of vegetation created by trees that blocks almost all direct sunlight.

channelized- the description of a stream that has been artificially straightened and deepened. This often results in faster water flow, more erosion and increased problems downstream.

correlation- a pattern between two or more characteristics that may indicate a cause-and-effect relationship. For example, the denser the tree canopy over a stream, the healthier the stream is at that location.

ecosystem- an interactive system composed of plants, animals and the environment in which they live.

ecosystem services- processes that occur naturally in a healthy environment, but could be replaced with expensive, engineered processes. For example wetlands reduce flooding and remove pollutants automatically and free of charge.

erosion- the removal of soil, sediment or rock by some agent such as moving water, wind or glaciers.

flash flood- a type of flood that is characterized by a rapid rise in water level, followed by a rapid decline in water level.

flashy- the description of a stream that is prone to flash floods. Changes in land use within a watershed can cause a stream to become more flashy.

floodplain- a flat area adjacent to a stream that is typically underwater during floods. Floodplains are created by sediment left behind after many floods.

gabion- a rectangular metal mesh container filled with loose rock. These rectangular gabions are often stacked to create walls or other erosion control structures.

geomorphic- pertaining to the shape, or contours, of the land.

gradient- the steepness or slope of an object.

high flow event- when an unusually large volume of water moves down a stream it is referred to as a high flow event. These events include floods and flows that approach floods.

impaired site- according to the LHCCD protocol, an impaired site is a location with one or more serious environmental problems.

impervious surfaces- surfaces that do not allow rainwater to soak into the ground and instead force the water to run off. Impervious surfaces include paved roads, driveways and parking lots, as well as sidewalks and roofs.

incision- when a stream erodes downward resulting in a stream bed that appears to be in the bottom of a trench.

infiltration- the process by which rain water soaks into the ground. This water can help replace the water found in aquifers.

invasive- a plant or animal that living in one place that originated in a distant location. Invasive organisms may spread rapidly and drive out local species because no local organisms prey on them.

land use- the type of use that an area of land has. These can include forested, urban, suburban, agricultural or commercial land uses. The local land uses strongly affects the percentage of rainfall that runs off the land into local streams.

least-squares regression- a statistical process to determine the straight line that best fits the data, and provides the equation of the best-fit line.

LHCCD- Lower Hudson Coalition of Conservation Districts. A coalition of the county Soil and Water Districts in southeastern New York State.

litter- (1) a layer of organic debris on the ground surface, including partially decayed leaves, pine needles, twigs, etc. (2) Man-made debris or trash.

macroinvertebrates- small organisms without backbones, including worms and insects, that are large enough to identify using a magnifying glass. Some species of macroinvertebrates require good water quality to survive, while others are very tolerant of polluted water. Therefore, the species present in a body of water can be used to determine its overall health.

meanders- the curves commonly found in slow moving streams and rivers. The size and location of these meanders normally change over time.

metrics- an item that can be easily measured and will indicate some larger property. For example the concentration of nitrate in stream water is often used to indicate the health of the stream.

Multiflora rose- an invasive shrub in the rose family.

precipitation- particles that fall from clouds to the earths surface and transport water either in liquid or frozen form. Precipitation includes rain, snow, sleet, hail, etc.

recharge- the process by which aquifers are replenished through water infiltrating downward into the ground.

riparian- describing land immediately adjacent to a body of water or the legal rights of owners of such land.

Riparian Zone- the swath of land adjacent to, and on both sides of, a stream or other body of water.

rip-rap- large crushed stones used to cover slopes or streambanks in order to help slow erosion.

R-squared value- a statistical metric used in the least-squares regression method that ranges in value from zero to one. The closer the R-squared value is to one, the closer the data fits to a straight line.

runoff- the portion of rainfall that moves downhill along the surface of the earth. Runoff that reaches local streams, after a rain storm, causes the water level to rise and sometimes to flood.

sediment- loose particles, including silt, sand, gravel or cobbles, found in streambeds among other places.

sedimentation- the process that causes sediment to be deposited in streambeds or other locations.

stormwater runoff- the portion of rainfall that moves downhill along the surface of the earth, it is also known as runoff.

stream class- A classification of the "best use" of a body of water according to NYSDEC. Class A indicates water suitable for drinking, class B indicates water suitable for swimming, and class C indicates the water is suitable for fishing or boating.

stream segment- a portion of a stream chosen for study, usually with a landmark at each end.

turbulence- the flow of a fluid, such as water, along rapid, complex and chaotic pathways. Turbulent stream water flow produces much more erosion than non-turbulent flow.

understory- shorter plants, including shrubs and saplings, located underneath a forest canopy.

urban stream syndrome- a collection of symptoms commonly affecting streams in urban or suburban areas. These symptoms include increased flooding, erosion and water pollution among others.

visual assessment- a way of evaluating the health of a stream using characteristics that can be seen with the eye. This type of assessment does not detailed chemical or biological analysis.

watershed- an area of land in which precipitation drains into a common body of water. For example, the area of land that drains into Jackson Creek is called the Jackson Creek Watershed.

water table- the upper surface of the usable underground water supply. Streams and lakes levels are at the water table. The water table can rise after abundant rainfall and will drop during dry periods or if large amounts of water is pumped out of the ground.

wetted width- the width of the water in a stream. This width will change as stream level rises or falls.

Appendix

Each number in the table below represents the score at the given site location and for that stream characteristic. The Overall Segment Score is the average of those 12 site scores.

Site No.	Depth (dec. ft)	Width (dec. ft)	Channel Condition	Hydro-logy	Riparian Zone	Bank Stability	Water Appearance	Nutrient Enrich-ment	Barriers to Fish Move-ment	Pools	Instream Fish Cover	Insect/ Invert. Habitat	Canopy Cover	Embed-dedness	Overall Segment Score
1.1	0.458	12.50	10	10	10	5	10	10	10	5	5	10	10	10	8.750
1.2	0.250	9.00	10	10	10	5	10	10	8	5	5	10	10	10	8.583
1.3	0.333	9.25	10	5	5	3	10	10	10	5	5	10	7	10	7.500
1.4															
2.1	0.250	7.00	5	7	9	7	10		5	5	5	10	10	10	7.545
2.2	0.210	5.33	5	8	8	1	10		3	5	5	10	10	10	6.818
2.3	0.125	6.83	10	9	10	7	10		10	5	5	10	10	10	8.727
2.4	0.210	2.75	10	8	4	2	10	8	10	5	5	10	7	6	7.083
3.1	0.000	0.000	5	8	1	3			1	5	1	10	1	2	3.700
3.2	0.084	5.17	10	10	10	9	10	8	10	5	7	10	7	10	8.833
3.3	0.040	8.42	10	10	10	10	10	8	9	5	3	10	1	5	7.583
3.4	0.250	5.08	10	7	10	7	9	7	9	5	3	7	1	5	6.667
4.1	0.250	12.00	8	8	10	7	9	8	10	8	7	10	10	5	8.333
4.2	1.170	10.92	9	9	7	8	9	8	10	5	8	10	2	2	7.250
4.3	0.280	9.67	5	7	1	5	9	5	10	5	6	7	1	7	5.667
4.4	1.250	12.25	9	7	9	7	10	8	5	5	8	7	10	7	7.667
5.1	1.000	16.00	8	8	9	7	10	8	1	8	7	10	9	8	7.750
5.2	0.330	33.33	10	10	10	8	10	9	10	5	4	10	10	6	8.500
5.3	0.330	24.08	9	8	10	4	9	9	10	8	7	10	8	10	8.500
5.4	0.420	16.75	9	9	10	6	10	9	5	5	3	10	10	5	7.583
6.1	0.460	12.00	9	10	9	9	10	9	10	5	7	8	10	8	8.667
6.2	0.000	0.000	9	10	10	9			1	3	3	6	10		6.778
6.3	0.580	10.75	8	8	8	8	5	5	10	5	3	10	3		6.636
6.4	0.250	5.42	10	10	10	10	10	9	8	5	3	8	8	8	8.250
7.1*	0.210	13.67	9	10	10	8	9	7	10	5	5	7	7	8	7.917
7.2*	0.290	9.17	10	10	10	9	9	8	10	3	3	7	10	10	8.250
7.3*	0.250	7.17	8	8	10	7	9	9	10	5	7	10	10	5	8.167
7.4*	0.580	22.75	9	9	10	8	9	7	10	5	5	10	10	8	8.333

* Segments 7 and 8 combined.

(table continued on next page)

Site No.	Depth (dec. ft)	Width (dec. ft)	Channel Condition	Hydro-logy	Riparian Zone	Bank Stability	Water Appearance	Nutrient Enrich-ment	Barriers to Fish Move-ment	Pools	Instream Fish Cover	Insect/ Invert. Habitat	Canopy Cover	Embed-dedness	Overall Segment Score
9.1	0.420	10.75	3	7	1	6	10	7	10	3	5	7	3	10	6.000
9.2	0.420	10.75	3	10	1	9	9	8	10	5	3	10	1	8	6.417
9.3	1.000	15.67	4	7	3	6	9	8	10	5	5	10	3	8	6.500
9.4	0.920	17.25	7	8	9	7	9	9	10	8	8	10	10	9	8.667
10.1	0.420	8.08	7	9	6	7	9	8	10	5	4	10	10	8	7.750
10.2	0.330	13.17	7	10	3	4	9	7	10	5	7	10	1	8	6.750
10.3	0.250	6.83	7	7	10	3	9	10	10	5	3	7	8	8	7.250
10.4	0.500	13.33	7	7	3	6	9	6	10	5	3	7	1	8	6.000
11.1	0.920	19.83	8	9	10	7	9	9	10	5	5	7	9	8	8.000
11.2	0.750	18.17	8	10	10	8	9	8	10	5	5	7	10	10	8.333
11.3	0.500	12.50	8	10	10	9	9	8	10	5	3	7	10	8	8.083
11.4	0.920	8.50	9	9	9	8	9	8	10	5	7	7	7	10	8.167
12.1	0.380	20.42	9	9	10	7	9	8	10	3	3	6	2	8	7.000
12.2	0.420	13.00	9	10	10	9	9	7	10	5	3	7	10	5	7.833
12.3	0.290	7.42	9	10	10	8	9	9	10	5	5	7	10	10	8.500
12.4	0.830	9.25	10	10	10	9	9	8	10	3	3	7	1	8	7.333
			8.116	8.721	8.023	6.791	9.293	8.079	8.721	5.047	4.814	8.674	6.930	7.780	7.582

Overall Segment Scores   Method: Lowest Score

Each number in the table below represents the lowest score for a given segment and a given stream characteristic.
The Overall Segment Score is the average of those 12 segment lowest scores.

Seg. No.	Avg. Depth (dec. ft)	Avg. Width (dec. ft)	Channel Condition	Hydro-logy	Riparian Zone	Bank Stability	Water Appearance	Nutrient Enrich-ment	Barriers to Fish Move-ment	Pools	Instream Fish Cover	Insect/ Invert. Habitat	Canopy Cover	Embedded-ness	Overall Segment Score
1	0.347	10.25	10	5	5	3	10	10	8	5	5	10	7	10	7.33
2	0.199	5.48	5	7	4	1	10	8	3	5	5	10	10	6	6.17
3	0.125	6.22	5	7	1	3	9	7	1	5	1	7	1	2	4.08
4	0.738	11.21	5	7	1	5	9	5	5	5	6	7	1	5	5.08
5	0.520	22.54	8	8	9	4	9	8	1	5	4	10	8	5	6.58
6	0.430	9.39	8	8	8	8	5	5	1	3	3	6	3	8	5.50
7	0.333	13.19	8	8	10	7	9	7	10	3	3	7	7	5	7.00
8															
9	0.815	15.88	3	7	1	6	9	7	10	3	5	7	3	8	5.75
10	0.523	10.13	3	9	1	4	9	7	10	5	3	7	1	8	5.58
11	0.490	12.46	7	7	3	3	9	6	10	3	3	6	1	8	5.50
12	0.490	12.77	8	10	10	8	9	7	10	5	3	7	10	5	7.67

Overall Segment Scores Method: Average Score

Each number in the table below represents the average score for a given segment and a given stream characteristic.
The Overall Segment Score is the average of those 12 segment average scores.

Seg. No.	Avg. Depth (dec. ft)	Avg. Width (dec. ft)	Channel Condition	Hydro-logy	Riparian Zone	Bank Stability	Water Appearance	Nutrient Enrich-ment	Barriers to Fish Move-ment	Pools	Instream Fish Cover	Insect/ Invert. Habitat	Canopy Cover	Embedded-ness	Overall Segment Score
1	0.347	10.25	10.00	8.33	8.33	4.33	10.00	10.00	9.33	5.00	5.00	10.00	9.00	10.00	8.28
2	0.199	5.48	7.50	8.00	7.75	4.25	10.00	8.00	7.00	5.00	5.00	10.00	9.25	9.00	7.56
3	0.125	6.22	8.75	8.75	7.75	7.25	9.67	7.67	7.25	5.00	3.50	9.25	2.50	5.50	6.90
4	0.738	11.21	7.75	7.75	6.75	6.75	9.25	7.25	8.75	5.75	7.25	8.50	5.75	5.25	7.23
5	0.520	22.54	9.00	8.75	9.75	6.25	9.75	8.75	6.50	6.50	5.25	10.00	9.25	7.25	8.08
6	0.430	9.39	9.00	9.50	9.25	9.00	8.33	7.67	7.25	4.50	4.00	8.00	7.75	8.00	7.69
7	0.333	13.19	9.00	9.25	10.00	8.00	9.00	7.75	10.00	4.50	5.00	8.50	9.25	7.75	8.17
8															
9	0.815	15.88	5.50	7.75	5.75	6.50	9.25	8.25	10.00	5.25	5.75	8.50	6.25	8.75	7.29
10	0.523	10.13	6.50	9.50	4.75	7.00	9.00	7.75	10.00	5.00	5.25	9.25	4.75	8.50	7.27
11	0.490	12.46	8.25	8.25	8.25	6.25	9.00	8.00	10.00	4.00	3.00	6.75	3.00	8.00	6.90
12	0.490	12.77	8.50	10.00	10.00	8.50	9.00	8.00	10.00	5.00	4.00	7.00	10.00	8.25	8.19