Aquatic Habitat

Onondaga Creek Fact Sheet

INTRODUCTION

The term 'habitat' is usually used with respect to a specific group of organisms, most frequently a species. This section introduces methods broadly applied in the Onondaga Creek watershed for assessing habitat degradation in general terms that are relevant to biological communities rather than individual species. Species-specific methods may be important if either conservation or reintroduction of individual species is an eventual goal for Onondaga Creek. Scores from habitat and biological surveys are usually interpreted in comparison to a reference system. A generalized stream habitat continuum concept is described to illustrate expected conditions in an unimpacted system.

What is the relationship between an aquatic "ecosystem" and "habitat"? An aquatic ecosystem is made up of the interactions between all of the animals and plants, and their physical and chemical surroundings (e.g., physical habitat, nutrients, oxygen, temperature), in a specific place. The term "habitat" may be broadly defined as the subset of ecosystem components that directly relate to the biological requirements and preferences of a particular group of organisms (see Text Box 1). Typically, habitat is thought of in relation to a particular species, but can also apply to a larger group such as coldwater fish, or a subset of individuals within a species, such as early life stages. Habitat for a species may include other organisms as part of their surroundings. For instance, some fish prefer the presence of rooted aquatic plants, which in turn have their own habitat requirements. A species' habitat can differ between life stages and between seasons for adults.

How are habitat assessments and restoration goals related? Habitat assessments cannot by themselves lead to restoration planning goals. The field of ecological restoration draws a clear distinction between value-based goals themselves, and the knowledge that can be used to formulate the value-based goals (Davis and Slobodkin 2004; Lancaster 2000). The knowledge obtained from habitat assessments could be used in prioritizing steps toward achieving goals.

Text Box 1

Examples of factors that are used to describe stream habitat:

Water quality
- temperature
- nutrients (phosphorus, nitrogen)
- dissolved oxygen
- pH
- turbidity

Hydrology
- water flow (volume / time)
- water velocity
- water level relative to bank full
- channel shape
- steepness of grade

Physical structure
- shading
- substrate composition
- cover from predation
- riffle/pool alternation
- stream bed shape
- size and shape of riparian wetlands and flood-plains
- sinuousity (degree of stream meandering)

Biological structure
- aquatic plants
- riparian wetland plants
- floodplain plants

Relative importance among these factors depends on:
- Species - size, resource requirements, and tolerance ranges
- Annual cycles – some fish spawn under one set of conditions, but live the rest of the year under other conditions, such as migratory species that live only part of their lives in streams
- Life stage - preferred habitat for adults and early life stages may differ significantly

What would habitat look like in an undisturbed creek? Habitat typically changes dramatically from headwaters to the mouth of the main stem of a stream. A classical paradigm of changes in flowing water systems from headwaters to mouth is called the River Continuum Concept (Text Box 2). The unimpacted continuum of conditions can be disrupted by changes to hydrology (due to damming, loss of riparian wetlands and floodplains, and channelization), and pollution (nutrients, suspended solids, and toxics). Unaltered streams in temperate climates can flood during seasons of high precipitation or during snowmelt. The transitional zone between adjacent aquatic and terrestrial ecosystems is called the "riparian zone" (Mitsch and Gosselink 2000). It is the area where the soil can become saturated due to the influence of surface water. Riparian wetlands are closely linked to aquatic habitats, providing important habitat for birds, insects, fish, and animals. They provide an infusion of food material during spring floods that support the food web of early life stages of many fish species. Riparian zone vegetation is important for shading the water, providing cover during flood periods, and contributing vegetative detritus that is the base of the food web in headwaters areas. If riparian vegetation is sufficiently dense, and/or its width is sufficient, then it may serve as a buffer to intercept nutrients or sediments in surface runoff from open areas such as pastures, crop fields, suburban lawns, and urban open areas.

Text Box 2

The River Continuum Concept (RCC)

The river continuum concept (RCC) is a classic paradigm in stream and river ecology (Vannote et al. 1980). It proposes that an unimpacted stream will exhibit somewhat predictable physical and chemical changes from the headwaters to its outlet. Additionally, these changes are reflected in changes in the plant and animal life, or biota, in the stream. In the classic model, the water in the upper reaches of a stream are fast-moving due to relatively steep topography, shallow, cold due to groundwater springs and forest shading, well-oxygenated, clear, and relatively nutrient-poor. The food web near the headwaters is based primarily on energy sources from outside of the system (allochthonous sources), such as leaf fall, because relatively little photosynthesis occurs in the swift-flowing, nutrient-poor, shaded waters. Species richness (number of species) and biomass (total weight) are relatively low near the headwaters compared to downstream areas of the system. Near the outlet of an unimpacted stream, the topography has flattened out, the waters are slower, deeper, wider, and more turbid, less oxygenated, less shaded, and relatively nutrient-rich. A greater fraction of the energy entering the food web is captured within the system (autochthonous sources) by photosynthetic algae and macrophytes, and both species richness and overall biomass are greater than at the headwaters. Between these extremes is a continuum of habitat conditions for biota. According to the RCC paradigm, both autochthony and species richness are greatest in middle reaches of the stream system, where biota from both upstream and downstream converge, and the waters are still clear enough to support high levels of photosynthesis.

FINDINGS

Who has been monitoring Onondaga Creek habitat? Between 1981 and 2005, various habitat assessment methods were applied in an assortment of reaches in the Onondaga Creek watershed by regulatory agencies (NYS Department of Environmental Conservation (NYSDEC), US Environmental Protection Agency (USEPA)), academic researchers (State University of New York, College of Environmental Science and Forestry (SUNY ESF]- students of Dr. Neil Ringler and Dr. Karin Limburg), and an environmental consultant to Onondaga County (EcoLogic) (see Text Box 3).

How can information from different studies be interpreted? The variety of approaches to assessing aquatic habitat in Onondaga Creek yielded results that were not readily integrated into consensus habitat quality scores. Three general types of formal surveys on Onondaga Creek habitat were located (Text Box 3). Academic studies investigated the relationship between several specific habitat variables and certain aspects of creek biology, usually having to do with particular fish species or communities. In other studies, benthic invertebrate surveys (referring to streambed organisms, like insect larvae, crayfish, and mussels) in a limited number of locations were used to infer water and substrate quality, which in turn could be used as an index of overall creek degradation. The third type of survey assessed a number of physical and biological variables, and integrated them into a single, overall index, ultimately represented in verbal terms such as "poor" or "good". Six different benthic community or biological index surveys were conducted, each with a different set of variables measured, and different ways of combining those data into final habitat scores. Additional data are occasionally collected by students from regional colleges for fulfilling thesis or class requirements, by high school students involved in educational programs such as Project Watershed, or during the course of community educational events, such as SUNY ESF's Bioblitz. Such information collected for educational purposes was generally of limited geographic scope (relative to the entire watershed), and/or did not utilize nationally recognized and accepted methodologies, so they were not incorporated into this watershed-wide aquatic habitat summary at this time. These data may be reviewed during the course of developing specific recommendations for habitat improvements in specific reaches.

It is beyond the scope of this fact sheet to develop a rigorous method for combining the various study results into a defensible integrated score. However, the compiled information showed encouraging qualitative corroboration between the studies. Survey data from EcoLogic (2001, 2003) were selected as the basis for comparing relative habitat quality and causes of degradation over the length of the main stem, for several reasons: (1) they were geographically the most extensive and used the largest number of sites among all of the studies; (2) they surveyed sections of the creek not covered in any other study (e.g., above the Vesper impoundment, and on the Onondaga Nation territory); (3) they used a consistent method of scoring (Stream Visual Assessment Protocol), developed by the US Department of Agriculture (USDA), in two separate years; (4) habitat quality descriptions, at the most frequently sampled locations (Spencer Street, Dorwin Avenue, Webster Road, and Tully Farms Road), were qualitatively similar across studies with different methods, providing a degree of corroboration of the EcoLogic results; (5) the EcoLogic reports identify potential causes of the observed habitat degradation at each sampling point, which will assist in decisions of how to prioritize remediation along reaches. The following section presents the habitat assessment findings for Onondaga Creek in qualitative terms.

Text Box 3

Habitat assessments conducted in Onondaga Creek, 1982–2005.

Classical Habitat Surveys (SUNY ESF – Bannon/Ringler: 1982; Danehy/Ringler: 1991-94; Coghlin/Ringler: 2002-03). SUNY ESF researchers surveyed locations in the watershed for a number of attributes, including:

- Creek bed substrate
- Water velocity
- Riperian vegetation
- Discharge
- Creek bed and bank stability
- Water surface slope
- Water quality

Stream Visual Assessment Protocol (SVAP) (EcoLogic: 2000, 2002; entire watershed). Developed by the Natural Resources Conservation Service, USDA. The SVAP was developed for landowners to score overall habitat quality using a composite score of 15 habitat factors, each scored between 1 and 10, that could be assessed visually - mostly physical conditions.

Family Level Biotic Index (EcoLogic: 2000, 2002; entire watershed). This index is based on a well-known survey method (Hilsenhoff 1982, 1987,1988) used to score the general status of organic pollution and habitat on a scale between 0 and 10 based on the composition of the macroinvertebrate community.

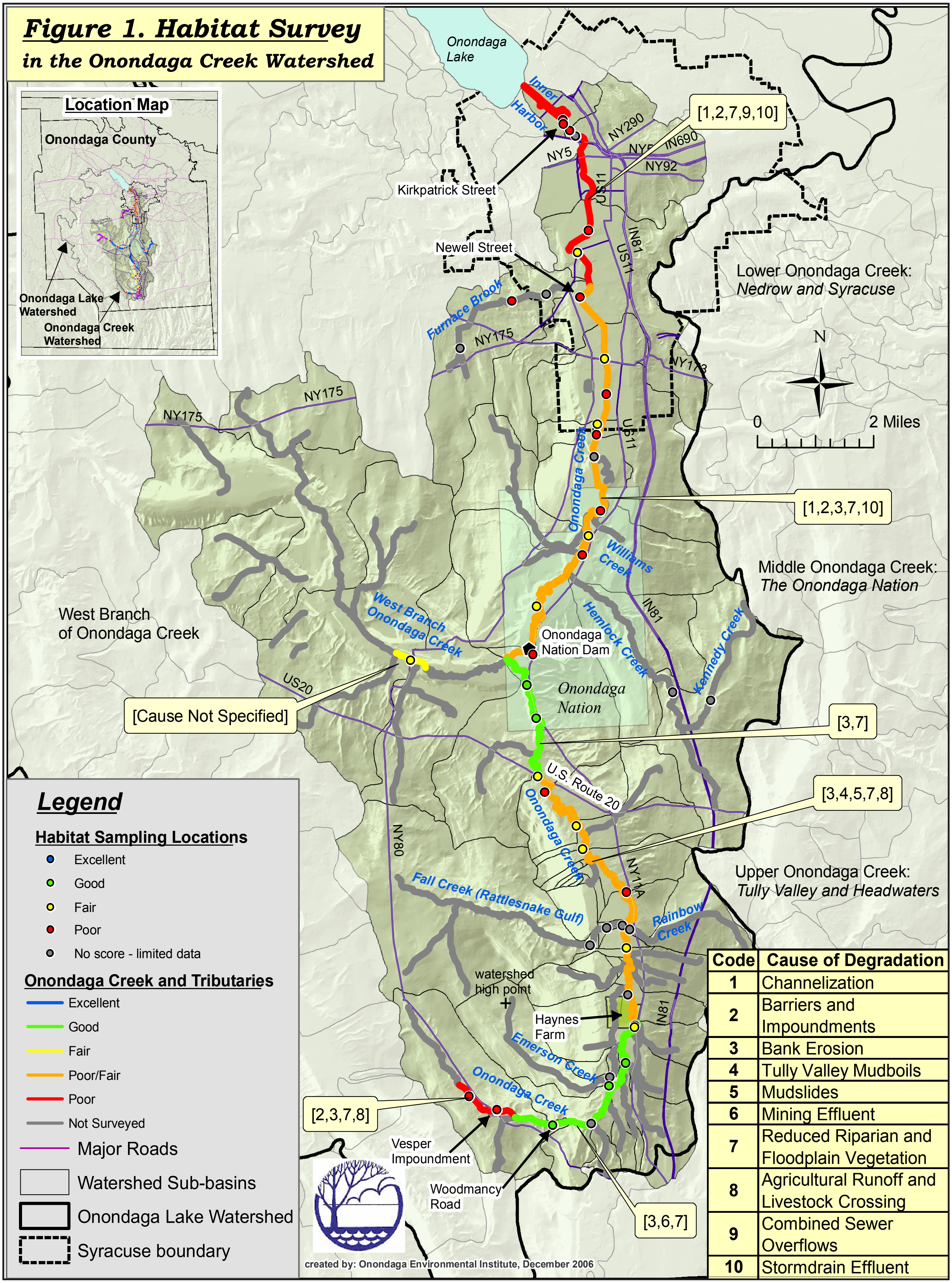
Bioassessment Profile Score (NYSDEC: 1994; EcoLogic: 2000). This methodology was developed at the NYSDEC Department of Water. The overall BAP score is the mean of four indices (species richness, Hilsenoff Biotic Index, EPT index, and percent model affinity) whose scores have been scaled to between 0 and 10, and interpreted as follows: severe impact (0-2.5), moderate impact (>2.5-5), slight impact (>5-7.5), no impact (>7.5-10).

Habitat Assessment Score (USEPA: 1993). This index is a complex combination of 12 component indices in an adaptation of EPA's Rapid Bioassessment Protocol, which normalized each index to a score of 0, 2, 4, or 6, and then summed all scores for an overall assessment score, with possible values ranging between 0 (no impact) to 72 (severe impact).

Biotic Index (SUNY ESF - Coghlin/Ringler: 2002-03). This index is a variation on the BAP that relies on only one of the four component indices, the Hilsenhoff Index, scaled from 0-10.

Index of Biotic Integrity (SUNY ESF – Limburg et al.: 2005). The fish IBI, based on a classic assessment method (Karr et al. 1986), is used to score fish communities relative to a reference community and rank the degree of impact between multiple sites.

Where are the most and least degraded aquatic habitats? What parts of Onondaga Creek haven't been surveyed? Refer to Figure 1 for a creek watershed map that shows the following information.



Code	Cause of Degradation
1	Channelization
2	Barriers and Impoundments
3	Bank Erosion
4	Tully Valley Mudboils
5	Mudslides
6	Mining Effluent
7	Reduced Riparian and Floodplain Vegetation
8	Agricultural Runoff and Livestock Crossing
9	Combined Sewer Overflows
10	Stormdrain Effluent

Onondaga Creek reaches having the *worst* habitat or biological community survey scores (most degraded conditions) were located in:

- Vesper near the old mill impoundment on NY Route 80; and
- Syracuse below Newell Street (see Figure 1).
  These areas are shaded red for "poor" on Figure 1.

The best survey scores (least degraded conditions) were in:

- The main stem of Onondaga Creek in the reach above the mudboils in the Tully Valley to Woodmancy Road (shaded green for "good" on Figure 1)

The next best scores were obtained:

- Between the dam on the Onondaga Nation territory and US Route 20 (shaded green on Figure 1).

Reaches of Onondaga Creek not surveyed intensively or not surveyed at all were shaded grey on Figure 1 map:

- West Branch of Onondaga Creek;
- Tributaries of the main stem of Onondaga Creek, including Furnace Brook, Williams Creek, Hemlock Creek, Kennedy Creek, Fall Creek, Rainbow Creek, Emerson Creek, and many smaller, unnamed tributaries.
  Grey-shaded survey points on Figure 1 represent sites studied by researchers, but resulting data can not be readily interpreted using a "good/poor" scale.

Interestingly, fish community structure upstream of the urbanized areas was a fairly consistent cold water assemblage (see Fish Fact Sheet), despite a wide range of habitat assessment scores, although fish densities varied with reach. Other tributary reaches off the main stem and areas of the West Branch sub-watershed that were not intensively surveyed may also be relatively intact. High densities of brook trout were observed in the upper reaches of tributaries in NYSDEC fish surveys that did not also score habitat.

What are the primary causes of habitat degradation in Onondaga Creek? A number of causes of aquatic habitat degradation were identified in surveys conducted along the main stem of Onondaga Creek (numbers below correspond to Figure 1 and Table 1), but limited information is available elsewhere in the watershed. Results of a number of habitat and biological community surveys are generally in agreement as to the nature and principal causes of degradation in the Onondaga Creek watershed. The following factors were repeatedly identified as important impacts (Table 1 describes biological implications for each cause of habitat degradation):

1. Channelization is associated with flood control in Syracuse, drainage in agricultural areas, and flow control around and through structures such as bridges and the dam on the Onondaga Nation territory. Habitat surveys have identified channelized reaches throughout the urban lower creek (Figure 2), much of which is further degraded by a concrete liner. Unlined channels in agricultural areas are associated with bank erosion and turbidity. By design, channels eliminate the hydrological connection to floodplains, and can also severely reduce or eliminate riparian zone vegetation.

Figure 2. Urban Reach of Onondaga Creek (Courtesy of Atlantic States Legal Foundation)

2. Barriers and impoundments are flow control devices (see Flood Control Fact Sheet). A 'drop structure' is located at Dorwin Avenue in the city, a dam is located on the Onondaga Nation, and a former mill pond is located near the headwaters in Vesper. The Dorwin Avenue drop structure and the Vesper impoundment create a terraced slope, slowing the flow of water, which allows the water to warm and siltation to occur behind the barrier. The dam on the Onondaga Nation is primarily for flood control; a culvert under the dam channelizes water flow and limits water flow-through during high flow periods. There is an additional low barrier just south of Spencer Street in the city.

3. Bank Erosion occurs where riparian vegetation has been severely reduced, at road or cattle crossings, on the outer banks of stream bends, and in areas that were channelized but not lined with concrete, such as short reaches in agricultural areas. In addition to the habitat surveys (Text Box 3), the Onondaga County Soil and Water Conservation District (OCSWCD) has conducted bank stability and erosion surveys in the watershed and identified areas most in need of improvement (Blatchley, 2000).

4. Tully Valley Mudboils are a continuous source of suspended sediment and salinity to the creek (see Tully Valley Mudboils Fact Sheet). Various researchers have identified the mudboils as a critical source of degradation, principally including severe turbidity in the water column and fine sediment loading to the substrate.

5. Mudslides have occurred near Onondaga Creek tributaries due to slumping after heavy rain or snowmelt, or from streambank "toe-cutting" by surface water. They are a relatively continuous source of suspended particles to the water column, with pulsed heavier contributions associated with heavy rain or snowmelt (see Geology Fact Sheet).

6. Mining effluent from the gravel mine on the Tully Valley terminal moraine, ½ mile south of Solvay Road, makes the downstream tributary turbid after significant precipitation. The settling pond also likely warms the surface water. The impact to a wild brook trout population identified in the moraine tributaries by the NYSDEC in 1992 has not been formally assessed. This contributor to creek habitat degradation was not identified in the EcoLogic reports, but was mentioned in other studies.

7. Reduced riparian and floodplain vegetation occurs along almost the entire main stem of Onondaga Creek. In some channelized urban areas and in heavily agricultural areas in the upper creek there is reduced shading from riparian vegetation, which increases water temperature and reduces leaf fall and vegetation litter, a source of habitat and nutrients to life in the creek. Trees and plants in riparian zones provide a buffer to the creek, filtering runoff and stabilizing streambanks with their roots.

8, 9, 10. Pollution occurs throughout the watershed, but is most evident in heavily urbanized and heavily agricultural reaches of the main stem. Non-point nutrient loadings from fertilizers and manure in the upper creek and CSOs in the city can promote algae growth. Toxic chemicals have been reported in Onondaga Creek fish at levels unsafe for consumption (see Fish Fact Sheet).

Is anyone taking measures to improve habitat?

- The Onondaga Creek Working Group, a volunteer group of citizens who live or work in the Onondaga Creek watershed, will develop a revitalization plan for the Onondaga Creek corridor, based on technical information and public input. The Working Group will identify goals for the corridor as they develop the revitalization plan. The goals will help define recommendations for specific habitat improvements.
- In the mean time, stream bank stabilization and non-point source pollution reduction projects (funded under the Onondaga Lake Partnership (OLP) and implemented by Onondaga County Soil and Water Conservation District (OCSWCD)) are on-going in the rural regions of the watershed. Some of the bank stabilization projects, particularly between Nichols and Tully Farms Roads in Tully Valley, include measures to reconstruct riffle-pool alternating reaches in Onondaga Creek, direct water flow, and improve trout breeding habitat.
- The US Geological Survey (also under OLP auspices) has been conducting mudboil remediation measures in the Tully Valley for many years, and has greatly reduced sediment loadings to the middle creek reaches.
- The Combined Sewer Overflow (CSO) treatment projects that are being implemented by Onondaga County in the city are designed to remove large solids and treat for bacteria, but are not designed to reduce nutrient loadings or suspended solid loadings to the lower creek from CSOs, and are likely to discharge chemical byproducts of the chlorination-dechlorination process into the lower creek.
- Additional habitat improvement studies are underway by SUNY ESF researchers.

IMPLICATIONS

This section describes reaches of the creek with similar degrees of degradation, identifies the nature and principal causes of degradation in those reaches, interprets the observed degradation in terms of biological impacts (Table 1), and provides a general assessment of the usefulness of the aquatic habitat surveys for prioritizing improvements.

What is the geographic distribution of impacts to Onondaga Creek habitat? The entire creek main stem is impacted to varying degrees, but reaches of relatively similar quality and causes of degradation were identifiable (Figure 1). Few of the tributaries were surveyed for habitat quality, and sites in tributaries that were sampled are very near the main stem. The two most thoroughly studied segments of the creek are the Tully Valley and Headwaters, and the Lower Creek in the city. The following summary describes habitat conditions along the main stem from the Vesper headwaters to Onondaga Lake, as described in habitat surveys found in the available literature. Biological implications are described in Table 1. The following discussion corresponds to the Onondaga Creek habitat map (Figure 1).

Tully Valley and Headwaters

Above the Vesper impoundment at NY Route 80. *Rating: Poor.* Some of the lowest habitat scores observed in the watershed in 2000 and 2002 (EcoLogic). Impacts and likely causes include:

- Increased water temperature due to inadequate shading from riparian vegetation
- Non-point nutrient loading due to sparse riparian buffer vegetation between the creek and crop fields
- Sediment loads from direct bed and bank disturbance from livestock and dirt road crossings

Vesper impoundment and immediately downstream. *Rating: Poor.* Likely impoundment impacts that affected habitat scores in 2005 (SUNY ESF – Limburg) include:

- Increased temperature immediately downstream due to pooling of water
- Possible excessive nutrients reflected in algae and macrophyte growth. Aquatic plants larger than algae are called macrophytes.
- Occasional introduction of warmwater fish species washed downstream during high flow events

Just above Woodmancy Road to just above the Haynes Farm[1] on NY Route 11A. *Rating: Good.* This segment has the best habitat scores in the watershed based on surveys in 2000 and 2002 (EcoLogic), and 2005 (SUNY ESF – Limburg). The segment was likely affected by sediment loading due to bank erosion; some remediation of these problems in ongoing by OCSWCD.

Haynes Farm to US Route 20. *Rating: Poor/Fair.* Habitat scores are either fair or poor throughout this segment, based on surveys conducted by EcoLogic (2000, 2002), NYSDEC (1989, '90, '95, 2001), SUNY ESF – Coghlin/Ringler (2002, '03), and SUNY ESF – Limburg (2005). Some of the issues are currently being addressed by the OCSWCD. Principal impacts and likely causes include:

- Increased turbidity and benthic degradation principally from mudboil discharge
- Additional sediment loadings due to bank erosion from occasional unlined channelization, cattle crossings, dirt road crossings, unstable stream bed due to dredging, and crop field runoff
- Possible non-point nutrient loadings from manure and fertilizer applications, due to reduced riparian buffer zone, resulting in observed algae growth at Nichols and Turner Road crossings
- Webster Rd. was surveyed most frequently in this segment, with ratings as follows:
  - "slightly impacted" in 1989, 1990, and 1995 (NYSDEC)
  - "moderately impacted" in 2001 (NYSDEC)
  - "fair" overall habitat score in 2000 and 2002 (EcoLogic)

US Route 20 to just upstream of the Onondaga Nation dam. *Rating: Good.* This segment had the second best set of habitat scores, but was only evaluated once in 2000 (EcoLogic). Some turbidity and algae were observed, likely due to local bank erosion, unstable creek bed from dredging, and upstream inputs. Thin riparian cover was also noted.

West Branch of Onondaga Creek

---

1 The term "Haynes Farm" is simply a place label (there is no nearby road crossing), and is not used here to imply any causal connection to habitat condition.

Table 1. Relationships between degraded states in Onondaga Creek, and their causes and potential biological effects.

Cause(s) (per Figure 1 map)	Degraded State	Potential Biological Implications
1. Channelization	• Bed scouring from increased water velocity during high flow periods reduces, or eliminates, diverse substrate (e.g. sand, gravel, etc.) and cover (protected places for fish, other organisms) • Elimination of meanders • Elimination of alternating shallow and deep habitats (riffle/pool) • Few large rocks and boulders • Virtual elimination of riparian wetlands, floodplain connection in lined urban channels	• Food Web. Reduced aquatic vegetation abundance leads to decreased macroinvertebrate (small aquatic animals, visible to the naked eye) and periphyton (attached algae) abundance and/or diversity, hence possibly reduced fish species abundance or richness (number of species). • Fish Cover, Spawning and Nursery Habitat. Riparian and floodplain wetlands provide vegetative structure, as cover, and an infusion of food material during early development of some fish species, and cover for young of the year (less than one year old), juvenile, and small adult fish. Reduction in riparian and floodplain vegetation may significantly reduce fish diversity and recruitment to adulthood (reproductive age). • Fish and Benthic (stream bottom) Communities. Virtual elimination of variety in the stream's aquatic vegetation, physical shape, and natural means to dissipate water energy (e.g., flood plains, riparian vegetation, obstructive boulders and rocks, meanders and pools) combine to limit the number of resident species that can both survive and reproduce within the channelized reaches.
2. Barriers and Impoundments /	• Reduced water velocity, likely resulting in: ◦ Increased water temperature ◦ Reduced oxygen ◦ Sediment accumulation • Increased turbidity (cloudiness) downstream during high flow events from re-suspended sediments • Reduced fish movement	• Fish Health. Water that is slowed and warmed at dams and impoundments carries less oxygen, yet increases the physiologic requirement for oxygen. Fish that are adapted to clear water expend more energy foraging for food in turbid water. High levels of suspended solids could interfere with respiration (breathing water), especially in early life stages, small fish species, and macroinvertebrates. These impacts may lead to severely impacted energy balance that can reduce growth, reproductive success, and survival rate. • Benthic Community. A heavy accumulation of sediment in the stream bed reduces substrate diversity for benthic invertebrates and is more readily disturbed than rock substrate. This severely reduces benthic invertebrate abundance and/or diversity, which in turn affects fish communities – benthic macroinvertebrates are an important food source for fish. • Fish Spawning. Many species require specific substrate conditions for successful spawning. Heavy accumulation of fine particles in the creek bed can interfere with spawning, especially in some cold water species that require gravel or cobble.
3. Bank Erosion **4. Tully Valley Mudboils** **5. Erosion of Mudslide Soils** **6. Mining Effluent**	Increased sediment loading (input) to creek, usually associated with high flow from precipitation or snow melt (except for mudboils, which are relatively continuous), resulting in: • Increased turbidity, sometimes very high • Sediment accumulation • Likely increased temperature (from mining impoundment)	• Fish Health. Fish that are adapted to clear water expend more energy foraging for food in turbid water. High levels of suspended solids could interfere with respiration, especially in small fish and invertebrates. These impacts may lead to severely impacted energy balance that can reduce growth, reproductive success, and survival rate. • Benthic Community (see discussion under 2. Barriers and Impoundments). • Fish Spawning (see discussion under 2. Barriers and Impoundments).
7. Reduced Riparian and Floodplain Vegetation	• Reduced shading, resulting in: • Increased water temperature • Reduced oxygen • Reduced cover (protected places for fish, other organisms) • Reduced input of vegetation litter	• Food Web. Near headwaters, vegetation litter forms the foundation of the nutrient poor headwaters food web, and diversifies substrate for benthic macroinvertebrates. Reduced litter may reduce abundance and/or diversity. • Fish Health. Unshaded water warms and carries less oxygen, yet increases the physiologic requirement for oxygen. Severely impacted energy balance can reduce growth, reproductive success, and survival rate. • Fish Reproduction. Riparian and floodplain wetlands provide vegetative structure as cover and a temporary infusion of food material during spring floods that support the food web of early life stages of many fish species. The abundance and sustainability of fish populations are highly dependent on their ability to successfully reproduce and recruit the next generation of fish to reproductive age.
8. Agricultural Runoff and Cattle Crossings	Runoff is closely related to precipitation and spring melt, while disturbances at cattle crossings are not. Both are related to inadequate riparian zone vegetation buffer (protective filter). The resulting degradation includes: • Nutrient and bacteria loading • Increased turbidity • Sediment accumulation • Pesticide loading	• Ecosystem. Excessive nutrients promote algae growth in reaches with low enough turbidity to allow photosynthesis (capture of the sun's energy by plants). Thick beds of attached algae can reduce local benthic (stream bottom) diversity, and reduce oxygen in the downstream water during decomposition. Increased phytoplankton production can affect turbidity (phytoplankton are microscopic free-floating plants). • Human Health. The extent and persistence of bacteria in the creek are discussed in the Pathogens Fact Sheet • Fish Health. Fish that are adapted to clear water expend more energy foraging for food in turbid water. High levels of suspended solids could interfere with respiration, especially in small fish and invertebrates. These impacts may lead to severely impacted energy balance that can reduce growth, reproductive success, and survival rate. • Benthic Community (see discussion under 2. Barriers and Impoundments). • Fish Spawning (see discussion under 2. Barriers and Impoundments).
9. Combined Sewer Overflows	• Nutrient and bacteria loading • Increased turbidity • Sediment accumulation • Toxics	• Ecosystem (see discussion under 8. Agricultural Runoff and cattle Crossings) • Human Health (see Pathogens Fact Sheet) • Fish Health (see discussion under 8. Agricultural Runoff and cattle Crossings) • Benthic Community (see discussion under 2. Barriers and Impoundments) • Fish Spawning (see discussion under 2. Barriers and Impoundments) • Toxic Effects. Certain impacts to benthic invertebrate communities may be consistent with generalized toxic chemical exposures, but the habitat surveys provided little specific information on potential for human health or ecological toxic effects from treated or untreated CSO effluent.
10. Storm Drain Effluent	• Increased turbidity • Increased water velocity	• Fish Health. (see discussion under 8. Agricultural Runoff and cattle Crossings)

Rating: Fair. This entire segment was assessed only once at a single location in 2001 by the NYSDEC at the NY Route 80 crossing, where water quality was scored as "slightly impacted" based on a biological survey, but the likely cause of degradation was not discussed.

Onondaga Nation

Rating: Poor/Fair. Only one formal survey was located, conducted by EcoLogic in 2000, which included four sites on the Onondaga Nation territory. Scores were fair and poor throughout this segment; the principal impact was high turbidity, likely from upstream contributions, as well as local bank erosion, thin riparian buffer, and some channelization and dredging. Poor riparian cover was noted just above the flood control dam, and at other locations.

Lower Creek (Nedrow and Syracuse)

Onondaga Nation to Newell Street. *Rating: Poor/Fair*. This segment was surveyed in 1999, 2000, and 2002 (EcoLogic) and in 2005 (SUNY ESF – Limburg). The most frequently sampled location was Dorwin Ave., which was rated as "slightly impacted" in 1999 and 2000 (EcoLogic), and "poor' in 2002 (EcoLogic). Survey scores were mostly 'poor,' due to effects from channelization and poor riparian zone vegetation.

Newell Street to Kirkpatrick Street. *Rating: Poor*. Various sites within this segment were sampled during numerous surveys conducted between 1989 and 2005. This is the largest severely impacted segment of the main stem, with ratings of 'poor' in nearly all cases, interspersed with occasional 'fair' and 'severe impact' scores. There is no evidence in the available survey data that conditions changed during that time. Degradation includes: no floodplain; channelization essentially throughout this segment; bacteria and loading of solids from CSO effluent; algal growth from CSO nutrient loadings; garbage and stormdrain effluent; and poor riparian zone and benthic substrate.

Are existing survey data adequate for prioritizing habitat improvements? It depends on the goals for the biological communities. If conservation of a general community type – such as a cold water fish community - is the goal, then the existing surveys likely provide sufficient information for prioritizing the most obvious improvements in the main stem of the creek. Habitat information is generally more sparse in tributaries, and may need to be supplemented. Remediation of obvious sources of degradation, such as mudboils and bank erosion, is already occurring. Additional information is likely necessary to evaluate the efficacy of those remediation efforts. On the other hand, if the conservation or increase of a naturally sustainable population of a particular set of species is a goal, then detailed information particular to those species (e.g., Coghlan and Ringler, 2005) is likely required.

REFERENCES

Bannon, E. 1984. Prediction of diet in a natural population of brown trout (Salmo trutta) from the analysis of foraging costs. Master's Thesis. SUNY College of Environmental Science and Forestry, Syracuse, New York.

Blatchley, T.C. 2000. A streambank and roadbank erosion inventory of the Onondaga Creek watershed, Onondaga County, NY. Onondaga County Soil and Water Conservation District report. August 17, 2000.

Bode, R.W., and M.A. Nowak. 1988. Proposed biological criteria for New York State streams. In: T. Simon, L. Holst, L.J. Shepard (Eds). Proceedings of the 1st National Workshop on Biological Criteria, Lincolnwood, IL. Dec 2-4, 1987. EPA Region 5, Chicago, IL. EPA Doc. No. EPA-905/9-89/003..

Bode, R.W., M.A. Novak, and L.E. Abele. 1989. Biological stream assessment: Streams tributary to Onondaga Lake, Onondaga County, New York. 1989 Survey. Stream Biomonitoring Unit, Bureau of Monitoring and Assessment, Division of Water, NYSDEC.

Coghlan, S.M. and N.H. Ringler. 2005. Survival and bioenergetic responses of juvenile Atlantic salmon along a perturbation gradient in a natural stream. Ecol Freshwat Fish 14: 111-124.

Danehy, R.J. 1994. Geomorphic, hydrologic, and hydraulic determinants of fish and macroinvertebrate communities in a small watershed. PhD Dissertation. SUNY College of Environmental Science and Forestry, Syracuse, New York.

Davis, M.A. and L.B. Slobodkin. 2004. The science and values of restoration ecology. Restor Ecol 12(1): 1-3.

Danehy, R.J., N.H. Ringler and J.Ruby. 1999. Hydraulic and geomorphic influence on macroinvertebrate distribution in the headwaters of a small waters. J Freshwat Ecol 14: 79-91.

EcoLogic. 2001. 2000 Onondaga lake tributary mapping. Prepared for: Onondaga County Department of Water Environment Protection, Syracuse, NY. Prepared by: EcoLogic, LLC., Cazenovia, NY.

EcoLogic. 2001. 2000 Onondaga lake and tributaries macroinvertebrate monitoring. Prepared for: Onondaga County Department of Water Environment Protection, Syracuse, NY. Prepared by: EcoLogic, LLC., Cazenovia, NY. October, 2001.

EcoLogic. 2003. 2002 Onondaga lake tributary mapping. Prepared for: Onondaga County Department of Water Environment Protection, Syracuse, NY. Prepared by: EcoLogic, LLC., Cazenovia, NY. April, 2003.

EcoLogic. 2003. 2002 Onondaga lake and tributaries macroinvertebrate monitoring: Significant findings and data summaries. Prepared for: Onondaga County Department of Water Environment Protection, Syracuse, NY. Prepared by: EcoLogic, LLC., Cazenovia, NY. April, 2003.

Hilsenhoff, W.L. 1982. Using a biotic index to evaluate water quality in streams. Wisconsin Department of Natural Resources Technical Bulletin No. 132. 22 pp. As cited in Bode and Novak 1988.

Hilsenhoff, W.L. 1987. An improved biotic index of organic stream pollution. The Great Lakes Entomologist. 20(1): 31-40. As cited in Bode and Novak 1988.

Hilsenhoff, W.L. 1988. Rapid field assessment of organic pollution with a family-level biotic index. J N Amer Benthol Soc 7: 65-68.

Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R. Yant and I.J. Schlosser. 1986. Assessing biological integrity in running waters: A method and its rationale. Illinois Natural History Survey. Special Publication 5. September, 1986.

Lancaster, J. 2000. The ridiculous notion of assessing ecological health and identifying useful concepts underneath. Human Ecol Risk Assessm 6(2): 213-222.

Limburg, K., V. Collins, C. Landis, J. Popoli, C. Whritenour, and A. Wilson. 2005. (Unpublished data).

Misch, W.J. and J.G. Gosselink. 2000. Riparian Ecosystems (Chapter 15). pp 513-567. In Wetlands (3rd ed.), John Wiley & Sons, Inc., New York.

Natural Resources Conservation Service (NRCS). 1998. Stream Visual Assessment Protocol. United States Department of Agriculture. National Water and Climate Center Technical Note 99-1. 36 pp. December, 1998. http://www.nrcs.usda.gov/technical/ECS/aquatic/svapfnl.pdf.

Simpson, K.W. 1982. Technical Memorandum: Biological Survey of Onondaga Creek. Center for Laboratories and Research, NYS Department of Health, Albany, NY. November, 1982. 28 pp.

Smith, A.J. and R.W. Bode. 2004. Analysis of variability in New York State benthic macroinvertebrate samples. Division of Water, NYSDEC, Albany, NY.

Ringler, N.A., C. Gandino, P. Hirethota, R. Danehy, P. Tango, C. Morgan, C. Millard, M. Murphy, M.A. Arrigo, R.J. Sloan and S.W. Effler. 1996. Fish communities and habitats in Onondaga Lake, adjoining portions of the Seneca River, and lake tributaries. pp 453-494. In: S.W. Effler (Ed). Limnological and Engineering Analysis of a Polluted Urban Lake: Prelude to Environmental Management of Onondaga Lake, New York. Springer-Verlag, New York.

Upstate Freshwater Institute. 1994. The state of Onondaga Lake. Prepared by: Upstate Freshwater Institute, Syracuse, NY. Prepared for: Onondaga Lake Management Conference, Syracuse, NY. pp 6-97 to 6-102.

US Environmental Protection Agency (USEPA). 1996. Combined sewer overflows and the multimetric evaluation of their biological effects: Case studies in Ohio and New York. USEPA Office of Water, Washington, DC. EPA Doc. No. EPA-823-R-96-002.

Vannote, R.L., G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37:130-137.

FOR MORE INFORMATION:

Onondaga Environmental Institute

102 West Division Street, 3rd Floor
Syracuse, NY 13210

Phone: (315) 472-2150
Fax: (315) 474-0537
Email: outreach@oei2.org

The Onondaga Lake Partnership (OLP) sponsors the Onondaga Creek Revitalization Plan project with funds from the U.S. Environmental Protection Agency. Visit www.onlakepartners.org for more information about the OLP.

This fact sheet and additional information about the Onondaga Creek Revitalization Plan project can be found on the World Wide Web at www.esf.edu/onondagacreek/.