

Ecological Status of Onondaga Creek in Tully Valley, New York — Summer 1998

Onondaga Creek flows through the Tully Valley (fig. 1) and supports a cold-water fishery (brook trout and brown trout) along its length. Several unusual hydrogeologic features cause the water quality of the creek to deteriorate as it flows northward. Mudboils, which are found in the central part of the valley, discharge artesian-pressured freshwater, brackish water, and fine-grained sediment to the land surface and to Onondaga Creek. Several mudslides (the latest in 1993) have exposed brackish-water springs that also discharge to the Creek. The result is a further degradation of water quality and possible adverse effects to stream biota. Even though remedial efforts in the mudboil area have decreased sediment loading to the creek (from 30 tons per day in 1992 to less than 1 ton per day in 1998), the discharge of brackish water is a concern to local citizens as well as to State and Federal agencies.

An ecological survey of the creek was made by the New York State Department of Environmental Conservation (NYSDEC) and the U.S. Geological Survey (USGS) in July and August 1998. Fish populations were sampled at eight sites and macroinvertebrate

status of the creek and serve as a baseline for future study and for comparison of the effects of remediation projects within this part of the Onondaga Creek watershed.

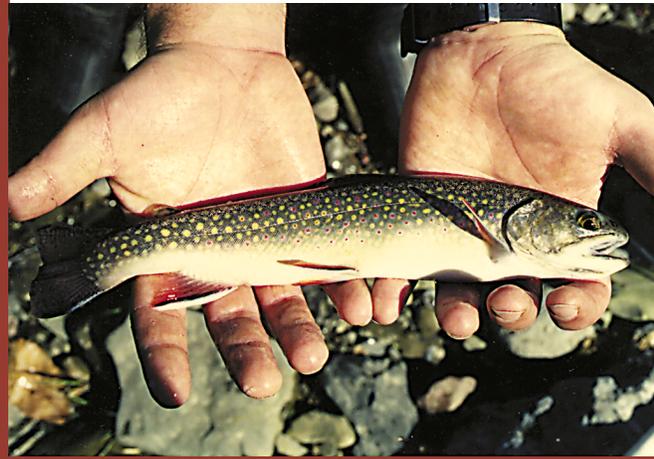
Physical Setting

The Tully Valley is a north-south-trending glacial trough which is about 6 miles long and a mile wide. The valley walls consist of till (compact soils) over weathered bedrock, and the valley floor overlies more than 400 feet of glacial deposits (gravel and sand grading upward to silt and clay at land surface) and the floor slopes gently from the valley walls toward the center of the valley. Onondaga Creek begins in the southern uplands of the Tully Valley and flows northward toward Syracuse, where it drains to the Seneca River and eventually flows to Lake Ontario. Land use in the valley is agricultural and low-density residential, and a brine-mining operation at the southern end of the valley was active for nearly a century (1889-1986).

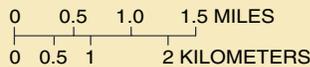
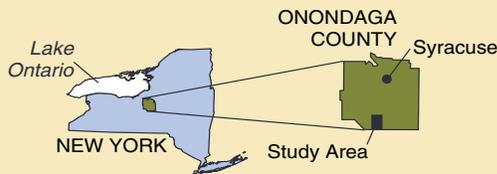
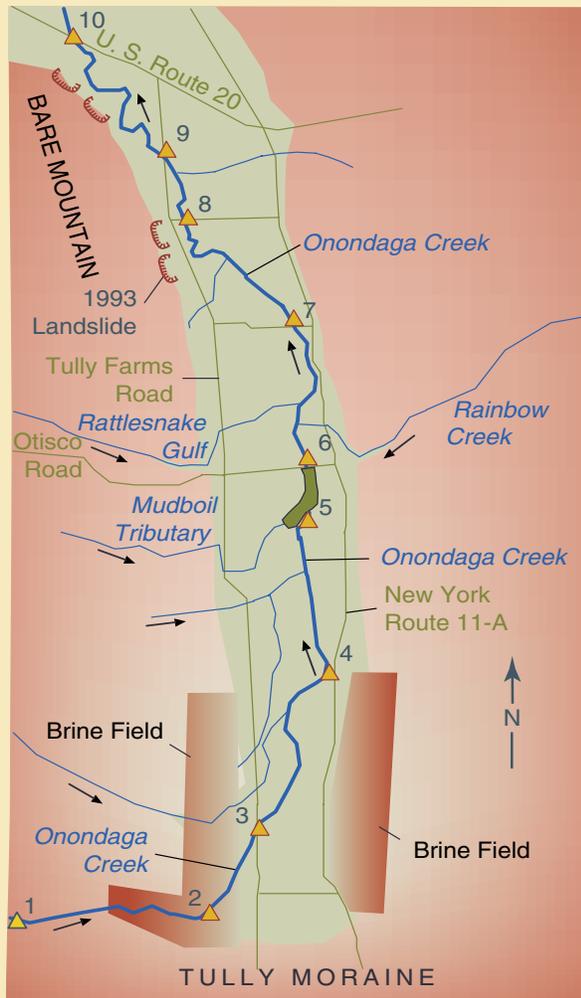


Brown Trout — *Salmo trutta*

populations were sampled at nine sites in the upper 5 miles of the Onondaga Creek watershed (south of U.S. Route 20). The resulting data were correlated with streamflow and water-quality data collected by the USGS at 10 locations in the same reach to evaluate the ecological



Brook Trout — *Salvelinus fontinalis*



EXPLANATION

- LANDSLIDE AREA
- MUDBOIL AREA
- STREAM CHANNEL-
arrow shows direction
of streamflow
- VALLEY FLOOR
- VALLEY WALLS
- STREAM MONITORING
SITE AND NUMBER

Fig. 1. Principal hydrologic features and locations of sampling sites in Tully Valley, N.Y.

Discharge and Water Quality

The discharge measurements made along Onondaga Creek in July 1998 indicate that streamflow is supplemented by springs discharging from the Tully Moraine at the southern end of the valley, by streams along the flanks of the valley (primarily Rattlesnake Gulf and Rainbow Creek), and by springs discharging from the mudslide areas along the base of Bare Mountain. Little if any flow comes from the valley floor, except from mudboils, or from wells drilled around the mudboil area to lower the local artesian pressure.

The chemical quality of Onondaga Creek changes at each inflow point (table 1). Specific conductance (a measure of dissolved-solids concentration) ranged from 500 to 600 $\mu\text{S}/\text{cm}$ (microsiemens per centimeter) upstream from the mudboils but increased to 1,400 $\mu\text{S}/\text{cm}$ just downstream from the mudboil tributary. The specific conductance was lowered slightly by inflow from Rattlesnake Gulf and Rainbow Creek but increased to 2,000 $\mu\text{S}/\text{cm}$ downstream from the 1993 landslide area and to 2,250 $\mu\text{S}/\text{cm}$ downstream from the northernmost landslide areas at the base of Bare Mountain. Dissolved

oxygen concentration was fairly constant (7.00 to 7.92 mg/L) along the creek, but was near 6.0 mg/L in the mudboil tributary and at site 10 at U.S. Route 20. pH varied only slightly (8.4 to 8.6 units) along the creek, but was about 7.5 in the mudboil tributary. Chemical concentrations were relatively stable along the creek except for sodium chloride (halite/salt) and calcium sulfate (gypsum), which increased as a result of discharges from mudboil and mudslide areas. Water temperature increased downstream, but this change was related to the time of day at which the temperature was measured.

A similar but less rigorous water-quality study of Onondaga Creek was done by the New York State

Department of Health (NYSDOH) in December 1981 in response to reports of excessive turbidity in the creek at that time. The values of specific conductance and pH upstream from the mudboil tributary then were similar to those measured in 1998, but specific conductance downstream from the mudboils was less than a third of the 1998 value. The turbidity resulting from mudboil discharges in 1981 was described as “hyper-turbid” and was probably much greater than at present. No other water-chemistry measurements on Onondaga Creek were made in 1981, but the lower specific conductance measured then indicates that the halite and gypsum concentrations were probably much lower than at present.

Fish-Survey Results

Onondaga Creek, like many central New York streams, is home to several species of trout and a variety of smaller, native fish species such as suckers, chubs, and dace. The abundance and diversity of fish in a stream are affected by habitat conditions and by water quality. Ten species of fish were found within the surveyed section. The number of species at each survey site ranged from four (site 1) to as many as eight (sites 4 and 6), although most sites were dominated by two or three species. Fish diversity, based on the Shannon-Wiener diversity index, ranged from 1.05 to 1.76 (see fig. 2). (A diversity index combines information about the

Table 1. Discharge and water quality data of Onondaga Creek within Tully Valley, Onondaga County, N.Y., July 20, 1998

ft³/s = cubic feet per second; °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter, Analyses by USGS.

Location and source of flow	Time	Dis-charge (ft ³ /s)	Dissolved oxygen (mg/L)	Specific conductance (µS/cm)	pH	Sodium, as Na (mg/L)	Chloride, as Cl (mg/L)	Calcium, as Ca (mg/L)	Sulfate, as SO ₄ (mg/L)
Onondaga Ck. at Woodmancy Road - Site 1 (On west valley wall, in headwaters above waterfalls)	0745	3.26	7.11	490	8.41	18.2	28.4	70.5	11.0
Onondaga Ck. at Tully Farms Road - Site 3 (Entering valley, additional flow from moraine springs)	0945	7.09	7.73	456	8.48	13.6	21.2	59.8	12.2
Onondaga Ck. at NYS Route 11A - Site 4 (East side of valley, additional flow from moraine springs)	1015	10.4	7.37	554	8.44	34.2	38.6	59.9	17.2
Onondaga Ck. above mudboil area - Site 5 (Central valley floor, limited side-wall tributary inflow)	1030	11.4	7.92	604	8.59	52.6	50.7	58.0	18.6
Mudboil Tributary to Onondaga Creek (Valley floor, flow from mudboils and depressurizing wells)	1215	0.728	6.04	6,940	7.50	1,230.	2,100.	160.	250.
Onondaga Ck. at Otisco Road - Site 6 (Valley floor, downstream of mudboil and well discharges)	1330	12.0	7.55	1,410	8.50	185.	286.	68.4	50.4
Onondaga Ck. at Nickols Road - Site 7 (Valley floor, below Rattlesnake Gulf and Rainbow Creek)	1415	14.1	7.00	1,160	8.44	174.	268.	68.9	49.9
Onondaga Ck. at Webster Road - Site 8 (Valley floor, below 1993 mudslide springs)	1430	18.3	7.25	2,010	8.35	295.	468.	84.1	73.1
Onondaga Ck. at Bear Mt. Road - Site 9 (Valley floor, below east-valley-wall tributary)	1530	18.8	7.05	1,970	8.39	290.	456.	83.5	71.7
Onondaga Ck. at US Route 20 - Site 10 (Valley floor, below 2 northern slide area springs)	1600	17.5*	5.90	2,250	8.17	340.	525.	86.0	91.5

*Streamflow measurement at Route 20 affected by upstream beaver dam, which diverted flow from stream channel

number of species present with the relative abundance of those species to indicate how strongly the community is dominated by one or more species.)

The uppermost 3 miles of Onondaga Creek (not shown on the map) above site 1, contains relatively poor habitat for cold-water fish (brook trout and brown trout) because of the low streambed gradient (about 22 ft/mi), warm water, and unfavorable habitat conditions. The creek plunges over a series of waterfalls to the valley floor just upstream from site 1. The gradient of the creek from site 1 to site 3 is about 140 ft/mi, which provides the fast-moving, clean-bottom habitat required for trout. This reach also receives cold inflow

from several spring-fed tributaries flowing northward from the Tully Moraine. The density of brook trout in five of these tributaries is high (9,800 to 37,000 fish per acre of streambed), according to previous NYSDEC fish surveys. The unique habitat of these small tributaries may be endangered, however, by recent gravel mining on the Tully Moraine, which could cause increases in turbidity and(or) water temperature in the tributaries.

Brown trout have become naturalized (successfully reproduce) since they were introduced in the past century and are the dominant fish predators in Onondaga Creek. They have out-competed native brook trout along the main stem, confining the

brook trout to the small tributaries in which the water is too cold for brown trout. Only site 2 was inhabited by an appreciable number of brook trout; this site represents the 1.5-mile reach in which most of the small moraine tributaries enter Onondaga Creek upstream from Tully Farms Road. Even at this site, however, brown trout biomass was 7 times that of brook trout. The only other main-stem site with brook trout was site 3, also near Tully Farms Road; here the brown trout biomass exceeded the brook trout biomass by a factor of 230. Site 3 also contained the largest biomass of brown trout in the surveyed stream system — an estimated 113 lb/acre. Reproduction of trout in this reach is adequate

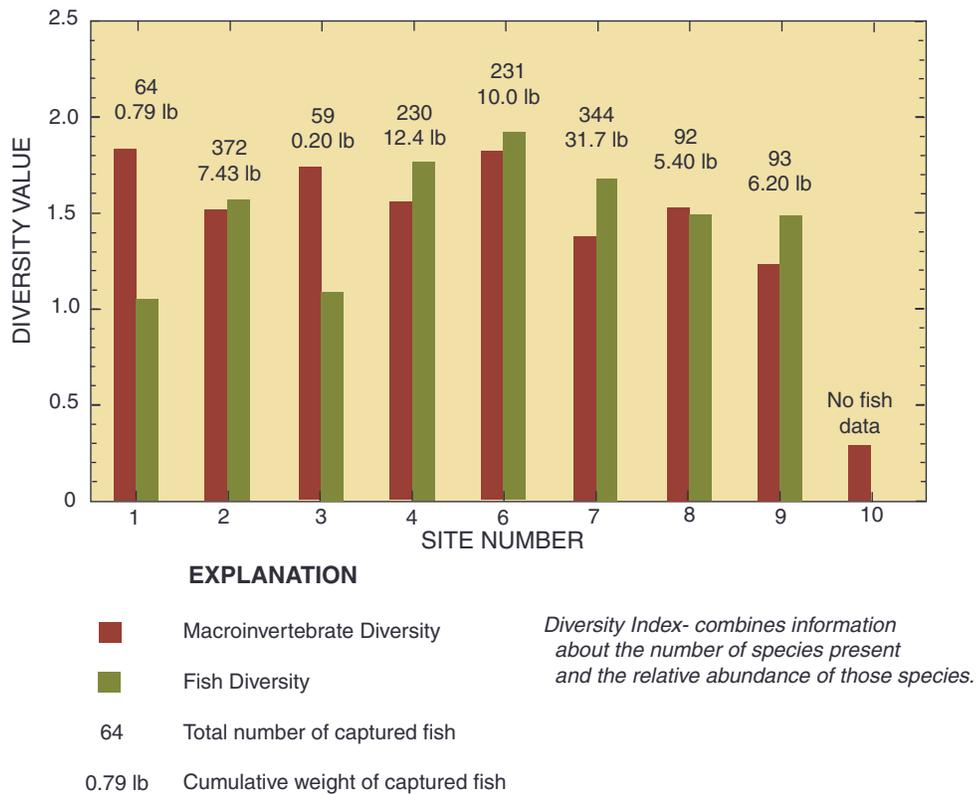


Fig. 2. Diversity of macroinvertebrates and fish at sites along Onondaga Creek, July and August 1998. No biological data were collected from Site 5 and no fish data were collected from Site 10. (Site locations shown on fig. 1)

to fill the available habitat throughout the creek because conditions in the lower reaches do not support natural reproduction.

Water temperature from site 1 to site 9 was low enough to support trout, even during summer hot spells, but competition from non-trout species and changes in water quality (primarily increased turbidity from the mudboil tributary) probably decrease trout density. Brown trout biomass decreases downstream, in the vicinity of the mudboil tributary. The average brown trout biomass at four sites above the mudboil discharge was 53 lb/acre, but at sites downstream of the mudboils, it was about 16 lb/acre. White suckers are found in greater numbers in the turbid waters below the mudboil tributary, where the stream gradient decreases to about 20 ft/mi. Although the change in fish species composition and diversity occurs just downstream of the mudboil tributary, the composition of fish species above and below the mudboil area indicate that habitat availability may be more important to fish community structure than water quality. Also, an increase in one species is generally offset by a decline in another because biological systems support a finite biomass. The changes in fish-population composition and species abundance noted in this survey, and comparison of results with those of previous NYSDEC surveys, indicate that Onondaga Creek is at or near its carrying capacity for trout.

Invertebrate Survey Results

Macroinvertebrates (mostly aquatic insects) are an integral part of any stream ecosystem. They form the major component of fish diets and are a link between fish and the lower end of the food chain.

Macroinvertebrates also are indicators of a stream's environmental condition because they are less mobile than fish; thus, their abundance and distribution reflect local conditions.

Nine sites along Onondaga Creek (sites 1-4, 6-10) were sampled for macroinvertebrates in July 1998; eight of these sites corresponded to the fish-sampling locations (sites 1-4, 6-9). Sixteen invertebrate taxa or groups (mostly insects) were found in the survey. Site 10 had the fewest taxa (5), and site 3 had the most (13). Invertebrate diversity generally decreased downstream from the headwaters (site 1) to sites 9 and 10, near U.S. Route 20 (fig. 1). The number of individual invertebrates found in each sample generally exceeded 100, but the number per sample at site 10 was less than 30. The composition of the invertebrate community changed along the length of the creek, but midges were the most common at all sites. Downstream from the headwaters, the next most dominant taxa changed in the following sequence: stonefly, mayfly, true flies, beetle, caddisfly, and worm. This sequence indicates a change from good to poor environmental conditions, and the changes in predominant taxa downstream from the mudboil tributary indicate a shift from intolerant groups to tolerant groups; a similar change was measured during the NYSDOH survey of the creek in 1981. The change in macroinvertebrate community composition along the measured reach of the creek indicates that habitat is probably more important to the invertebrate-community structure than changes in water quality.

Site 2, upstream from Tully Farms Road, had the highest diversity of macroinvertebrates but a low number of individuals (about 60 per sample).

This site had the highest density of predatory fish (brown trout and brook trout), which probably accounts for the low number and high diversity of macroinvertebrates. A 1981 survey of invertebrates in Onondaga Creek by NYSDOH also revealed an absence of mayflies below the mudboils and the dominance of worms (oligochaetes) in the most downstream areas. That study also indicated a lower prevalence of midges, and a greater range in stoneflies, than was found in this study. Collection locations and analytical methods differed from those used in this study, however; thus, rigorous comparisons are infeasible.

Conclusions

Downstream changes in fish and invertebrate assemblages and in water quality along the 5-mile surveyed reach of Onondaga Creek can be attributed to physical, chemical, and habitat changes along the stream. Stream gradient is flatter (about 15 ft/mi), and streamflow is slower, just downstream of the mudboil tributary than above it. The mudboil discharge strongly affects water quality and fish-population composition along the stream, but the effects of inflows from the mudslide areas, further downstream, are difficult to quantify.

Fish and macroinvertebrate diversity values change along the surveyed reach of Onondaga Creek in response to changes in both stream morphology and water quality. Fish diversity increases downstream from site 1 to site 4 but decreases below the mudboil tributary (sites 6-9). The predominant species above the mudboils are brown trout, brook trout, and mayflies, whereas those below the mudboil tributary are suckers, dace, and caddisflies. In the transition area below the mudboil

tributary, the defining species were suckers, sculpin, and beetles. Species unique to the upstream sites can successfully compete in (and require) a fast-flowing, clean-bottom habitat, whereas species downstream from the mudboils include those that are tolerant of degraded environmental conditions. Although the change in species composition and diversity is greatest just downstream of the mudboil tributary, the similarity of species assemblages above and below the mudboil area indicate that habitat availability may be more important to species structure than water quality. The restricted range of stonefly occurrence in this survey may indicate a sensitivity to the increased concentration of halite discharged from the mudboil tributary. The changes in turbidity since the 1981 DOH invertebrate survey have had little effect on the invertebrate groups. The 1998 survey provides a baseline for future study and comparison as investigations of the stream, mudboil, mudslide, and watershed-remediation projects continue.

Sources of Technical Information

- Danehy, R.J., Ringler, N.H., and Ruby, R.J., 1999, Hydraulic and geomorphic influence on macroinvertebrate distribution in the headwaters of a small watershed: *Journal of Freshwater Ecology*, v. 14, no. 1, p. 79-91.
- Kappel, W.M., Sherwood, D.A., and Johnston, W.H., 1996, Hydrogeology of the Tully Valley and characterization of mudboil activity, Onondaga County, New York: U.S. Geological Survey Water Resources Investigations Report 96-4043, 1996, 71 p.
- Simpson, K.W., 1982, Biological survey of Onondaga Creek, Center for Laboratories and Research, New York State Department of Health, Technical Memorandum, 28 p.

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