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Saw Kill Studies for Micro-hydropower Development

Final report on 2020 activities

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Hudsonia

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Introduction

This report presents pre-case surveys of American eel and other fishes, Louisiana waterthrush, wood turtle, and plants along the Saw Kill, as well as installation and operation of an automatic water quality monitoring station at the Annandale Dam. The surveys will be repeated in the first season after the turbines become operational at the Annandale Dam. Water quality will be monitored continuously except during winter.

We have focused the biological surveys on flora and fauna that are uncommon or rare, or of conservation concern for other reasons (e.g., the range-wide decline of American eel on the U.S. East Coast). It is these organisms that are potentially vulnerable to impacts of the micro-hydropower facility to be built in Annandale.

Annandale Dam Eel Trapping, June 2020

Robert E. Schmidt and Lea Stickle

Introduction

The Annandale Dam is located on the Saw Kill in Annandale, Dutchess County, New York. A hydropower generating facility has been proposed at this dam. As part of assessing environmental concerns about the proposed facility, we sampled American eels (*Anguilla rostrata*) in the vicinity of the dam. American eels are the only migratory fish in the Annandale area of the Saw Kill, are considered a significant species in the Hudson River watershed, listed as a New York Species of Greatest Conservation Need, and are suffering a population decline on the East Coast. This report summarizes our effort to collect American eels from the plunge pool under the Annandale Dam.

Methods

Two fish traps were deployed in the plunge pool under the Annandale Dam. The traps were 1 m long with two funnels and were baited with cans of cat food with holes punctured in the cans. These are the same traps used in a previous study of the Annandale Dam plunge pool (Anderson and Schmidt 2006). The traps were deployed on 10 June 2020 and were checked and rebaited every two or three days until 19 June 2020 when sampling ceased.

Captured eels were anesthetized with clove oil, measured (total length [TL] in cm), tip of the right pectoral fin was clipped, and the animals were returned to the plunge pool. Other organisms captured were identified, counted, and released.

Results

Traps were fished for 9 days (18 trap-days). Three American eels were captured and one of them was recaptured for a total catch per unit effort of 0.22 eels per trap-day. The eels were large (58, 74, and 90 cm TL) and the recaptured eel was the smallest of the three. In contrast, Anderson and Schmidt (2006) caught 10 American eels and had 7 recaptures in 38 trap-days for a catch per unit effort of 0.45 eels per trap-day with a population estimate of 13 eels. Sizes were smaller in that study, 42-79 cm TL.

Other species collected (Table 1) were rock bass (*Ambloplites rupestris*), cutlip minnow (*Exoglossum maxillingua*), white sucker (*Catostomus commersonii*), pumpkinseed (*Lepomis gibbosus*), and spinycheek crayfish (*Orconectes limosus*). All of these species are native to the Hudson River and tributaries except the rock bass.

Table 1. Summary of the fishes collected under the Annandale Dam using baited traps.

Survey Dates	**6/10/2020**		**6/12/2020**		**6/15/2020**		**6/17/2020**		**6/19/2020**	
	West Trap	East Trap	West Trap	East Trap	West Trap	East Trap	West Trap	East Trap	West Trap	East Trap
American eel	1				2*		1			
rock bass	4		7		1	2		1		2
cutlip minnow				3		3				
white sucker						1				
pumpkinseed						1			1	
spinycheek crayfish				2						

*one of these eels was a recapture

Discussion

American eels inhabiting the plunge pool under the Annandale Dam are large, in fact the 90 cm TL individual may be the largest accurately measured in the Hudson River watershed. These large eels are females and, once they return to the Sargasso Sea to spawn, contribute to the glass eel populations in future years. Anderson and Schmidt (2006) estimated only 13 American eels living in the plunge pool. The catch per unit effort in 2020 was half the value in 2006 but traps were fished for twice as long in 2006. We conclude that both studies showed that few eels (< 20) inhabit the plunge pool, but they are large and that there was little difference seen between these two studies.

Even though the numbers are small, these large female eels are important. Great care should be taken during construction, maintenance, and running the power facility to minimize disturbance of the plunge pool habitat and any possibly injury to the eels.

Louisiana Waterthrush

The Louisiana waterthrush is a warbler that is listed as a Species of Greatest Conservation Need in New York. This bird breeds along streams and in swamps, and is reported to typically build its nest beneath a tree root or a log, or in a soil cavity, on an eroding bank. Almost every spring since the 1970s, a Louisiana waterthrush has been heard singing regularly in the vicinity of the lowest waterfall on the Saw Kill (i.e., between the Lower Dam and the tidewater of South Bay).

During the 2016 bird surveys for this project, Kiviat found Louisiana waterthrushes singing in the traditional location, as well as foraging just above the Lower Dam, and at a location between the Annandale Pond and Route 9G. On one day in early June 2020, Chris Graham surveyed the Saw Kill from the tidal mouth upstream to the Annandale residential cluster, and Susan Rogers surveyed on the morning of 26 June by boat from River Road to Route 9G. Graham found a singing male Louisiana waterthrush in the typical location between the Lower Dam and the tidal mouth. Rogers did not find the species upstream. The downstream waterthrush is unlikely to be affected by micro-hydropower at the Annandale Dam, whereas an earlier considered hydropower development at the Lower Dam could have disturbed the singing male (and presumably a female) whose breeding territory includes that dam and probably the banks down to the tidal mouth.

Wood Turtle

The wood turtle is a Species of Greatest Conservation Need that is closely associated with streams and rivers and their riparian zones. Wood turtles also occur in springfed ponds and fresh-tidal swamps, neither of which is directly relevant to the Saw Kill. There is a historic record of wood turtle near the Saw Kill at Bard, and recent (2018) documentation of a population in the Saw Kill upstream of Route 9G. A wading survey for wood turtle in the lower Saw Kill at Bard on 7 (Lower Dam area upstream to Annandale Dam) and 15 October (upstream end of Annandale Pond to Route 9G). Flows were fairly low and the turtles would probably have been in the water rather than on land. The survey was performed by Hudsonia collaborator Jason Tesauro with Erik Kiviat (special permission was obtained from Bard for Tesauro to work outdoors on campus during the pandemic). No wood turtle was found. Notwithstanding, Tesauro deemed the habitats of good quality and expects that wood turtles do occur there.

Flora

By Gretchen Stevens

In 2016, for this project, I surveyed the vascular flora of the entire lower Saw Kill from the tidal mouth upstream to Route 9G, and including the old penstock ditch from the Lower Dam to the location of the historic Montgomery Place hydroelectric generating plant. At that time, there was consideration of a micro-hydropower turbine installation at the historic site, an option that is not now considered viable. The flora was surveyed in two, 1 meter belts from the low water level up the banks. A flora list was appended to our original report (Kiviat et al. 2017). Bryophytes were also surveyed, by Julia Palmer, in several sample plots along the Saw Kill, 2016-2017. My findings in 2016 included documentation of two large populations of the winged monkeyflower (*Mimulus alatus*; New York State S3 Rare), one of which was previously unknown and the other last studied in 1992. Palmer discovered the rare two-ranked moss (*Pseudotaxiphyllum distichaceum*; New York State S2S3) at “The Lake” (above the Lower Dam).

In summer 2020 I revisited parts of the Saw Kill corridor to survey for two-ranked moss, to assess the winged monkeyflower (*Mimulus alatus*) stands, and to survey the vascular plants above and below the Annandale Dam. The purpose of these surveys was to extend the 2016-17 flora surveys along the Saw Kill and provide further baseline data for considering potential effects of installation and operation of a microhydropower turbine at the dam.

Winged Monkeyflower

Winged monkeyflower is a perennial herb of moist to wet habitats, and is known to occur at tidal and nontidal sites along the Hudson River and inland in the Hudson Valley. It is ranked as Rare in the New York State Environmental Conservation Law (6 CRR-NY 193.3) and as S3 (vulnerable) on the New York Natural Heritage Program Watch List (Young 2019). The plant is insect-pollinated, and propagates via both seeds and rhizomes. On the Saw Kill it occurs at the margin of "the Lake" impounded by the lower dam, and in a floodplain wetland ca. 115 m (380 ft) upstream from the Bard water intake building.

I visited the Lake on 21 July 2020 and found that none of the monkeyflower plants were yet in bloom, and most had been severely grazed by white-tailed deer (presumably). When I returned on 18 August, most of the plants had somewhat recovered, sending up new shoots that were now flowering. I counted 87 winged monkeyflower stems, all along the same length of the southern and eastern shore where we had found them in 2016, and all within the muddy 3-meter-wide drawdown zone at the Lake edge. (In 2016 Erik Kiviat and I counted just 40 stems.) The habitat was partially- to deeply-shaded and, although the vegetation in this shoreline zone was sparse in some places, elsewhere the monkeyflower plants were crowded by abundant Japanese stiltgrass (*Microstegium vimineum*), beggar-ticks (*Bidens*), water-hemp (*Boehmeria cylindrica*), and water purslane (*Ludwigia palustris*). Most of the monkeyflower plants showed significant leaf damage from a grazing insect, but I could not find the animal to identify it.

At the location east of the Bard water intake, I counted 43 winged monkeyflower stems on 18 August 2020. (In 2016 I did not do a thorough count, but estimated 50-100 stems.) This is a wet meadow in the Saw Kill floodplain, separated from the stream by a low natural levee. The monkeyflower plants were in the midst of tall, lush, herbaceous vegetation, so I could easily have missed some small, non-flowering individuals hidden in the dense greenery. Other plants in the wet meadow included abundant stiltgrass and low smartweed (*Persicaria longiseta*), and lesser amounts of bristly sedge (*Carex comosa*), wood reedgrass (*Cinna arundinacea*), tussock sedge (*Carex stricta*), mad-dog skullcap (*Scutellaria lateriflora*), and moneywort (*Lysimachia nummularia*). This stand of monkeyflower showed little evidence of grazing by deer or insects.

Annandale Millpond

On 9 October 2020 I surveyed the flora of the Annandale Millpond and shore via canoe and on foot. The millpond is a 0.8-km (0.5-mile) long, narrow impoundment that extends ca. 230 meters (750 ft) south from the dam and then bends abruptly northeast and

terminates a short distance east of NYS Route 9G. (My survey extended only to Route 9G.) A complete list of plants observed at the Annandale Millpond is in Table 1.

Submerged aquatic plants were abundant, especially Eurasian watermilfoil (*Myriophyllum spicatum*), common coontail (*Ceratophyllum demersum*), and Canada waterweed (*Elodea canadensis*), and were often bound up with large masses of filamentous green algae. Masses of stonewort (Characeae) were present at scattered locations. Lesser duckweed (*Lemna minor*), greater duckweed (*Spirodela polyrhiza*), and watermeals (*Wolffia brasiliensis, W. columbiana, W. borealis*) were present in moderate amounts, and fringed heartwort (*Ricciocarpus natans*, a liverwort) was here and there. The shallows had plants such as hybrid cattail (*Typha* x *glauca*), broad-leaved arrowhead (*Sagittaria latifolia*), bur-reeds (*Sparganium*), water dock (*Rumex brittanica*), and dotted smartweed (*Persicaria punctata*). Broad cattail stands bordered the western and eastern shores of the pond downstream (north) of the big bend.

The one-meter zone above the water was mostly shrubby and herbaceous in the downstream half of the impoundment, and mostly forested upstream. The western and southern shores in the downstream half had shrubs such as speckled alder (*Alnus incana* ssp. *rugosa*), silky dogwood (*Cornus amomum*), northern arrowwood (*Viburnum dentatum*), common elder (*Sambucus nigra* ssp. *canadensis)*, and multiflora rose (*Rosa multiflora*), and scattered trees such as red maple (*Acer rubrum*), American sycamore (*Platanus americanus*), tulip tree (*Liriodendron tulipifera*), and white ash (*Fraxinus americana*). A few individuals of bladdernut (*Staphylea trifolia*) and American prickly-ash (*Zanthoxylum americanum*) were on the south shore at the big bend, and bladdernut was also on the east shore near the dam. Herbaceous plants were diverse; species such as bristly sedge (*Carex comosa*), shallow sedge (*Carex lurida*), beggar-ticks (*Bidens cernua, B. connata, B. frondosa*), purple loosestrife (*Lythrum salicaria*), blue vervain (*Verbena hastata*), and marsh fern (*Thelypteris palustris*) were common.

The millpond bends around a ca. 0.5 hectare (1.2-acre) swamp that is substantially flooded during high-water events, but was dryish at survey time. Dense thickets of silky dogwood, buttonbush (*Cephalanthus occidentalis*), common elder, Bell's honeysuckle (*Lonicera* x *bella)*, and smooth alder (*Alnus serrulata*) characterized much of the swamp. Openings in the thickets had diverse graminoids and forbs such as bristly sedge, woolgrass (*Scirpus cyperinus*), dark-green bulrush (*Scirpus atrovirens*), dotted smartweed, eastern willow-herb (*Epilobium coloratum*), bog-hemp (*Boehmeria cylindrica*), climbing hempweed (*Mikania scandens*), arrow-leaved tearthumb (*Persicaria sagitatta*) , and purple loosestrife. The swamp was cut with many small channels—perhaps made or enlarged by muskrat or beaver—and had much evidence of deer use. Bordering the swamp on the west and south sides was a narrow-to-broad zone of

emergent marsh with abundant cattail, and smaller amounts of bur-reeds, bluejoint (*Calamagrostis canadensis*), rice-cutgrass (*Leersia oryzoides*), broad-leaved arrowhead, beggar-ticks, dotted smartweed, and many other marsh species.

Below Annandale Dam

On 18 August 2020 I surveyed the Saw Kill between the Annandale Dam and the Route 9G bridge, recording the abundance of vascular plant species encountered in the stream itself, the 0-1-meter zone and the 1-2-meter zone above the water level at survey time. A complete list of plants observed between the Annandale Dam and the Route 9G bridge with their common and scientific names is in Table 1.

The instream plants included Canada waterweed, lesser duckweed, Columbian watermeal, long-leaved pondweed (*Potamogeton nodosus*), common coontail, and water purslane. Many of the rocks were covered with brownish algae. The banks were shrubby with diverse forbs and graminoids, and partially tree-shaded. The banks of the upstream (southern) half of this reach were ledgy. The 0-1-meter zone had small trees ($\leq$ 15 cm [6 in] dbh) such as tulip tree, northern catalpa (*Catalpa speciosa*), blue-beech (*Carpinus caroliniana*), and elm (*Ulmus*), and several larger butternut (*Juglans cinerea*) (up to 30 cm [12 in] dbh). The shrub layer had multiflora rose, Bell's honeysuckle, gray dogwood, northern arrowwood, common buckthorn (*Rhamnus cathartica*), blue-beech, speckled alder, and bladdernut, along with saplings of slippery elm (*Ulmus rubra*), sugar maple, and green ash (*Fraxinus pensylvanica*). Beggar-ticks, bog-hemp, wood nettle (*Laportea canadensis*), mugwort, stinging nettle (*Urtica dioica*), garlic-mustard (*Alliaria petiolata*), wild ginger (*Asarum canadense*), autumn bent (*Agrostis perennans*), fowl bluegrass (*Poa palustris*) , and Japanese stiltgrass are just a few of the herbaceous species.

Some of the slopes in the 1-2-meter zone of the west side of the Saw Kill were gentle and the zone extended far from the stream. Much of the zone was young forest with trees such as white pine (*Pinus strobus*), tulip tree, sugar maple, and green ash. The shrub layer was similar to that of the 0-1-meter zone, but also had saplings of sassafras (*Sassafras albidum*), black cherry (*Prunus serotina*), swamp white oak (*Quercus bicolor*), and American sycamore (*Platanus occidentalis*). The ground layer had many of the same species as the 0-1-meter zone, but also had Oriental bittersweet (*Celastrus orbiculatus*), carrion-flower (*Smilax herbacea*), spotted Joe-pye weed (*Eutrochium maculatum*), and seedlings of bitternut hickory (*Carya cordiformis*), among many others. The slopes on the east side were steeper and the 1-2-meter zone had more mature trees, including northern catalpa (up to 38 cm [15 in] dbh), white mulberry (*Morus alba*) and quaking aspen (*Populus tremuloides*). Multiflora rose, gray dogwood, and Bell's honeysuckle were the most

common shrubs. Oriental bittersweet was abundant. Black swallow-wort (*Cynanchum louiseae*), stickseed (*Hackelia virginiana*), smooth goldenrod (*Solidago gigantea*), zigzag goldenrod (*S. flexicaulis*), virgin's bower (*Clematis virginiana*), and bittersweet nightshade (*Solanum dulcamara*) are a few of the forbs occurring on the east side that were not seen on the west.

Two-ranked Moss

In 2016-2017 surveys along the Saw Kill, Julia Palmer collected a specimen of two-ranked moss from the south side of "the Lake"—the ca 0.4-hectare (1-acre) backwater area impounded above the lower dam. Two-ranked moss is listed as S2S3 (imperiled or vulnerable) by the New York Natural Heritage Program (2008). In 2020 I attempted to find the moss again and to ascertain the distribution and size of the occurrence. On 21 July 2020 I surveyed the upland 0-1-meter-zone above the water level along the south shore of the Lake and found just one small patch of a moss that resembled two-ranked moss. The patch was ca. 130 cm^2 (20 in^2) on moist soil ca. 0.8 m above the water level. I collected a specimen that I later identified as *Pseudotaxiphyllum elegans* (small flat moss), which is not a listed rare species.

Other Notes

Alterations to water levels during installation and operation of a microhydropower turbine at the dam are likely to most acutely affect plants in the pond and stream themselves and the 0-1-meter zone above the water level, but plants of the 1-2-meter zone would also be affected by a raised or lowered water table and by raised or reduced water levels during high-water events.

I found no state-listed or regionally-rare plants in the 2020 surveys above and below the Annandale Dam. Many of the plant species in the stream corridor are well-adapted to changing water levels or duration of soil saturation, and to episodic inundation and droughts. Should the depth of the millpond be reduced for prolonged periods during the growing season, then the character of the large shrub swamp would change somewhat, favoring plants of drier affinities and altering the wetland configuration. The areas of emergent marsh at the millpond edges would migrate further into the now-ponded area as the water depth is reduced. Prolonged changes to pond or stream water levels would also somewhat alter the composition of plant communities of the 0-1-meter and 1-2-meter zones, but we expect the shifts to be subtle as long as the hydrological changes are not drastic. Abrupt, large hydrological changes, however, could favor the spread of non-native invasive plants such as multiflora rose, Bell's honeysuckle, and Japanese stiltgrass.

Two other notes about rare species: We have corrected the identification of a plant reported in Kiviat et al. (2017) as golden corydalis (*Corydalis aurea*), a native species ranked as Threatened in New York State. Upon reexamination, we found this plant to be the non-native yellow corydalis (*Corydalis lutea*), which is of no conservation concern. It occurs on an island at the mouth of the Saw Kill, where it probably established from propagules washed down from upstream gardens. In 2020 we reconfirmed the presence of Canada yew (*Taxus canadensis*, regionally-rare) on the peninsula between the Lake and main Saw Kill channel—four seedlings, each approximately 12 cm (5 in) tall at the same location where we had found the species in 2016.

Table 1 (next page). Plant species and abundances observed along the Saw Kill above and below the Annandale dam, summer-fall 2020. Streambank plants were recorded in two zones—within one meter vertical elevation of the stream water surface at survey time, and between one meter and two meters above the water surface. At the Annandale Millpond, plants were recorded within one vertical meter of the water surface. Scientific nomenclature generally follows Weldy et al. (2021). Abundance codes are A = abundant, C = common, O = occasional, R = rare, p = patchy.

Common Name	***Scientific Name***	**Native? (Yes, No)**	**Duration***	**below Annandale dam, instream**	**below Annandale dam, 1 m zone**	**below Annandale dam, 2 m zone**	**Annandale Millpond, in pond**	**Annandale Millpond, 1 m zone**
TREE LAYER								
ash	*Fraxinus*	Y	p					O
ash, green	*Fraxinus pensylvanica*	Y	p			R		O
aspen, quaking	*Populus tremuloides*	Y	p			Rp		
basswood, American	*Tilia americana* var. *americana*	Y	p		R	R		O
butternut	*Juglans cinerea*	Y	p		R	R		R
catalpa, northern	*Catalpa speciosa*	N	p		R	R		
elm, slippery	*Ulmus rubra*	Y	p		O	O		
hornbeam, American	*Carpinus caroliniana* ssp. *virginiana*	Y	p		R			
locust, black	*Robinia pseudoacacia*	N	p					R
maple, red	*Acer rubrum* var. *rubrum*	Y	p		R			O
maple, sugar	*Acer saccharum* var. *saccharum*	Y	p			R		
mulberry, white	*Morus alba*	N	p			R		

(continued)

Table 1. (cont.)

Common Name	***Scientific Name***	**Native? (Yes, No)**	**Duration***	**below Annandale dam, instream**	**below Annandale dam, 1 m zone**	**below Annandale dam, 2 m zone**	**Annandale Millpond, in pond**	**Annandale Millpond, 1 m zone**
TREE LAYER (cont.)								
pine, eastern white	*Pinus strobus*	Y	p			R		
poison-ivy, eastern	*Toxicodendron radicans* ssp. *radicans*	Y	p		C	C		
sycamore, American	*Platanus occidentalis*	Y	p					O
walnut, black	*Juglans nigra*	Y	p					R
willow, black	*Salix nigra*	Y	p					R
SHRUB LAYER								
alder	*Alnus*	Y	p					R
alder, smooth	*Alnus serrulata*	Y	p		R	R		O
alder, speckled	*Alnus incana* ssp. *rugosa*	Y	p		R	O		Cp
arrowwood, northern	*Viburnum dentatum* var. *lucidum*	Y	p		R			O
ash, green	*Fraxinus pennsylvanica*	Y	p		O			
ash, white	*Fraxinus americana*	Y	p					R
barberry, Japanese	*Berberis thunbergii*	N	p		R			O
bittersweet, Oriental	*Celastrus orbiculatus*	N	p			A		O
blackberry, common	*Rubus allegheniensis*	Y	p			O		
bladdernut	*Staphylea trifolia*	Y	p		R			R
blueberry, highbush	*Vaccinium corymbosum*	Y	p					R

Table 1 (cont.)

Common Name	Scientific Name	Native? (Yes, No)	Duration*	below Annandale dam, instream	below Annandale dam, 1 m zone	below Annandale dam, 2 m zone	Annandale Millpond, in pond	Annandale Millpond, 1 m zone
SHRUB LAYER (cont.)								
buckthorn, common	*Rhamnus cathartica*	N	p		R	O		O
buttonbush	*Cephalanthus occidentalis*	Y	p					Op
cedar, eastern red	*Juniperus virginiana* var. *virginiana*	Y	p		R	R		
cherry, black	*Prunus serotina*	Y	p			R		
creeper, Virginia	*Parthenocissus quinquefolia*	Y	p		O	O		O
dogwood, gray	*Cornus racemosa*	Y	p		C	C		
dogwood, silky	*Cornus amomum* ssp. *amomum*	Y	p				Op	C
elder, common	*Sambucus nigra* ssp. *canadensis*	Y	p		O	C		O
elm, slippery	*Ulmus rubra*	Y	p		O	O		
grape, riverbank	*Vitis riparia*	Y	p			C		O
hickory, bitternut	*Carya cordiformis*	Y	p			R		
honeysuckle, Bell's	*Lonicera* x *bella*	N	p		C	C		O
hornbeam, American	*Carpinus caroliniana* ssp. *virginiana*	Y	p		O			
maple, red	*Acer rubrum* var. *rubrum*	Y	p					O
maple, sugar	*Acer saccharum* var. *saccharum*	Y	p		O	O		
oak, swamp white	*Quercus bicolor*	Y	p		R	R		
prickly-ash, American	*Zanthoxylum americanum*	Y	p					R

Table 1 (cont.)

Common Name	Scientific Name	Native? (Yes, No)	Duration*	below Annandale dam, instream	below Annandale dam, 1 m zone	below Annandale dam, 2 m zone	Annandale Millpond, in pond	Annandale Millpond, 1 m zone
SHRUB LAYER (cont.)								
raspberry, black	*Rubus occidentalis*	Y	p					O
rose, multiflora	*Rosa multiflora*	N	p		C	C		C
sassafras	*Sassafras albidum*	Y	p			R		
sumac, smooth	*Rhus glabra*	Y	p		R	R		
sumac, staghorn	*Rhus typhina*	Y	p			R		
sycamore, American	*Platanus occidentalis*	Y	p			R		
willow, pussy	*Salix discolor*	Y	p		R	R		
GROUND LAYER								
arrowhead, broad-leaf	*Sagittaria latifolia*	Y	p		Op			C
aster	*Symphyotrichum*	Y	-		O			
aster, calico	*Symphyotrichum lateriflorum*	Y	p					O
aster, lance-leaved	*Symphyotrichum lanceolatum*	Y	p					R
aster, white wood	*Eurybia divaricata*	Y	p			O		O
avens	*Geum*	Y	p					R
avens, white	*Geum canadense*	Y	p		R	R		
beggar-ticks	*Bidens*	Y	a		C	C	O	C
beggar-ticks, devil's	*Bidens frondosa*	Y	a					O
beggar-ticks, nodding	*Bidens cernua*	Y	a					O

Table 1. (cont.)

Common Name	Scientific Name	Native? (Yes, No)	Duration*	below Annandale dam, instream	below Annandale dam, 1 m zone	below Annandale dam, 2 m zone	Annandale Millpond, in pond	Annandale Millpond, 1 m zone
GROUND LAYER (cont.)								
beggar-ticks, purple-stem	*Bidens connata*	Y	a					O
beggar-ticks, smooth	*Bidens laevis*	Y	a					R
bellwort, sessile-leaved	*Uvularia sessilifolia*	Y	p			R		
bent, autumn	*Agrostis perennans*	Y	p		O			
bittersweet, Oriental	*Celastrus orbiculatus*	N	p		C	C		
bluegrass	*Poa*	N	-		R			
bluegrass, fowl	*Poa palustris*	Y	p		O	R		
bog-hemp	*Boehmeria cylindrica*	Y	p		C			O
bulrush, dark-green	*Scirpus atrovirens*	Y	p					R
bulrush, soft-stemmed	*Schoenoplectus tabernaemontani*	Y	p					O
bur-reed	*Sparganium*	Y	p		R		Op	Op
bur-reed, American	*Sparganium americanum*	Y	p				Op	
bur-reed, large-fruited	*Sparganium androcladum*	Y	p		O			
bur-reed, narrow-leaved	*Sparganium angustifolium*	Y	p				Op	
buttercup	*Ranunculus*	Y	p		R			
buttercup, northern swamp	*Ranunculus caricetorum*	Y	p		O			
buttercup, hooked	*Ranunculus recurvatus* var. *recurvatus*	Y	p					R

Table 1. (cont.)

Common Name	Scientific Name	Native? (Yes, No)	Duration*	below Annandale dam, instream	below Annandale dam, 1 m zone	below Annandale dam, 2 m zone	Annandale Millpond, in pond	Annandale Millpond, 1 m zone
GROUND LAYER (cont.)								
buttercup, white water	*Ranunculus trichophyllus*	Y	p					Rp
carrion-flower, common	*Smilax herbacea*	Y	p			R		
cattail, broad-leaved	*Typha latifolia*	Y	p				C	
cattail, hybrid	*Typha x glauca*	Y	p				C	A
cedar, eastern red	*Juniperus virginiana* var. *virginiana*	Y	p			R		
celandine, greater	*Chelidonium majus*	N	b			R		
chickweed, common	*Stellaria media* var. *media*	Y	a		R	R		O
clearweed, dark-fruited	*Pilea fontana*	Y	a					C
clearweed, green-fruited	*Pilea pumila*	Y	a		Op	O		C
cocklebur	*Xanthium strumarium*	?	a		R			Cp
coltsfoot	*Tussilago farfara*	N	p			R		
coontail, common	*Ceratophyllum demersum*	Y	p		R		A	
creeper, Virginia	*Parthenocissus quinquefolia*	Y	p		O	C		R
cress	*Cardamine*	-	-		R			R
cutgrass, rice	*Leersia oryzoides*	Y	p				Op	Op
ditch-stonecrop	*Penthorum sedoides*	Y	p					R
dock, water	*Rumex britannica*	Y	p				R	O

Table 1 (cont.)

Common Name	Scientific Name	Native? (Yes, No)	Duration*	below Annandale dam, instream	below Annandale dam, 1 m zone	below Annandale dam, 2 m zone	Annandale Millpond, in pond	Annandale Millpond, 1 m zone
GROUND LAYER (cont.)								
dodder, common	*Cuscuta gronovii* var. *gronovii*	Y	p		R			
duckweed, greater	*Spirodela polyrhiza*	Y	-				O	
duckweed, lesser	*Lemna minor*	Y	p				C	C
elder, common	*Sambucus nigra* ssp. *canadensis*	Y	p		O			
fern, marsh	*Thelypteris palustris* var. *pubescens*	Y	p					O
fern, sensitive	*Onoclea sensibilis*	Y	p		O			C
flag, blue	*Iris versicolor*	Y	p		R			R
fleabane	*Erigeron*	Y	-		R			
forget-me-not, smaller	*Myosotis laxa*	Y	b					Rp
garlic-mustard	*Alliaria petiolata*	N	b		O			
ginger, wild	*Asarum canadense*	Y	p		Op	C		
goldenrod, smooth	*Solidago gigantea*	Y	p			O		
goldenrod, zig-zag	*Solidago flexicaulis*	Y	p			R		
grape, riverbank	*Vitis riparia*	Y	p			C		
grass, bent	*Agrostis*	-	p					O
grass, reed canary	*Phalaris arundinacea*	Y	p		O			
hedge-parsley, erect	*Torilis japonica*	N	a		R			

Table 1 (cont.)

Common Name	Scientific Name	Native? (Yes, No)	Duration*	below Annandale dam, instream	below Annandale dam, 1 m zone	below Annandale dam, 2 m zone	Annandale Millpond, in pond	Annandale Millpond, 1 m zone
GROUND LAYER (cont.)								
helleborine, eastern	*Epipactis helleborine*	N	p		R			
hempweed, climbing	*Mikania scandens*	Y	p					O
hickory, bitternut	*Carya cordiformis*	Y	p			R		
horseweed, common	*Erigeron canadensis* var. *canadensis*	Y	a		R	R		
hosta	*Hosta*	N	p			R		
iris, yellow	*Iris pseudacorus*	N	p		R			O
jewelweed, common	*Impatiens capensis*	Y	a		C	O		C
Joe-Pye-weed, hollow	*Eutrochium fistulosum*	Y	p		O			
Joe-Pye-weed, spotted	*Eutrochium maculatum* var. *maculatum*	Y	p			O		
lettuce, wild	*Lactuca*	Y	p			R		
loosestrife, fringed	*Lysimachia ciliata*	Y	p		R			
loosestrife, purple	*Lythrum salicaria*	N	p		C	O	O	C
maple, red	*Acer rubrum* var. *rubrum*	Y	p					O
maple, sugar	*Acer saccharum* var. *saccharum*	Y	p			C		
moneywort	*Lysimachia nummularia*	N	p					Op
mugwort	*Artemisia vulgaris* var. *vulgaris*	N	p		O	O		
mullein, common	*Verbascum thapsus*	N	b			R		

Table 1 (cont.)

Common Name	Scientific Name	Native? (Yes, No)	Duration*	below Annandale dam, instream	below Annandale dam, 1 m zone	below Annandale dam, 2 m zone	Annandale Millpond, in pond	Annandale Millpond, 1 m zone
GROUND LAYER (cont.)								
nettle, stinging	*Urtica dioica* ssp. *gracilis*	Y	p		O			R
nightshade, bittersweet	*Solanum dulcamara* var. *dulcamara*	N	p		Op	Op	O	
poison-ivy, eastern	*Toxicodendron radicans* ssp. *radicans*	Y	p		C			O
pondweed	*Potamogeton*	Y	p			Rp		
pondweed, long-leaved	*Potamogeton nodosus*	Y	p	R				
pondweed, ribbon-leaved	*Potamogeton epihydrus*	Y	p			Rp		Cp
Queen-Anne's-lace	*Daucus carota*	N	b			R		
reedgrass, wood	*Cinna arundinacea*	Y	p					R
rush, soft	*Juncus effusus* var. *solutus*	Y	p					O
sedge	*Carex*	-	p		R			R
sedge, bristly	*Carex comosa*	Y	p				O	A
sedge, hop	*Carex lupulina*	Y	p					R
sedge, lakeside	*Carex lacustris*	Y	p					R
sedge, shallow	*Carex lurida*	Y	p					O
sedge, three-way	*Dulichium arundinaceum* var. *arundinaceum*	Y	p				Op	
sedge, tussock	*Carex stricta*	Y	p					O
seedbox, marsh	*Ludwigia palustris*	Y	p	R			C	C

Table 1 (cont.)

Common Name	Scientific Name	Native? (Yes, No)	Duration*	below Annandale dam, instream	below Annandale dam, 1 m zone	below Annandale dam, 2 m zone	Annandale Millpond, in pond	Annandale Millpond, 1 m zone
GROUND LAYER (cont.)								
skullcap, mad-dog	*Scutellaria lateriflora*	Y	p		O			
smartweed, creeping	*Persicaria longiseta*	N	a		O	O		O
smartweet, dotted	*Persicaria punctata*	Y	p		R			C
snakeroot, white	*Ageratina altissima* var. *altissima*	Y	p		O	R		R
Solomon's-seal, hairy	*Polygonatum pubescens*	Y	p			R		
spikerush, needle	*Eleocharis acicularis*	Y	a				O	
St. Johnswort, common	*Hypericum perforatum* ssp. *perforatum*	N	p			R		
stickseed	*Hackelia virginiana*	Y	b		O	O		
stiltgrass, Japanese	*Microstegium vimineum*	N	a		C	C		Cp
swallow-wort, black	*Cynanchum louiseae*	N	p			C		
tearthumb, arrow-leaf	*Persicaria sagittata*	Y	p					Cp
vervain, blue	*Verbena hastata* var. *hastata*	Y	b					O
virgin's-bower	*Clematis virginiana*	Y	p		R	R		R
water-hemlock, bulb-bearing	*Cicuta bulbifera*	Y	p		R			
water-horehound	*Lycopus*	Y	p					O
water-horehound, Virginia	*Lycopus virginicus*	Y	p					O
water-lily, fragrant	*Nymphaea odorata* ssp. *odorata*	Y	p					Cp

Table (cont.)

Common Name	Scientific Name	Native? (Yes, No)	Duration*	below Annandale dam, instream	below Annandale dam, 1 m zone	below Annandale dam, 2 m zone	Annandale Millpond, in pond	Annandale Millpond, 1 m zone
GROUND LAYER (cont.)								
watermeal, Brazilian	*Wolffia brasiliensis*	Y	p				C	C
watermeal, Columbian	*Wolffia columbiana*	Y	p				C	
watermeal, northern	*Wolffia borealis*	Y	p				O	
watermilfoil, Eurasian	*Myriophyllum spicatum*	N	p				A	
water-plantain, broad-leaved	*Alisma subcordatum*	Y	p					R
water-weed, Canada	*Elodea canadensis*	Y	p	O			A	
willow-herb, eastern	*Epilobium coloratum*	Y	p		R			O
wintercress, common	*Barbarea vulgaris*	N	b					O
wood-nettle	*Laportea canadensis*	Y	p		O			Op
woolgrass, common	*Scirpus cyperinus*	Y	p					C

* Duration codes: a = annual; b = biennial; p = perennial

Saw Kill Water Quality Monitoring Update

By Emily White

The planned 2020 water quality monitoring was delayed due to shutdowns associated with the COVID-19 pandemic. On 8 June 2020, a YSI EXO2 multiparameter sonde was redeployed in the impoundment above Annandale Dam (42°0’40.98” N, 73°54’31.038” W, Figure 1), after being retrieved at the end of the field season in November 2019. Data were collected for six months in 2020 (from 8 June to 3 December). The sonde collects data (temperature, conductivity, water depth, turbidity, dissolved oxygen, pH, total algae) every 15 minutes at a depth of approximately 1.2 m (Figure 2). The sonde will be installed in spring of 2021 (late March/early April) for the field season and will continue to be maintained at this location for at least one season post-installation and into the foreseeable future for long-term monitoring of the impoundment by the Community Science Lab in the Center for the Study of Land, Air, and Water at Bard College. The Bard labs reopened in August 2020 (following closure in March) and monthly grab samples were collected and analyzed as part of the Saw Kill Monitoring Program (from August to December 2020). Data loggers will also be installed at a single location below the dam, beginning in spring 2021, to capture water quality (i.e., temperature, turbidity, conductivity, and dissolved oxygen) downstream of the proposed tailrace. Additional temperature loggers will also be used to explore potential temperature variations associated with the microhydro installation. A second water quality monitoring sonde, deployed much farther downstream, provides long-term data for comparison. Data have been collected at this site (just above the lower dam; 42°01'01.8"N 73°54'53.8"W) by the Hudson River National Estuarine Research Reserve since 1995.

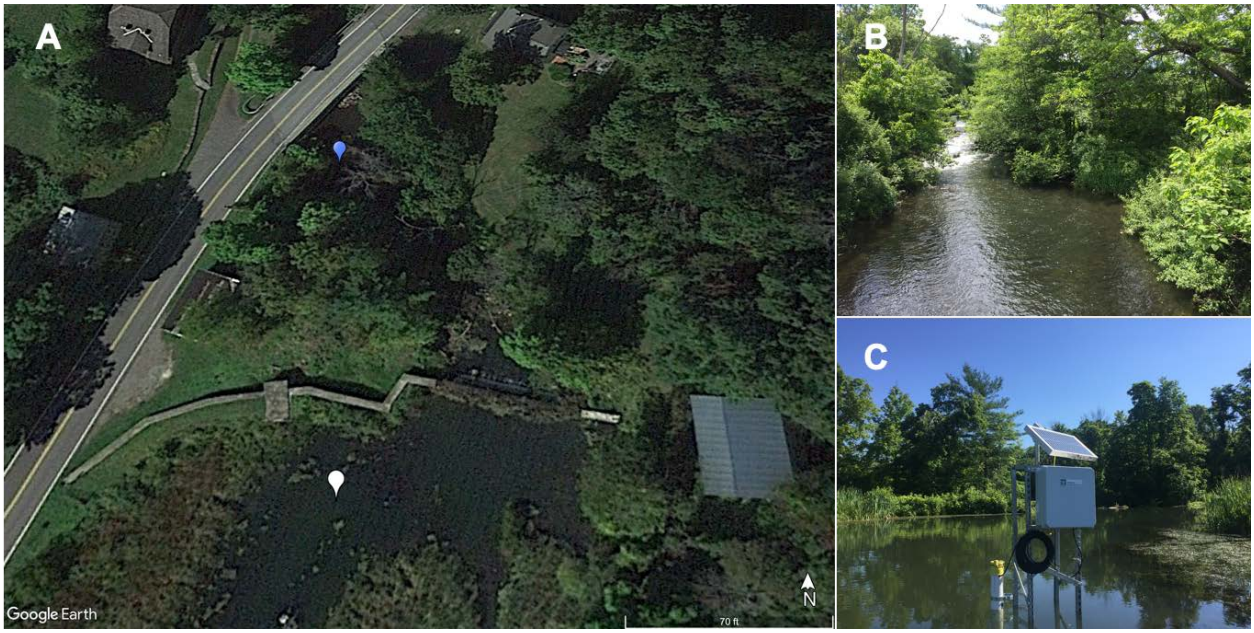
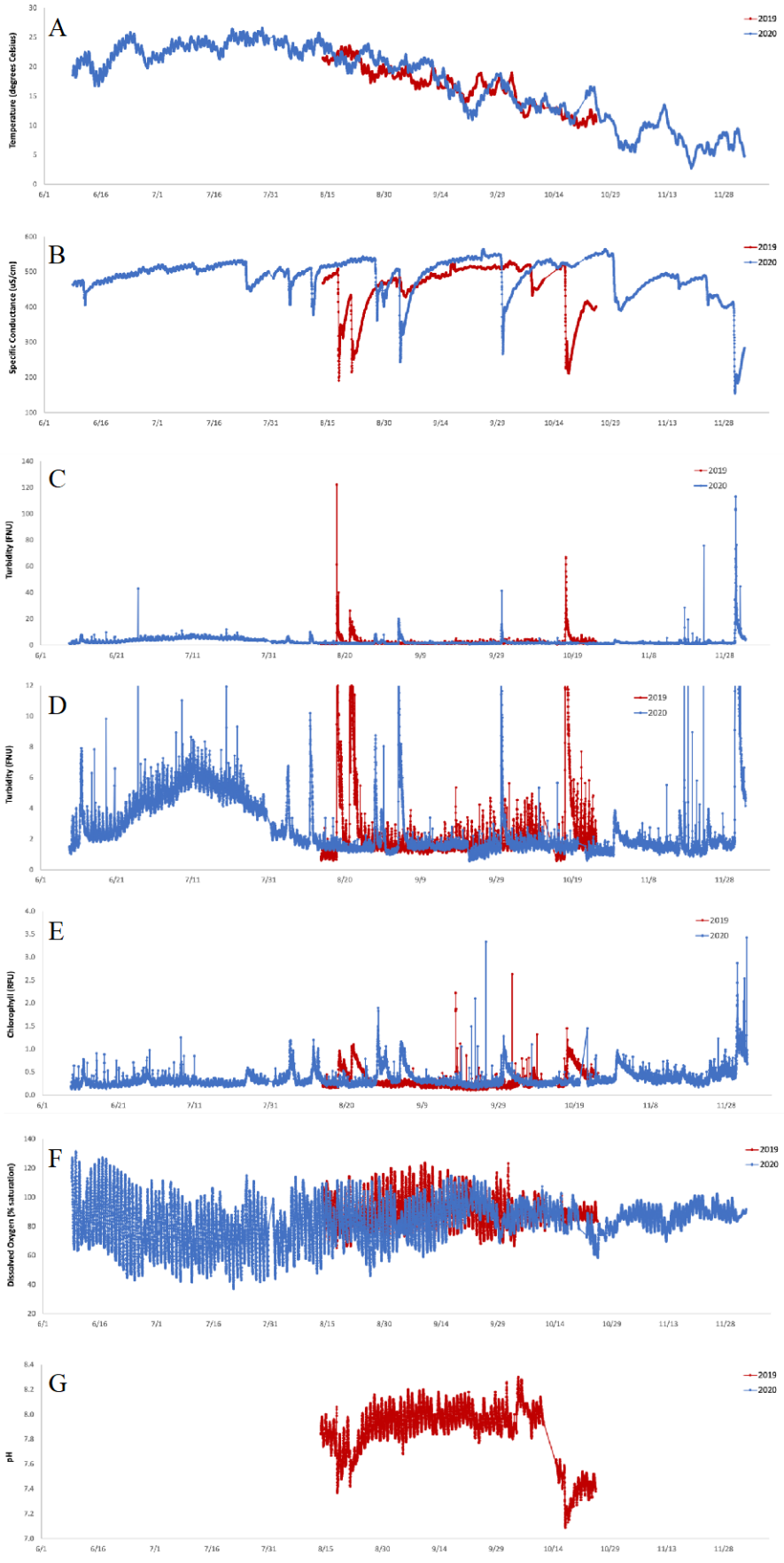


Figure 1. (A) Google Earth image showing the location of sampling equipment in the project A. The blue marker is the approximate location of data loggers downstream of the dam and the microhydro installation. The white marker is the location of the water quality sonde in the impoundment above Annandale Dam. (B) Photo showing the general area where data loggers will be deployed below the dam. The view is from the River Road bridge facing southeast. (C) Photo showing the water quality sonde deployed in the impoundment. The view is facing northeast. Both photos were taken in June 2019.

Figure 2 (next page). (A) Water temperature in degrees Celsius, (B) specific conductance in microSiemens per centimeter, (C and D) turbidity in formazin nephelometric units, (E) chlorophyll in relative fluorescence units as measured with the total algae sensor, (F) dissolved oxygen reported as percent saturation, and (G) pH measured in the impoundment above Annandale Dam in 2019 (red) and 2020 (blue). pH was not measured in 2020 due a problem with the sensor. A new pH sensor has been purchased for the 2021 field season.


A
Temperature (degrees Celsius)
2019
2020
B
Specific Conductance (uS/cm)
C
Turbidity (FNU)
D
Turbidity (FNU)
E
Chlorophyll (RFU)
F
Dissolved Oxygen (% saturation)
G
pH

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