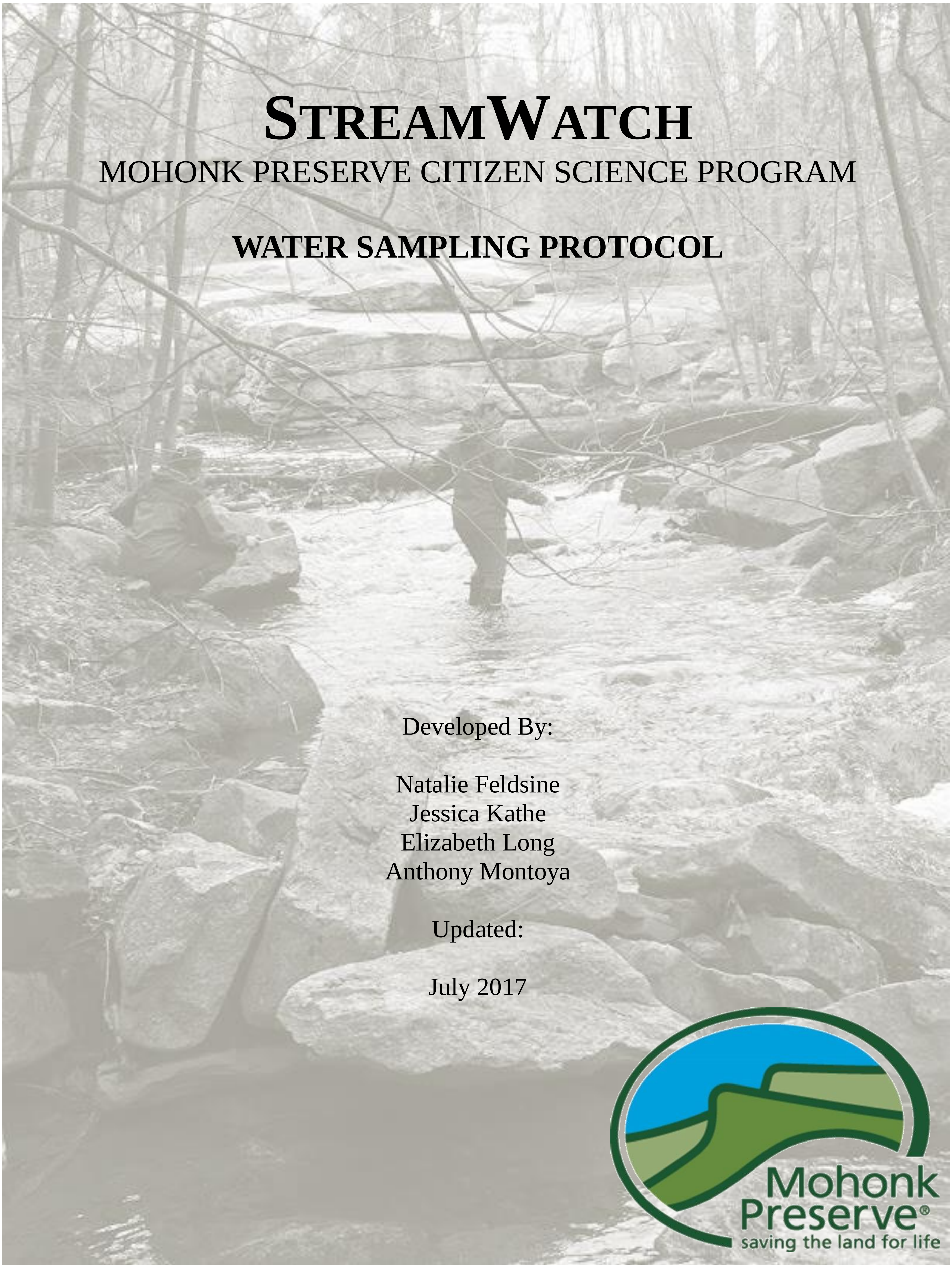

STREAMWATCH

MOHONK PRESERVE CITIZEN SCIENCE PROGRAM

WATER SAMPLING PROTOCOL

Developed By:

Natalie Feldsine
Jessica Kathe
Elizabeth Long
Anthony Montoya

Updated:

July 2017

ACKNOWLEDGEMENTS

Special thanks to the New York State Department of Environmental Conservation for providing the funding for this program via the Hudson River Estuary Program Grant for Local Stewardship Planning.

Additional thanks to the State University of New York at New Paltz for their partnership in the Mohonk Preserve Geography Intern Program.

TABLE OF CONTENTS

I. Purpose of Monitoring……………………………………………………......3
II. Equipment……………………………………………………………………4
III. Precautions…………………………………………………………………4
IV. Decontaminating Waders……………………………………………………..4
V. Water Appearance…………………………………………………….......5
VI. Water Odor……………………………………………………………………5
VII. Canopy Cover……………………………………………………….........6
VIII. Current and Recent Weather……...……………….……………………6
IX. Stream Width and Depth……………………………………………………7
X. Water Temperature……………………………………………………....7
XI. Turbidity……………………………………………………………...…..8
XII. pH…………………………………………………………………………...9
XIII. Dissolved Oxygen…………………………………………………………..9
XIV. Invasive Species ……………………………………………………….10
XV. Macroinvertebrates…………………………………………………...14
References……………………………………………………………………..18
Datasheet……………………………………………………………………19

I. PURPOSE OF MONITORING:

The mission of the Mohonk Preserve is to "protect the Shawangunk Mountains region and inspire people to care for, enjoy, and explore their natural world." Among these 8,000 acres are the vernal pools, permanent springs, tributaries, Humpo Marsh, and the Humpo Kill, and parts of the Kleine Kill and Coxing Kill watersheds within the Hudson River Drainage Basin. Not only are the areas around the Shawangunks established habitats for New York State (NYS) protected species, including an Audubon-designated Important Bird Area, but the watershed also encapsulates more than one agricultural land use area, as well as Rondout Creek, which is an important waterway for the New York City water supply. A conservation plan must be implemented in these areas in particular, keeping in line with the Mohonk Preserves goal to conserve the Shawangunk region for both humans and the greater ecosystem within it.. Recognizing the immediate and long-term conservation needs of the streams in this region by employing volunteer data collection will be a catalyst to the Preserve's understanding of which environmental threats of this area should be prioritized.

The "StreamWatch" citizen science program will be the newest addition to an array of volunteer research areas, which include collection of weather data, phenology observations, monitoring of peregrine falcon breeding activities, and monitoring of fall hawk migration. Using concise stream monitoring protocol designed for volunteer safety and maximum data accuracy, StreamWatch will evaluate water quality using an array of parameters. Following thorough observation and assessment (which will include analyzing appearance and smell of the water, shape of the stream, canopy cover, nearby land uses, recent weather, and presence of riparian vegetation including invasive species) water quality will be evaluated by means of temperature, dissolved oxygen, pH, and turbidity measurements, in addition to a macroinvertebrate count. Width and depth will also be measured, being indirect contributors to stream quality.

The StreamWatch protocol aims to follow a simple procedure that will yield accurate and useful data from all of these aforementioned parameters in order to confirm relevant needs for riparian buffers, changes in nearby agricultural practices (some of which directly affect portions of the watershed), protection against invasive species, and any other potential solutions to problems these watersheds may be afflicted by presently or in the future. Volunteer involvement in this stream water sampling process will encourage the concept of stewardship among visitors of the preserve, while simultaneously honing in on and pursuing various conservation goals.

II. EQUIPMENT:

Field equipment:

- Thermometer(in Fahrenheit)
- Turbidity tube
- Forest densitometer
- Sample containers
- Measuring tape/yardstick(centimeters)
- Wading apparel (rubber boots/waders)
- Isopropyl alcohol 90%
- Kicknet
- Weighted line (For streams deeper than 1 meter)
- 2 Buckets
- White enamel pan
- Decontamination kit (spray bottle containing 5% bleach solution, to be refreshed monthly)
- Ice cube trays
- Paint brushes
- Dissolved oxygen meter (To be used only by DSRC staff)
- Magnifying glass

Lab equipment

- pH meter

III. PRECAUTIONS:

- StreamWatch volunteers must collect data in pairs for safety.
- Consider wearing water-resistant clothing and footwear, or a personal flotation device if streams seem too vigorous or deep, and stay hydrated in hot temperatures.
- Know when not to wade; if the current is even remotely strong, use caution or skip wading. When wading is a possibility, your monitoring partner should be close by and aware.
- Consider weather conditions and be aware of approaching bad weather.
- Be cautious walking on streambanks, causing erosion will damage the ecosystem and could result in unstable footing.
- Follow the instructions step-by step, ideally read through instructions before you reach the site.
- Avoid excessive contact between hands and, eyes, nose, or mouth after touching sample materials.
- Use all equipment responsibly to ensure further use.
- Some stream locations require longer hikes to get to, while others are directly accessible by car; use good judgment in considering how far you can comfortably hike.

IV. DECONTAMINATING WADERS:

Remove all mud, organic matter, etc. from boots/waders.

- Prepare 5% fresh bleach mixture in spray bottle and spray thoroughly.
- Dry thoroughly.
- Alternatively, leaving boots/waders in freezing temperatures overnight has same effect

This prevents the spread of invasive microorganisms which can lead to overgrowth and spread of freshwater invasive species to different streams.

(Adapted from Sequoia and Kings Canyon National Parks Decontamination Strategy)

V. WATER APPEARANCE:

Clear – Very clear water with no living organisms can mean pollution that is not easily detected by appearance. While clear water may also indicate good stream health, analysis of other stream variables must be taken into account to determine good or poor health, such as macroinvertebrate count and pH.
Multi-colored sheen – Light sheen is from breakdown of vegetation/organic matter, or other means of iron oxidizing bacteria, but heavy sheen can be from oil pollution.
Foamy – This foam is produced from natural oils and particulates from soil or pollen, unless it exceeds 5 or 6 inches in thickness, in which case pollution of animal waste or soapy-material is present.
Muddy / Cloudy – Precipitation, stream shape, or recent disturbance are all factors in muddiness/turbidity, which is determined by erosion, which makes the water muddy. Excessive erosion can take place naturally or from human impact.

Brown – Presence of decaying organic matter can be very dark in swamps and marshes.
Green – Aquatic flora which causes light green coloration can indicate a healthy stream, but presence of invasive aquatic flora or an overabundance of phytoplankton (algae) can be the result of fertilizer, animal waste, or sewage runoff. This eutrophication is a much darker green, akin to pea soup.
Orange / Red – Iron or tannins present in soil on streambanks cause this hue if the causes are natural. If site is near mining or oil-related operation, pollution runoff is a potential.
Milky – Usually natural sediments of certain types, more unusual causes include pulp from paper manufacturing or dairy operations.
Scummy – Decaying organic matter which is not entirely decomposed or floating algae causes this appearance.

(Adapted from Geiger & Mesner, n.d.)

VI. WATER ODOR:

Sulphur (rotten egg) – Anaerobic respiration or certain minerals can emit this smell, but sewage or animal waste could also play a role.
Chlorine (pool water) – Chlorine from water or sewage treatment has diffused into stream area.

Sewage (foul, rancid odor) – Diffusion from sewage treatment operation.
Petroleum (gasoline) –Diffusion from oil-related operation.
Other - Any other unnatural odor from the stream should be taken note of on the data sheet.

(Adapted from Geiger & Mesner, n.d.)

VII. CANOPY COVER:

The breakdown of organic matter within streams is influenced by temperature, precipitation, organisms, and riparian vegetation, and may change based on the amount of sunlight and moisture which can reach the stream itself. Canopy cover provides shade which can impact water temperatures, an important variable which affects organism diversity, and furthermore affects available food quantity for decomposers within the stream. In this section use the **densitometer** to measure **canopy cover**; record as **percentage**:

1. Starting from the marker ribbon used to mark stream site, look through densitometer while standing, and level the sight using the two bubble-levels within the eyepiece. Secondly, it is necessary to align the two lenses comprising the scope. Adjust your view of inside the scope as to align the cross-hairs in the far lens to the center of the circle in the near lens.
2. The densitometer will give a view of the area just above you once it is leveled. Record if any canopy cover occurs at this point by checking if the crosshairs within the scope runs under any canopy cover (tree foliage). Record presence or absence of foliage cover.
3. Repeat the above two steps, moving a total of 10 meters upstream and 10 meters downstream, taking measurements in 1 meter intervals, and staying as close to the stream as possible. A total of 21 data points will be collected, including the original data point recorded at the ribbon. The data sheet contains a number line which may be useful in keeping track of the points and their values; 0 denotes the initial point under the ribbon.
4. Divide the number of points in which canopy cover was present by the total number of data points collected (21) in order to obtain the percentage of canopy cover.

VIII. CURRENT AND RECENT WEATHER:

Observed weather is an important factor in water monitoring because it can allow us to determine causation for stream features, and explain outliers in data (i.e. higher than normal stream volume and velocity after rainfall, etc.). Long-term increases in air temperature have been associated with increases in stream water temperature (Kaushal *et al.*, 2010). Precipitation is also important to document as periods of heavy precipitation, or the lack of precipitation, can impact stream flow, nearby runoff, and environmental conditions for stream biota (Mitsch & Gosselink, 2007).

AIR TEMPERATURE – Record air temperature on the data sheet to the nearest whole degree using the provided thermometer. This can be obtained from any weather recording device, including NYS Mesonet or various weather apps.

PRECIPITATION – All forms of precipitation are notable. Rain varies from drizzle to downpour. Include even a few flakes of snow on datasheet.

SKY CONDITIONS – Assess the relative amount of cloud coverage during your sampling time.

WIND – Wind interacts with precipitation itself, influences stream turbidity, and can disturb vegetation in severe situations. Anything from a breeze to high winds is notable.

IX. STREAM WIDTH/DEPTH:

Width and depth of a stream determines its **velocity**, which is a main component in how the streambank erodes and sinuosity develops, and is a determinant factor in what may live in a particular stream. . Various aquatic species have different preferred state conditions for flow velocity and stream depth (Macura *et al.*, 2015). Additionally, stream width and depth relate to how nutrients are cycled through the aquatic ecosystem (Kaufmann & Faustini, 2012). Stream width may change according to seasonal flooding pulses, which is also an important process by which nutrients are cycled (Mitsch & Gosselink, 2007).

WIDTH

1. Have one participant hold the measuring tape directly under the purple ribbon marking the measuring point. This point will be used each time this measurement is taken (make sure footing is secure/ use caution)
2. Stretch measuring tape across bank by wading or walking and touch to opposite edge of bank directly across from the purple ribbon
3. Record width in centimeters.

CHANNEL DEPTH

Rest your yard stick on deepest portion of the stream bottom, where the water flow is relatively continuous, without applying pressure and record the depth in inches. The very middle of the stream is often deepest in comparison to the sides close to the stream banks.

* It is important to note that there may be instances where stream sites may be too flooded to obtain width and depth. If it is too deep to wade comfortably, or if flooding has occurred to a point where no clear river bank is discernable, do not take these measurements. Make a note of the conditions which led to these omissions.

X. WATER TEMPERATURE:

Stream temperature is modified by a large number of variables, including sunlight, turbidity, shade/canopy cover, stream depth, and seasonality. Human modifiers include deforestation/land clearance, and irrigation (decreasing stream volume), among others. Water temperature impacts a variety of ecosystem functions, including rates of nutrient cycling, dissolved oxygen concentrations, algal blooms, spawning and larval development, spatial distribution and abundance of stream biota, and presence of invasive species (Kaushal, *et al.*, 2010).

In the field, measure water temperature using the **thermometer**. Submerge the thermometer bulb in water for 2-3 minutes, out of direct sunlight, and record results. Measurements should be taken in the same location for each trip; it may be helpful to take temperature in the same spot as where depth measurements are taken.

(Adapted from Geiger & Mesner, n.d.)

XI. TURBIDITY:

The clarity of the water in a stream is a good indicator of erosion, as it measures dislodged sediment which can be natural due to weather or stream shape conditions, or from nearby land disturbances. This motion of particles through the stream aerates the water, provides shelter for microbes, especially protozoa, and thus has an impact on the overall biological content in the water (Ashman & Puri, 2002). However, excess sedimentation in streams has been associated with increases in nearby impervious surfaces, poor erosion control methods, and extreme weather events. Excess sedimentation can negatively impact stream biota including fish, macroinvertebrates, and aquatic turtles (Grosse *et al.*, 2010).

In the field, measure the water clarity using the **turbidity tube**.

Distance from bottom of tube (cm)	NTU's
< 6.25	> 240
6.25 to 7	240
7 to 8	185
8 to 9.5	150
9.5 to 10.5	120
10.5 to 12	100
12 to 13.75	90
13.75 to 16.25	65
16.25 to 18.75	50
18.75 to 21.25	40
21.25 to 23.75	35
23.75 to 26.25	30
26.25 to 28.75	27
28.75 to 31.25	24
31.25 to 33.75	21
33.75 to 36.25	19
36.25 to 38.75	17
38.75 to 41.25	15
41.25 to 43.75	14
43.75 to 46.25	13
46.25 to 48.75	12
48.75 to 51.25	11
51.25 to 53.75	10
53.75 to 57.5	9
57.5 to 60	8
Over 60	0

1. Submerge turbidity tube in order to fill completely, cover top and thoroughly shake. If the stream depth is too low in order to submerge the tube, a bucket may be needed to obtain a water sample; water may then be poured from the bucket to the tube and the standard procedure may continue.
2. Keeping the tube out of direct sunlight, look through top of tube to bottom.
3. If the disk is visible, record the water level in centimeters (cm).
4. If the disk is not visible, slowly release water from the release valve, until the disk becomes visible. Record the water level in centimeters
5. Once the water level is measured in centimeters, use the conversion chart to obtain the NTU measurement from the stream (Nephelometric Turbidity Unit's)

<u>WATER SAMPLE COLLECTING INSTRUCTIONS for pH and DISSOLVED OXYGEN</u>

Rinse the sample container with stream water, then:

If depth allows: Submerge closed sample container, open underwater right-side up, tap sides to dislodge air bubbles, and cap underwater.

If stream is too shallow for container immersion: Place container opening close to substrate facing upstream and allow container to fill via stream flow.

(Adapted from Geiger & Mesner, n.d.)

XII. pH:

pH is defined as the concentration of hydrogen ions in an aqueous solution. The pH of a stream can be influenced by nearby vegetation, precipitation amounts and types, the condition of the water table, and the chemical content of nearby soil (especially the presence of calcium carbonate). Having a pH that is too high or too low can change the biological availability of nutrients for micro and macro biota, as well as alter solubility of more detrimental chemical constituents such as heavy metals. Both changes can adversely affect organisms living within the stream. (Ashman & Puri, 2002; Berlemann, 2013).

In the field, collect and bring back **water sample** to measure **pH** back in the lab.

Make sure label on container matches with parameter and stream location being measured and store in safe place for transport. Once in the lab, process each sampling according to the pH meter instructions.

XIII. DISSOLVED OXYGEN:

The amount of oxygen dissolved in water impacts the metabolism of living organisms in the water and the rate of photosynthesis for aquatic flora. Low dissolved oxygen levels can be a major indicator of pollution, especially of fertilizers, which can cause eutrophication in bodies of water. Eutrophication occurs when high nutrient levels allow for increased growth of aquatic plants, typically algae, followed by subsequent death of algae once nutrient levels have been exhausted. As the algae decays and microorganism populations increase, available oxygen subsequently decreases (Ashman & Puri, 2002). Additionally, dissolved oxygen concentrations decreases as water temperatures increase, which can have negative on the aquatic ecosystem (Berlemann, 2013).

Due to the nature of the equipment being used to measure this variable, scientists from the Conservation Science department will take this measurement themselves. No action is needed.

XIV. INVASIVE SPECIES ASSESSMENT:

Invasive species are considered to be non-native species whose introduction and establishment is associated with loss of biodiversity, changes in ecosystem processes, and reduced ecosystem services as they overpopulate and outcompete native species (Ringold *et al.*, 2008). Invasive species can be particularly problematic in riparian areas as these areas can be disturbed easily through natural and anthropogenic erosion and deposition events (Ringold *et al.*, 2008). This issue has been regarded as the second greatest threat to global biodiversity (Allendorf & Lundquist, 2003).

Observe the habitat directly adjacent to the sampling site to determine the presence and relative abundance of any invasive species. Several species are highlighted in Table 1.

Table 1. Guide to invasive species that may be found in in the Coxing Kill and Kleine Kill watersheds (Center for Invasive Species and Ecosystem Health).

Species	Description	Photo
DIDYMO *(Didymosphenia geminate)*	Blooms of didymo appear as a thick greenish brown algae carpet in the stream, can span long segments of the stream bottom, and can persist for months through slow and fast moving flows. The presence of the didymo disrupts oxygen and nutrient cycling causing fish and other organisms to suffer, and in some cases can alter erosion patterns.	 David Richardson, SUNY New Paltz, nyis.info
JAPANESE KNOTWEED (*Reynoutria japonica*)	This hollow, segmented stemmed plant with tough heart shaped leaves up to 6 inches, and small greenish white flowers can grow up to 10 feet tall. Any part of the plant can sprout, most likely along streams.	 K.A. Rawlins, University of Georgia, Bugwood.org

COMMON REED/ PHRAGMITES (*Phragmites australis*)	The common reed reproduces from seed and from rhizomes, and grows in vast fields in marginally wet, marshy areas. They can be identified by their feathery heads which distribute thousands of seeds annually, and grow up to 15 feet in height.	 L.J. Mehrhoff, University of Connecticut, Bugwood.org
PURPLE LOOSESTRIFE (*Lythrum salicaria*)	Also growing in large quantities in marshy areas, the 2-7 foot purple loosestrife has a cone-like spike of pink/purple flowers atop a stiff stem.	 R. Gardner, UMES, Bugwood.org
MULTIFLORA ROSE (*Rosa multiflora*)	Multi-stemmed, thorny shrub with green-red canes, and stiff, recurved thorns. Flowers are white with five petals. Multiflora rose forms dense thickets that displace native plants.	 L.J. Mehrhoff, University of Connecticut,Bugwood.org

GARLIC MUSTARD (*Alliaria petiolata*)	A biennial, herbaceous plant with foliage that is recognized by a strong garlic odor. Highly tolerant of shade and produces compounds that inhibit seed germination of native species.	 L.J. Mehrhoff, University of Connecticut,Bugwood.org
JAPANESE /EUROPEAN BARBERRY (*Berberis thunbergii/vulgaris*)	Invasive shrub popular in home and commercial landscapes. Can range 3 to 7 feet in height, and grow broadly in dense compact form. Alternate, simple leaves. Multi-stemmed with spikes, with young stems being reddish, and older stems being grayer. Bear red fruits.	 Arthur Haines, New England Wildflower Society, Go Botany.newenglandwild.org
DAME'S ROCKET *(Hesperis matronalis*)	Non-native herbaceous biennial wildflower. Behaves like a perennial due to its aggressive reseeding frequency. Reaches 2 to 3 feet and develop purple or white flowers with upright spikes.	 Arthur Haines, New England Wildflower Society, Go Botany.newenglandwild.org

ORIENTAL BITTERSWEET *(Celastrus orbiculatus)*	Perennial, deciduous vine with elliptic to ovate alternate leaves which spiral evenly around the dark brown stem. Bears reddish-orange fruit in the fall months.	 Donald Cameron, New England Wildflower Society, Go Botany.newenglandwild.org
WINEBERRY *(Rubus phoenicolasisus)*	Invasive shrub in the same genus as raspberries and blackberries. Silvery underside to leaf which contains 3 leaflets. Thorny stem is covered by fine red hairs. Hairy flowers which are resinous and sticky.	 Arthur Haines, New England Wildflower Society, Go Botany.newenglandwild.org
JAPANESE STILTGRASS *(Microstegium vimineum)*	Grass found in riparian or moist forests that forms dense stands in the forest understory. Resembles a very small and delicate bamboo with silvery hairs on upper leaf surfaces.	 Arthur Haines, New England Wildflower Society, Go Botany.newenglandwild.org

XV. MACROINVERTEBRATES:

Macroinvertebrate assessments are useful measures of water quality because of the environmental conditions required by certain groups of macroinvertebrates. Certain species require high stream water quality in order to survive, while others may be able to exist in polluted and disrupted waters. If these high requirement species are able to function within a stream-ecosystem, water quality is essentially deemed adequate without the need for further investigation.

Two different procedures exist for collecting macroinvertebrates: Procedure A and Procedure B are for regular collection throughout the year and Procedure C is to be conducted three times a year in May, July, and September.

PROCEDURE A AND PROCEDURE B

In this section, collect **macroinvertebrates** using **kicknet**, observe in **white enamel pan**, and preserve in **sample container** with **isopropyl alcohol.** Procedure B details a special collection method for use in muddy bottom streams with low stream flow, such as that in Humpo Marsh or Old Clove sampling sites. Use of this procedure will be instructed to volunteers by conservation science staff if it is needed for their particular site.

Procedure A

1. Participant with proper attire: Wade into stream staying close or directly across from the marker ribbon on the bank, hold net on stream bottom between legs with the opening facing upstream. Measure a diagonal transect spanning 5 meters from the starting point to the opposite stream bank.
2. While slowly walking upstream, drag feet from outside to center in a waddling motion, kicking sediment into or near the mouth of the net. Brush any large stones within the water by hand to uplift any organisms latched onto their surfaces. Continue collecting for 5 minutes (to be tracked by the second participant), along the 5 meter transect with even timing and effort.
3. Once 5 minutes have elapsed, empty kicknet into white enamel pan after rinsing with stream water and then clearing of any large debris (rocks, branches, etc.), identify, count, and record any macroinvertebrates on datasheet.
4. If any collected macroinvertebrates are unable to be identified, keep preserved in the sample container with isopropyl alcohol and bring back to the Daniel Smiley Research Center (DSRC), for identification by Conservation Science staff.
5. The five meter span of river where collection takes place should be rotated between three different, distinct sections close to the marker ribbon. These areas should not overlap with one another, and should be rotated between every site visit. A potential setup can include one five meter span from the ribbon marker to downstream five meters, a five meter span from the ribbon marker to upstream five meters, and a third section adjoining either of these locations and going further downstream or upstream.

Procedure A-1

1. Starting downstream from the marker ribbon, move the kicknet upstream by one foot in a prodding motion, having the net dislodge and collect the first few inches of organic layer. This will be considered one scoop.

2. Rinse the mesh bottom of the net after each scoop by sweeping it back and forth through the water, not allowing water to run over the top of the net.
3. Once rinsed, deposit the collected material into the enamel pan for sorting.
4. Continue these steps until 10 scoops are collected, record macroinvertebrate counts as normal.

PROCEDURE C

Procedure C follows the same procedure as Procedures A and B, however, a total of 100 macroinvertebrates are to be collected for laboratory analysis at the research center. Perform multiple repetitions of Procedure A/B if necessary until 100 macroinvertebrates are collected. Each repetition should take place in a different area of the stream. Gather all macroinvertebrates into sample container and preserve with alcohol. These do not need to be identified and can be brought back to the DSRC and placed in the sample refrigerator for staff to analyze.

(Adapted from Onion, n.d., NYS DEC WAVE Protocol)

Refer to Table 2 on the next page for macroinvertebrate identification. Additional identification guides to macroinvertebrates can be found online at www.macroinvertebrates.org

Table 2. Macroinvertebrate Identification Guide (Voshell 2003; all images retrieved from NYSDECFreshwater Macroinvertebrates of NY)

- A + sign denotes a preferred organism (healthy stream conditions required)
- A – sign denotes an unwanted organism (Can live in polluted waters)

FLATWORMS(-) *(Platyhelminthes)*	Will be in slowly running or still water, clung to rocks, out of direct sunlight.	
SNAILS(-) *(Mollusca: Gastropoda)*	Enclosed in coiled cone-like shell. Will be in non-turbulent areas on rocks, substrate, or vegetation.	
WORMS(+/-) *(Oligochaeta)*	Reside in silt and mud or in mats of algae, etc. In stagnant or slow moving water; important to look closely at smaller ones to ensure it is a worm, rather than a true fly or scud.	

LEECHES(-) *(Hirudinea)*	Found in large groups, not individually. Attach to rocks in shallow areas without any sediment.	
SCUDS(-) *(Amphipoda)*	Bottom-dwellers often entangled in aquatic plants or partially buried in substrate. More active in darkness. Smaller ones may appear to look like a worm if not careful; overall looks like a small shrimp.	
CRAYFISH(-) *(Decapoda)*	Can reside anywhere in stream. Tend towards spaces between rocks. Swims backwards, looks like a small lobster.	
SOWBUGS(-) *(Isopoda)*	Hides between crevices of aquatic plants, rocks, loose substrate, and debris. Have 7 pairs of legs with the last pair appearing to look like a pair of flat tails.	
MAYFLIES(+) *(Ephemeroptera)*	Larvae found on firm substrate, swimming, crawling, clinging, or burrowing. Usually have 3 cerci (tails) and 1 tarsal claw (nail) on each leg.	
DRAGONFLIES AND DAMSELFLIES(+) *(Odonata)*	Larvae found in still waters, especially small, temporary habitats (resembling puddles/ponds near stream). Visible "face mask" appears as a net around the mouth.	

STONEFLIES(+) *(Plecoptera)*	Small streams with very low temperatures and coarse substrate (cobbles/boulders). Most have 2 long cerci (tails) and 2 tarsal claws (nails) at the end of each leg.	
TRUE BUGS(-) *(Hemiptera)*	Have tolerance for many habitats, including muddy or polluted areas. Can exist in almost any water. Have three pairs of segmented legs and is capable of folding its wings when not in use.	
DOBSONFLIES AND ALDERFLIES(+) *(Megaloptera)*	Inhabits intermittent and damp semi-terrestrial (muddy/near shore) area of streams, bogs, ponds. Long pairs of structures alongside the body, and the end of the body has either a pair of unjointed legs or one single long tapering structure.	
WATER BEETLES(-) *(Coleoptera)*	Can tolerate running water or still water. Hard, shell like cover with a single center line appearing on the back. 3 pairs of legs.	
CADDISFLIES(+) *(Trichoptera)*	Most prefer medium sized, cool, running streams. 3 pairs of segmented legs with head and third thoracic segment always having hardened skin similar to a shell.	
TRUE FLIES(+/-) *(Diptera)*	Larvae can survive in as little as 10 milliliters of water, in even the most hostile of environmental conditions. Long and soft, similar to a worm, but some may have hardened skin on their head, and some have unsegmented legs present	

REFERENCES

Allendorf, F.W. & L.L. Lundquist. 2003. Introduction: Population Biology, Evolution, and Control of Invasive Species. *Conservation Biology* 17(1): 24-30.

Ashman, M. & G. Puri. 2002. Essential soil science a clear and concise introduction to soil science. Malden, MA: Blackwell.

Berlemann, A. 2013. Using a water quality index to determine and compare creek water quality. *Journal (American Water Works Association)* 105(6): E291-E298.

Center for Invasive Species and Ecosystem Health. The University of Georgia, 21 Feb. 2010. Retrieved from https://www.bugwood.org/index.cfm

Equipment Decontamination Protocol for Field Staff in Sequoia and Kings Canyon National Parks [PDF]. (n.d.). Sacramento, CA: Fws.gov.

Freshwater Macroinvertebrates of NY [Digital images]. (n.d.). Retrieved from http://www.dec.ny.gov/animals/35772.html

Geiger J. & L. Mesner. n.d. *"*Utah Stream Team Manual*"* [PDF]. Utah State University Extension.

Grosse, A.M., S.C. Sterrett, and J. Maerz. 2010. Effects of Turbidity on the Foraging Success of the Eastern Painted Turtle. *Copeia* 2010(3): 463-467.

Kaufmann, P.R., and J.M. Faustini. 2012. Simple measures of channel habitat complexity predict transient hydraulic storage in streams. *Hydrobiologia* 685: 69-95.

Kaushal, S.S., G.E. Likens, N.A. Jaworski, M.L. Pace, A.M. Sides, D. Seekall, K.T. Belt, D.H. Secor, and R.L. Wingate. 2010. Rising stream and river temperatures in the United States. *Frontiers in Ecology and the Environment* 8(9): 461-466.

Macura, V., Z. Štefunková, and A. Škrinár. 2015. Determination of the Effect of Water Depth and Flow Velocity on the Quality of an In-Stream Habitat in Terms of Climate Change. *Advances in Meteorology* 2016: 1-17.

Mitsch, W.J. and J.G. Gosselink. 2007. *Wetlands*. Hoboken, New Jersey: John Wiley & Sons. Inc.

Onion, A. n.d.. (DEC) WAVE: Water Assessments by Volunteer Evaluators [PDF]. NYS Dept. of Environmental Conservation.

Ringold, P.L., T,K, Magee, and D.V. Peck. 2008. Twelve invasive plant taxa in US western riparian ecosystems. *Journal of the North American Benthological Society* 27(4): 949 966.

Voshell, J. R. 2003. A guide to common freshwater invertebrates of North America. Manitoba, Canada: McDonald & Woodward Pub.

STREAMWATCH
WATER SAMPLING DATASHEET

NAME(S) ______________________ DATE______ TIME______ SITE__________

1. OBSERVATION/ASSESSMENT

1a. WATER APPEARANCE: *clear* *foamy* *cloudy/muddy* *brown* *green* *orange/red*
multi-colored sheen *milky* *scummy* *other*

1b. WATER ODOR: *sulfur* *chlorine* *sewage* *petroleum* *chemical* *none* *other*

1c. CANOPY COVER: ______%

10	9	8	7	6	5	4	3	2	1	**0**	1	2	3	4	5	6	7	8	9	10

1d. AIR TEMPERATURE: _____°F

1e. PRECIPITATION: *no rain* *light rain* *heavy rain* *downpour* *other*

1f. SKY CONDITIONS: *overcast* *precipitation* *partly cloudy*
sunny *other*

1g. WIND: *calm* *light breeze* *moderate winds* *high winds*

2. STREAM CONDITIONS

2a. WIDTH: _____centimeters

2b. DEPTH: _____ centimeters

2c. VELOCITY: *trickle* *slow* *medium* *rapid*

3. WATER QUALITY

3a. WATER TEMPERATURE: ___°F

3b. TURBIDITY: Water level in tube: ____cm NTU's: ____

*3c. pH: ______

3d. DISSOLVED OXYGEN: _____ppm
**In-lab parameter*

Distance from bottom of tube (cm)	NTU's
< 6.25	> 240
6.25 to 7	240
7 to 8	185
8 to 9.5	150
9.5 to 10.5	120
10.5 to 12	100
12 to 13.75	90
13.75 to 16.25	65
16.25 to 18.75	50
18.75 to 21.25	40
21.25 to 23.75	35
23.75 to 26.25	30
26.25 to 28.75	27
28.75 to 31.25	24
31.25 to 33.75	21
33.75 to 36.25	19
36.25 to 38.75	17
38.75 to 41.25	15
41.25 to 43.75	14
43.75 to 46.25	13
46.25 to 48.75	12
48.75 to 51.25	11
51.25 to 53.75	10
53.75 to 57.5	9
57.5 to 60	8
Over 60	0

4. STREAM BIOTA

4a. INVASIVE SPECIES ASSESSMENT: *(check boxes that apply)*

SPECIES	*none*	*sparse*	*some*	*dense*
DIDYMO				
JAPANESE KNOTWEED				
GIANT HOGWEED				
COMMON REED (PHRAGMITES)				
PURPLE LOOSESTRIFE				
MULTIFLORA ROSE				
GARLIC MUSTARD				
JAPANESE/EUROPEAN BARBERRY				
DAME'S ROCKET				
ORIENTAL BITTERSWEET				
WINEBERRY				
JAPANESE STILTGRASS				
OTHER:				

4b. MACROINVERTEBRATES: *(check boxes that apply)*

SPECIES	*# present*	**SPECIES**	*# present*
FLATWORMS (-)		*DRAGONFLIES /DAMSELFLIES(+)*	
SNAILS (-)		*STONEFLIES (+)*	
WORMS (+/-)		*TRUE BUGS (-)*	
LEECHES (-)		*DOBSONFLIES (+)*	
SCUDS (-)		*WATER BEETLES (-)*	
CRAYFISH (-)		*CADDISFLIES(+)*	
SOWBUGS (-)		*TRUE FLIES (+/-)*	
MAYFLIES (+)			