POESTEN KILL FACT SHEET: WATER QUALITY

INTRODUCTION

Water quality monitoring is an incredibly vital component of stream assessments. Selecting what parameters to include in a stream survey can be challenging, given all the options. However, relatively simple and inexpensive tests, such as temperature, dissolved oxygen, pH, and water clarity, can provide a tremendous amount of information on overall stream health. By understanding what each parameter measures, its relative importance in an aquatic ecosystem, and how parameters may interact with each other in the natural environment, researchers and citizen scientists can better predict and understand the responses of aquatic organisms. And in doing so, one can make more informed assessments of stream health and prioritize monitoring, restoration, and/or conservation efforts. Thus, an invested interest in water quality is an invested interest in the health, diversity, and abundance of biota.

Water quality includes a number of parameters that environmental scientists use to measure the "health" and character of natural waters. Water quality has a direct relationship with the biota living within the water body. Technicians, scientists, and citizens can measure physical and chemical measurements directly in the field (in-situ) or via laboratory analysis. Common water quality parameters include, but are not limited to (1):

- **Temperature**
- **Dissolved oxygen**
- **Salinity (specific conductivity; total dissolved solids)**
- **Turbidity (suspended solids, water clarity)**
- **Alkalinity and pH**
- **Pathogens / Fecal indicator bacteria (e.g., fecal coliform, E. coli, Enterococcus, total coliform)**
- Hardness (calcium and magnesium)
- Major ions (e.g. chloride, sulfate)
- Nutrients (e.g., phosphorus and nitrogen
- Trace metals (e.g. copper, iron)·
- Trace organic chemicals (e.g. pesticides, PCBs, herbicides)

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(1) Parameters that were measured as part of the Poesten Kill Ecological Survey are denoted in bold and discussed in further individual factsheets.

The concentration at which water quality parameters are measured and reported cover an extremely wide range, from part-per-trillion levels (e.g. dissolved mercury) to part-per-thousand levels (e.g. salinity); emphasizing that the effects of these parameters on water quality and wildlife is relative and do not exert the same effects. Moreover, multiple factors in a waterbody can compound effects and exacerbate impacts to stream health and biological quality. Measurements of water quality can be incredibly informative to understanding overall stream health. However, due to the dynamic nature of waterbodies, and in particular stream systems, identifying the potential sources of impairment to water quality can be particularly challenging. Measures of water quality at a given location are not necessarily indicative of water quality for the entire stream reach and can be relatively localized in spatial extent and effects on stream health. And likewise, most sources of water quality impairment and pollution originate at, or are a result of, sources from outside of the stream (Fig. 1).

Figure 1. Sources of stream pollution can originate from multiple sources. (Image obtained from: FilterWater.com)

POESTEN KILL WATER QUALITY: TEMPERATURE

Stream temperature is a very easy water quality parameter to measure and can be incredibly informative to understanding the health of a stream system. Water temperature is most commonly measured with a thermometer or a water quality meter equipped with a temperature sensor. Stream temperature is largely a function of climate, influenced by season and altitude (e.g., higher elevations tend to maintain colder stream temperatures). Water temperature can be locally influenced by groundwater inputs, shade canopy provided by overhanging vegetation, and human activities. In temperate climates, such as the Northeastern United States, aquatic life is adapted to colder stream temperatures. Therefore, warmer stream systems are more likely to preclude aquatic life than colder stream systems (Fig. 1). As a result, colder stream temperatures can be suggestive of a healthy stream system capable of supporting abundant and diverse aquatic life.

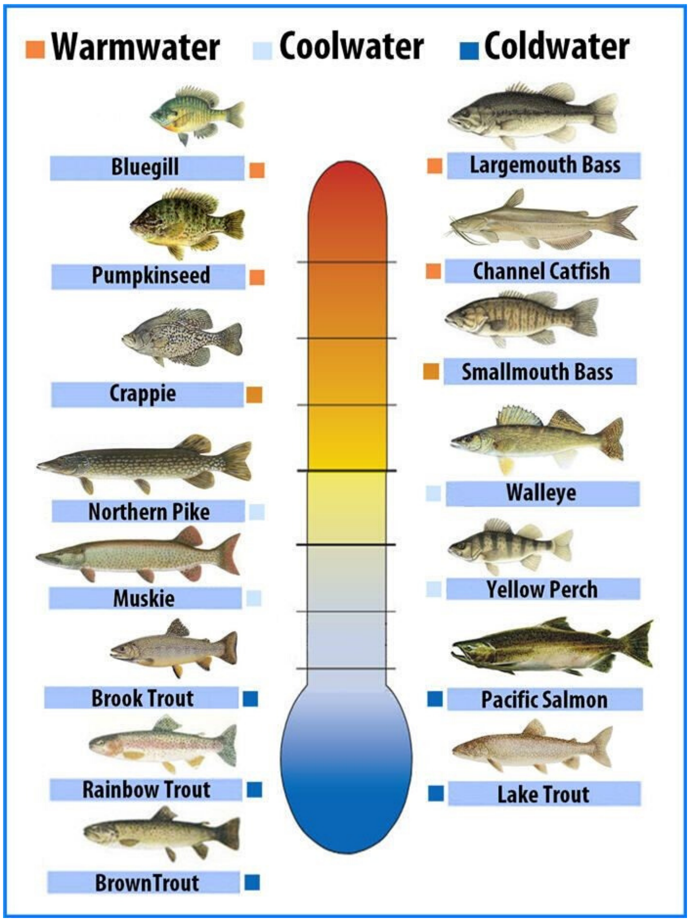

Figure 1. Examples of fish thermal tolerance designations. (Image obtained from: ShaddockFishing.com)

Sensitive species, such as trout require low temperatures year-round. Excessive heat in the summer can limit the available habitat and/or threaten the sustainability of fish populations. The loss or absence of sensitive species such as trout in streams once capable of supporting such species could be indicative of a change in temperature and suggestive of a decline in stream health.

IMPLICATIONS

- As water temperature approaches 70° F (21°C), trout are less able to compete with other fish species for food. Lethal temperatures for trout range from 73°F to 79°F (23°– 26°C) (Cushing and Allen 2001).·
- Temperature is inversely related to dissolved oxygen (please see below). Therefore, measures of temperature can inform scientists about potential impacts to dissolved oxygen, and thus, aquatic life.

WATER TEMPERATURE IN POESTEN KILL

Stream temperatures in Poesten Kill ranged between cool (14.72˚C) and warm (21.93˚C) ranges (Fig. 2). During each survey, stream temperatures were warmest at the most upstream site (Site #31). This site was directly downstream of the Dyken Pond outlet. The large, open waterbody has a high exposure to sunlight with relatively stagnant conditions; likely contributing to the higher temperatures at this site. Overall, stream temperatures were within normal ranges for mid- to late-June and were not indicative of any impairment to water quality or biotic health.

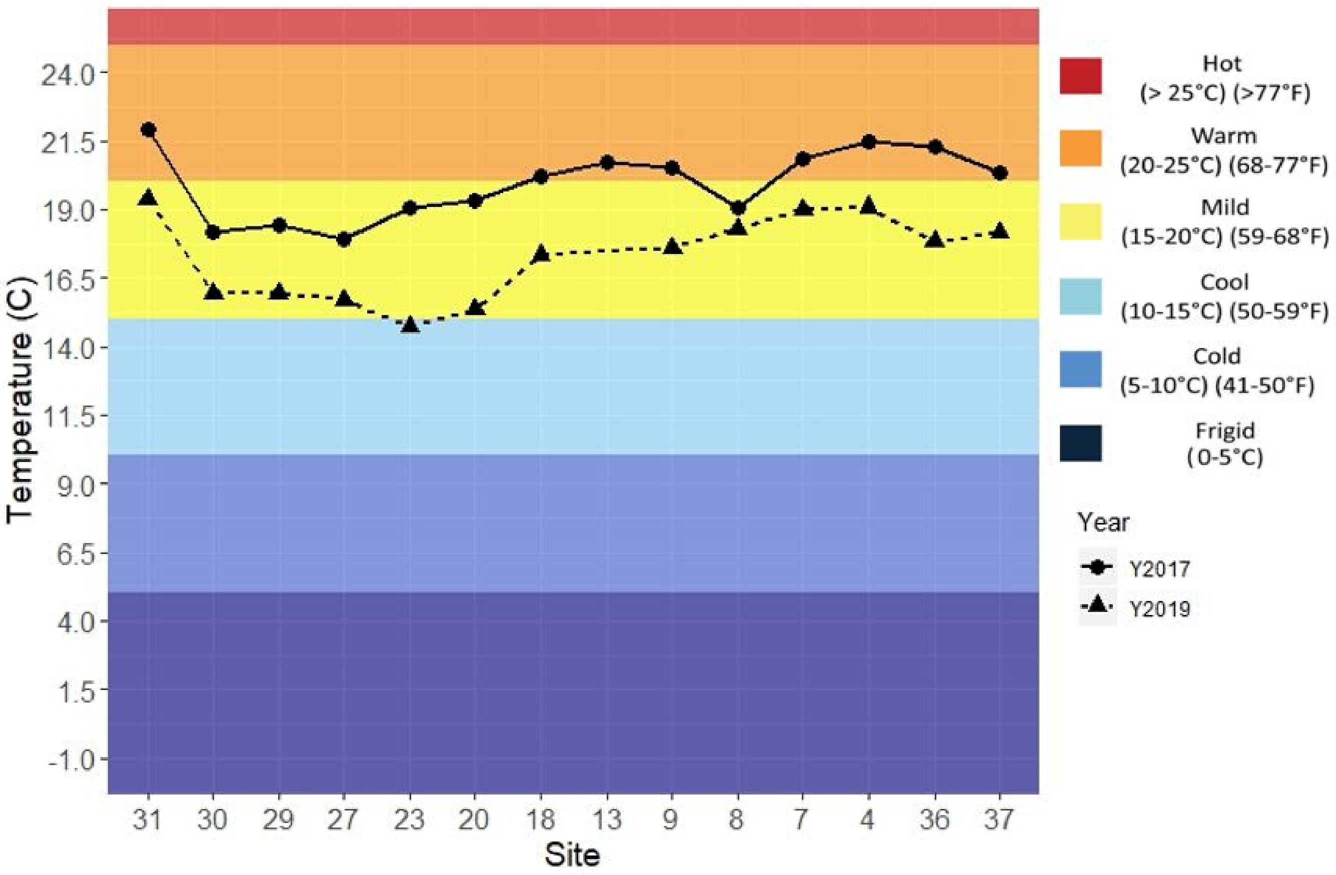

Figure 2. Stream temperatures in Poesten Kill (2017 & 2019). Sites are arranged in downstream order.

POESTEN KILL WATER QUALITY: DISSOLVED OXYGEN

Dissolved oxygen (D.O.) is one of the most important water quality indicators because nearly all aquatic life, ranging from bacteria to fish, require oxygen. Even plants, which produce oxygen via photosynthesis during the daylight hours, need oxygen to respire. Only certain forms of microorganisms do not require oxygen to survive. In addition to its critical biological role, oxygen also regulates chemical reactions in aquatic systems. Inversely related to temperature, as oxygen levels decline, species richness and diversity decline, and sensitive organisms decline or become absent altogether (Fig. 1).

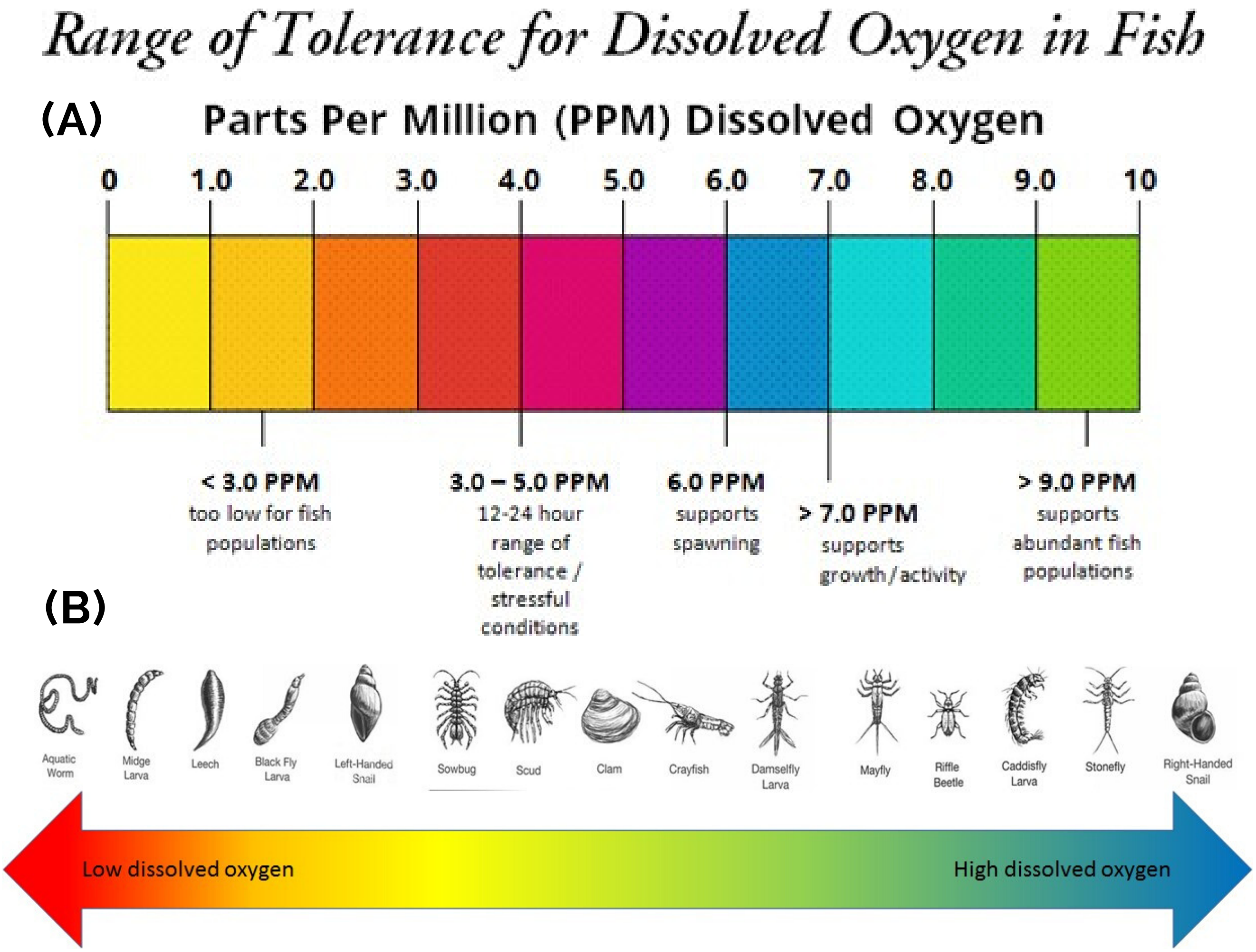

Figure 1. Dissolved oxygen tolerances for (a) Fish and (b) Macroinvertebrates.
(Images obtained from: limnoloan.org and fineartamerica.com, respectively)

D.O. is highest (13-15 mg/L) in cold weather, and lowest in the summer (8-9 mg/L) because the solubility (the ability to dissolve in water) of oxygen decreases as temperature increases. Animal respiration also increases when temperatures increase. As a result, oxygen levels become further reduced (Fig. 2). High salinity concentrations also affect D.O. solubility, causing a reduction in total D.O. levels.

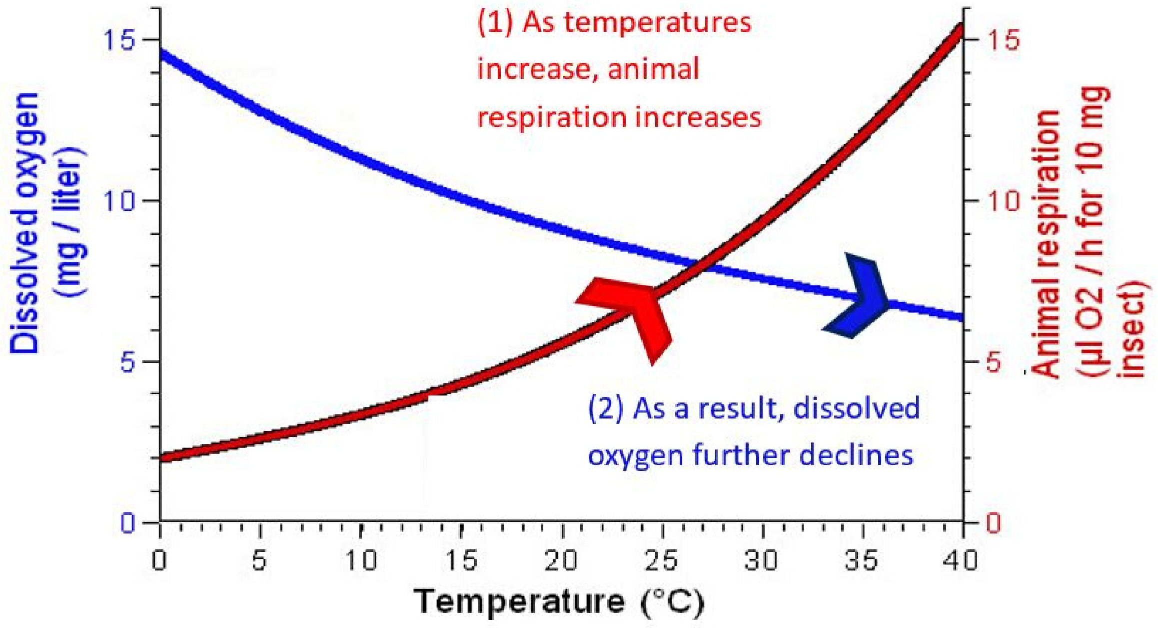

Figure 2. Relationship between dissolved oxygen and temperature.

WHERE DOES OXYGEN IN STREAMS COME FROM AND WHERE DOES IT GO?

Dissolved oxygen concentrations in streams are affected by many different physical, chemical, and biological processes (Text Box 1).

TEXT BOX 1: DISSOLVED OXYGEN IN STREAMS – SOURCES & SINKS

OXYGEN SOURCES:

- Aquatic plants, algae (photosynthesis)
- Aeration from the atmosphere
- Forces that increase aeration:
  - Wind energy
  - Kinetic energy & turbulence – movement of water through stream channel

OXYGEN SINKS (INPUTS WHICH REMOVE OXYGEN):

- Sewage inputs
- Carbonaceous (organic) matter decomposition
- Sediment oxygen demand
- Plant and microbial respiration

In streams affected by organic (i.e., sewage) pollution, a characteristic oxygen sag curve is often observed (Fig. 3)

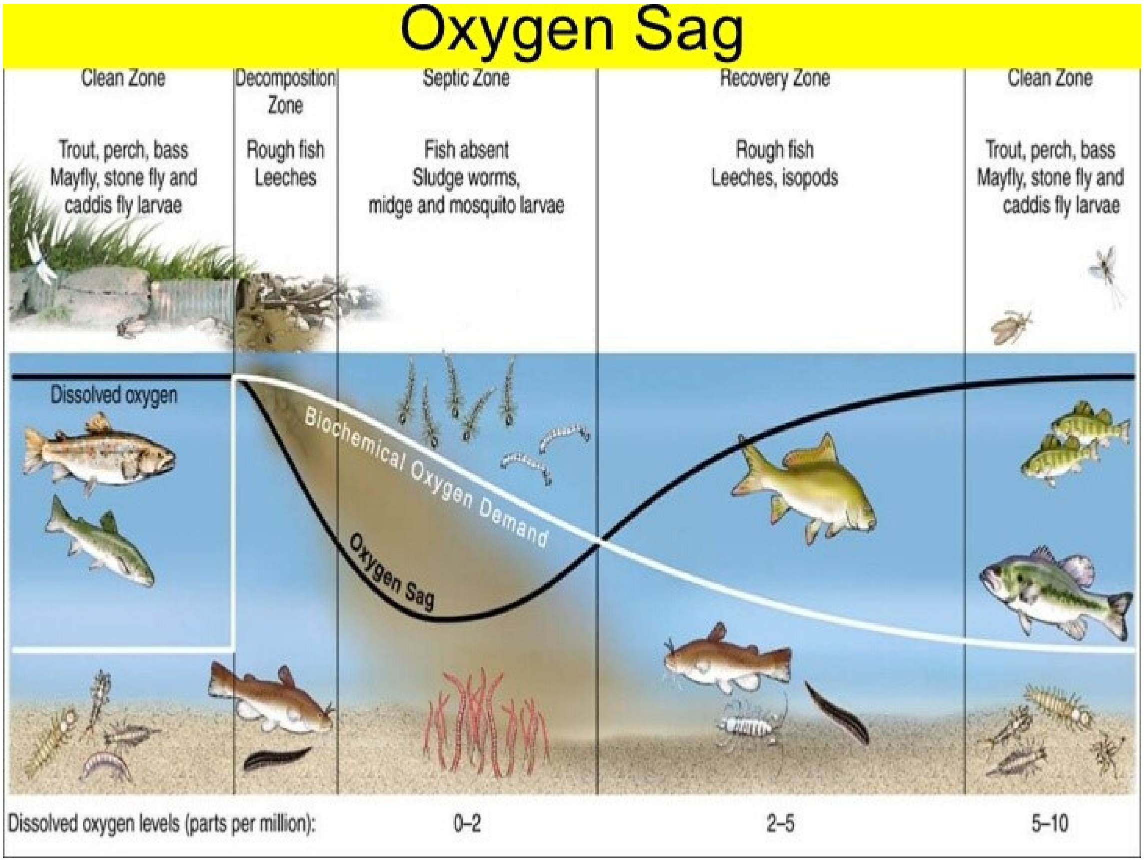

Figure 3. Dissolved oxygen sag curve typical of streams affected by organic pollution and the predicted effects on stream biota. (Image obtained from: slideshare.net)

IMPLICATIONS

- D.O. concentrations below 5 mg/L can begin to stress aquatic life, ultimately leading to mortality.
- Rapid changes in D.O. concentrations can cause "fish kills" that significantly reduce populations in a short period of time. Prolonged reductions in D.O. can cause long-term impacts to fish populations, significantly reducing reproductive success and juvenile survival.
- Declines in D.O. can also induce reductions in important prey items for fishes (e.g., aquatic macroinvertebrates), causing significant alterations to the food web.

DISSOLVED OXYGEN REQUIREMENTS IN NEW YORK STATE

New York State Department of Environmental Conservation (NYSDEC) sets a regulatory standard for allowable D.O. concentrations in streams, based on stream class. In Poesten Kill, waters are classified as Class C(T) in the lower watershed and Class C(TS) in the upper watershed. Such designations have classified Poesten Kill as a waterbody best suitable forfishing (Class C), capable of supporting trout populations (T) in the lower watershed and trout spawning (TS) in the upper watershed. Based on these classifications, minimum daily average D.O. concentrations in Poesten Kill shall not be less than 6.0 mg/L in the lower watershed and not less than 7.0 mg/L in the upper watershed. Additionally, at no time in Poesten Kill shall dissolved oxygen concentrations be less than 5.0 mg/L (NYSDEC 2019a)

DISSOLVED OXYGEN IN POESTEN KILL

D.O. concentrations in Poesten Kill were relatively consistent among sampling sites and between survey years (Fig. 4). D.O. was consistently within the 'high' range and indicative of good water quality. The relatively constant D.O. concentrations throughout the reach did not indicate evidence of organic pollution as modeled by the Oxygen Sag Curve (Fig. 3). D.O. concentrations were found well above the required concentrations set forth by NYSDEC, maintaining concentrations necessary for the survival, growth, and reproduction of trout.

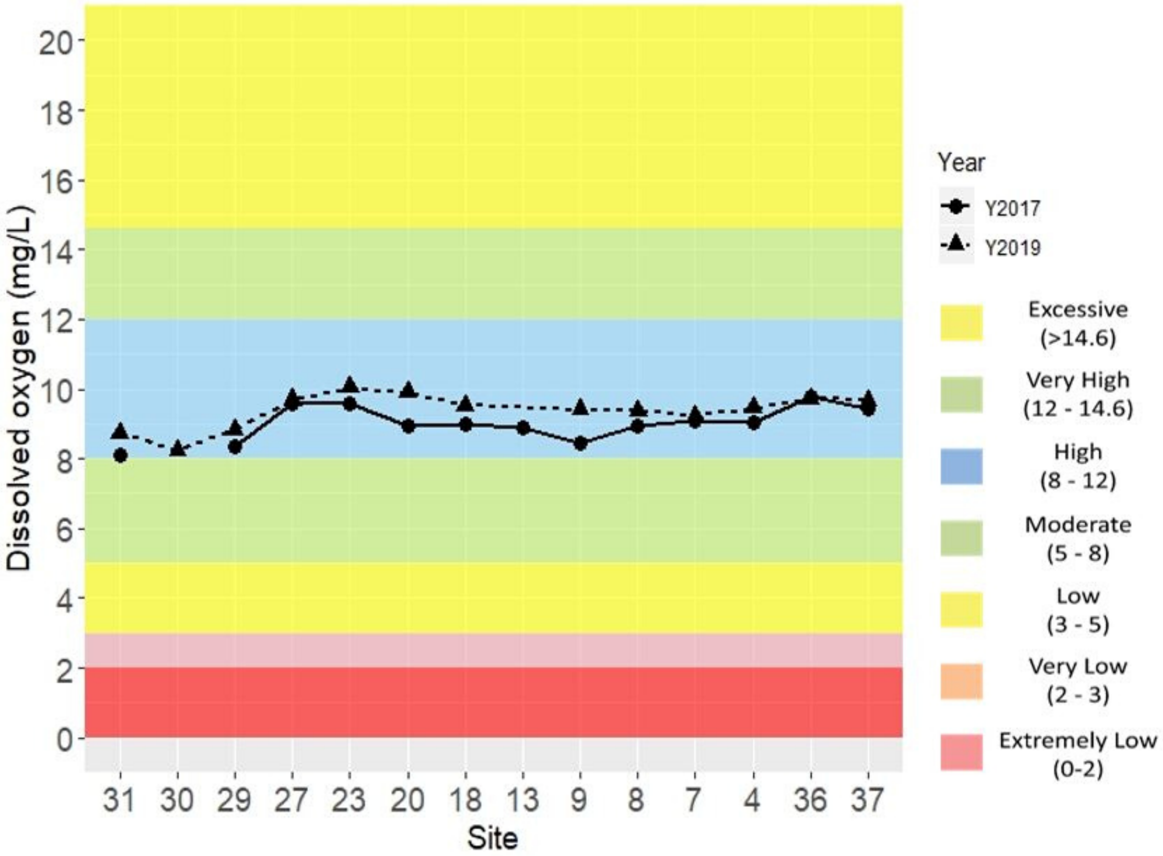

Figure 4. Dissolved oxygen levels in Poesten Kill (2017 & 2019). Sites are arranged in downstream order.

POESTEN KILL WATER QUALITY: SALINITY

Natural waters contain dissolved solids, primarily inorganic salts. Salinity is the concentration of salts in water. These salts consist of positive and negative ions, including:

MAJOR POSITIVE IONS
Calcium (Ca^{++})
Magnesium (Mg^{++})
Sodium (Na^{+})
Potassium (K^{+})

MAJOR NEGATIVE IONS
Bicarbonate (HCO_3^{-})
Chloride (Cl^{-})
Sulfate ($SO_4^{=}$

Other dissolved inorganic constituents, including nitrate (NO_3^{-}), silica (SiO_2), and iron oxides (e.g. Fe_2O_3), occur at relatively minor concentrations. Dissolved salts do not affect the appearance of water, while in solution. Often, salts become visible when forming solid precipitates. Dissolved salts above 500 mg/L can affect the usefulness of water as a source of drinking water and above 1000 mg/L for agricultural purposes. Salts can adversely affect some freshwater organisms. (Allan 1995)

Salinity (saltiness) can be measured as:

- Total dissolved solids (TDS) [units = mg/L]
- Specific conductivity (or conductance) [units = microSiemens per cm (μS/cm)]
- Sum of individual ions (e.g. chloride) [units = mg/L]

Table 1 provides the reader with a frame of reference for differing levels of salinity in the environment.

	uS/cm
DISTILLED WATER	0.5 - 3
MELTED SNOW	2 - 42
TAP WATER	50 - 800
POTABLE WATER IN THE US	30 - 1500
FRESHWATER STREAMS	100 - 2000
INDUSTRIAL WASTEWATER	10000
SEAWATER	55000

Table 1. Typical concentrations of conductivity (μS/cm) in various types of water. (Image obtained from: Fondriest Environmental, Inc.)

SALINITY SOURCES

Contributions of salts to freshwater systems can come from natural (e.g., salt springs, erosion of rocks) and anthropogenic (human) sources (Fig. 1). Increases in salinity can significantly impair biological communities in streams, as well as negatively affect the use of waterbodies by humans (e.g., drinking, swimming, recreation).

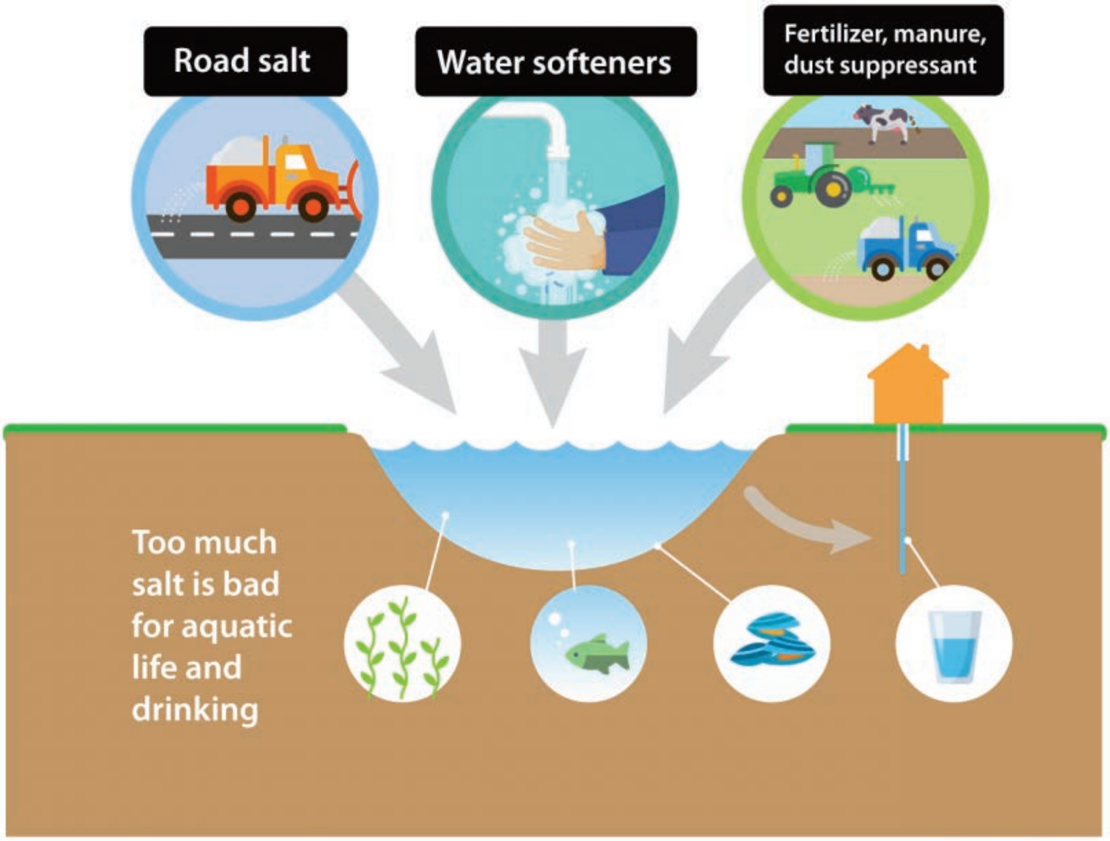

Figure 1. Sources of salt into waterbodies. (Image obtained from: pca.state.mn.us/water/chloride-101)

More recently, scientists have discovered an alarming trend in freshwater streams across the United States; freshwater salinity is on the rise (Fig. 2). One of the most pervasive sources of elevated salinity concentrations is from road salt applications by state and municipal highway departments and homeowners. Researchers studying the Mohawk River basin in New York State concluded that the two major components of road salt, sodium and chloride, had increased by 130 and 240%, respectively over the period 1952-1998 (Godwin et al. 2002).

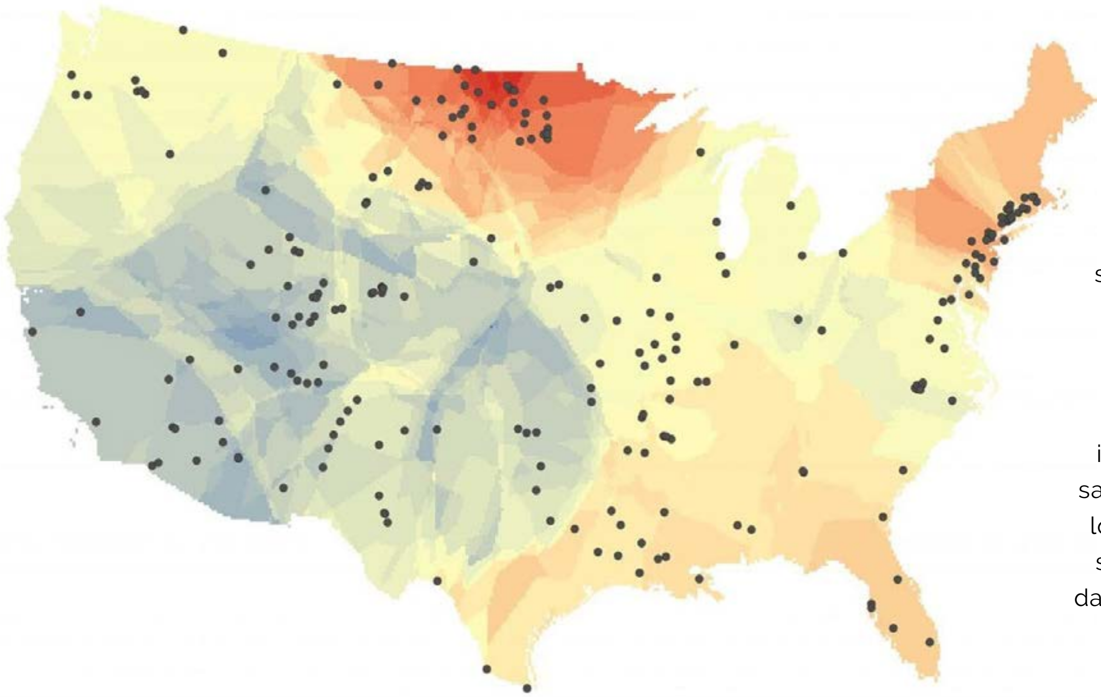

Figure 2. Changes in salinity in rivers and streams throughout the United States. Warmer colors indicated an increase in salinity, whereas cooler colors indicated a decrease in salinity. Dots indicated the location of USGS gaging stations from which the data to build the map were derived (Dennis 2018).

IMPLICATIONS

- Freshwater aquatic organisms are adapted to low conductivity waters. Increases in turbidity can alter their internal controls for regulating internal salt concentrations (i.e., osmoregulation); which can induce stress and cause mortality.
- Increases in salt inputs can suppress aquatic plant growth, altering physical habitat and food web dynamics.

SPECIFIC CONDUCTIVITY IN THE POESTEN KILL

Conductivity concentrations in Poesten Kill fell within the normal range for freshwater streams, with all sites considered 'pristine' during both surveys (Fig. 3). However, a noticeable downstream increase in conductivity was evident during both surveys. From the headwaters to the outlet, land use follows a distinct rural-urban gradient. The increase in urbanization, and thus road density and impervious surfaces, along the stream gradient is likely contributing to increased road salt runoff and ultimately stream conductivity levels. Of the water quality parameters measured during this survey, conductivity appears to pose the greatest impact to stream health. In the future, road salt application management may need to be considered by municipalities for the long-term protection of Poesten Kill.

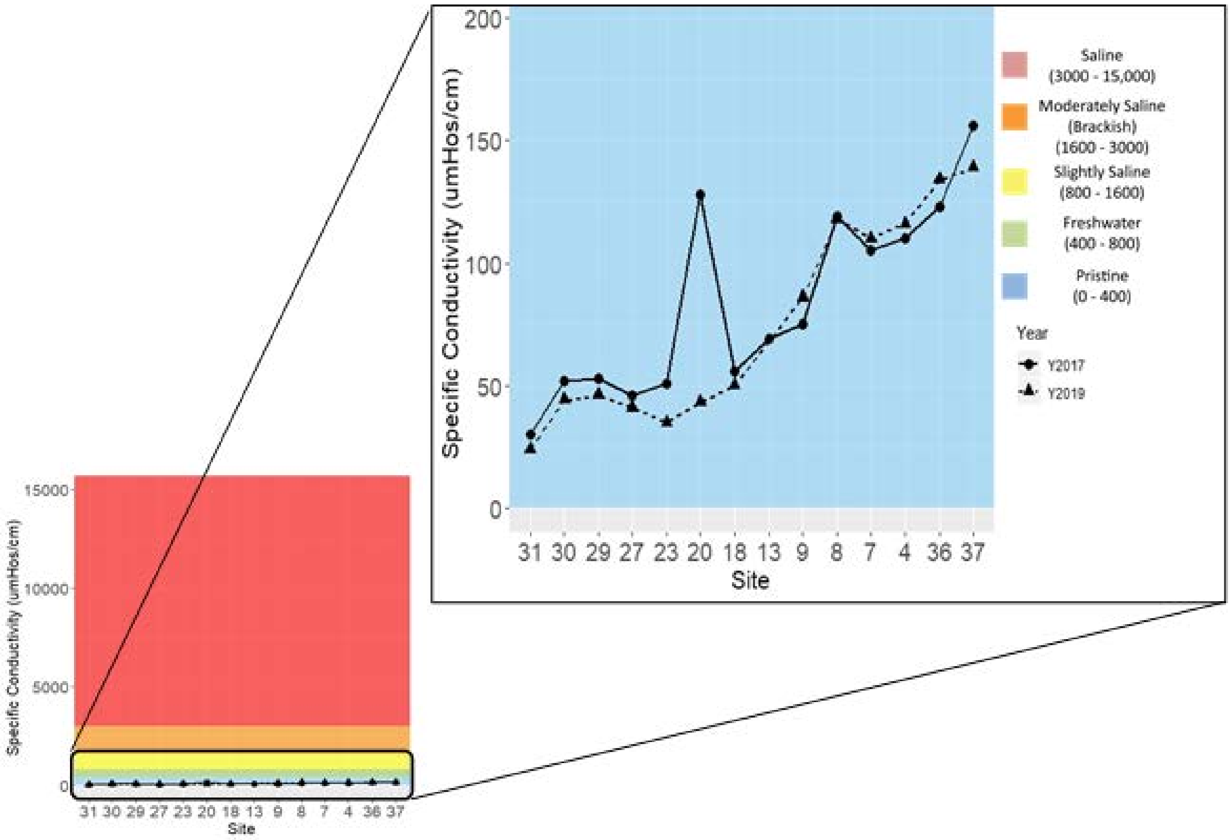

Figure 3. Conductivity levels for Poesten Kill (2017 & 2019). Sites are arranged in downstream order. The inset is meant to highlight the narrow range of conductivity levels measured in the Poesten Kill relative to the total color-interpretative scale used.

POESTEN KILL WATER QUALITY: ALKALINITY & PH

Alkalinity is a measurement of ions that control the pH of water. A pH of 7 is considered neutral. A pH value above 7 is considered alkaline and below 7 is considered acidic. Alkalinity is determined primarily by the amount of bicarbonate and carbonate ions in water. Levels of pH are largely driven by the geological composition of the watershed and often change very little in stream systems. Water draining from land characterized by limestone (calcium carbonate) rock can be strongly alkaline, whereas water draining from lands characterized by igneous rocks tend to be more acidic. Generally, alkaline waters are more biologically productive than acidic waters (Cushing and Allan, 2001). However, inputs from industrial and municipal discharges, as well as urban runoff can negatively impact the pH of freshwater systems. More recently, scientists have identified climate change, as a result of increased carbon emissions, as a primary cause of aquatic acidification, particularly in oceans (NOAA 2013). Highly acidic or highly alkaline waters can stress aquatic life and ultimately alter the biological community (Fig. 1).

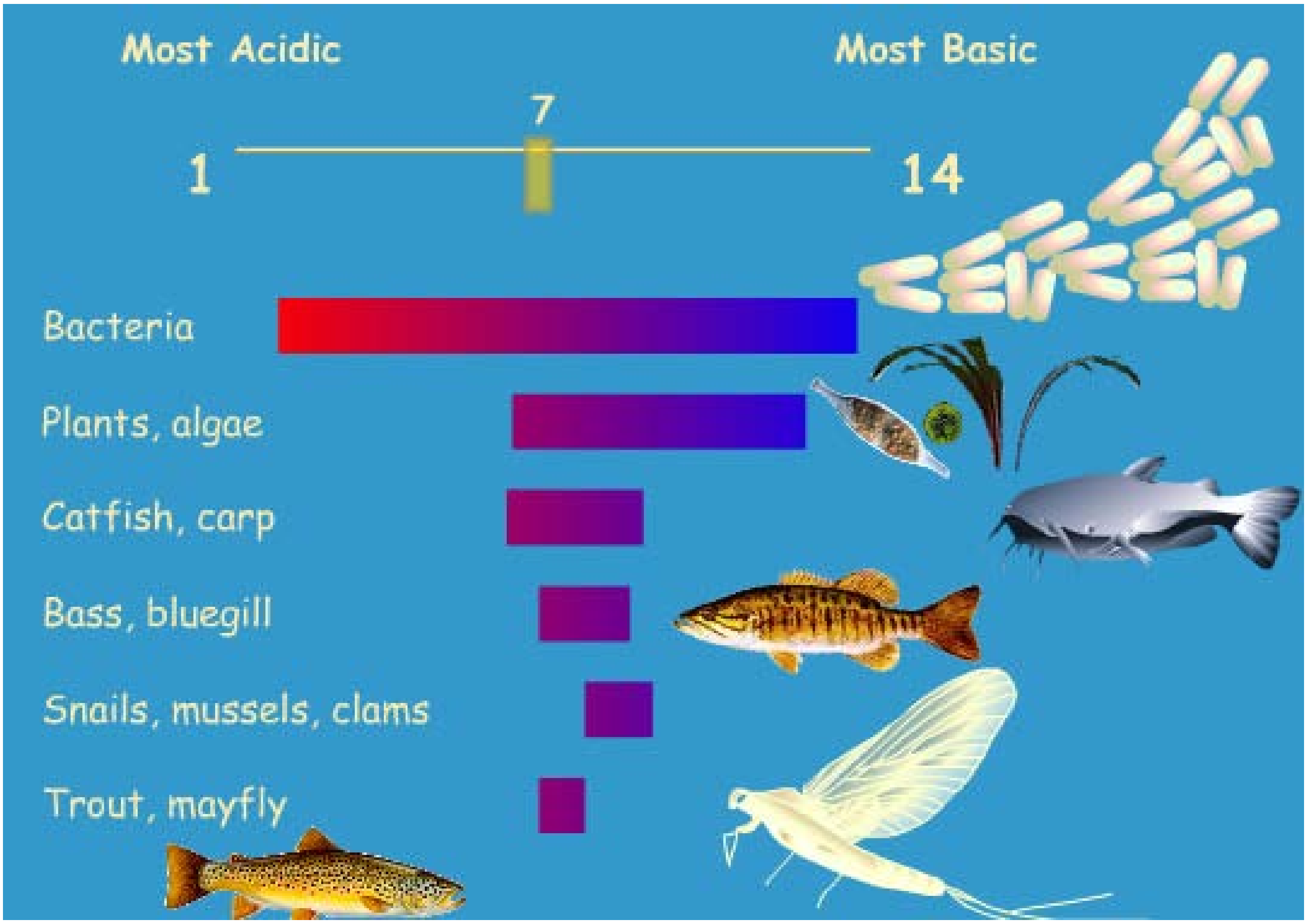

Figure 1. Examples of pH tolerances of freshwater organisms. Image obtained from: techalive.mtu.edu.

IMPLICATIONS

- Slight rapid and/or pervasive changes to pH can stress aquatic life, affect reproductive success, and lead to mortality
- For sensitive species such as trout and mayflies, deviations beyond a neutral pH (< 7 or > 8) can affect populations.
- For most fish species, a pH of < 6.5 and > 9 can cause stress or mortality.
- Changes to pH can significantly alter other water quality parameters and pollutants:
  - Lower pH levels can mobilize heavy metals, making them more toxic to aquatic life and humans (Fondriest Environmental, Inc. 2013)
  - Changes in pH can increase the solubility of nutrients, such as phosphorus, causing changes in plant and algal productivity; ultimately affecting parameters such as water clarity, dissolved oxygen, and temperature.

PH LEVELS IN POESTEN KILL

Levels of pH ranged between alkaline (pH = 8.49 at Site #31 in 2019) and slightly acidic (pH = 6.01 at Site #27 in 2017) conditions (Fig. 2). For most sites during both years, pH was considered neutral. Surveys did not identify anthropogenic factors that could be affecting pH; rather, pH appeared to be indicative of natural conditions. Levels of pH were within ranges not considered harmful to aquatic life.

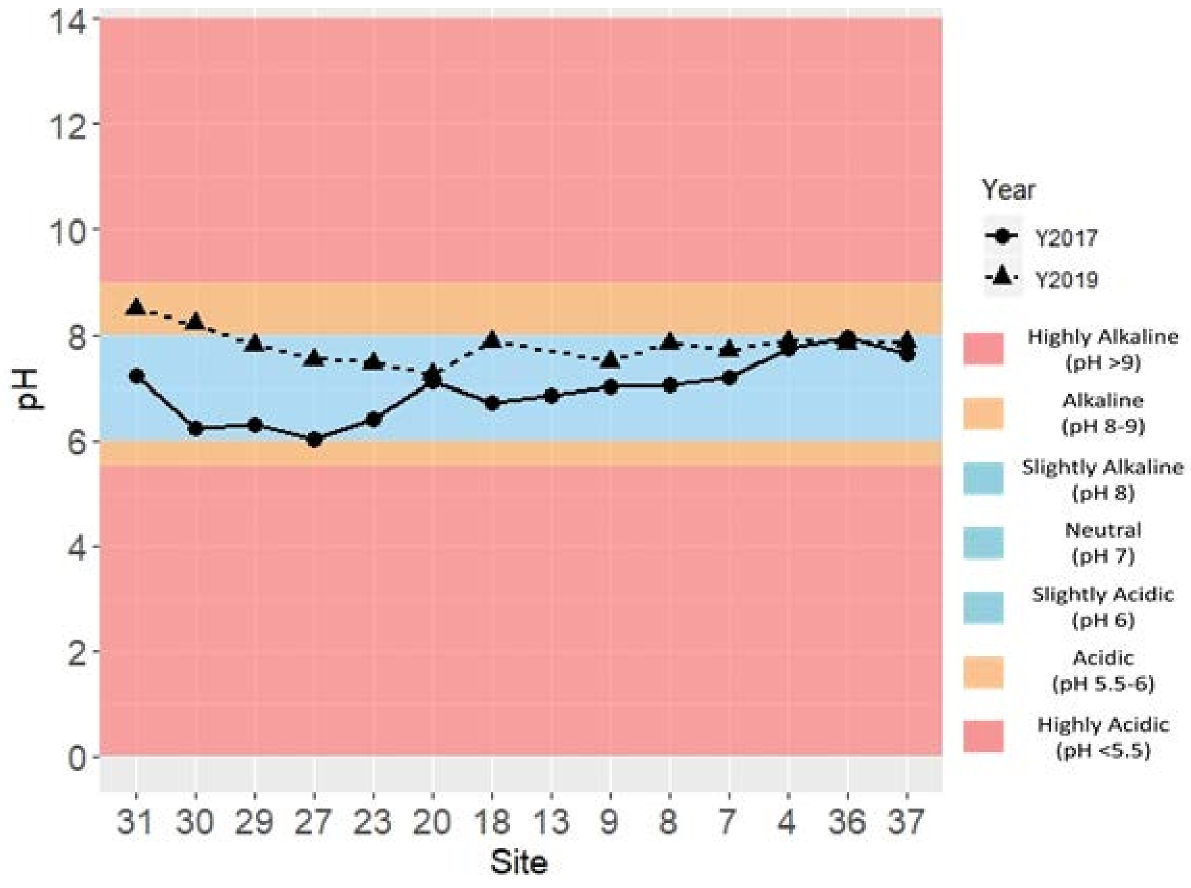

Figure 2. pH levels in Poesten Kill (2017 & 2019). Sites are arranged in downstream order.

POESTEN KILL WATER QUALITY: TURBIDITY

Particles in water are measured two different ways: turbidity and total suspended solids (TSS). Turbidity is a measure of water clarity, or light attenuation (extinction), caused by materials (e.g., clay, silt, and sand, algae, plankton, microbes, & other substances, including dissolved substances) suspended in the water. TSS is the dry weight of suspended (not dissolved) particles in the water. Turbidity and TSS are well-correlated (the presence of one predicts the other) and are very dynamic. In most stream systems, they are low when stream flow is constant and high during major runoff and storm events when scour and erosion occur. Fluctuations in turbidity can be caused by both natural (e.g., snow melt, rainstorms) and anthropogenic events (e.g., land/soil disturbance, point-source pollution).

IMPLICATIONS

The effects of elevated turbidity in aquatic systems includes (FISRWG 1998) (Fig. 1):

- Suffocation of aquatic insect and fish eggs/larvae
- Interference with fish reproduction
- Clog and abrade fish gills
- Aesthetically displeasing
- Sediments can serve as a transport mechanism for toxic substances (e.g. pesticides), pathogens, and nutrients such as nitrogen and phosphorus
- Settled sediments can interfere with stream flow, fish passage, and navigation by filling in channels
- High volumes of deposited sediments can reduce the storage capacity of the channel, thereby increasing flooding risks

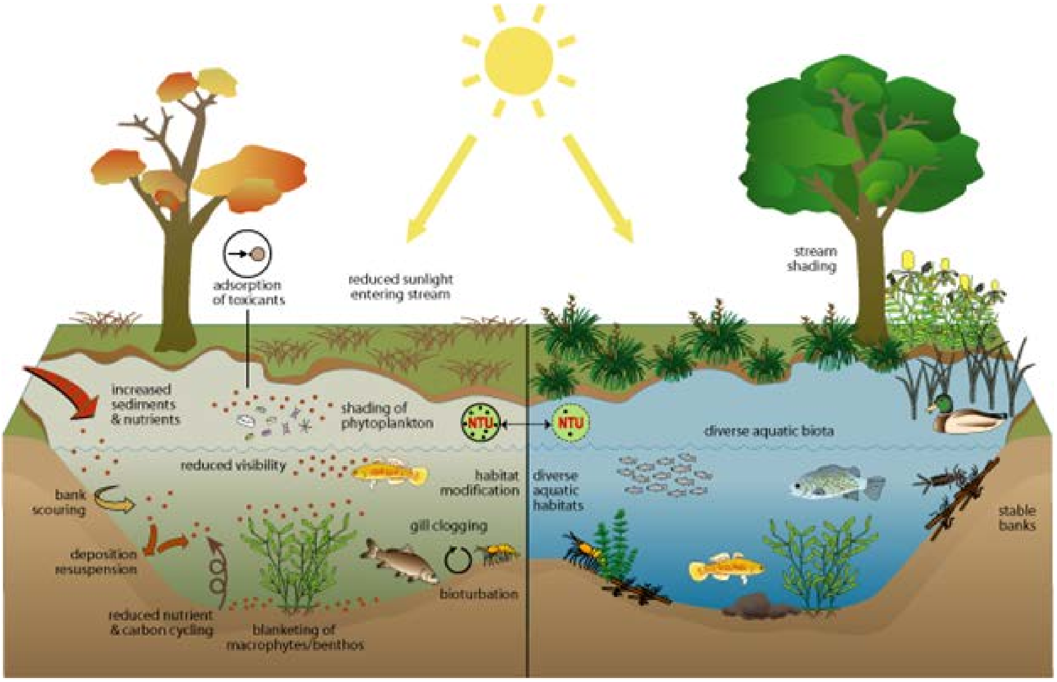

Figure 1. Effects of high (left) versus low (right) turbidity in aquatic systems. Image obtained from: wetlandinfo.des.qld.gov.au.

TURBIDITY LEVELS IN POESTEN KILL

The 2017 and 2019 ecological surveys in Poesten Kill found turbidity levels to range between 'pristine' and 'very low' levels (Fig. 2). The very low turbidity levels indicate pristine water clarity. During the 2019 survey, water levels were slightly elevated compared to 2017 due to a large rain event that had preceded sampling; possibly explaining why levels (albeit still very low) were a little more variable in 2019. Overall, the Poesten Kill is lined with large boulders and bedrock, with very little fine sediment. This appears, in part, to limit sediment transport, and thus, turbidity during high flow events.

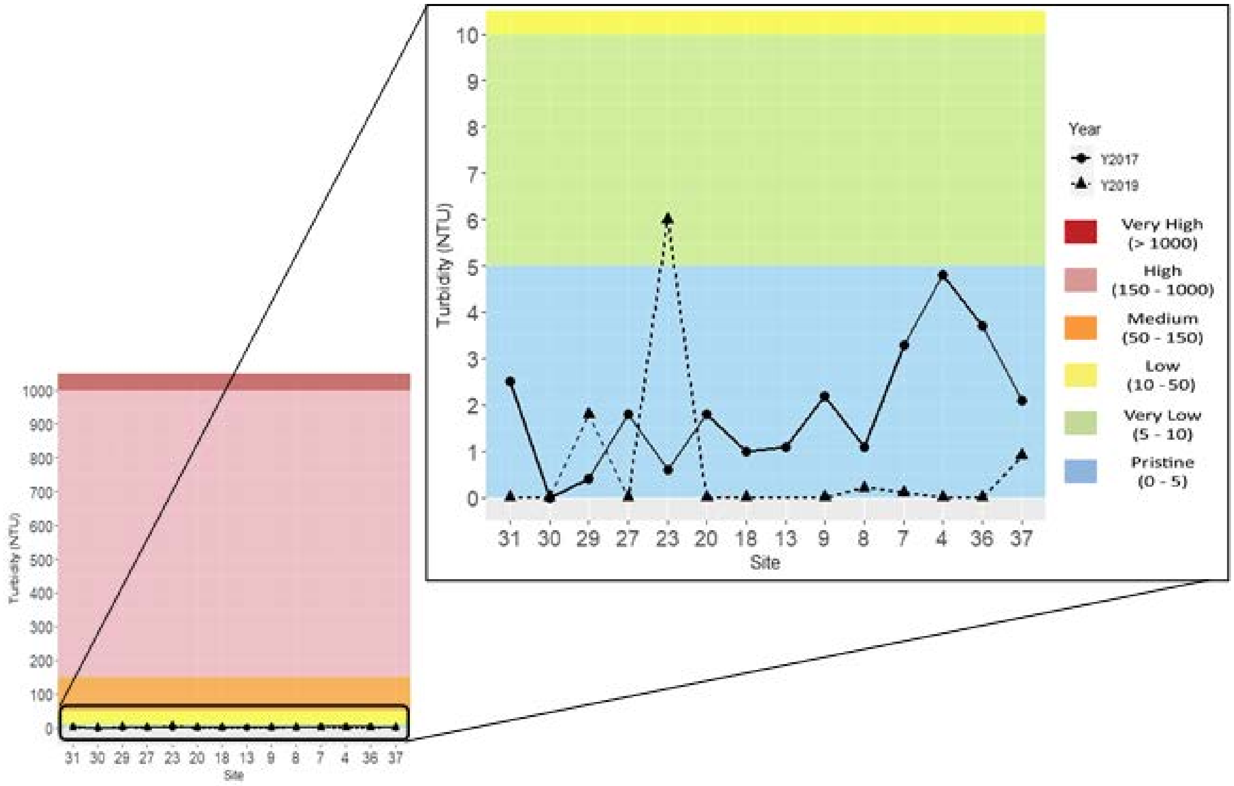

Figure 2. Turbidity levels in Poesten Kill (2017 & 2019). Sites are arranged in downstream order. The inset is meant to highlight the narrow range of turbidity levels measured in the Poesten Kill relative to the total color-interpretative scale used.

POESTEN KILL WATER QUALITY: PATHOGENS

Figure 1. Examples of sources of fecal contamination into waterbodies. Image obtained from: whatcomcounty.us/2169/Sources-of-Bacterial-Pollution.

Pathogens are microorganisms such as bacteria, viruses, and protozoans that can cause disease. Pathogens are commonly associated with decomposing carcasses and fecal material from animals of all kinds (human, other mammals, birds, etc.). Sources of fecal contamination to surface waters include untreated sewage, on-site septic systems, domestic and wild animal manure, and storm runoff from agricultural and urban lands (USEPA 1997) (Fig. 1).

Two bacteria groups, coliforms (2) and fecal streptococci, are used as indicators of possible sewage contamination because both groups are commonly found in human feces. Although generally not harmful, both groups indicate the potential presence of pathogens that also live in human and animal digestive systems. It is not practical to test for every pathogenic organism, so water is tested for indicator bacteria instead (USEPA 1997).

Because fecal bacteria can survive in waterbodies for varying periods of time, their introduction to aquatic systems can have lasting impacts that are affected by numerous, often compounding, factors and ambient conditions (Fig. 2).

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(2) Coliforms, as the name suggests, are bacteria having a form similar to E. Coli, which is a major bacterium present in the intestinal tract of humans and other warm-blooded animals.

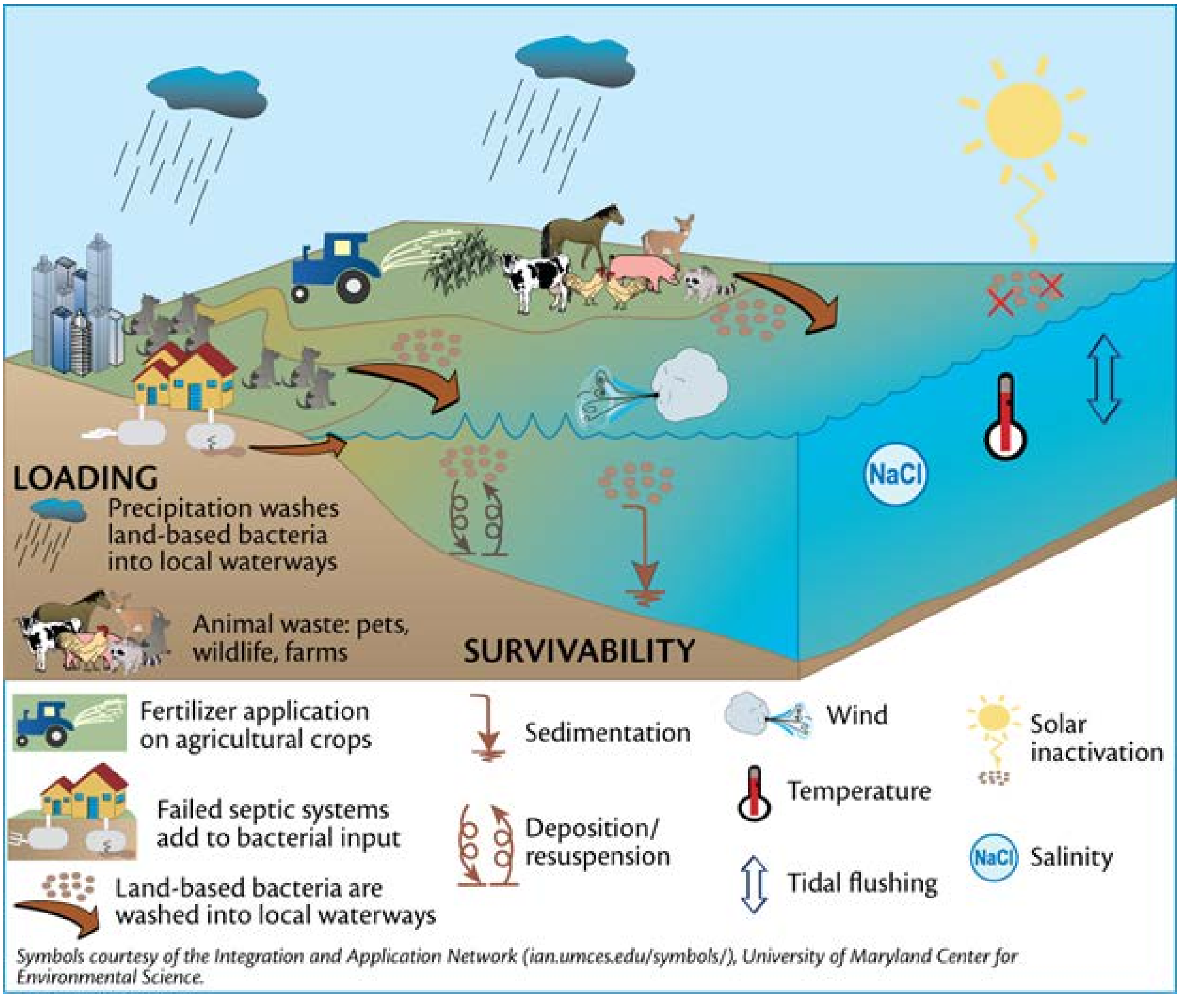

Figure 2. Conceptual model of factors affecting bacteria contamination and concentrations in an aquatic system. Image obtained from: aacounty.org.

IMPLICATIONS

- Fecal contamination can lead to algal blooms, causing significant alterations to the trophic structure of an aquatic ecosystem
- Fecal contamination can deplete oxygen levels, inducing stress on aquatic life
- High bacteria concentrations can impede recreation, such as swimming, boating, and fishing
- Fecal contamination can pollute drinking water sources, causing drinking water restrictions and shortages

WATER QUALITY STANDARDS

Fecal indicator bacteria are a primary measure used to evaluate compliance with water quality standards. In New York State, total coliforms and fecal coliforms are used to measure water quality compliance for bacteria in freshwater systems. In Class C waters (e.g., Poesten Kill), the monthly median value (from ≥ 5 samples) and >20% of total coliforms are not to exceed a concentration of 2400 colonies/100 mL and 5000 colonies/100 mL, respectively (NYSDEC 2019b). For fecal coliforms, the monthly geometric mean (from ≥ 5 samples) shall not exceed a concentration of 200 colonies/100 mL (NYSDEC 2019b).

PATHOGENS IN POESTEN KILL

Samples were collected for fecal coliform and Bacteroides analysis in 2017. Fecal coliform results indicated the concentration and extent of potential fecal contamination in Poesten Kill, providing a quantitative analysis of bacterial pollution. Bacteroides analysis is a genetic-based test that indicates the host-source (e.g., human, cow, deer, etc.) of bacterial contamination; which could then be used to isolate the physical source(s) of contamination (e.g., farm versus public sewer system).

In Poesten Kill, fecal coliform concentrations were relatively low, ranging between 'low' (27 colonies/100 mL at Site #29) and 'moderate' (300 colonies/100 mL at Site #37) (Fig. 3). The highest fecal coliform concentrations observed occurred at the three most downstream locations (Sites #4, #36, #37), suggesting that increased urbanization may be affecting bacteria concentrations. In Troy, residents are connected to municipal sewer lines. Aging infrastructure has been identified as a known source of fecal contamination, particularly in cities in the Northeast (OEI 2019). It is possible that a similar problem could be occurring in Troy. However, fecal coliform levels were still low compared to streams impacted by Combined Sewer Overflows (OEI 2019). Due to the comparably low fecal coliform levels, Bacteroides analysis did not yield any findings, with all sampling below detectable limits for host-source identification. Because only one sampling event was performed, comparisons to water quality standards could not be made.

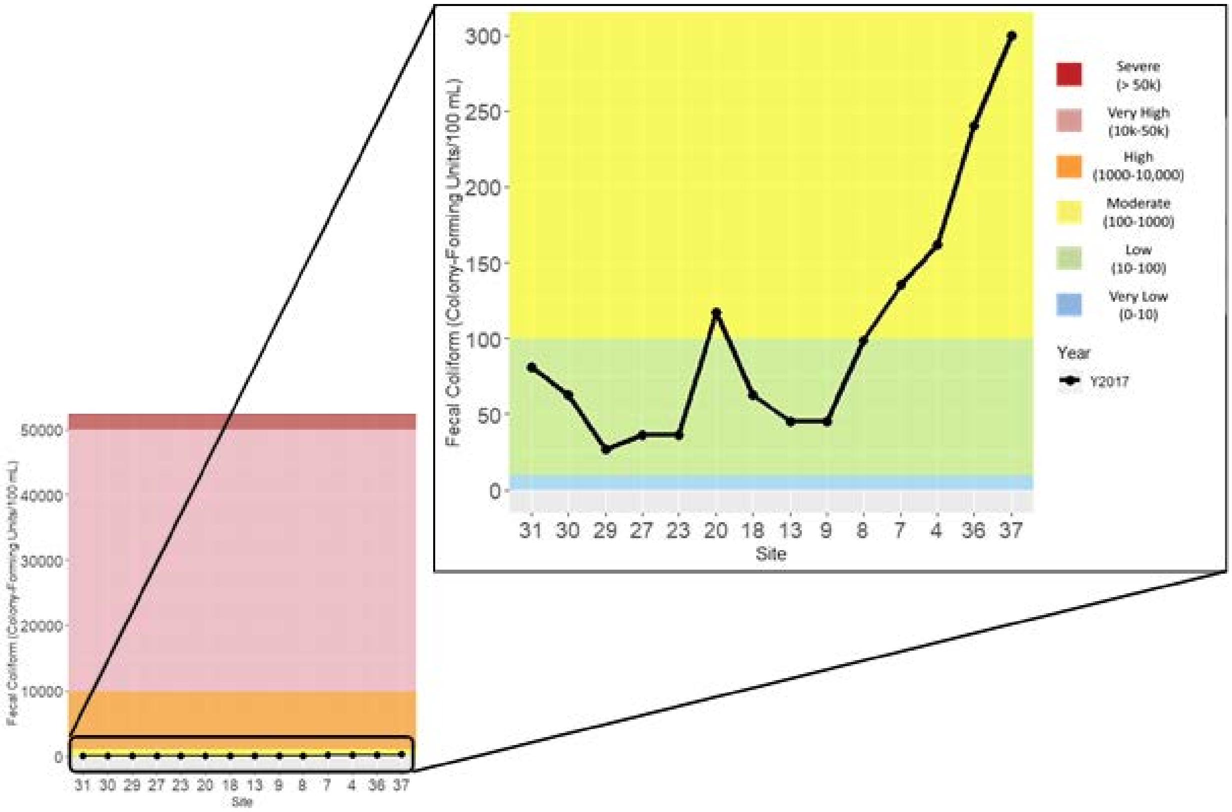

Figure 3. Fecal coliform concentrations in Poesten Kill (2017). Sites are arranged in downstream order. The inset is meant to highlight the narrow range of fecal coliform concentrations measured in the Poesten Kill relative to the total color-interpretative scale used.

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POESTEN KILL FACT SHEET: AQUATIC HABITAT

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 Poesten Kill watershed for assessing habitat degradation in terms that can be relevant from community-level (e.g., fish community) and/or species-level (e.g., brown trout) planning, restoration, or management efforts. Species-specific assessments of habitat can be important should conservation or reintroduction of individual species (e.g., American eel, brook trout) be an eventual goal for Poesten Kill.

WHAT IS AN "ECOSYSTEM"?

An ecosystem is comprised of the site-specific interactions between all biota and their physical and chemical surroundings (e.g., substrate composition, temperature, dissolved oxygen concentrations, etc.). An ecosystem includes all the living and non-living structural components within a defined region and the internal connections and functions among components (Fig. 1). Depending on the spatial scope of the assessment or survey, an aquatic ecosystem can include both aquatic and terrestrial (i.e., land-based) components.

WHAT IS "HABITAT"?

The term "habitat" may be broadly defined as the subset of ecosystem components that directly relate to the biological requirements and preferences of a group of organisms (Fig. 1). Typically, habitat is thought of in relation to a 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 biotic (i.e., living) factors as part of the surroundings. For instance, some fish prefer the presence of rooted aquatic plants, which in turn have their own habitat requirements. A species' preferred habitat can differ among life stages and seasons. Examples of factors that can be used to assess and describe stream habitat are shown in Text Box 1. Relative importance among habitat factors on the organism(s) or community in question can depend on, but not be limited to:

- Organism
  - Resource requirements
  - Tolerance ranges to environmental perturbations or disturbances
- Population
  - The need for certain habitat conditions can be greatly affected by population size and the capacity of the ecosystem to support populations of varying sizes
- Species
  - The size of an organism can influence survivorship; parameters important to small organisms may be less significant to larger individuals of the same species, and vice versa
- Life stage
  - Similar to species size, which is often used to identify different life stage, preferred habitat for adults and early life stages may differ significantly
- Annual cycles
  - For example, some fish spawn under one set of conditions, but live the rest of the year under other conditions or in altogether different ecosystems; such as migratory species that live most of their lives in freshwater streams and reproduce in marine systems (i.e., catadromous fish) or vice versa (i.e., anadromous fish).

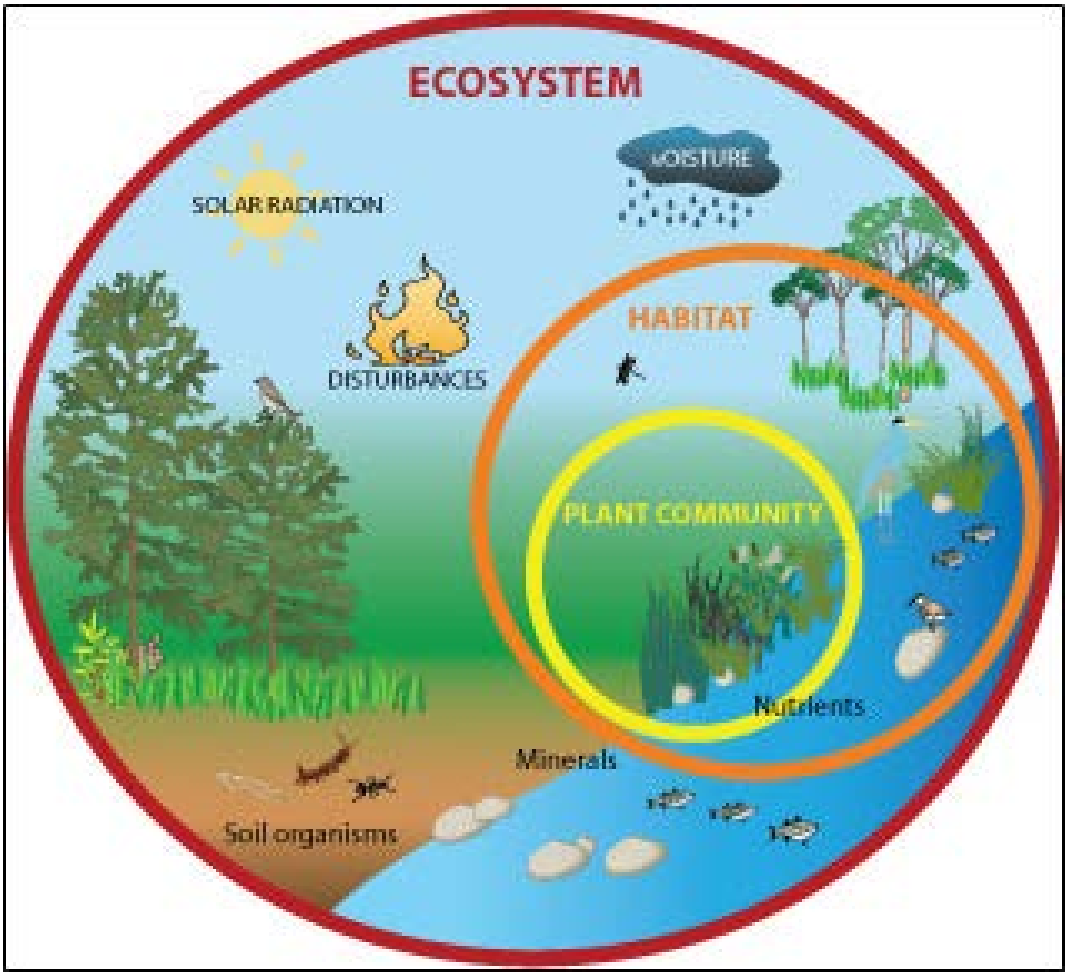

Figure 1. Example of an ecosystem with aquatic and terrestrial linkages. Habitat for a given species or community is a subset of an ecosystem. Image obtained from: Socratic.org.

RIPARIAN ZONE

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 becomes saturated due to the influence of surface water (Fig. 2). Riparian zones are closely associated with aquatic habitats and are vital in providing important habitat for birds, insects, fish, and animals. They provide sources of food that support the food web for early life stages of many fish. Riparian zone vegetation is important for shading, and thus, maintaining cool waters, providing cover during flood periods, and contributing vegetative detritus; forming the base of the food web in headwater areas. Sufficiently dense, and/or wide riparian vegetation serves as a buffer to intercept nutrients and sediments contained in surface water runoff from pastures, crop fields, suburban lawns, and urban open areas.

TEXT BOX 1: FACTORS USED TO DESCRIBE STREAM HABITAT

WATER QUALITY
- TEMPERATURE
- CONDUCTIVITY/SALINITY
- NUTRIENTS (PHOSPHORUS, NITROGEN)
- DISSOLVED OXYGEN
- PH
- TURBIDITY

BIOLOGICAL STRUCTURE
- AQUATIC PLANTS
- RIPARIAN TREES AND SHRUBS
- FLOODPLAIN PLANTS

PHYSICAL STRUCTURE
- SHADING (A.K.A. CANOPY COVER
- SUBSTRATE COMPOSITION
- COVER FROM PREDATION (E.G., WOODY DEBRIS, UNDERCUT BANKS
- STREAM RIFFLE/POOL ALTERATION
- STREAM BED SHAPE (PROFILE)
- SIZE AND SHAPE OF RIPARIAN WETLANDS AND FLOODPLAINS
- SINUOSITY (DEGREE OF STREAM MEANDERING)

HYDROLOGY
- WATER FLOW (VOLUME/TIME)
- WATER VELOCITY (SPEED/DISTANCE)
- WATER LEVEL RELATIVE TO BANK FULL
- CHANNEL SHAPE
- STEEPNESS OF GRADE

ECOLOGICAL STRUCTURE
- ABUNDANCE
- POPULATION
- COMMUNITY
- DIVERSITY

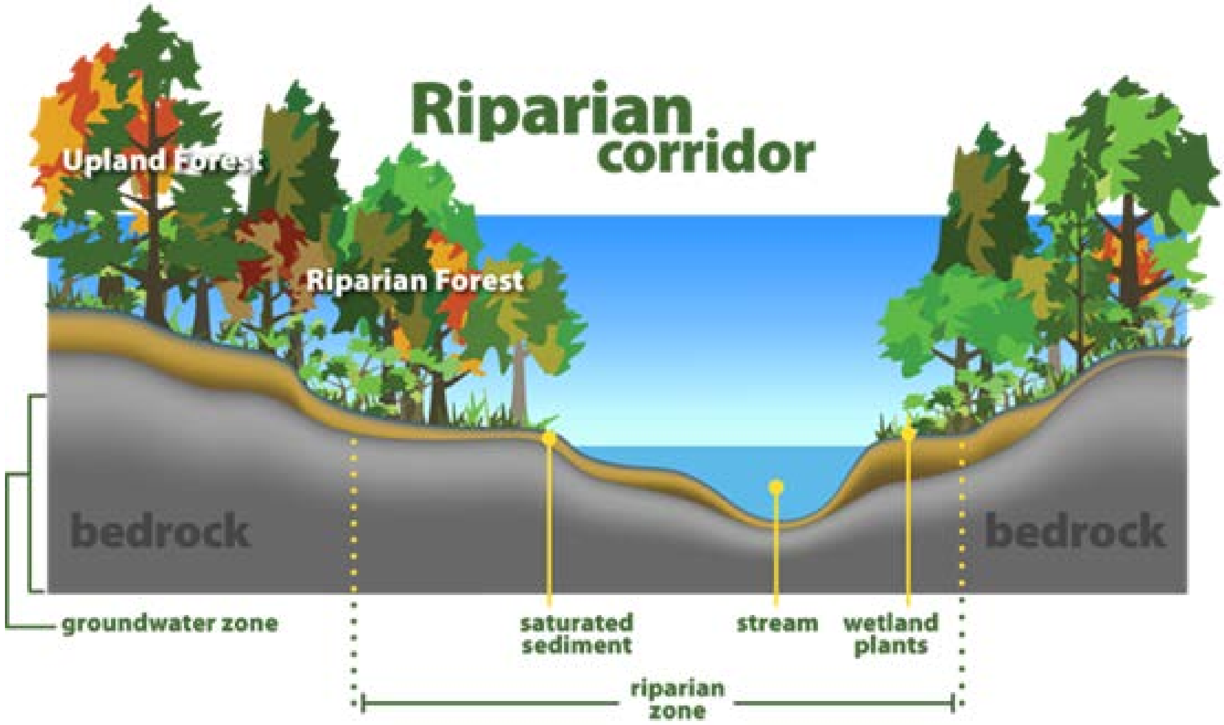

Figure 2. Riparian zone schematic. Image obtained from: Lakeconesteenaturepark.com

REFERENCE CONDITION

Numerical scores and species composition from habitat and biological surveys are usually interpreted in comparison to a reference system, or reference condition. A reference system is a background or baseline set of conditions for a given habitat, such as a stream reach, that would be expected in an otherwise undisturbed (non-impacted), natural setting. A background site references a state of conditions prior to anthropogenic influence. A baseline site typically references a past unimpacted condition, prior to disturbance or perturbation. By defining reference condition, assessments of stream condition can be effectively measured against a defined, non-impacted system and deviations from reference condition can be quantified. Results can be used to identify stream impairments and prioritize remedial efforts. Definitions of reference condition vary depending on the geographic location of the survey, agency/organization performing the survey, and local, state, or federal monitoring program requirements. In New York State, the Department of Environmental Conservation (NYSDEC) Stream Biomonitoring Unit (SBU), which assesses state-wide stream condition on a rotating basis, defines reference conditions as:

"For watersheds with minimal disturbance such as those within the Catskills and Adirondacks reference sites typically exceed 95% natural cover (forest, wetland, open water, etc.). In regions with more extensive anthropogenic disturbance, a minimum of 75% natural [cover] and less than 2% impervious surface may be used to represent best attainable reference condition. In cases where best attainable condition may not be non-impacted, the highest water quality designation should be used. Water chemistries if available should indicate background condition. A good surrogate for water chemical information is specific conductance and it should be less than 150 µS/cm which is the 25th percentile of all data collected in New York State's ambient water quality monitoring program but should not exceed 250 µS/cm." (Duffy et al. 2018)

IN-STREAM HABITAT

Habitat naturally changes dramatically from headwaters to the mouth of a stream. While each stream system is unique, scientists have identified relatively predictable transitions in stream and biotic condition along the longitudinal gradient of a stream in undisturbed systems. The River Continuum Concept is a classical paradigm of changes in flowing (lotic) water systems from headwaters to mouth (Text Box 2, Fig. 3). Similar to the reference condition concept, the River Continuum Concept serves as a model for predicting stream condition, identifying potential impairments, and estimating deviations in stream health from model conditions.

TEXT BOX 2: 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 predictable physical and chemical changes from the headwaters to its outlet. Additionally, these changes are reflected in changes in the stream biota, or plant and animal life. Water in upper stream reaches are fast-moving due to relatively steep topography, shallow, cold due to groundwater springs and forest shading, well-oxygenated, clear, and relatively nutrient-poor. Headwater food webs are primarily based on energy sources from outside of the system (allochthonous sources), such as leaf fall, because relatively little photosynthesis occurs in swift-flowing, nutrient-poor, shaded waters. As a result, the aquatic macroinvertebrate community is typically dominated by leaf-eating shredders, grazers, and predators. Sensitive fish species such as trout are characteristic of headwater fish communities. Species richness (number of species) and biomass (total weight) are relatively low near the headwaters compared to downstream reaches. Topography flattens out near the outlet of an unimpacted stream and the waters are slower, deeper, wider, and more turbid, less oxygenated, less shaded, exposed to sunlight, and relatively nutrient-rich. A greater fraction of energy entering the food web is captured within the system (autochthonous sources) by photosynthetic algae and macrophytes. Both species richness and overall biomass are greater than at the headwaters. A continuum of habitat conditions occurs between these extremes. According to the RCC paradigm, both autochthony and species richness are greatest in middle stream reaches, where biota from both upstream and downstream converge, and waters are still clear enough to support high levels of photosynthesis.

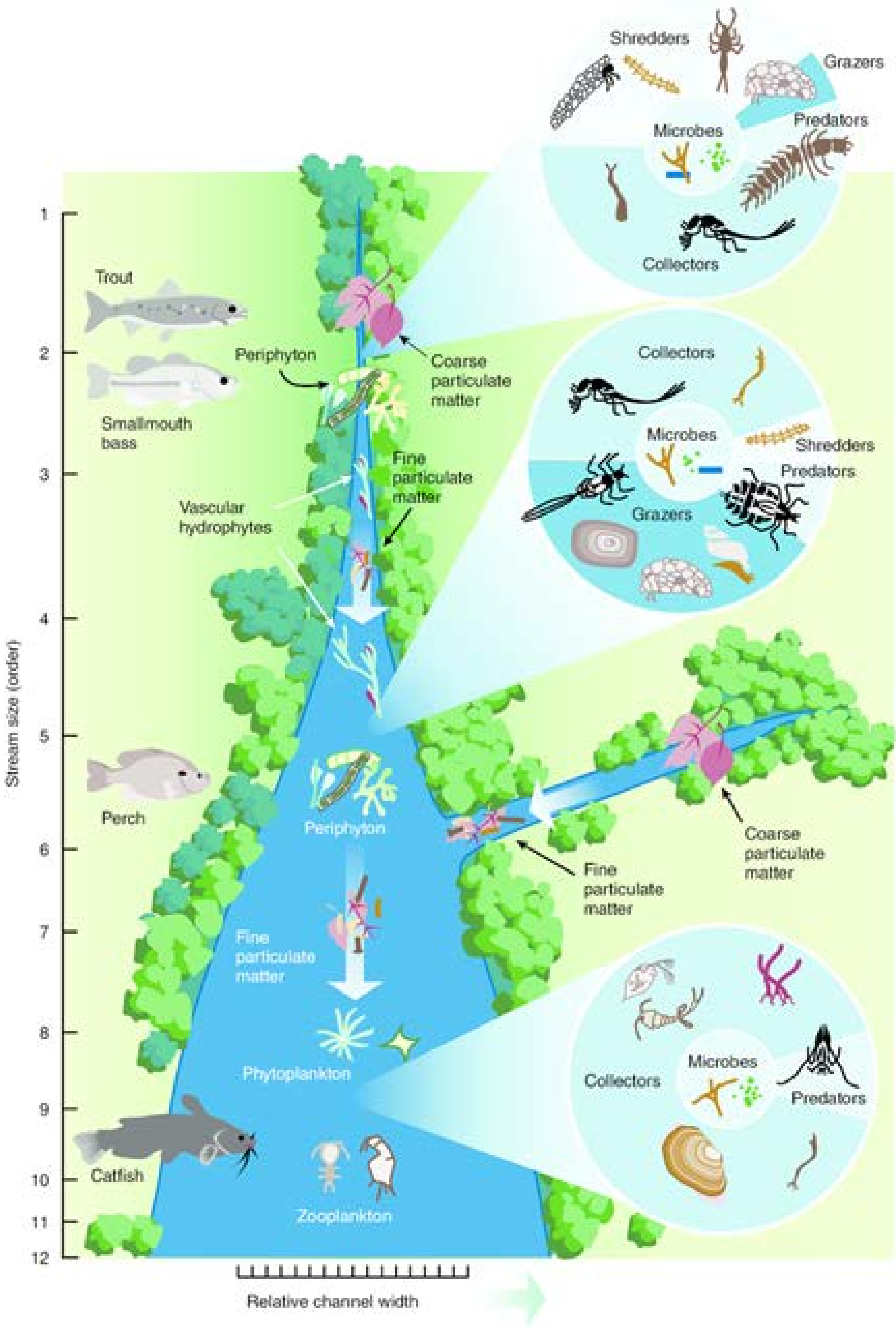

Figure 3. River Continuum Concept (Vannote et al. 1980). Image obtained from: Peters et al. 2011

THE STATE OF AQUATIC HABITAT IN THE UNITED STATES

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 toxins). Unfortunately, most streams in the United States are impacted to some degree. Approximately 46 % of stream and river miles are in poor biological condition, largely due to nutrient pollution, leading to a phenomenon known as eutrophication caused by excess anthropogenic discharges of nitrogen and phosphorus (USEPA 2017). The greatest impacts to physical condition of stream and riverine systems in the United States are not due to in-stream impairments, but rather to poor riparian vegetative cover and riparian disturbance; further highlighting the vital role that riparian zones serve to aquatic systems.

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POESTEN KILL AQUATIC MACROINVERTEBRATES

WHAT IS AN AQUATIC BENTHIC MACROINVERTEBRATE?

An aquatic benthic macroinvertebrate is an organism that lacks a vertebra (i.e., spine) and inhabits the bottom substrate of a waterbody. In the case of aquatic benthic invertebrates, macroinvertebrates are organisms that can be seen by the naked eye, without the aid of a microscope. While they can be seen without the use of a microscope, a microscope is often needed to identify them to a certain taxonomic level (e.g., family, genus, and species).

DEFINITION BREAKDOWN

AQUATIC: pertaining to water

BENTHIC: pertaining to the bottom of a waterbody

MACRO: large-scale (from the Greek word makros, meaning 'long' or 'large')

INVERTEBRATE: organism lacking a spinal cord, or vertebra

Aquatic macroinvertebrates include insects, snails, mussels, worms, crustaceans (e.g., crayfish), and leeches.

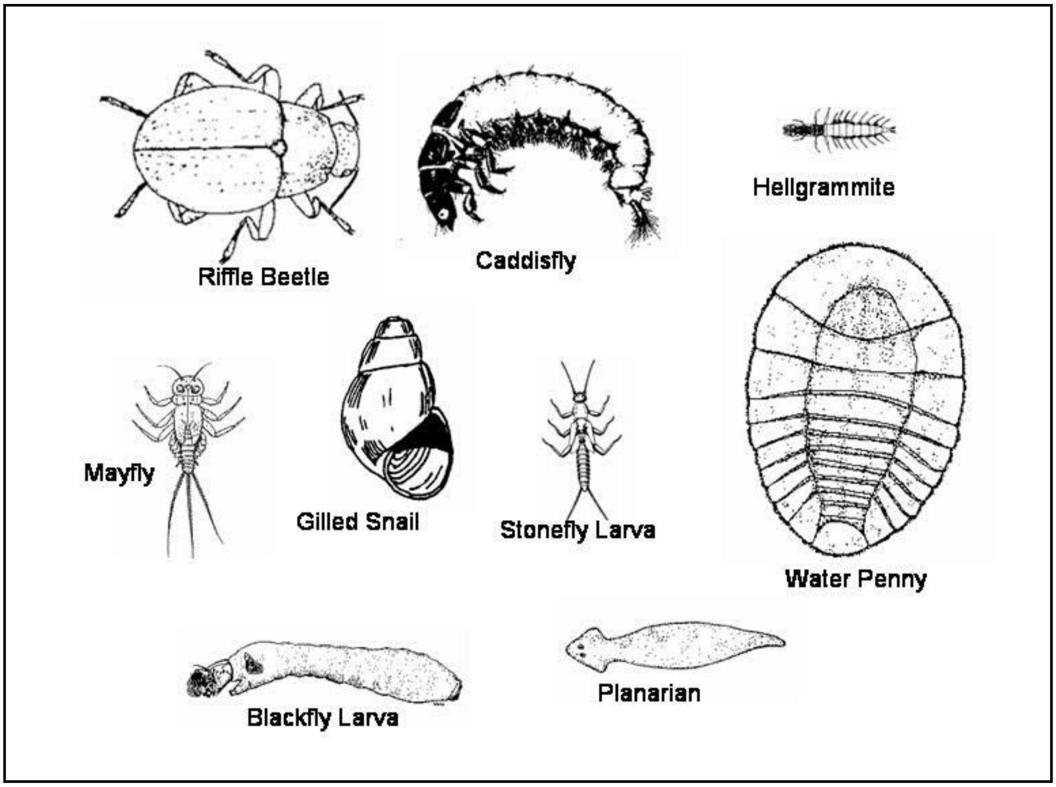


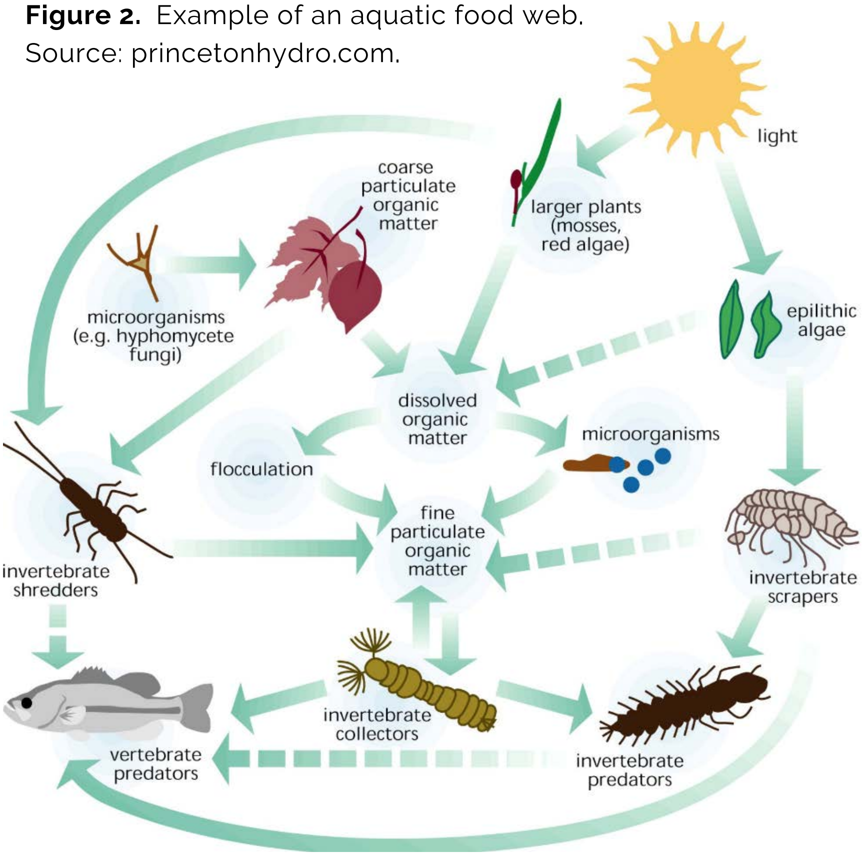
Figure 1. Examples of aquatic macroinvertebrates. Source: techalive.mtu.edu.

WHAT IS THE ECOLOGICAL ROLE OF AQUATIC MACROINVERTEBRATES?

Benthic macroinvertebrates play a significant ecological role in the structure and function of aquatic systems. As an intermediate level on the food chain, between other biological groups such as algae, zooplankton, and fish, aquatic benthic macroinvertebrates are key members of anaquatic community that can be used in understanding trophic, or food web, relationships. As a vital food resource for many species of fish, the study of macroinvertebrates is a critical component in developing a comprehensive understanding of aquatic systems (Voshell, 2002). By understanding changes in the macroinvertebrate community and/or their responses to stream impairments, scientists can make inferences about those effects on the larger aquatic community and how overall stream "health" is affected.

Up until the last several decades, aquatic organisms were considered vital components to only aquatic systems. It is now known that aquatic systems are inextricably linked to the surrounding terrestrial environment and, in fact, many interactions between the two environments are continuously taking place.

Figure 2. Example of an aquatic food web. Source: princetonhydro.com.



Just as the surrounding landscape can shape a stream and affect the organisms within them, the stream system can have an equally profound impact on the terrestrial environment. Aquatic macroinvertebrates have been shown to be a vital component of not only aquatic food webs, but terrestrial ones as well (McDowall et al. 1996, Nakano et al. 1999a, Nakano et al. 1999b, Kawaguchi and Nakano 2001, Nakano and Murakami 2001, Kawaguchi et al. 2003).

WHAT IS THE LIFE CYCLE OF AQUATIC INSECT?

Aquatic insects are a subset of macroinvertebrates that have been shown to serve an especially important ecological role to terrestrial ecosystems because of their unique life history. It is, therefore, worthwhile to discuss the lifecycle of aquatic insects.

Like frogs and butterflies, aquatic insects undergo metamorphosis, whereby they undergo distinctive changes in form and structure at discrete stages during their life cycle. Some species of aquatic insects undergo complete metamorphosis, like for example,butterflies, and have a pupal stage. Others, however, undergo incomplete metamorphosis and lack a pupal stage – changing directly from larvae to adult. Within each stage of development, aquatic insects may periodically shed their exoskeleton to allow for increases in size and shape. This is known as molting. The periods between molts are known as instars. Most species have four to six instars, while some species may undergo between more than 30 instars!

While some species of aquatic insects can spend their entire lives in the water, many species grow wings and emerge from the water, spending their adult stage in terrestrial environments as flying insects.

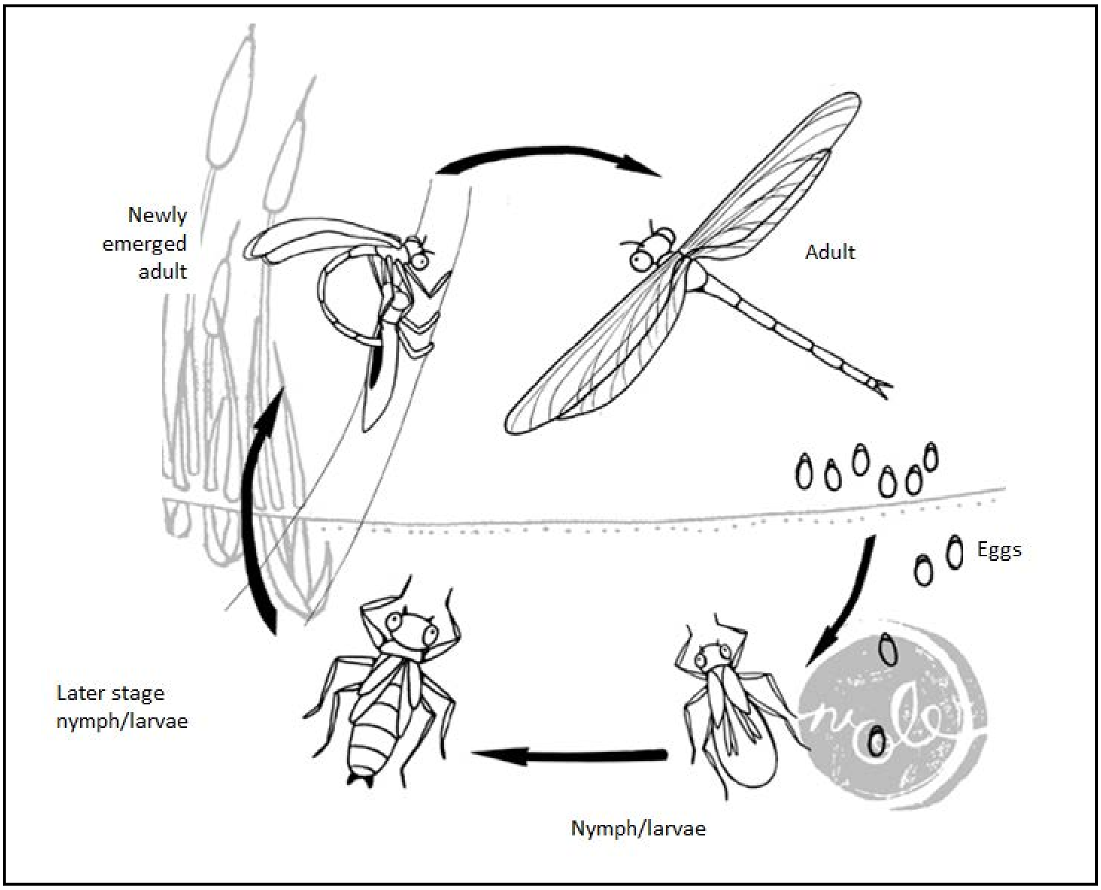


Figure 3. Example of the aquatic insect lifecycle.

WHAT IS BIOMONITORING?

Biomonitoring (biological monitoring, bioassessment) is the use of living organisms and/or their responses to ambient (surrounding) conditions and environmental stressors to make assessments of water quality, or stream health. There are two types of general biomonitoring surveys: 1) before and after an impact occurs, and 2) regular sampling on a routine basis (e.g., annually) to measure changes in condition over space and time. The former type of biomonitoring survey is a commonly used approached involving the use of aquatic macroinvertebrates. The latter type of survey can help scientists better understand long-term changes in water quality over time and along a stream gradient (i.e., upstream to downstream).

STREAM HEALTH: The structure, function, and sustainability of an ecosystem (Rapport et al. 1998)

Traditional approaches to measuring water quality were largely accomplished from a chemical-concentration approach, whereby the amount of a chemical pollutant(s) was/were measured for a given waterbody. While this approach helps to identify the causes of impairment to a waterbody, it does not identify the effects. And equally important, chemical tests do not identify ambient environmental factors that may be affecting water quality or compounding impairments. Aquatic organisms, however, are affected by both chemical pollution and environmental conditions. Therefore, their use in water quality surveys can provide extremely valuable information about the integrated effects of pollution and environment on stream health.

WHY ARE AQUATIC MACROINVERTEBRATES USED IN STREAM SURVEYS?

Bioassessments using aquatic macroinvertebrates has been a well-documented and widely accepted method for assessing water quality and impairment for many decades (Barbour et al. 1999, Rosenberg and Resh, 1993; Bode et al. 2002; Voshell, 2002; Davis and Simon, 1995). Through countless studies and surveys over many decades and in waterbodies across the globe, scientists have been able to describe the life history, habitat requirements, feeding habits, and pollution tolerances of thousands of aquatic macroinvertebrate species. This readily available, well-established information can then be applied to stream surveys where aquatic macroinvertebrates have been collected in order to make inferences about stream health. Traditional studies have used aquatic macroinvertebrates to assess the effects of organic pollution (Hilsenhoff 1987), non-point source pollution (Bode et al. 1995), and decreased habitat diversity (Erman and Erman 1984, Schmude et al. 1998) on stream health. While such studies continue today, the effects of land use and climate change on aquatic systems have become forefront issues and prime objectives of water quality monitoring programs today.

WHY AQUATIC BENTHIC MACROINVERTEBRATES MAKE GOOD BIOINDICATORS

(1) They are abundant in most streams.

(2) They are found in a wide range of habitats.

(3) They are reasonably easy and inexpensive to collect (Bode et al. 2002; Voshell, 2002.

(4) They are relatively stationary animals, in comparison to fish. Therefore, aquatic macroinvertebrates can provide valuable information about water quality at a specific location or area within a waterbody (Merritt and Cummins, 1996).

(5) They are sensitive to various environmental and anthropogenic impacts, such as chemical pollution, agricultural runoff, changes in temperature and habitat modifications (Bode et al, 2002).

(6) They allow for rapid assessment of stream conditions based on the presence or absence of certain species, as the sensitivity to various impacts varies between species (Merritt and Cummins, 1996; Barbour et al. 1999; Bode et al. 2002).

(7) They have comparatively long life cycles, making observations in temporal changes to population and abundance possible (Merritt and Cummins, 1996).

WHAT ARE THE DIFFERENCES BETWEEN POLLUTION TOLERANT AND POLLUTION INTOLERANT MACROINVERTERBATE COMMUNITIES?

Pollution occurs when a substance, chemical, or condition harms, contaminants, and/or poisons an ecosystem. Because aquatic macroinvertebrates have been repeatedly studied across a wide range of habitat types and water quality conditions all around the world, scientists have been able to describe the responses of aquatic macroinvertebrate species to varying degrees and types of pollution. As a result, a scale of pollution tolerance has been developed that helps categorize aquatic macroinvertebrates into distinctive groups: 1) species that are intolerant of pollution (i.e., pollution-sensitive), 2) species that are moderately tolerant to pollution (i.e., semi-tolerance), and 3) species that are very tolerant to pollution (i.e., pollution-tolerant). Depending on the study, the number of pollution-rating groups may vary, but all follow this general gradation. As a result, scientists can make predictions of water quality and pollution levels based on the macroinvertebrates found at a given location within a waterbody.

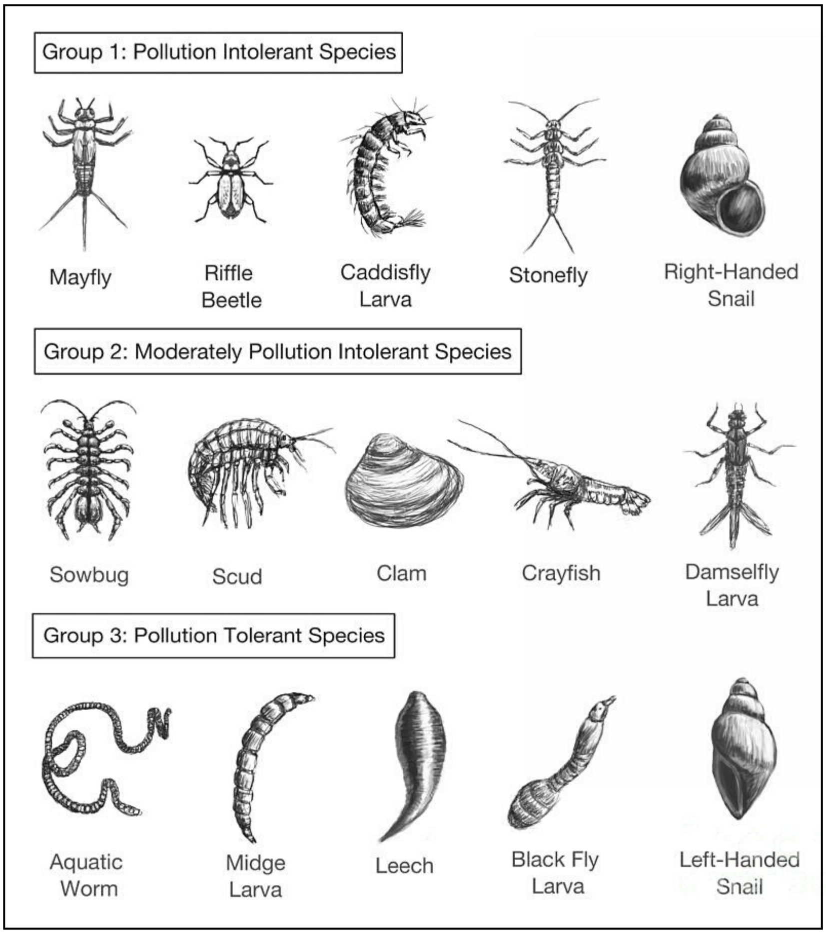


Figure 4. Example of macroinvertebrate pollution tolerance groupings. Source: fineartamerica.com, Artwork by Spencer Sutton.

For example, groups such as Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) are generally considered pollution-sensitive taxa, whereas groups such as Annelida (worms), Chironomidae (midges), and Hirudinea (leeches) are considered pollution-tolerant. Therefore, if a stream sample contains a mixture of pollution-tolerant taxa, but lacks pollution-sensitive taxa, then it can be deduced that the site/waterbody is impacted by pollution, and is therefore, considered impaired.

HOW DOES MONITORING AQUATIC MACROINVERTEBRATES IN NEW YORK STATE HELP WITH UNDERSTANDING WATER QUALITY?

The New York State Department of Environmental Conservation (NYSDEC) relies heavily on aquatic macroinvertebrate monitoring to make assessments of water quality in streams, rivers, and lakes across New York. The NYSDEC Stream Biomonitoring Unit performs surveys of water quality each year throughout the state using aquatic macroinvertebrates, which ultimately help to develop and implement watershed plans, develop numeric criteria for nutrient pollution assessments, classify waterbodies under the NYS 303(d) List of Impaired Waterbodies, and to inform the State Permit Discharge Elimination System (SPDES) process.

The NYSDEC provides an interactive mapping service on their website that allows for interested parties to review the data and results collected during current and historical biomonitoring surveys.

MAPPING RESOURCE
https://nysdec.maps.arcgis.com/apps/webappviewer/index.html?id=692b72ae03f14508a0de97488e142ae1

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FISH AS BIOINDICATORS

WHAT IS THE RELATIONSHIP BETWEEN AN AQUATIC "ECOSYSTEM" AND A FISH "COMMUNITY"?

An aquatic ecosystem is made up of the interactions between biota and their physical and chemical surroundings (e.g., physical habitat, nutrients, oxygen, temperature) in a specific place. A fish community is one part of the ecosystem, including only fish and their interactions with each other. The physical and chemical surroundings usually determine the character of the fish community and can vary between places and change over time (e.g., due to seasons or human influences). Fish communities are likely to reflect those environmental differences. Common ways to group fish are described in Text Box 1.

TEXT BOX 1: HOW DO ECOLOGISTS REFER TO GROUPS OF FISH?

Ecologists frequently group fish into broad categories based on the behavior of the fish, their preferred environment, or human use. A single fish species may belong to several of the following groups:

BY TEMPERATURE PREFERENCE:

- Cold water (e.g., trout, salmon, whitefish)
- Cool water (e.g., walleye, muskellunge)
- Warm water (e.g., carp, bluegill, largemouth bass)

BY MOVEMENT PATTERN:

- Resident (e.g., brook trout, minnows)
- Transient (e.g., large predatory fish)
- Migratory (e.g., salmon, eel)
  - Diadromous – fish that spend part of their lives in freshwater and the other part in saltwater
  - Anadromous – fish that spawn in freshwater and live most of their life in saltwater (e.g., salmon)
  - Catadromous - fish that spawn in saltwater and live most of their life in freshwater (e.g., eel)

BY LOCATION WITHIN THE ECOSYSTEM OR TYPE OF ECOSYSTEM:

- Lotic – flowing water
- Lentic – still water
- Benthic – bottom-dwelling
- Littoral – near shore
- Pelagic – open water

BY THE FOOD THEY EAT:

- Herbivore – aquatic vegetation
- Planktivore – free-floating plankton (usually zooplankton)
- Benthivore – benthic macroinvertebrates (e.g., insect larvae, mussels, or worms), periphyton (small attached algae and microbes)
- Piscivore – fish
- Omnivore – plant and animal

WHAT IS THE RELATIONSHIP BETWEEN AN AQUATIC "ECOSYSTEM" AND A FISH "COMMUNITY"?

Ecosystem or fish community boundaries are arbitrary, but they are usually defined by natural patterns in environmental features. For example, lakes or ponds are commonly identified as distinct ecosystems. Watershed divides are frequently used as boundaries between lotic (i.e., stream or riverine) ecosystems. Boundaries within natural rivers and creeks can be more difficult to define because the character of the system changes, sometimes gradually, along its length (Fig. 1). However, obstructions to water or fish movement sometimes provide clear boundaries between fish communities. These include natural barriers such as waterfalls, and man-made barriers like dams or extensive reaches of degraded habitat.

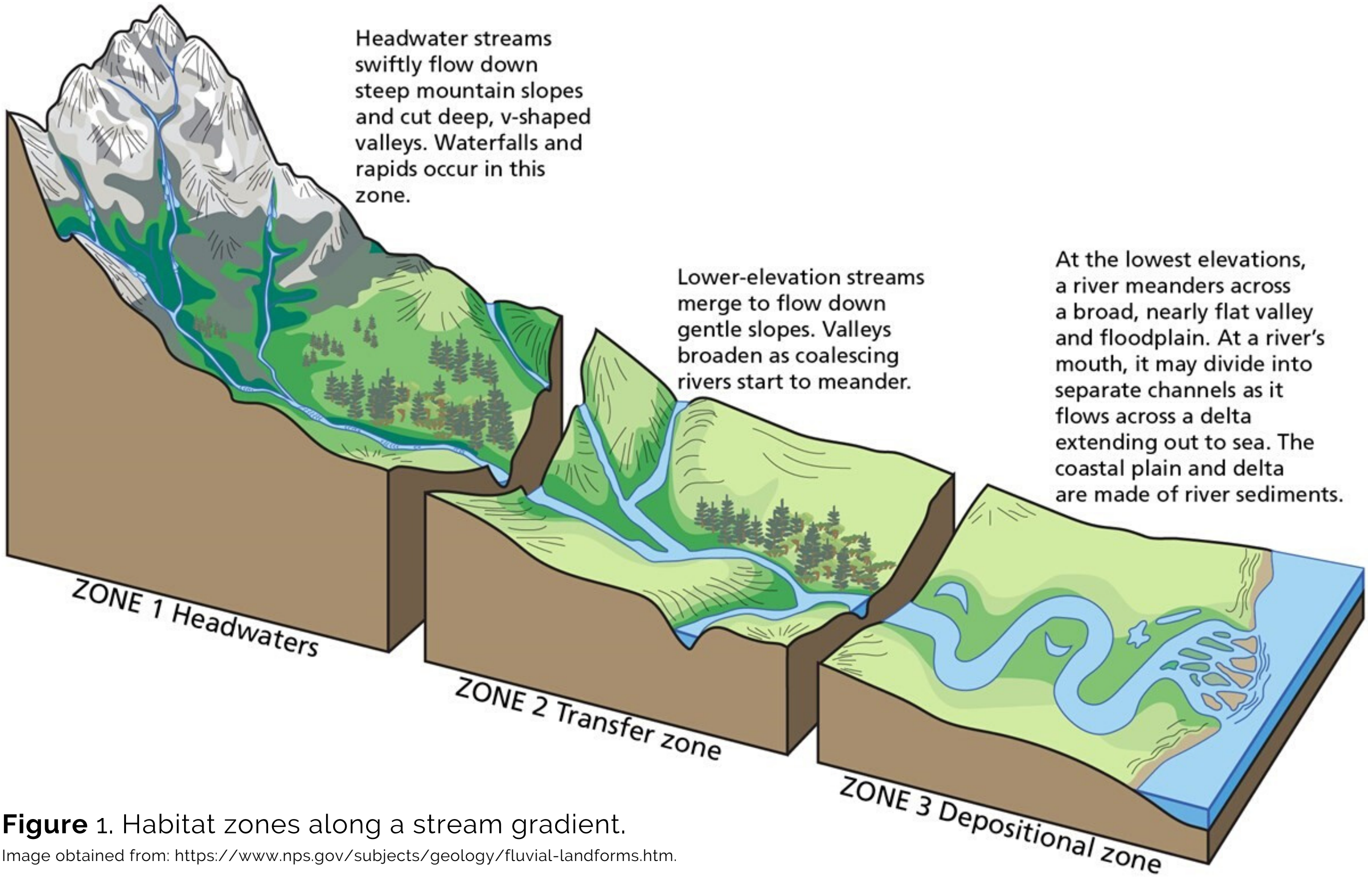

Figure 1. Habitat zones along a stream gradient.
Image obtained from: https://www.nps.gov/subjects/geology/fluvial-landforms.htm.

WHAT ARE FISH COMMUNITIES LIKE IN UNDISTURBED STREAMS?

Fish communities vary between headwaters and the mouth of a creek. In undisturbed streams, fish communities near headwaters are typically comprised of a few cold-water species, gradually transitioning to cool or warm water communities at the mouth, with the greatest diversity in between. This transition in species composition reflects changes in topographic, aquatic and riparian habitats, water quality, and food types along the length of a stream. Migratory and transient species may use parts of the creek seasonally for feeding, reproduction, or refuge, temporarily increasing diversity.

HOW ARE FISH COMMUNITIES STUDIED IN STREAMS?

Fish surveys can be used to investigate species, number, size, sex, reproductive status, and health of fish using many different field techniques. A common sampling technique for fish surveys in wadeable streams is backpack electroshocking (Fig. 2). Various types of nets can be used in deeper waters. Repeated sampling in an area enclosed with nets can be used to calculate the total number of fish at a location. Fish density (number / area) is the total abundance divided by the estimated stream area. During a particular fish survey, species composition at that time is affected by a number of environmental and circumstantial factors. The aquatic environment in Poesten Kill changes along its length, transitioning from a small, pond-fed stream in a largely undeveloped landscape to a wide, fast-moving stream containing several large waterfalls in a highly urbanized area of the watershed. Due to Poesten Kill's connection to the Hudson River estuary, as well as seasonal changes in stream condition, the fish community can change throughout the year. Multiple samples conducted at intervals along a creek and its tributaries, and at multiple times, can give an overall picture of local fish communities and their spatial relationships to natural and man-made conditions.

Figure 2. Fish sampling with the use of a backpack electrofisher in Poesten Kill, 2017. Photo credit: OEI.

THE ROLE OF FISH IN AQUATIC MONITORING PROGRAMS

Most water quality designations in the United States pertain to fish assemblages and fishing restrictions. In New York State, assigned designations such as "swimming/fishing", "fishing", "trout", and "trout spawning" are used to describe water quality and stream health. Fish is a common biotic assemblage that is incorporated into biological assessments of streams because (Barbour et al., 1999):

(1) Fish are long-lived and mobile; therefore, they are good indicators of temporal changes in habitat condition.

(2) Fish assemblages typically include species that occupy different trophic levels. Trophic structure is reflective of overall stream quality.

(3) Fish are of recreational and commercial value to humans.

(4) Fish are relatively easy to collect and identify to species

(5) Environmental requirements, life history, and distribution of fish are well known, and such data is usually easily obtainable.

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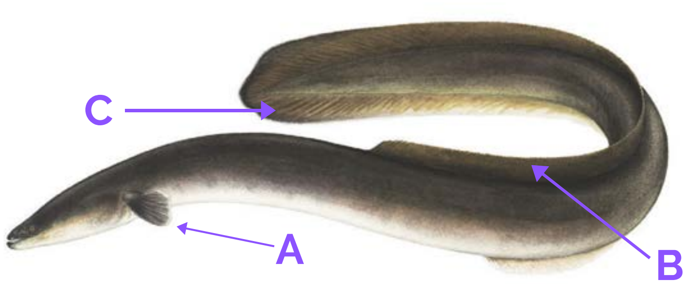
AMERICAN EEL *(Anguilla rostrata)*



FAMILY: Anguillidae (Freshwater Eels)

SIZE: Common Length: 50 cm (19.7 in); Max Length recorded: 152 cm (59.8 in); Max published weight: 7.3 kg (16.6 lbs).

LIFESPAN: Eels generally live 15-20 years. The oldest recorded Eel was 43 years old.

FIELD CHARACTERISTICS: Eels have a **long, slimy snake-like body**. Unlike the similarly shaped lampreys, **eels have jaws and a pair of pectoral fins** **(A)**. Distinguishing eels from other fishes in the northeast, aside from lampreys, can be done by observing the absence of dorsal, pelvic, and anal fins. Eels also have a caudal fin (tail) that starts dorsally (top) **(B)** and wraps around the base of the body to the ventral (bottom) end **(C)** making a fan like appearance.

HABITAT: Eels are born in a marine environment but are carried on ocean currents into estuaries. The young eels will eventually move up into freshwater streams to live and grow as adults.

LIFESTAGES: As they mature, the young start to develop a brownish-yellow color and are now considered "Elvers". As the elvers grow into adults, they are called "Yellow Eels" because they tend to have a distinct brownish-yellow coloration to their body.

SPAWNING: When eels are mature enough to spawn, they will begin to migrate from freshwater streams to the ocean. The process of living in freshwater and spawning in ocean water is termed catadromy. Most other diadromous fish in our region, those that inhabit two different water types during their lifetime, are termed anadromous because they live in marine water as adults and migrate into freshwater to spawn. Biologists studying eels have observed that spawning eels congregate in the Sargasso Sea to reproduce. After spawning has finished, the adult eels die.

DIET: Eels are carnivorous fish with a diet mainly consisting of worms, crustaceans, small fish, clams and other mollusks.

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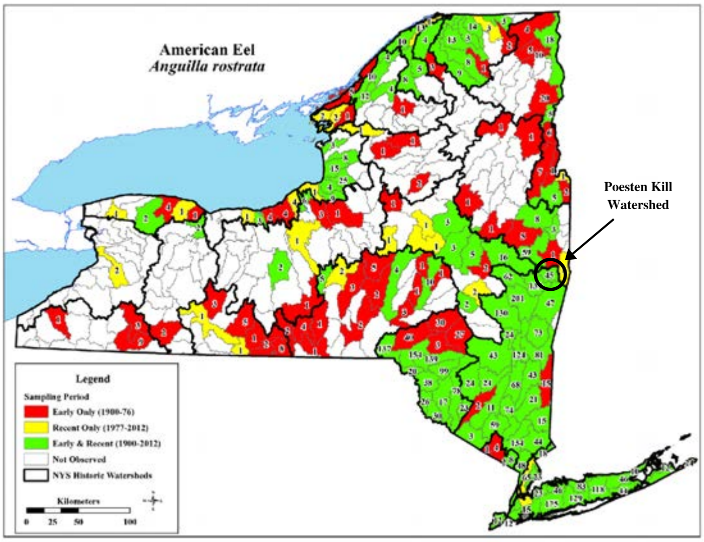
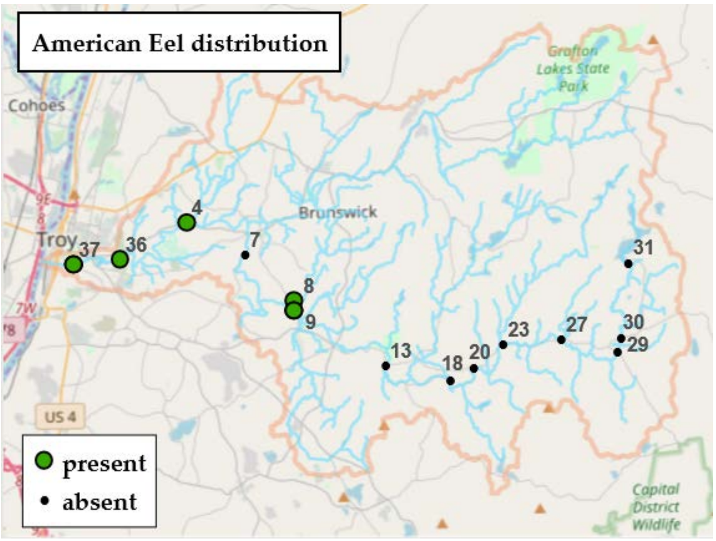


POESTEN KILL SPECIES DISTRIBUTION



(1) USFWS] U.S. Fish and Wildlife Service. 2019. Freshwater Fish of America: American Eel. [Internet] [Cited 11 October 2019]. Available from: https://www.fws.gov/fisheries/freshwater-fish-of-america/american_eel.html
(2) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pgs. 64-65.
Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 28

BLACKNOSE DACE *(Rhinichthys atratulus)*

FAMILY: Cyprinidae (Minnows, Shiners, Dace, Chubs, Carp, Goldfish)

SIZE: Adult length: 5.08-7.62 cm (2-3 in).

LIFESPAN: Blacknose Dace generally live between 2-3 years.

FIELD CHARACTERISTICS: Along with the longnose dace, these daces can be distinguished from other minnows by their pointed snout and one barbel on each side of the base of the mouth. Black nose dace are so called because of the **prominent black band that extends from the tail to the very tip of the nose.** The band on the longnose dace is not as prominent and does not extend to the tip of the nose. Longnose dace also have a snout that protrudes far out from the mouth (see below).

HABITAT: These fish are generally found in smaller, cool, clear streams with gravel bottoms.

LIFESTAGES: Aside from size, these fish do not have a distinct change from hatching to adulthood.

SPAWNING: These fish spawn in late May to June. Females will generally carry around 750 eggs. Females deposit eggs on gravel stream beds after being fertilized by the males.

DIET: Dace are omnivorous, eating insect larvae, small crustaceans, worms, and plant material.

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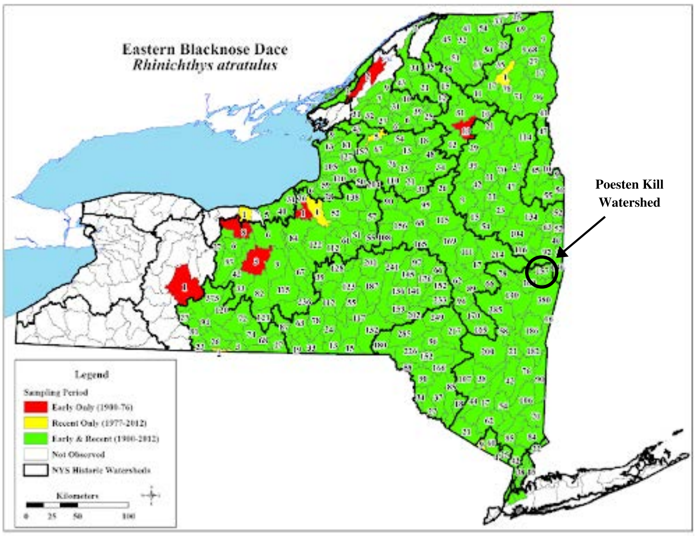

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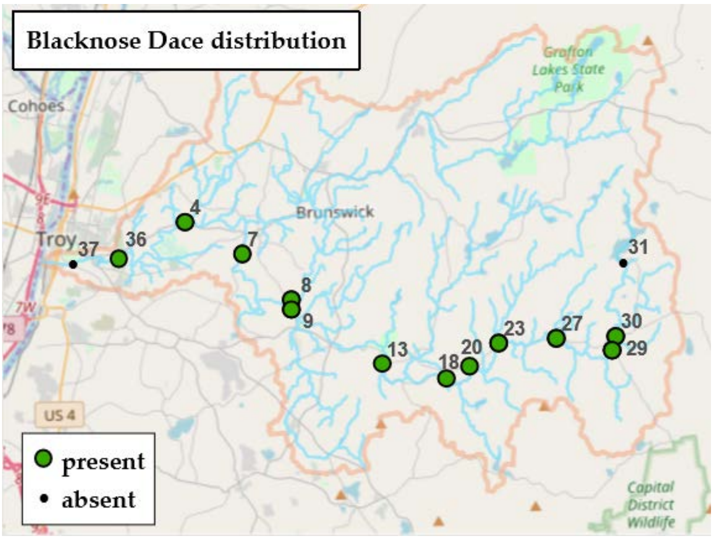
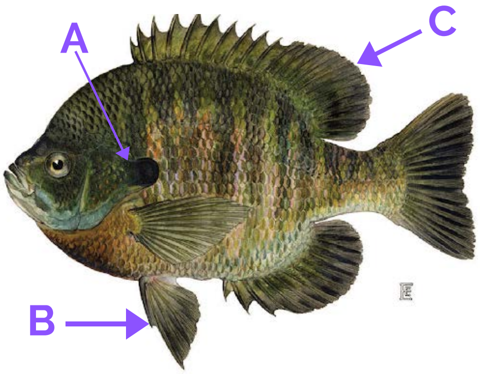


(1) [UNB] University of New Brunswick. 2019. Inland Fish Species of New Brunswick: Blacknose Dace. [Internet] [Cited 11 October 2019]. Available from: https://www.unb.ca/research/institutes/cri/links/inlandfishesnb/Species/blacknosedace.html
(2) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pgs. 128-129
Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 119

BLUEGILL *(Lepomis macrochirus)*



FAMILY: Centrarchidae (Sunfish)

SIZE: Common Length: 19.1 cm (7.5 in), Max reported length: 41 cm (16 in), Heaviest published weight: 2.2 kg (4.8 lb)

LIFESPAN: Bluegill may live to 10 years old.

FIELD CHARACTERISTICS: These fish have a dark blue opercular (gill) flap **(A)**. Redbreast sunfish also have this trait, but bluegill can be distinguished by the presence of long, pointed pectoral fins **(B)** and a dusky "thumb-print" mark on their soft (second) dorsal fin **(C)**. Also, these fish have vertical bars lining their body.

HABITAT: Bluegill can live in streams, ponds, and lakes. They prefer to live and spawn in weedy aquatic vegetation.

LIFESTAGES: Aside from size, these fish do not have a distinct change from hatching to adulthood.

SPAWNING: Bluegill begin to spawn in early summer. Males will move into shallower water where they will create small depressions in the substrate. If a female is attracted to a male's nest, she will move into the space with him and release her eggs while he releases his sperm. After spawning, the male will guard the nest until the young are capable of leaving.

DIET: Smaller, younger individuals will feed on zooplankton while larger, older individuals will feed on invertebrates and smaller fish.

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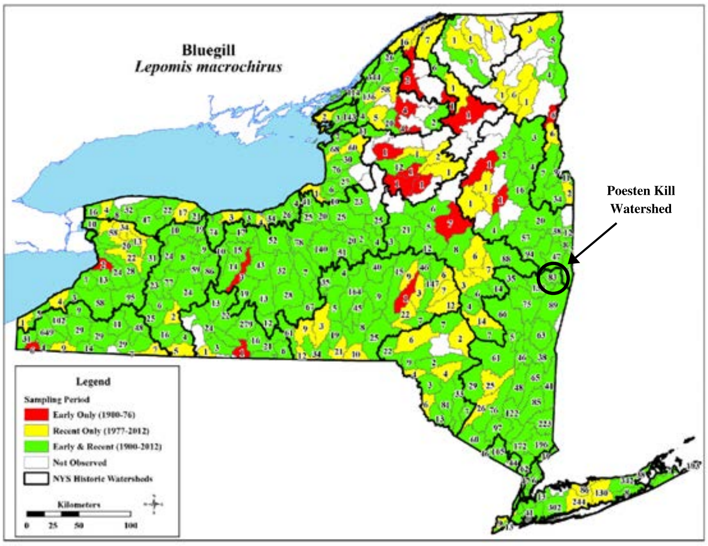

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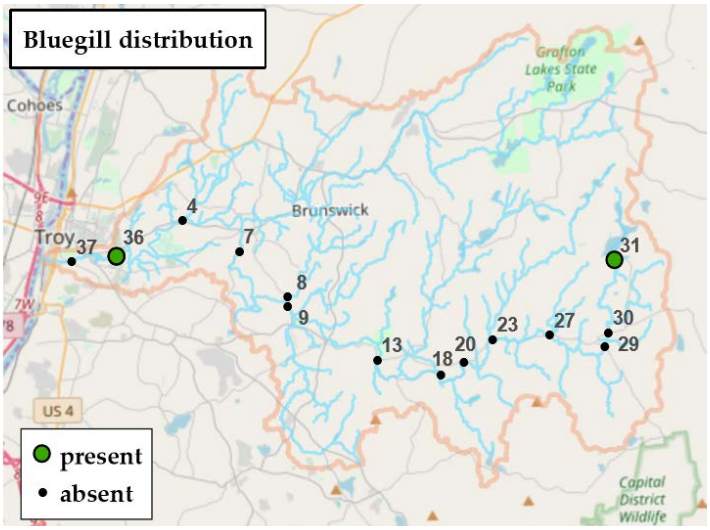

(1) U.S. Fish and Wildlife Service. 2019. Freshwater Fish of America: Bluegill. [Internet] [Cited 11 October 2019]. Available from: https://www.fws.gov/fisheries/freshwater-fish-of-america/bluegill.html
(2) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pgs. 238-239.
Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 279

BROWN BULLHEAD *(Ameiurus nebulosus)*

FAMILY: Ictaluridae (Bullhead Catfish)

SIZE: Brown Bullhead average around 35.56-40.64 cm (14-16 in) in length and may reach a mass of 0.454-0.907 kg (1-2 lb).

LIFESPAN: These fish may live up to 6 years old.

FIELD CHARACTERISTICS: Brown Bullhead have a square to rounded caudal fin (tail), a free adipose fin**(A)** -smaller fin behind the dorsal fin, and dark chin barbels (Sensory appendages on the chin). Distinguishing a brown from a yellow bullhead can be done by looking at their chin barbels **(B)** (Browns with dark barbels and Yellows with white barbels), and distinguishing them from black bullheads can be done by looking at the barbs on their pectoral spines (Brown's have much larger barbs than Black's).

HABITAT: If Brown Bullhead are observed in creeks or rivers, they generally prefer pools or slower-moving runs. If they are observed in ponds or lakes, they generally prefer vegetated areas.

LIFESTAGES: The hatchlings may develop a much darker skin pigment than the adults. Other than size and coloration, there is no distinct change from hatching to adulthood.

SPAWNING: Brown Bullhead begin to spawn from late spring into early summer. Males create nests under sheltered areas. Females generally carry anywhere from 2,000-14,000 eggs. Both parents release their reproductive materials into the bottom of the nest for fertilization. Once fertilized, both the male and female (usually the male) guard the nest. The female incubates the eggs by vigorously vibrating her body in the bottom of the nest. This period will usually last between 5-20 days. Once hatched, the young remain in the nest until they are mature enough to leave. Once out of the nest, the parents corral the young into a tight pod and protect them until they are mature enough to live on their own.

DIET: Brown Bullhead are omnivorous. They will eat invertebrates, smaller fish, fish eggs, and plants.

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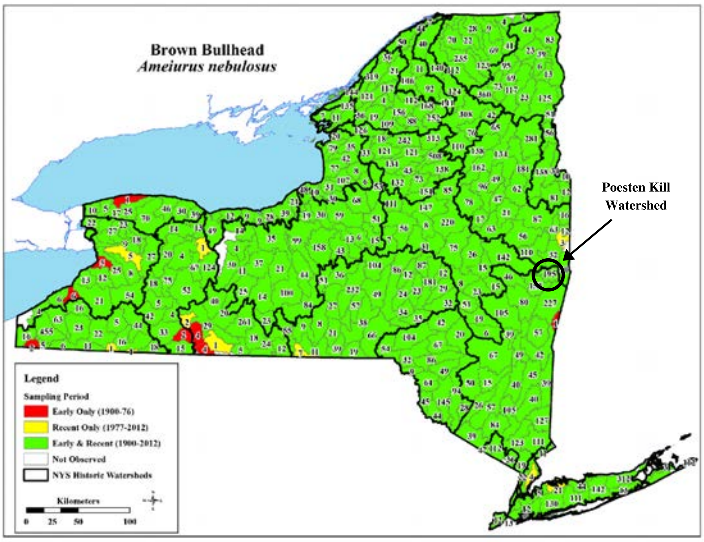

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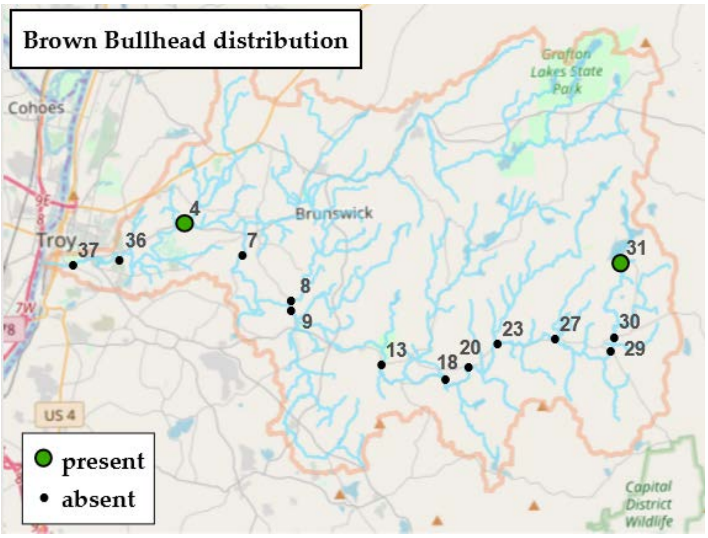

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(2) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pgs. 157-158.
Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 170.

BROWN TROUT *(Salmo trutta)*

FAMILY: Salmonidae (Trout, Salmon, Whitefish)

SIZE: Most individuals will be around 0.454 kg (1 lb) in weight. However, these fish can reach weights of 9.072-18.144 kg (20-40 lb).

LIFESPAN: These fish may reach up to 9-10 years old.

FIELD CHARACTERISTICS: These fish have **large dark spots on a lighter body** background. These **spots may either be black, brown, or orange and are usually encircled in a silver halo**. As the name suggests, these fish usually have a distinct brown coloration.

HABITAT: Brown Trout are capable of living in both streams and lakes. However, spawning habitat is mainly in streams, even for lake living individuals. Like other salmonids, they prefer cold water, but Brown Trout may endure higher temperatures than species like Brook Trout (Salvelinus fontinalis).

LIFESTAGES: Like many other salmonids, Brown Trout exhibit a fascinating life history cycle. When young hatch from their eggs, they are called alevins or "sac-fry" because of the yolk sac that is still attached to their bodies. Alevins continue to get nutrients from their yolk sac until it is empty. After the sac-fry is finished the alevins are now considered "fry". After living as fry, the individual will eventually mature into a "parr", Vertical body markings develop during this stage and are called "parr" marks. OEI staff were lucky enough to sample some Brown Trout in the "parr" stage of their life (See fact sheet for site 9). Once the parr mature further, they lose their parr marks and become adults.

SPAWNING: Brown Trout spawn in the fall, usually between October and November. Females generally carry between 200-2,000 eggs. Like other species of Trout, Brown Trout females create a nest called a "Redd". Once the redd is completed, the male and female will release reproductive materials into the nest for fertilization. Once this is done, the female will then sweep gravel and sand over the eggs. The eggs will hatch in around 65-100 days.

DIET: Brown Trout are carnivorous. Hatchlings will start on smaller insects, making their way up to larger food items as they grow until their adult diet mainly consists of insects, amphipods, mollusks, and fishes.

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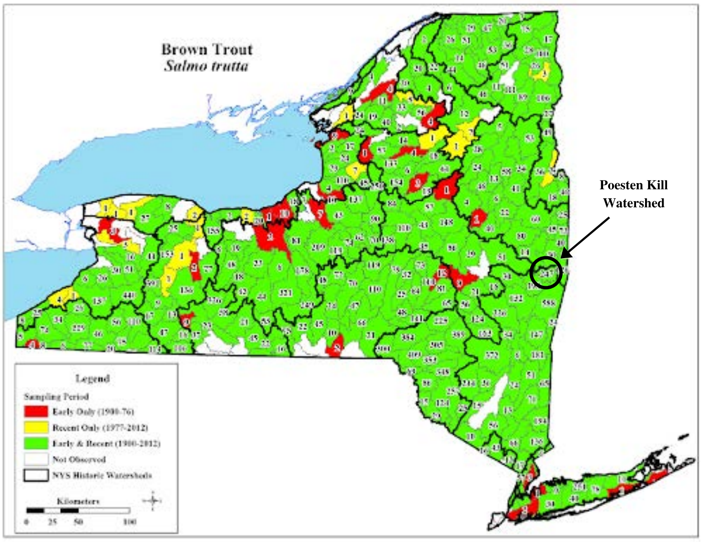

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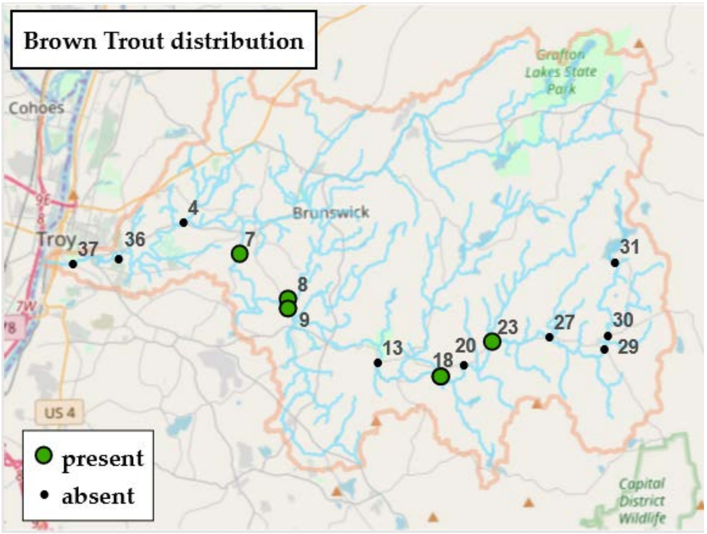

(1) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pgs. 189-190.

Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 206

CHAIN PICKEREL *(Esox niger)*

FAMILY: Esocidae (Pike, Pickerel, Muskellunge)

SIZE: Adults generally grow to lengths of 38.1-45.72 cm (15-18 in) and masses of 0.68 kg (1.5 lb).

LIFESPAN: Most individuals do not live long after sexual maturity around 3-4 years old, but some may live up to 8-9 years old.

FIELD CHARACTERISTICS: Chain Pickerels, like the other esocidae species, have an **elongate body** with their dorsal (back) fin positioned very close to the tail. The pickerels have a distinct **black "tear-drop" marking under their eyes.** Distinguishing the chain pickerel from the other pickerel species can be done by observing the **"chain" like patterning** on the body.

HABITAT: Chain Pickerel can be found in lakes, streams, swamps, and ponds. These fish prefer submerged cover like logs and aquatic vegetation. Dense cover is a requirement when chain pickerel hunt because they are ambush predators.

LIFESTAGES: Aside from size, these fish do not have a distinct change from hatching to adulthood.

SPAWNING: Chain Pickerel spawn in early spring shortly after ice out, in marshy areas and shallow bays. The spawning window is short, only between 7-10 days. Females generally carry between 6,000-7,000 eggs, but as many as 50,000 have been reported. Males and females release reproductive materials into vegetation and then mix them up using vigorous tail undulations. The eggs will hatch in 6-12 days.

DIET: Larval pickerel will feed on plankton before switching to insects in their first summer. Around the age of one is when they switch to a fish diet.

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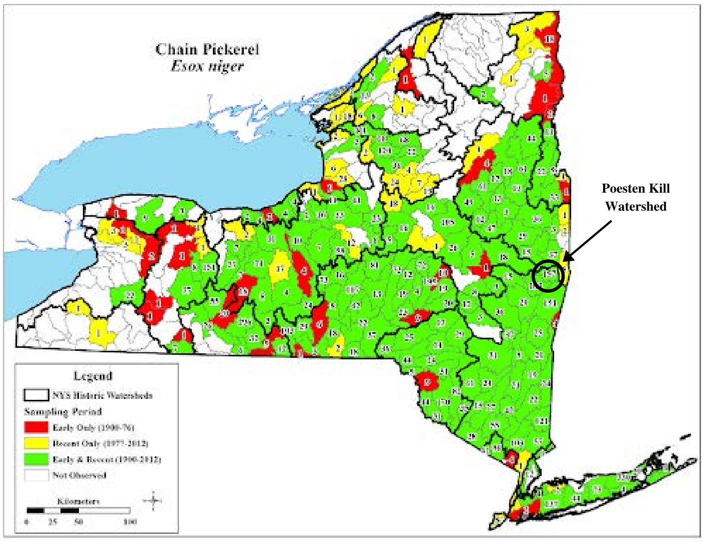

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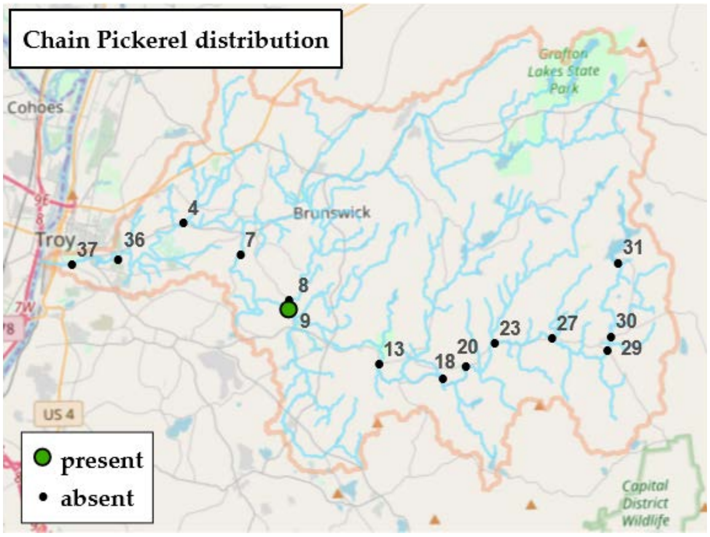

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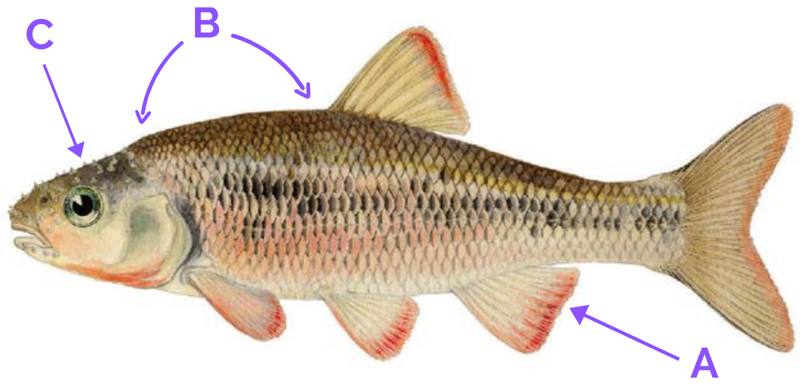
(2) Shelburne, Jacob. 2017. Esox niger, Animal Diversity Web. Webpage. [Internet] 2017 [cited 11 October 2019]. Available from: https://animaldiversity.org/accounts/Esox_niger/
Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 228.

COMMON SHINER *(Luxilus cornutus)*



FAMILY: Cyprinidae (Minnows, Shiners, Dace, Chubs, Carp, Goldfish)

SIZE: Common Shiners may grow to 17.78-20.32 cm (7-8 in) in length.

LIFESPAN: These fish may live up to 5 years.

FIELD CHARACTERISTICS: These fish have 9 anal rays (the bones in the anal fin **(A)**). The scales in front of the dorsal (back) fin, look crowded and small and are not outlined in dark pigment **(B)**. Distinguishing these fish from the Striped Shiner (Luxilus chrysocephalus) can be done by noting the absence of V-shaped markings on the sides of their body. During the breeding season, these fish may develop red tinges to their fins, and the males may develop nuptial tubercles **(C)** (hard bumps in the facial area).

HABITAT: Common Shiners are mainly found in small to moderate sized streams with gravel bottoms.

LIFESTAGES: Aside from size, these fish do not have a distinct change from hatching to adulthood.

SPAWNING: Spawning generally occurs in May and June when water temperatures reach 15.56-18.33 C (60-65 F). Females generally carry around 1,000 eggs. Males create depressions in the gravel that may or may not attract a female. In the event the female is attracted, she will enter the nest and deposit around 50 eggs which the male will then fertilize. The fertilized eggs are adhesive and will attach to the substrate in the bottom of the nest. Because females carry a lot more eggs than they release in a given males nest, it is assumed that she will repeat the spawning process many more times. Diet: Common Shiners prefer to eat insects, algae, and aquatic plants.

DIET: Common Shiners prefer to eat insects, algae, and aquatic plants.

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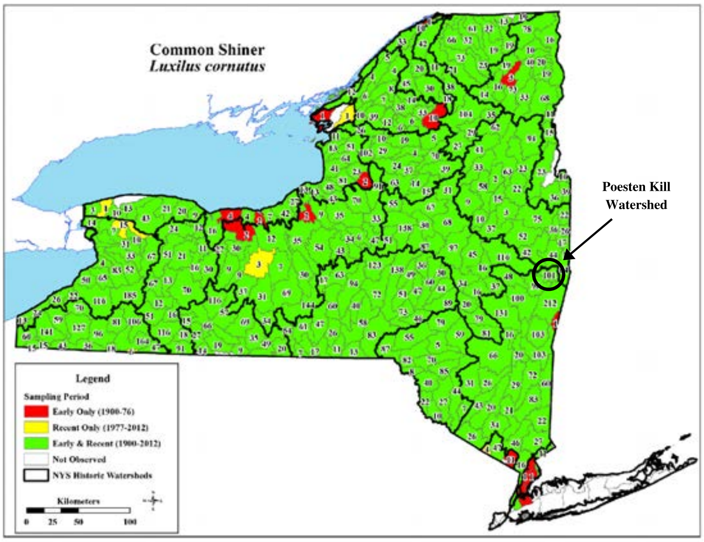

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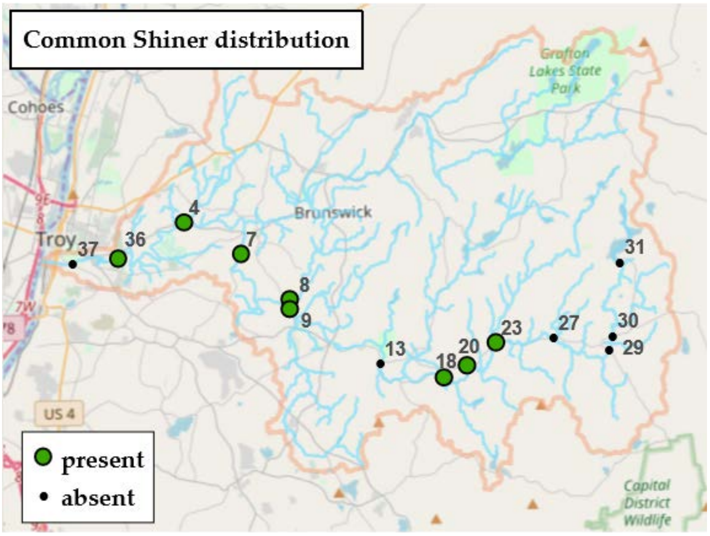

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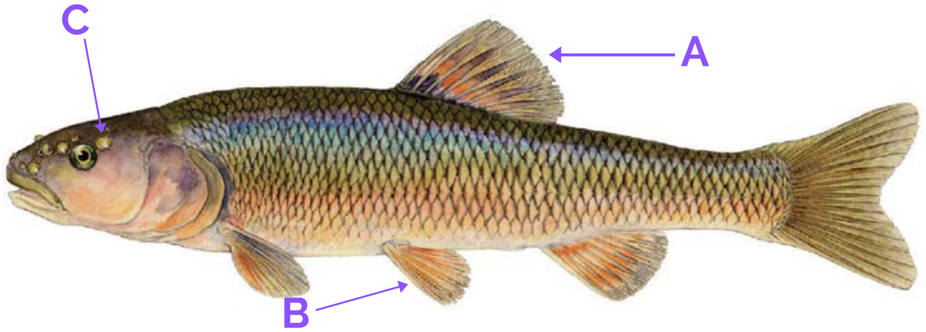
Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 73.

CREEK CHUB *(Semotilus atromaculatus)*



FAMILY: Cyprinidae (Minnows, Shiners, Dace, Chubs, Carp, Goldfish)

SIZE: The average adult length is 10.16-15.24 cm (4-6 in), but some may reach 25.4 cm (10 in).

LIFESPAN: Individuals may live between 3-8 years with an average of 5 years. Sexual maturity is reached around 1-4 years of age.

FIELD CHARACTERISTICS: These fish have a large mouth as well as a large dorsal **(A)**(back) fin that originates (positioning of the first ray of the fin) before the pelvic fin **(B)**. It is not uncommon to observe a dark band that extends from the tail to the tip of the snout. Further differentiating this fish from the Fallfish (Semotilus corporalis) can be done by observing the black spot at the front of the Creek Chubs dorsal fin. During the breeding season, the males may develop large nuptial tubercles-hard bumps **(C)**.

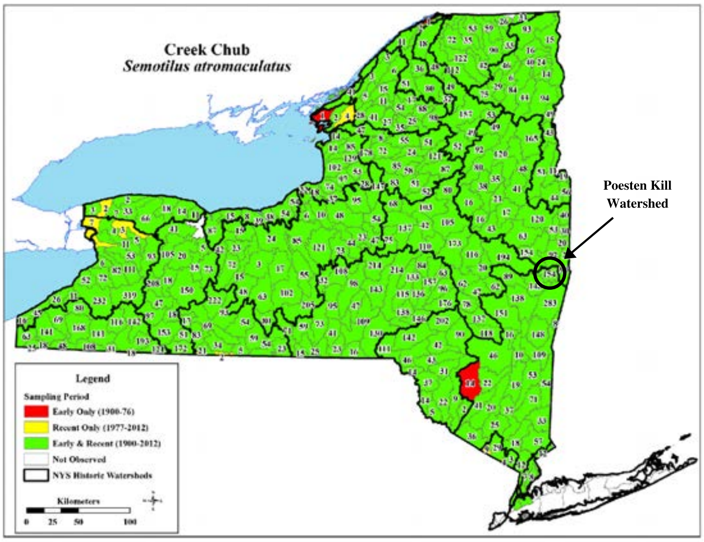
HABITAT: This species is common in headwater creeks, and small streams with gravel bottoms.

LIFESTAGES: Aside from size, these fish do not have a distinct change from hatching to adulthood.

SPAWNING: Creek Chub spawn in the spring. Males undertake a fascinating excavating project by transporting gravel upstream. During this process, the male creates a pit extending downstream and a large gravel mound upstream. If a female is attracted to the male's gravel mound display, she will join him in the pit. Swimming side by side, the male will flip the female vertically with his pectoral fin, wrap himself around her, and release sperm while she releases her eggs. After this 2-3 second event, the female will drift downstream appearing dead, and the male will cover the fertilized eggs with gravel from his mound. Once she has recovered, she will continue to visit this male or other nests and repeat the process. An average female will deposit around 3,000-4,000 eggs during a spawning season.

DIET: Creek Chub are termed "opportunistic omnivores" and will eat insects, small fish, and a lot of plant material.

NEW YORK STATE SPECIES DISTRIBUTION



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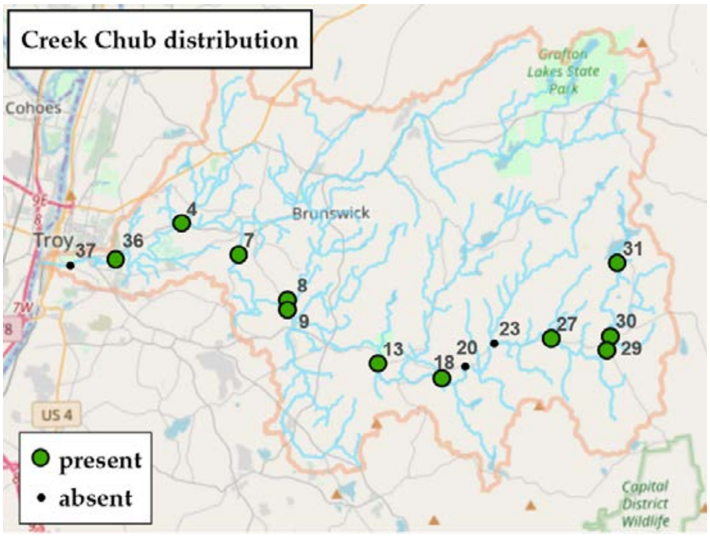

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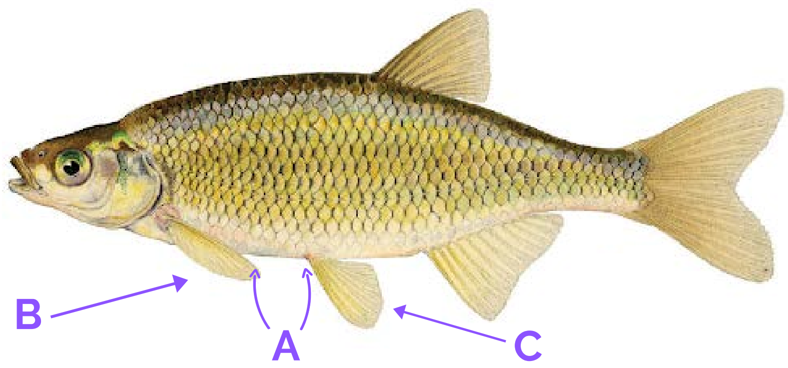
(2) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pgs. 131-132.
Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 128.

GOLDEN SHINER *(Notemigonus crysoleucas)*



FAMILY: Cyprinidae (Minnows, Shiners, Dace, Chubs, Carp, Goldfish)

SIZE: Golden Shiners may reach up to 25.4 cm (10 in) in length.

LIFESPAN: These fish may live to 8-9 years old. On average, males and females will reach sexual maturity around 1 year of age.

FIELD CHARACTERISTICS: These are a **deep-bodied fish**, meaning that the distance from the highest point of the back to the lowest point of the belly is comparatively long. These fish have a **fleshy keel (A)**, defined as a section where the body turns inward that is located along the underside of the fish between the pectoral **(B)** and pelvic fins **(C)**. They also have 10-15 anal (bones in the anal fin) rays. The adults generally have a distinct golden coloration while juveniles are green in color.

HABITAT: Golden Shiners may be found in lakes, ponds, swamps, creeks, and rivers. They generally prefer weedy, vegetated areas with stagnant water. Due to this fact, creek or stream dwelling individuals will mainly be found in pool sections of a reach.

LIFESTAGES: Aside from coloration and size, these fish do not have a distinct change from hatching to adulthood.

SPAWNING: Golden Shiners breed from May to August in ponds or lakes. These fish are “broadcast spawners”, meaning that they release reproductive materials over a given area without building a nest. In the case of this species, eggs and sperm are broadcasted over plots of vegetation. The eggs have an adhesive quality allowing them to stick to the vegetation. The eggs will hatch in 4-7 days.

DIET: Golden Shiners diet primarily consists of zooplankton, phytoplankton, and small insects.

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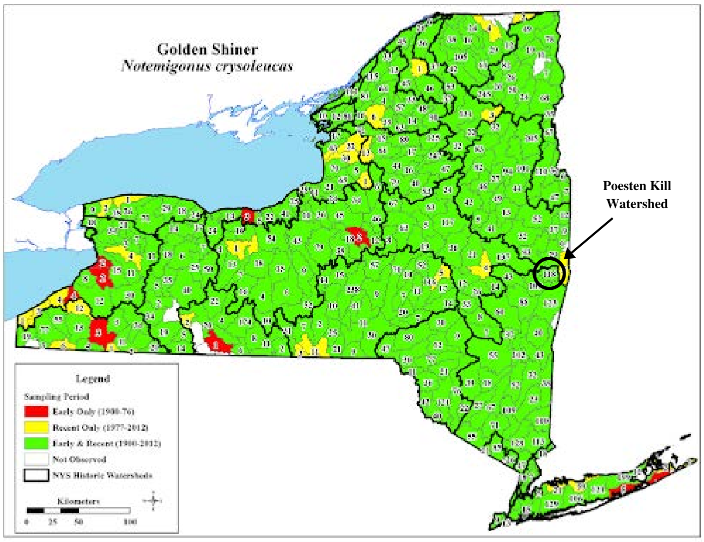

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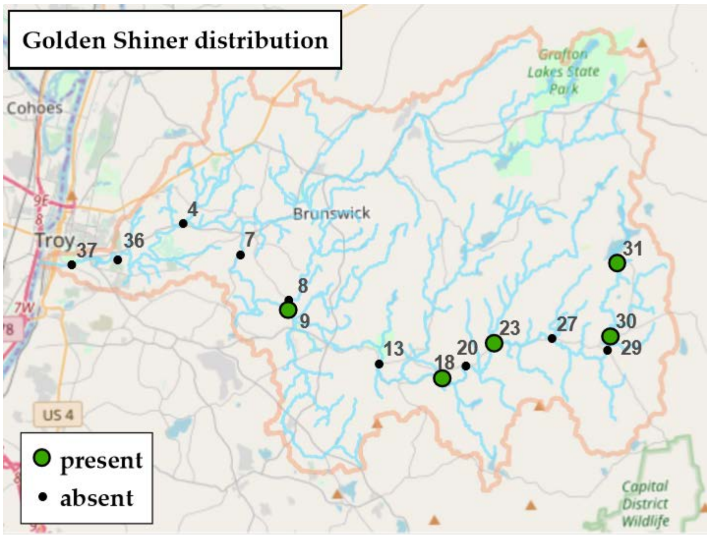

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(2) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pgs. 109-110.

Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 85.

LARGEMOUTH BASS *(Micropterus salmoides)*

FAMILY: Centrarchidae (Sunfish)

SIZE: Adults may reach 30-97 cm (11.81-38.19 in) in length with an average of 45 cm (17.72 in). They may weigh 0.45-10.1 kg (0.99-22.25 lb) with an average of 1.36 kg (3 lb).

LIFESPAN: Individuals may live up to 15 years old.

FIELD CHARACTERISTICS: As the name suggests, these fish have **large mouths**, with the maxilla (jawbone) reaching behind the orbit of the eye. These fish have a **dark horizontal band** running along their body and a **deep notch between their dorsal (back) fins**.

HABITAT: These fish are mainly found in lakes and rivers among weedy, vegetated areas with soft, shallow substrate.

LIFESTAGES: Aside from size, these fish do not have a distinct change from hatching to adulthood.

SPAWNING: Largemouth Bass spawn from late spring to early summer in shallow, weedy habitat. Males construct nests in hopes of attracting a female. If a female is attracted, she will release eggs into the nest while the male releases sperm. She may carry up 60,000 eggs. The eggs will hatch in 3-5 days, and the young will be strong enough to swim well in about one week. During this time, the male will constantly be on guard. He will continue to protect the babies for another month when they leave nest.

DIET: Hatchlings begin feeding on microscopic crustaceans and then make their way to small insects. As the individual grows, they will switch to frogs, fish, worms, and crayfish.

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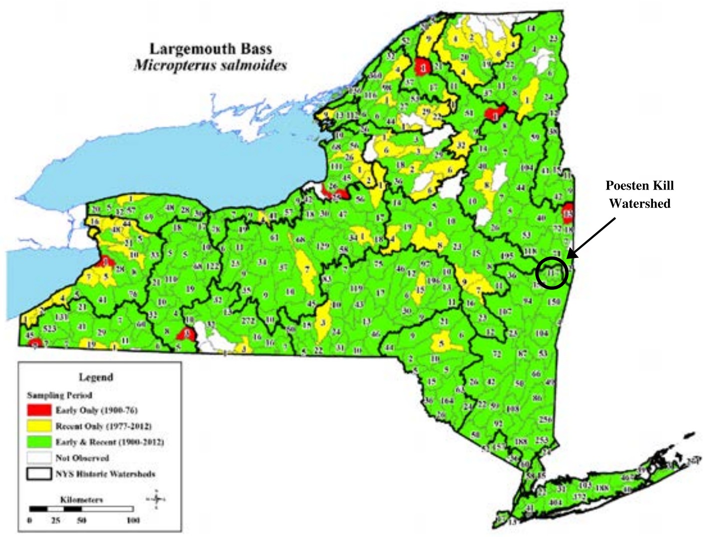

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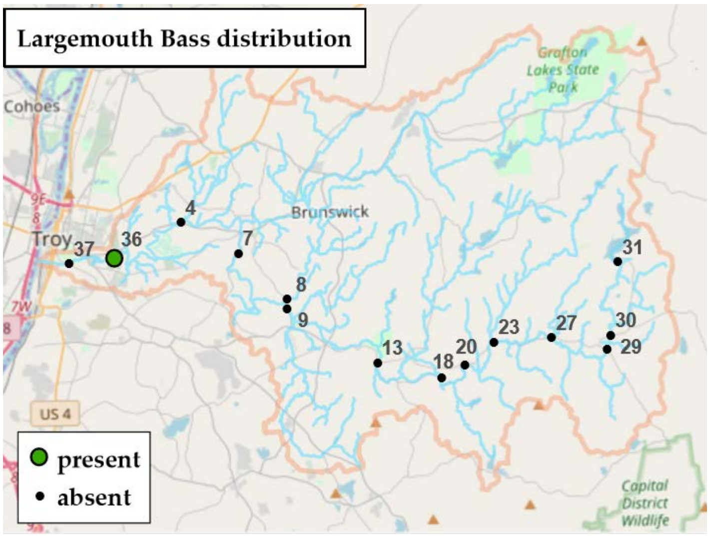


(1) Steed, Emily. 2018. Micropterus salmoides, Animal Diversity Web. Webpage. [Internet] 2018 [cited 14 October 2019]. Available from: https://animaldiversity.org/accounts/Micropterus_salmoides/.
(2) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pgs. 242-243.
Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 285.

LONGNOSE DACE *(Rhinichthys cataractae)*

FAMILY: Cyprinidae (Minnows, Shiners, Dace, Chubs, Carp, Goldfish)

SIZE: Adults may reach 60-225 mm (2.36-8.86 in)

LIFESPAN: Longnose Dace may live to 3-5 years old with an average of 3 years. Sexual maturity is reached at 1-2 years old.

FIELD CHARACTERISTICS: Longnose Dace are said to **look like miniature sharks**. They are very similar looking to Blacknose Dace, but they have a much longer snout and do not have a distinct black, horizontal line on their bodies.

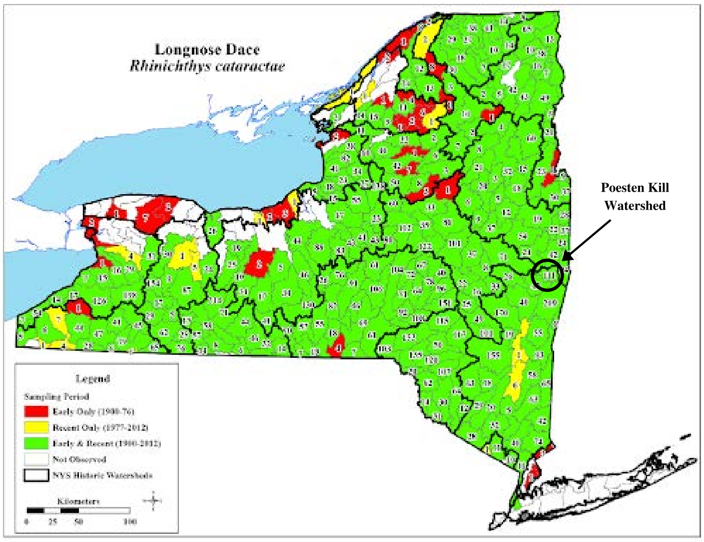
HABITAT: These fish will mainly be found in the fast-flowing, cold waters of the riffle habitats of streams. They generally prefer areas with rocky or gravel substrate.

LIFESTAGES: Besides size, these fish do not have a distinct change from hatching to adulthood.

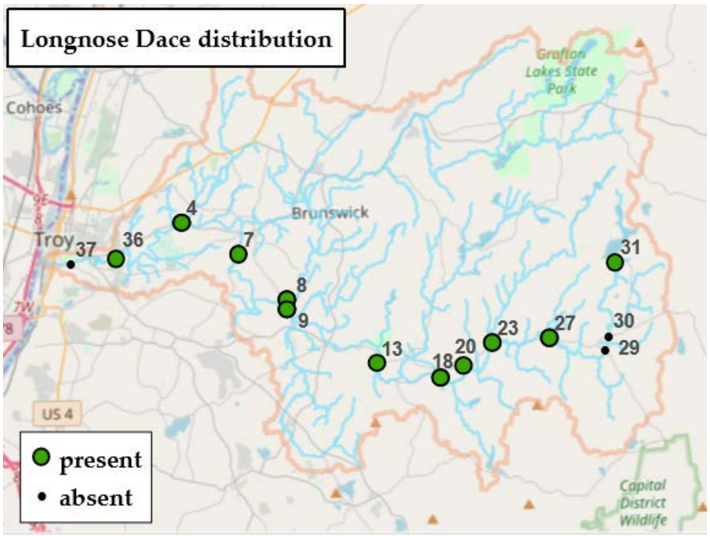
SPAWNING: Longnose Dace spawn between May and July. Males construct small nests in the gravely substrate. Females will carry around 1,155-2,534 eggs. After both parents release their reproductive materials, little parental care is given to the eggs and young. The eggs will hatch 3-4 days after spawning.

DIET: Longnose Dace feed on a variety of food including fish, fish eggs, insects, zooplankton, algae, and phytoplankton.

NEW YORK STATE SPECIES DISTRIBUTION



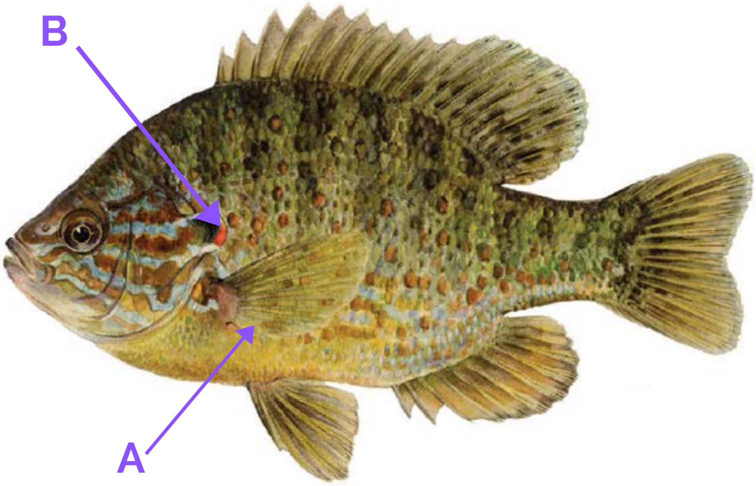
POESTEN KILL SPECIES DISTRIBUTION



(1) Duby, Kevin. 2014. Rhinichthys cataractae, Animal Diversity Web. Webpage. [Internet] 2014 [cited 14 October 2019]. Available from: https://animaldiversity.org/accounts/Rhinichthys_cataractae/.

Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 285.

PUMPKINSEED *(Lepomis gibbosus)*



FAMILY: Centrarchidae (Sunfish)

SIZE: Adults may max out around 25.4 cm (10 in) in length and 0.227 kg (0.5 lbs) in mass.

LIFESPAN: These fish may live up to 8-9 years.

FIELD CHARACTERISTICS: Common characteristics of this species are long, pointed pectoral fins **(A)**, a red spot **(B)** on the opercular (gill) flap, and "lightning-streak" turquoise bands on their face. These fish generally have a sandy, yellow coloration to their body.

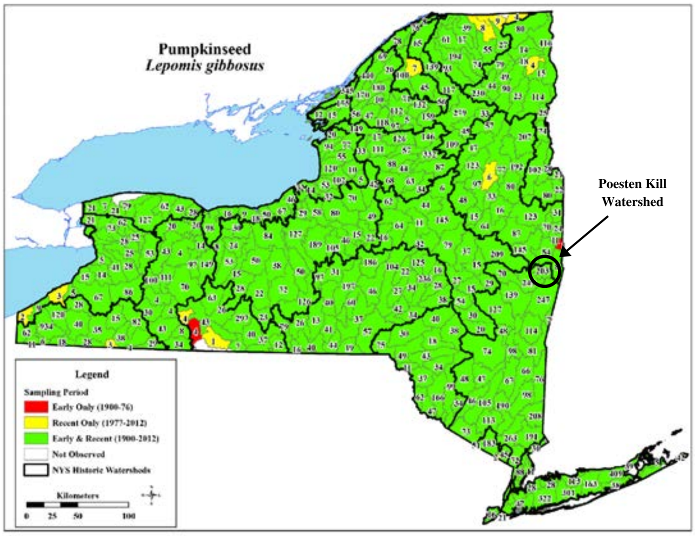
HABITAT: These fish are generally found in lakes and ponds but can be found in streams and rivers. In either scenario, lotic (stream/river) or lentic (Lake), these fish prefer vegetative or brushy cover.

LIFESTAGES: Aside from size, these fish do not have a distinct change from hatching to adulthood.

SPAWNING: Adults begin spawning in early summer. Males create small nests. Females will generally carry between 1,500-3,000 eggs. If a female is attracted to a male's nest, she will join him and begin a circular swimming courtship which results in both parents releasing reproductive materials into the bottom of the nest. The adhesive eggs become attached to the substrate of the nest. The males are the primary protectors of the eggs and hatchlings, guarding the young until they are ready to leave the nest. In particular, Pumpkinseed males are considered to be very aggressive defenders of their young.

DIET: These fish will feed on insects, small invertebrates, mollusks, and small fish.

NEW YORK STATE SPECIES DISTRIBUTION



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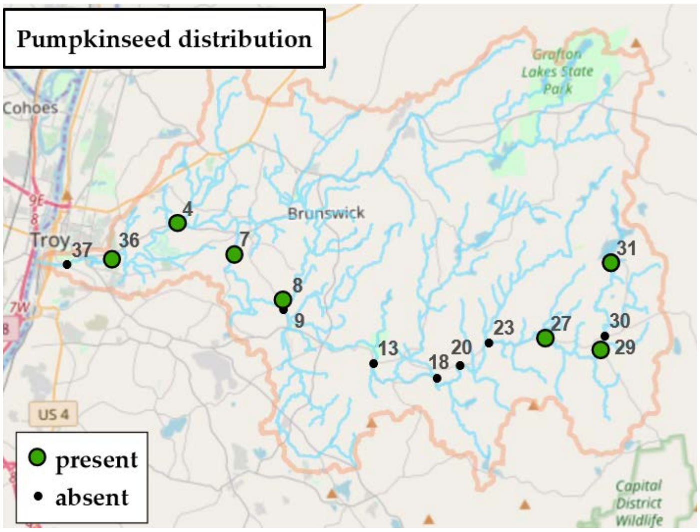
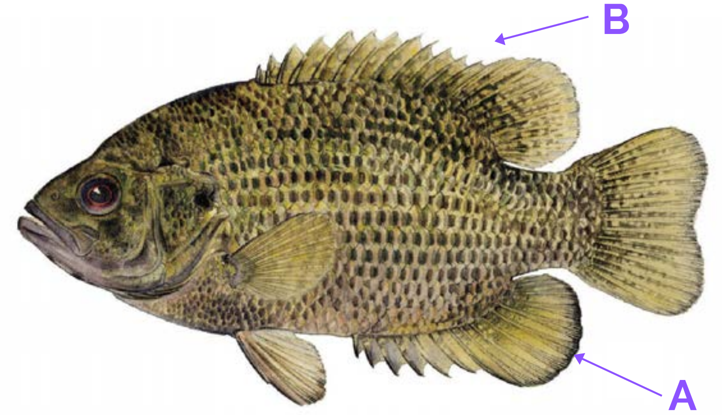


(1) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pgs. 236-237.
Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 276.

ROCK BASS *(Ambloplites rupestris)*



FAMILY: Centrarchidae (Sunfish)

SIZE: The average Rock Bass will measure 20-25 cm (7.87-9.84 in) in length. These fish may weigh a maximum of 3 kg (6.61 lbs), but the average is around 0.454 kg (1 lb).

LIFESPAN: An average Rock Bass will live between 5-8 years. The maximum recorded age was around 18 years. Both males and females will become reproductively mature around 2-3 years old.

FIELD CHARACTERISTICS: These fish have around 5-7 anal spines (the bones making up the anal fin **(A)**). To distinguish these fish from crappies, another species of sunfish with this trait, one can observe that the Rock Bass has an anal fin base length smaller than their dorsal (back) fin **(B)** base length where as the crappies are almost equivalent. Another distinguishing feature is the series of 8-10 lines of black spots below the lateral line. Above the lateral line (Sensory line running the length of the body), the body has a mottling of dark and irregular blotches.

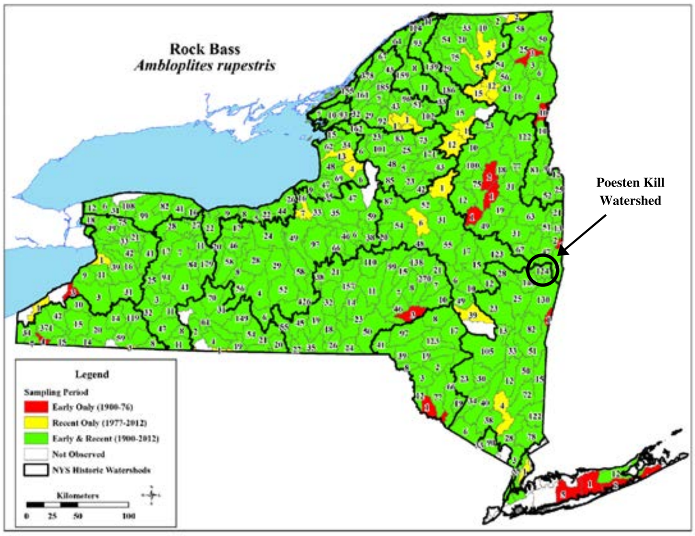
HABITAT: These fish may be found in lakes, ponds, streams, and rivers. They generally prefer vegetated areas with rocky or sandy substrate.

LIFESTAGES: Aside from size, these fish do not have a distinct change from hatching to adulthood.

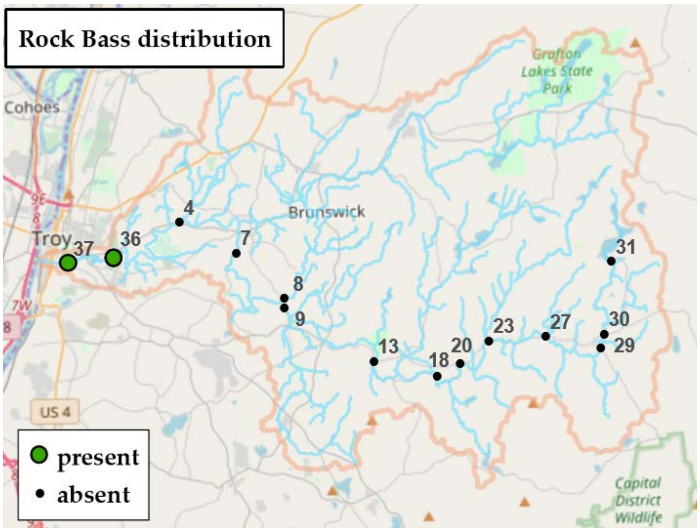
SPAWNING: These fish are early summer spawners. Males create nests. Females will generally carry around 5,000 eggs. Females may visit and reproduce with more than one male, and males may be visited and reproduce with more than one female. Males are aggressive defenders of their eggs, which hatch between 3-4 days after spawning. He continues to guard his young until they are ready to leave the nest.

DIET: Rock Bass feed on insects, crayfish, mollusks, and small fish.

NEW YORK STATE SPECIES DISTRIBUTION



POESTEN KILL SPECIES DISTRIBUTION

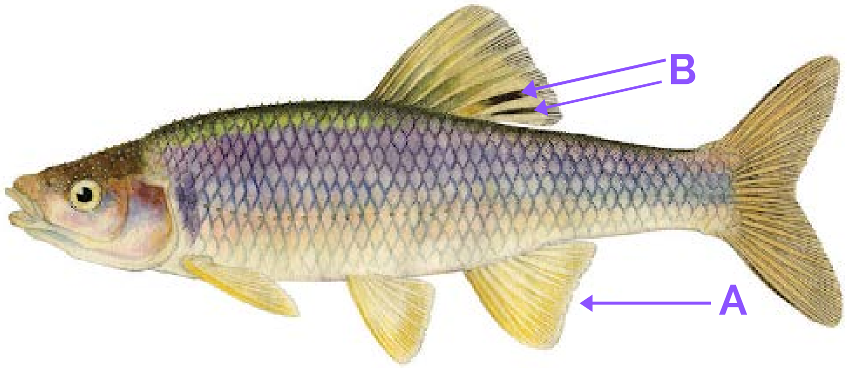


(1) Schnell, Brendan. 2014. Ambloplites rupestris, Animal Diversity Web. Webpage. [Internet] 2014 [cited 15 October 2019]. Available from: https://animaldiversity.org/accounts/Ambloplites_rupestris/.

(2) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pgs. 231-232.

Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 267.

SPOTFIN SHINER *(Cyprinella spiloptera)*



FAMILY: Cyprinidae (Minnows, Shiners, Dace, Chubs, Carp, Goldfish)

SIZE: Adults may reach 7.62-10.16 cm (3-4 in) in length.

LIFESPAN: These fish may live up to 4 years.

FIELD CHARACTERISTICS: These fish are described to be the only shiner species to have 8 anal rays (bones making up the anal fin **(A)**). Also, these fish have a **deep-body** (the distance from the highest point of the back to the lowest point of the belly is long compared to other species) and **dark pigmentation (B) on the fin membranes** (soft tissue of the fin) **between the last three dorsal (back) fin rays** (bones making up the dorsal fin).

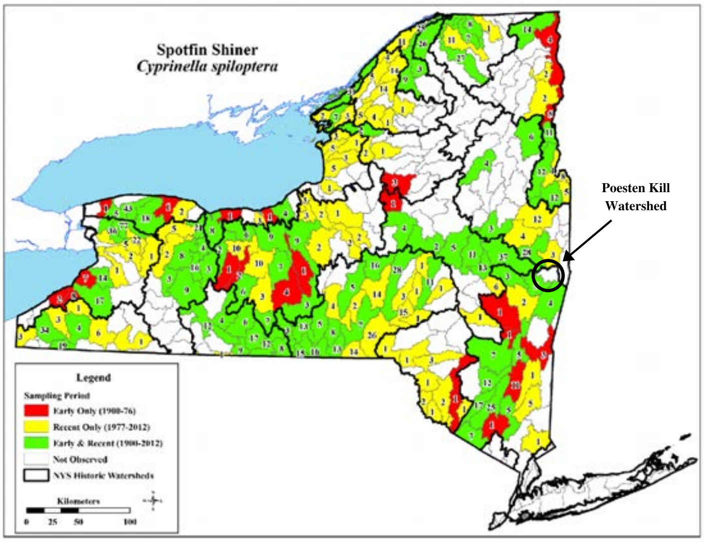
HABITAT: These fish generally inhabit creeks and lakes. It has been documented that this species can tolerate silty and turbid water conditions.

LIFESTAGES: Besides size, these fish do not have a distinct change from hatching to adulthood.

SPAWNING: Spotfin Shiners are fractional spawners, meaning that they will reproduce in day long intervals over a given spawning season. For this species, spawning is carried out over the summer months. Adults will use the crevices of rocks and logs to lay their eggs and spread their sperm. In general, adults will do this in 5-day intervals over the summer.

DIET: This species generally eats insects.

NEW YORK STATE SPECIES DISTRIBUTION



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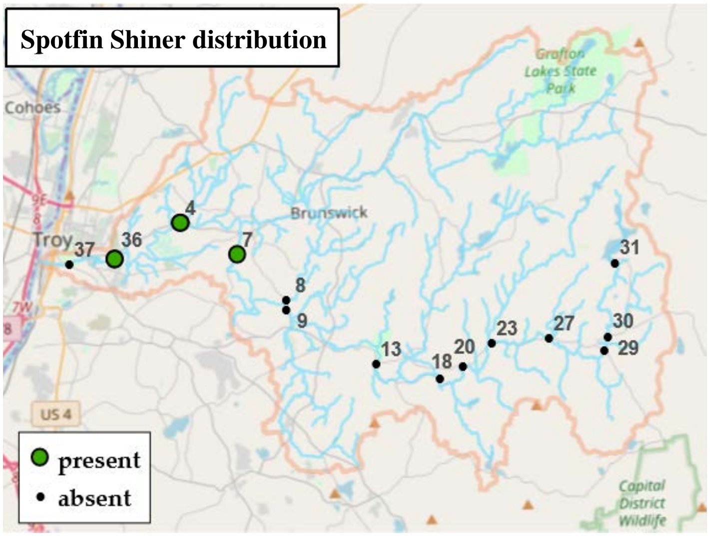


(1) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pg. 95.
Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 57.

TESSELATED DARTER *(Estheostoma olmstedi)*

FAMILY: Percidae (Perch, Darters)

SIZE: Adults may reach up to 6.35 cm (2.5 in) in length.

LIFESPAN: These fish may live 3-4 years.

FIELD CHARACTERISTICS: These fish have 9-11 X, W, M, or V shaped markings along their bodies. They also have around 12-14 rays (bones in the fin) in their soft (second) dorsal fin **(A)**. Distinguishing these fish from the Johnny Darter can be done by counting the rays in the soft dorsal fin. Johnny's only have 10-12. Tessellated Darters will commonly have a black "tear-drop" marking under both eyes.

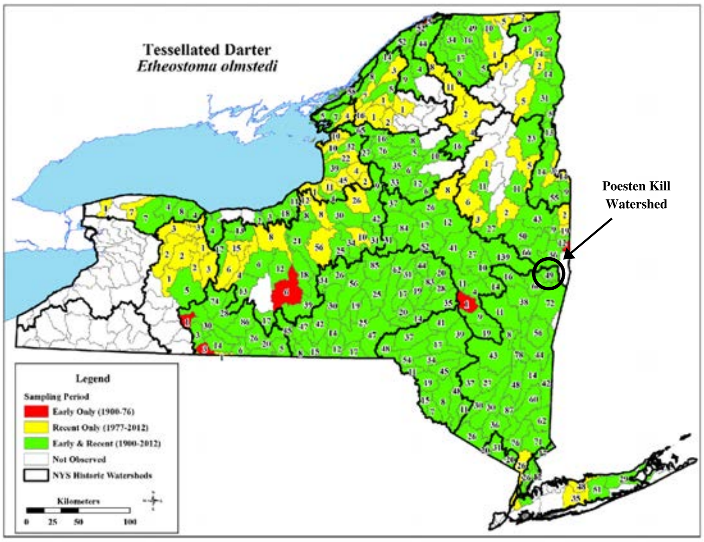
HABITAT: These fish are mainly found in the fast-flowing riffle habitats of streams. If they are found in lentic (lake) environments it will mainly be near the mouth and along the shores having silty or gravely substrate.

LIFESTAGES: Besides size, these fish do not have a distinct change from hatching to adulthood.

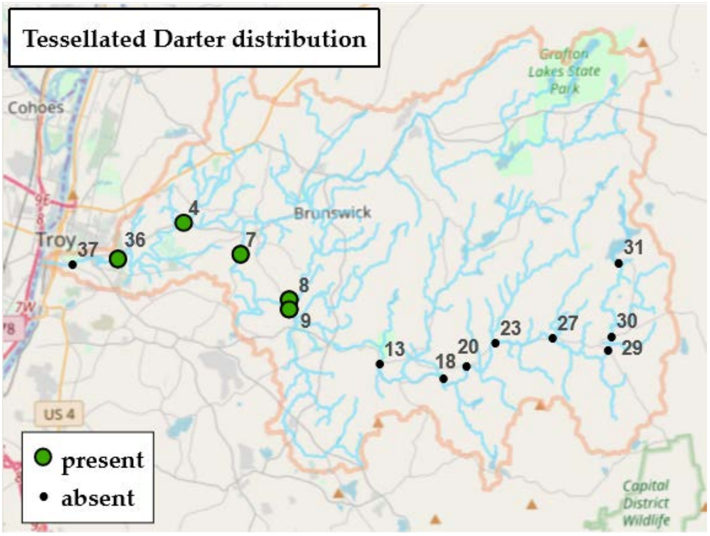
SPAWNING: Adults will reproduce any time from late April to May. Males will establish territories with rocky substrate that they defend vigorously. If a female is attracted, she will enter his territory and lay her eggs (usually 30-200) on the underside of a rock. The male will fertilize them right after. He will continue to guard the eggs and even fan them to keep water circulating over them. The eggs will hatch in 5-8 days.

DIET: These fish will generally feed on microscopic crustaceans, small insects, and organic benthic (bottom) debris.

NEW YORK STATE SPECIES DISTRIBUTION

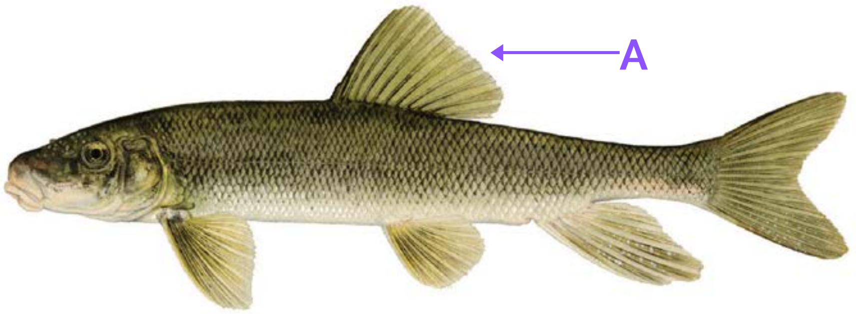


POESTEN KILL SPECIES DISTRIBUTION



(1) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pg. 260-261.
Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 306.

WHITE SUCKER *(Catostomus commersoni)*



FAMILY: Catostomidae (Suckers, Redhorses)

SIZE: Adults may reach 45.72-50.8 cm (18-20 in) in length, but the average is around 24.1 cm (9.49 in). They may also reach 1.36-1.81 kg (3-4 lbs) in mass with an average of 0.4 kg (0.88 lb) and a maximum of 2.5 kg (5.51 lb).

LIFESPAN: These fish may live up to 10 years, but certain dwarf varieties can reach up to 18 years. Both males and females will become sexually mature around 3-8 years old.

FIELD CHARACTERISTICS: These fish have a short, blunt snout and 10-13 rays (bones of the fin) in their dorsal fin **(A)**.

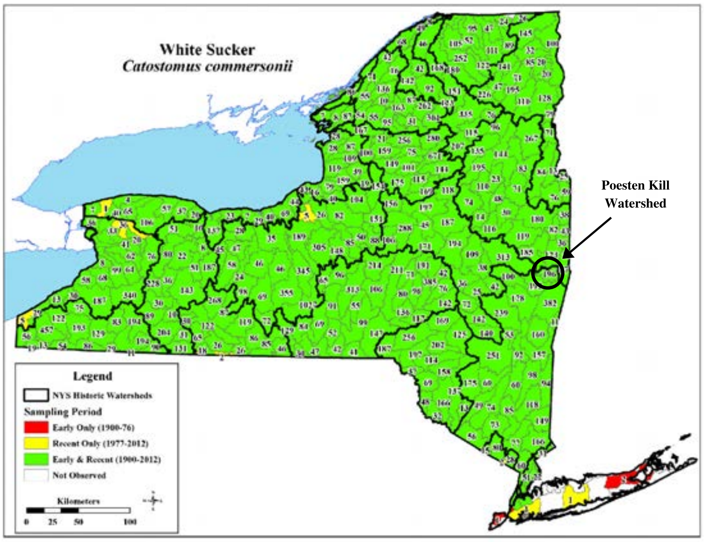
HABITAT: White Suckers may be found in creeks, streams, or lakes. Generally, these fish prefer cold, clear rivers that are small to medium in size. However, these fish are tolerant of polluted waters that may be murky and anoxic (Having very low dissolved oxygen concentrations).

LIFESTAGES: Besides size, these fish do not have a distinct change from hatching to adulthood.

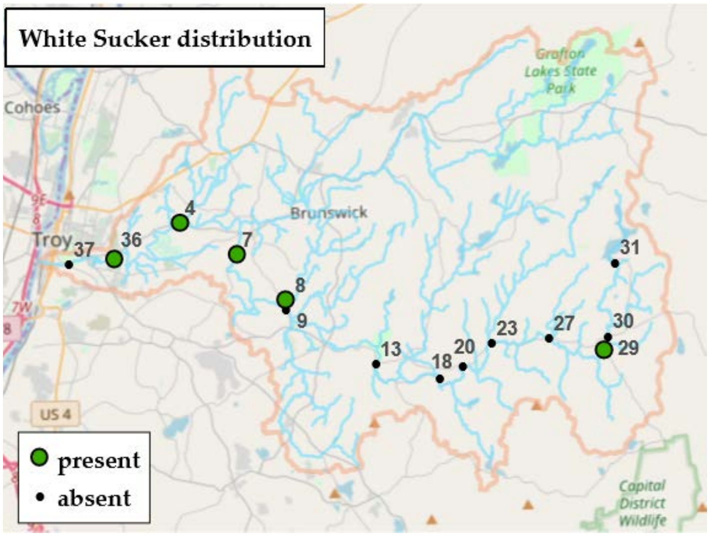
SPAWNING: White Suckers spawn between April and May. The preferred locations are upstream sections with gravel and good current, but some have been reported to spawn in pools and lakes. Males will generally develop nuptial tubercles (small bumps) on their anal and tail fins, and females have been reported to develop them at times as well. Females will generally carry between 20,000-50,000 eggs with a maximum being 140,000. The males and females will broadcast their reproductive materials over the substrate. The eggs are adhesive and will attach to the substrate after fertilization. The eggs will hatch in 5-10 days, and the hatchlings will receive no parental care.

DIET: Hatchlings, or "sac-fry" will obtain nutrients from their yolk sac until it is depleted. Once finished with their yolk sac, the fry will move downstream and feed on microcrustaceans, rotifers and algae. Adults will generally eat insects, crustaceans, snails, and clams.

NEW YORK STATE SPECIES DISTRIBUTION

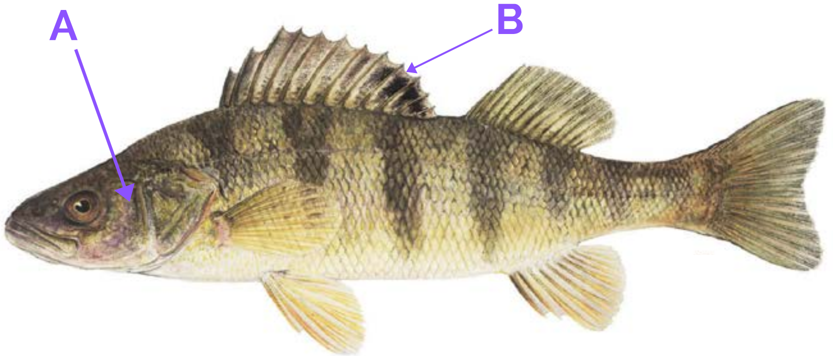


POESTEN KILL SPECIES DISTRIBUTION



(1) Hernandez, Aldo. 2014. Catostomus commersonii, Animal Diversity Web. Webpage. [Internet] 2014 [cited 15 October 2019]. Available from: https://animaldiversity.org/accounts/Catostomus_commersonii/.
(2) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pg. 142
Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 138

YELLOW PERCH *(Perca flavescens)*



FAMILY: Percidae (Perch, Darters)

SIZE: Adults may reach 25.4-27.94 cm (10-11 in) in length and average 1.06 kg (2.34 lbs) in mass.

LIFESPAN: Yellow Perch may live up to 8-9 years. Sexual maturity is reached around 3-4 years.

FIELD CHARACTERISTICS: These fish are easily identified by the presence of **wide, vertical, olive bands on a yellow body background.** They also have a serrated preoperculum **(A)** (edge at the front of the gill flap) and a dusky black print **(B)** at the back of their spiny (first) dorsal fin.

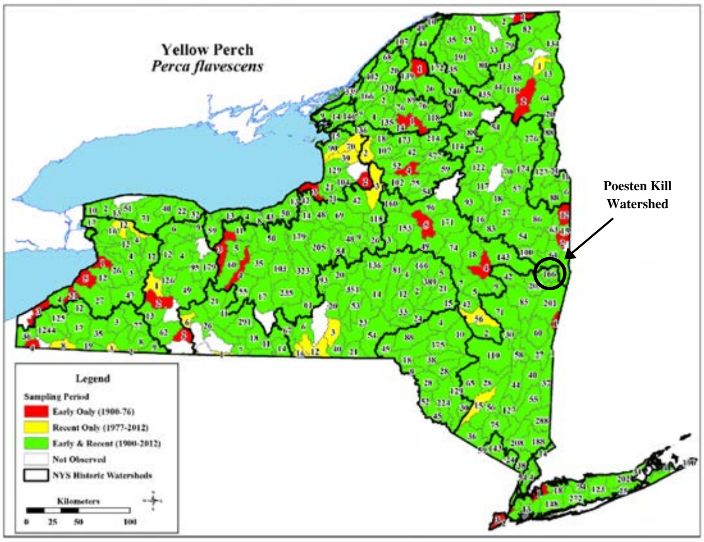
HABITAT: Yellow Perch are a primarily lentic (lake) dwelling species. They prefer water low in turbidity (cloudiness) and silt but can handle anoxic conditions.

LIFESTAGES: Besides size, these fish do not have a distinct change from hatching to adulthood.

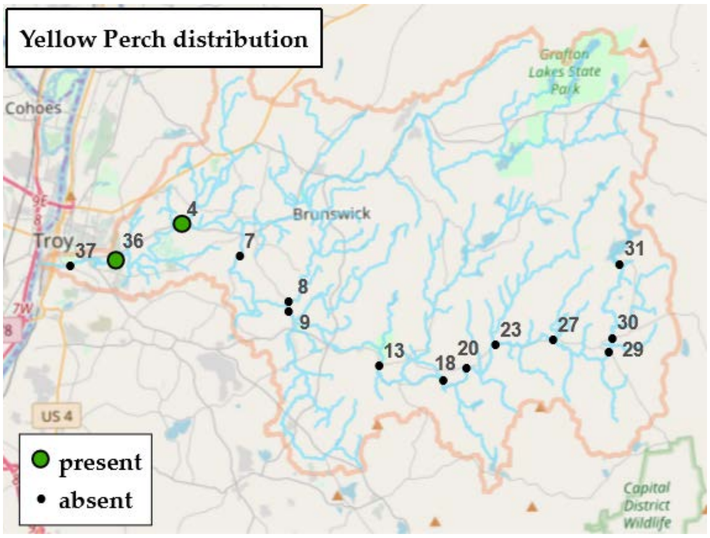
SPAWNING: Adults begin to spawn in early spring with water temperatures between 44-54 F. Spawning occurs in shallower water, sometimes in tributary streams. Females can carry anywhere from 3,000-100,000 eggs with an average of 20,000-30,000. The females will lead a train of males until she is ready to release a long gelatinous mass of eggs. The pursuing males will then release sperm to fertilize the eggs. The egg mass is semi buoyant in nature, allowing it to be suspended in the water column. The current moving through the mass allows for a constant flow of fresh water that keeps the eggs healthy and aerated. The eggs will hatch in 7-10 days and the young will not receive parental care.

DIET: Newborns feed on their yolk-sac until it is depleted. Once they have finished their yolk-sac, the fry will then begin feeding on zooplankton until they are large enough to start feeding on insects and crustaceans. They will continue this diet until the end of their first year. As adults, Perch will continue eating insects but also start on crayfish and small fishes.

NEW YORK STATE SPECIES DISTRIBUTION



POESTEN KILL SPECIES DISTRIBUTION



(1) Creque, Sara. 2000. Perca flavescens, Animal Diversity Web. Webpage. [Internet] 2000 [cited 15 October 2019]. Available from: https://animaldiversity.org/accounts/Perca_flavescens/.
(2) Werner, Robert. 2004. Freshwater Fishes of the Northeastern United States. Syracuse University Press. Pg. 1263-264.
Photo/Map Credit: Carlson, Douglas. Daniels, Robert. Wright, Jeremy. 2016. Atlas of Inland Fishes of New York. The New York State Education Department. Pg. 310

FISH FACT SHEET GLOSSARY

FAMILY: A taxonomic family is a grouping of organisms that share similar characteristics. These characteristics are ones that can easily distinguish species of a family from those of another family.

SIZE: Fish size classifications generally refer to their body lengths, from the tips of their snouts to the tips of their tails, and body mass, or how much they weigh. For the sake of simplicity, these are the measurements OEI reported in the following fact sheets. More advanced studies of fish anatomy by ichthyologists and anatomists may study specific “morphometric” traits which are measurements relating to various parts of the fish’s body that grow in length, width, depth, or mass.

LIFESPAN: This is the amount of time that a given individual of a particular species will live. This time is generally represented as an average for a given species, but there are constant cases of unique individuals living well beyond the average.

FIELD CHARACTERISTICS: These are the traits that a species has that helps biologists in differentiating the many species they will observe while sampling. These are generally traits that are not difficult to observe in the field and will yield a high degree of accuracy in identifying a species. These traits vary from things like color, anatomical features (e.g., number of fin rays, ratio of eye to head size, etc.), and size. In general, anatomical features tend to be more reliable than color and size due to their lack of variability. For example, a given species may vary widely in the color template that an individual can have, but certain structures that are coded for by their DNA will take many thousands of years to vary widely enough to confuse individual-to-individual in a species.

HABITAT: These are the particular areas where a species can be found. For a given species, these areas will generally consist of similar components that the species prefers for their survival and reproduction. There may even be fish species that occupy drastically different habitats at different points in their life history. These are generally the species that migrate vast distances to reproduce. Simple observations of a fish species habitat can be things like the depth of water they are found in, how much vegetation is present, and what type of substrate they use for building nests.

LIFESTAGES: These are the distinct points of development for a species. Unlike most mammal species (humans for example), fish can vary greatly in how a baby will look in comparison to when they are adults. Different life stages are where a biologist can observe the greatest variation in things like where a species will live, what they will look like, what they eat, and how they behave.

SPAWNING: Spawning is term used for fish reproduction. A general trend in fish spawning consists of a mating pair building a nest by creating depressions in the substrate, which can be soft sediment or coarse stone. Females will deposit eggs into the nest over which males release dense mixtures of sperm to fertilize the eggs. The fertilized eggs undergo an incubation period until hatching. The hatchlings are generally termed as “fry”. The fry will grow into “young-of-the-year” in their first year of life. The timing of fish reproduction generally occurs in the spring or fall.

DIET: This is what the animal eats.

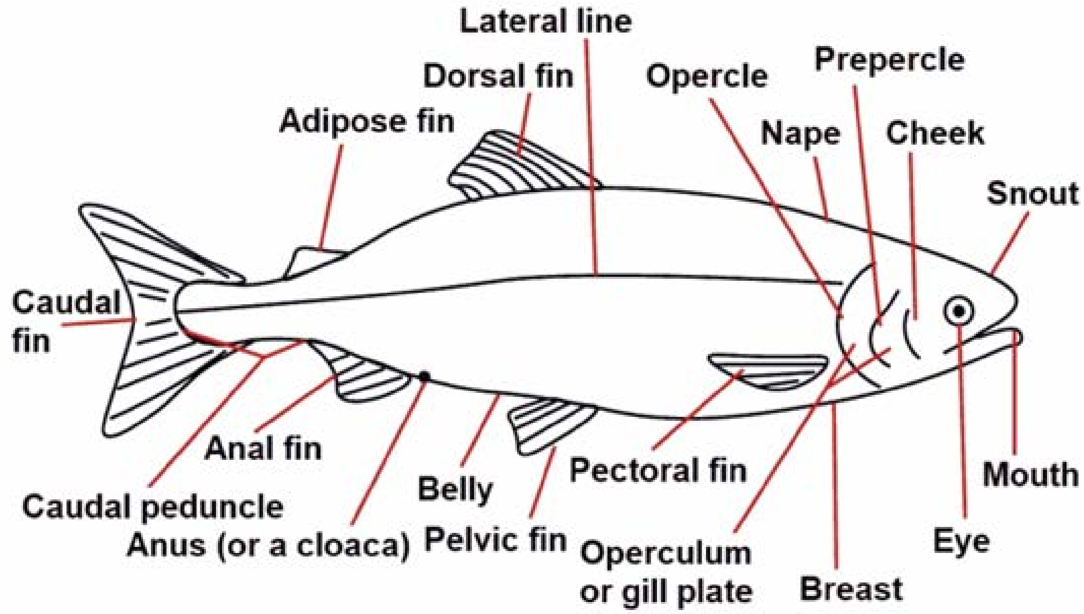


Figure 1. Generalized anatomy of bony fishes. (Image obtained from: https://www.pngtube.com/viewm/iiJmmwx_pull-fish-out-of-water/)

POESTEN KILL SITE-SPECIFIC FACTSHEETS

The Factsheets Presented in this section contain the physical, chemical, and biological data collected at each site, during the 2017 and 2019 surveys. Sites are arranged in downstream order; however, sites numbers are not consecutively ordered. Sites were numbered based on initial site reconnaissance.

DATA TABLE ABBREVIATIONS

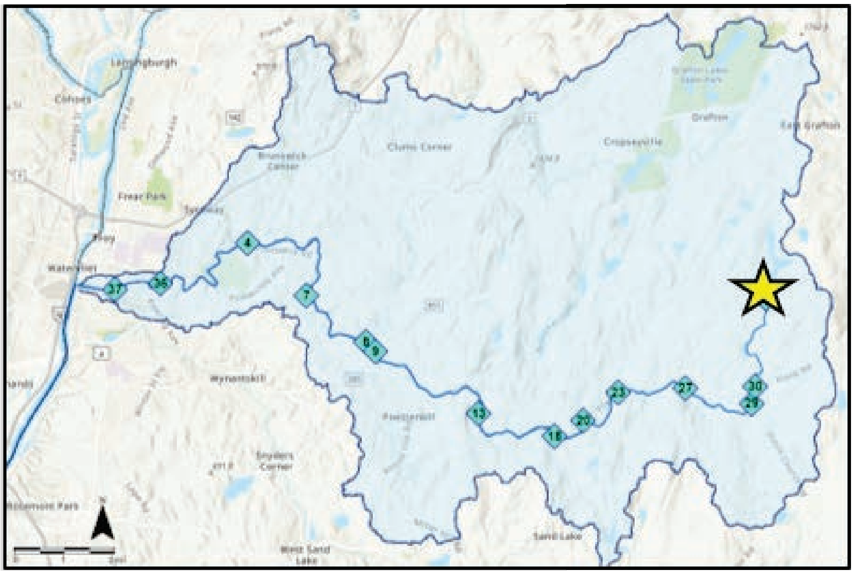
WATER QUALITY UNITS

Temperature (˚C) – reported as degrees-Celsius
Conductivity (µS/cm) – reported in microsiemens per centimeter
pH – unitless, measure of the hydrogen ion concentration
Turbidity (NTU) – reported in Nephelometric Turbidity Units
Dissolved oxygen (mg/L) – reported in milligrams per liter; also known as parts per million (ppm)

BIOLOGICAL UNITS

IBI – Index of Biotic Integrity
EPT richness – Ephemeroptera-Plecoptera-Trichoptera species richness
NCO richness – Non-Chironomidae and Oligochaeta richness
HBI – Hilsenhoff Biotic Index
PMA – Percent Model Affinity
NBI-P – Nutrient Biotic Index for Phosphorus
BAP – Biological Assessment Profile

POESTEN KILL SAMPLING DATA: SITE #31



SITE DESCRIPTION:

This site marks the beginning of the Poestenkill and is located right below Dyken Pond at Fifty Six Rd. The predominant surrounding land use consists of a mixture of forest, residential homes, and agriculture. The riparian zone of the stream is lined with a mixture of trees and shrubs.

SITE COORDINATES:

42.71704 N, -73.4278 W

2017 Downstream View

2019 Upstream View

2019 Downstream View

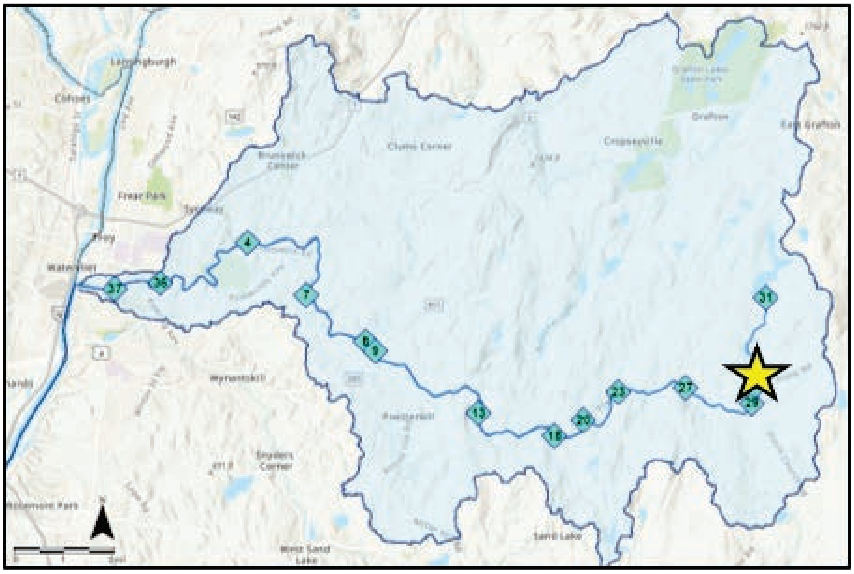
WQ	YEAR	
Measure	2017	2019
Temperature	21.93	19.35
Conductivity	30	24
pH	7.21	8.49
Turbidity	2.5	0
Dissolved oxygen	8.13	8.74

FISH SPP/COUNTS	YEAR	
Species	2017	2019
Bluegill	0	5
Brown Bullhead	1	0
Creek Chub	3	46
Golden Shiner	0	6
Longnose Dace	0	5
Pumpkinseed	14	22

FISH IBI	YEAR	
Measure	2017	2019
Abundance	18	84
Total Species Richness	3	5
Native Species Richness	3	5
Exotic Species Richness	0	0
Benthic Insectivore Species Richness	0	1
Water Column Species Richness	0	0
Terete minnow Species Richness	1	1
% Dominant	77.78	54.76
% White sucker	0.00	0.00
% Generalists	100.0	94.05
% Insectivores	0.00	5.95
% Top carnivore	0.00	0.00
Shannon Diversity	0.65	1.20
IBI Score	28	32
IBI Rating	Poor	Poor

INVERTEBRATES	YEAR	
Measure	2017	2019
Abundance	100	100
Richness	9	6
EPT Richness	3	3
NCO Richness	8	5
Diversity	1.57	0.47
Dominance-3	80	97
HBI	6.23	5.81
PMA	39	31
NBI-P	6.30	5.60
BAP	6.83	6.42
BAP Rating	Slight	Slight

POESTEN KILL SAMPLING DATA: SITE #30



SITE DESCRIPTION:

Located on Plank Rd, approximately 450 m north of Site 29. The surrounding land is predominately made up of forest. The riparian zone of the stream is lined with trees.

SITE COORDINATES:

42.69155 N, -73.43182 W

2017 Downstream View

2019 Downstream View

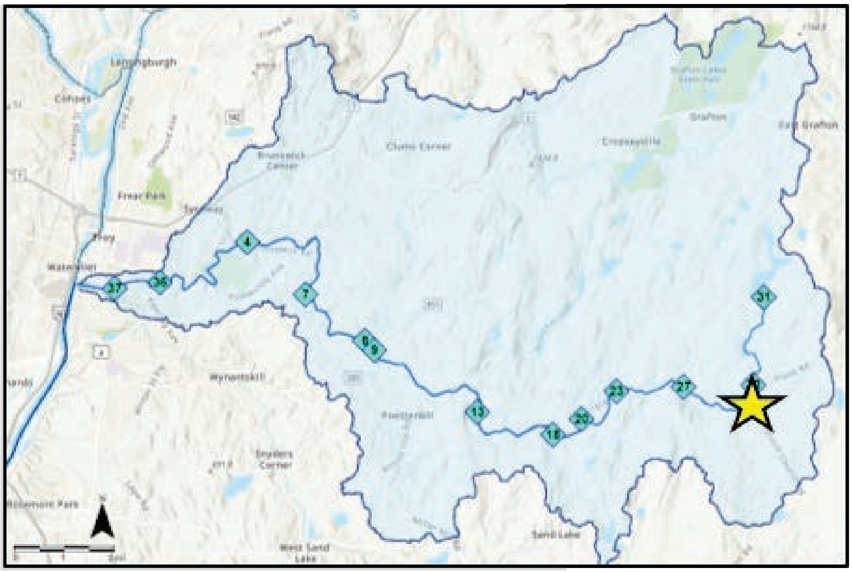
WQ	YEAR	
Measure	2017	2019
Temperature	18.15	15.93
Conductivity	52	44
pH	6.23	8.2
Turbidity	0	0
Dissolved oxygen	Not Sampled	8.24

FISH SPP/COUNTS	YEAR	
Species	2017	2019
Blacknose Dace	28	33
Creek Chub	25	36
Golden Shiner	0	1

FISH IBI	YEAR	
Measure	2017	2019
Abundance	53	70
Total Species Richness	2	3
Native Species Richness	2	3
Exotic Species Richness	0	0
Benthic Insectivore Species Richness	0	0
Water Column Species Richness	0	0
Terete Minnow Species Richness	1	1
% Dominant	52.83	51.43
% White sucker	0.00	0.00
% Generalists	100.00	100.00
% Insectivores	0.00	0.00
% Top carnivore	0.00	0.00
Shannon Diversity	0.69	0.75
IBI Score	26	26
IBI Rating	Poor	Poor

INVERTEBRATES	YEAR	
Measure	2017	2019
Abundance	100	100
Richness	17	12
EPT Richness	6	8
NCO Richness	16	11
Diversity	2.138	1.875
Dominance-3	62	75
HBI	4.62	4.89
PMA	53	59
NBI-P	6.919	6.379
BAP	8.602	8.615
BAP Rating	Non	Non

POESTEN KILL SAMPLING DATA: SITE #29



SITE DESCRIPTION:

Located on Dutch Church Rd, approximately 300 m east of Plank Rd. The surrounding land is predominately made up of forest and wetland. The riparian zone of the stream is lined with grass fields. There is a bridge that passes over this site.

SITE COORDINATES:

42.68668 N, -73.43312 W

2017 Upstream View

2019 Downstream View

2019 Upstream View

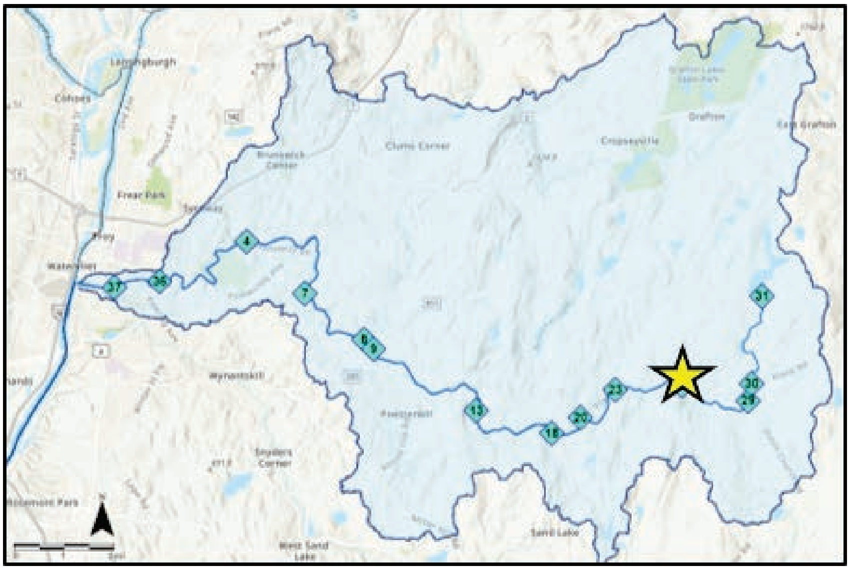
WQ	YEAR	
Measure	**2017**	**2019**
Temperature	18.45	15.95
Conductivity	53	46
pH	6.3	7.8
Turbidity	0.4	1.8
Dissolved oxygen	8.35	8.84

FISH SPP/COUNTS	YEAR	
Species	**2017**	**2019**
Blacknose Dace	33	25
Creek Chub	24	21
Pumpkinseed	3	0
White Sucker	0	4

FISH IBI	YEAR	
Measure	**2017**	**2019**
Abundance	60	50
Total Species Richness	3	3
Native Species Richness	3	3
Exotic Species Richness	0	0
Benthic Insectivore Species Richness	0	0
Water Column Species Richness	0	0
Terete minnow Species Richness	1	1
% Dominant	55.00	50.00
% White sucker	0.00	8.00
% Generalists	100.00	100.00
% Insectivores	0.00	0.00
% Top carnivore	0.00	0.00
Shannon Diversity	0.84	0.91
IBI Score	24	24
IBI Rating	Very Poor	Very Poor

INVERTEBRATES	YEAR	
Measure	**2017**	**2019**
Abundance	100	100
Richness	12	14
EPT Richness	3	10
NCO Richness	11	13
Diversity	1.00	1.64
Dominance-3	89	82
HBI	5.52	5.13
PMA	43	54
NBI-P	6.40	6.32
BAP	7.37	8.69
BAP Rating	Slight	Non

POESTEN KILL SAMPLING DATA: SITE #27



SITE DESCRIPTION:

Located on Plank Rd, just west of Dodge City Rd. The surrounding land is predominately made up of forest. The riparian zone of the stream is lined with trees. There is a bridge that passes over the site.

SITE COORDINATES:

42.69102 N, -73.45925 W

2017 Upstream View

2017 Downstream View

2019 Downstream View

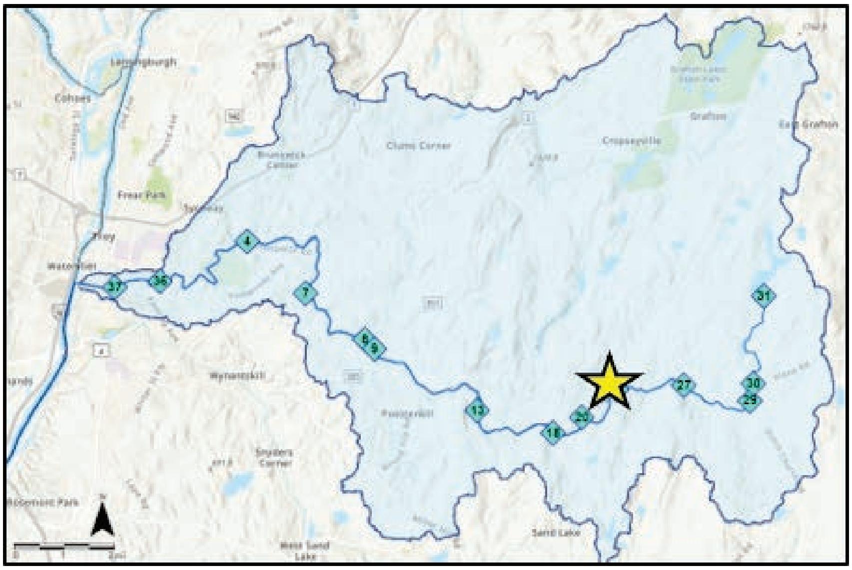
WQ	YEAR	
Measure	**2017**	**2019**
Temperature	17.94	15.66
Conductivity	46	41
pH	6.01	7.52
Turbidity	1.8	0
Dissolved oxygen	9.59	9.69

FISH SPP/COUNT	YEAR	
Species	**2017**	**2019**
Blacknose Dace	6	14
Creek Chub	7	9
Longnose Dace	7	2
Pumpkinseed	0	1

FISH IBI	YEAR	
Measure	**2017**	**2019**
Abundance	20	26
Total Species Richness	3	4
Native Species Richness	3	4
Exotic Species Richness	0	0
Benthic Insectivore Species Richness	1	1
Water Column Species Richness	0	0
Terete minnow Species Richness	1	1
% Dominant	35.00	53.85
% White sucker	0.00	0.00
% Generalists	65.00	92.31
% Insectivores	35.00	7.69
% Top carnivore	0.00	0.00
Shannon Diversity	1.09	1.02
IBI Score	30	28
IBI Rating	Poor	Poor

INVERTEBRATES	YEAR	
Measure	**2017**	**2019**
Abundance	100	100
Richness	8	13
EPT Richness	6	9
NCO Richness	7	12
Diversity	1.11	1.84
Dominance-3	89	72
HBI	2.82	4.73
PMA	32	75
NBI-P	2.29	5.34
BAP	5.64	9.19
BAP Rating	Slight	Non

POESTEN KILL SAMPLING DATA: SITE #23



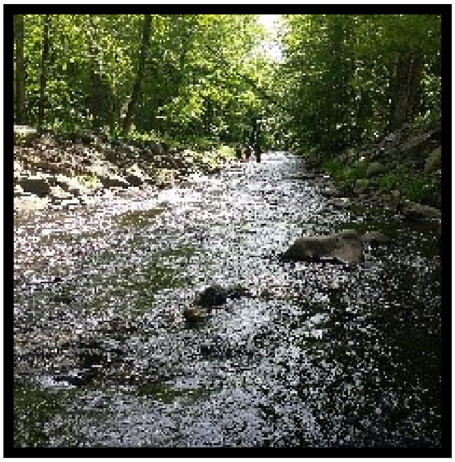
SITE DESCRIPTION:

Located on Fifty Six Rd, immediately north of the intersection with Plank Rd. The surrounding land is predominately made up of fields and residential homes. The riparian zone of the stream is lined with trees. There is a bridge that passes over the site..

SITE COORDINATES:

42.68987 N, -73.48589 W

2017 Upstream View



2017 Downstream View

2019 Downstream View

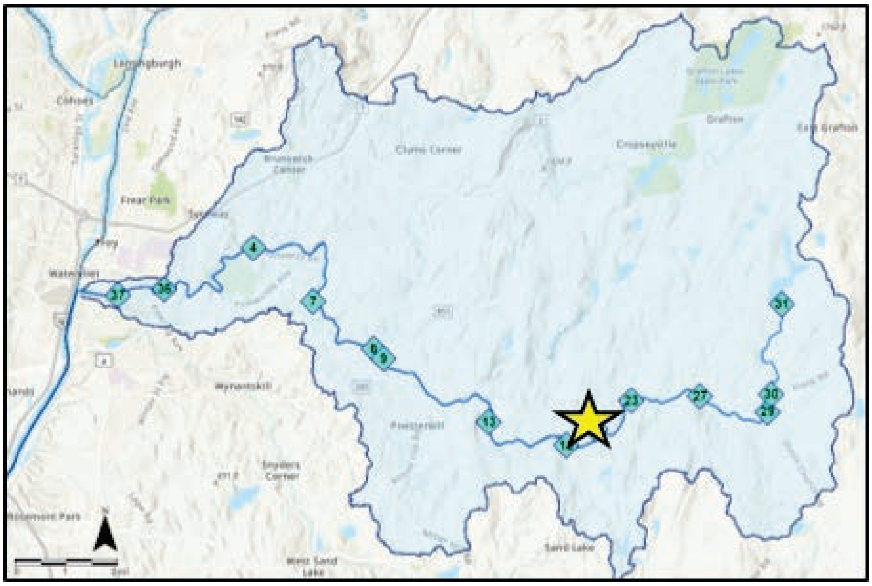
WQ	YEAR	
Measure	2017	2019
Temperature	19.03	14.72
Conductivity	51	35
pH	6.4	7.46
Turbidity	0.6	6
Dissolved oxygen	9.6	10.04

FISH SPP/COUNT	YEAR	
Species	2017	2019
Blacknose Dace	3	11
Brown Trout	0	2
Common shiner	0	4
Golden Shiner	0	1
Longnose Dace	15	2

FISH IBI	YEAR	
Measure	2017	2019
Abundance	18	20
Total Species Richness	2	5
Native Species Richness	2	4
Exotic Species Richness	0	1
Benthic Insectivore Species Richness	1	1
Water Column Species Richness	0	0
Terete minnow Species Richness	0	0
% Dominant	83.33	55.00
% White sucker	0.00	0.00
% Generalists	16.67	80.00
% Insectivores	83.33	10.00
% Top carnivore	0.00	10.00
Shannon Diversity	0.45	1.26
IBI Score	32	30
IBI Rating	Poor	Poor

INVERTEBRATES	YEAR	
Measure	2017	2019
Abundance	100	100
Richness	22	15
EPT Richness	13	11
NCO Richness	21	14
Diversity	2.65	1.77
Dominance-3	45	70
HBI	2.33	2.7
PMA	54	45
NBI-P	3.31	1.97
BAP	8.63	7.10
BAP Rating	Non	Slight

POESTEN KILL SAMPLING DATA: SITE #20



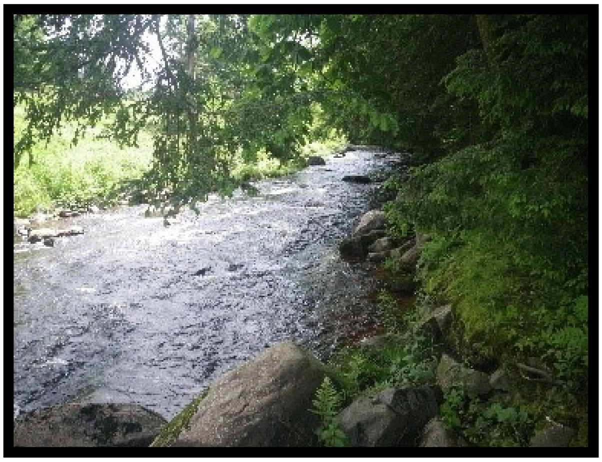
SITE DESCRIPTION:

Located on Columbia Hill Rd, immediately south of the intersection with Plank Rd. The surrounding land consists of a myriad of forest, fields, agriculture, and residential homes. The riparian zone of the stream is lined with trees. There is a bridge that passes over the site.

SITE COORDINATES:

42.68181 N, -73.49943 W

2019 Upstream View



2019 Downstream View

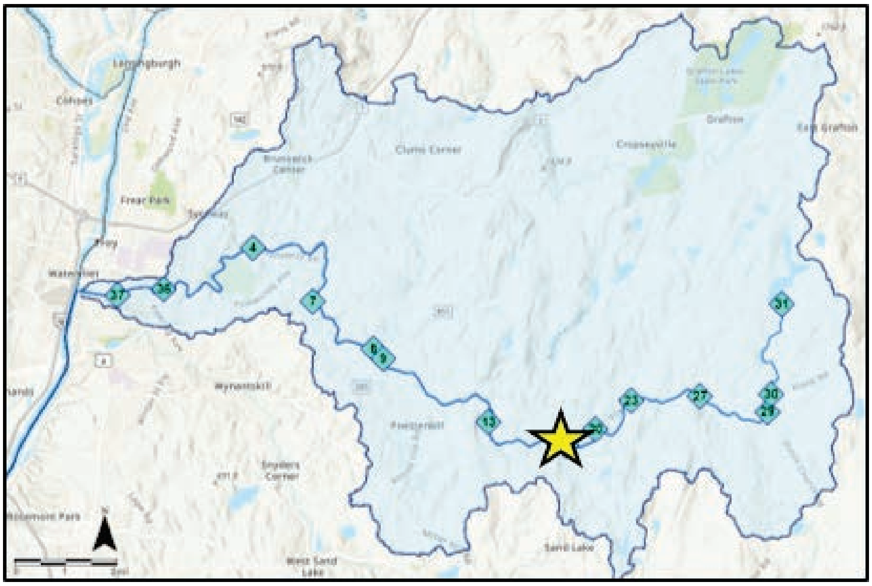
WQ	YEAR	
Measure	2017	2019
Temperature	19.32	15.33
Conductivity	128	43
pH	7.13	7.25
Turbidity	1.8	0
Dissolved oxygen	8.96	9.9

FISH SPP/COUNT	YEAR
Species	2019
Blacknose Dace	7
Common shiner	1
Longnose Dace	3

FISH IBI	YEAR
Measure	2019
Abundance	11
Total Species Richness	3
Native Species Richness	3
Exotic Species Richness	0
Benthic Insectivore Species Richness	1
Water Column Species Richness	0
Terete minnow Species Richness	0
% Dominant	63.64
% White sucker	0.00
% Generalists	72.73
% Insectivores	27.27
% Top carnivore	0.00
Shannon Diversity	0.86
IBI Score	26
IBI Rating	Poor

INVERTEBRATES	YEAR
Measure	2019
Abundance	100
Richness	15
EPT Richness	8
NCO Richness	14
Diversity	2.15
Dominance-3	63
HBI	3.94
PMA	79
NBI-P	4.24
BAP	7.96
BAP Rating	Non

POESTEN KILL SAMPLING DATA: SITE #18



SITE DESCRIPTION:

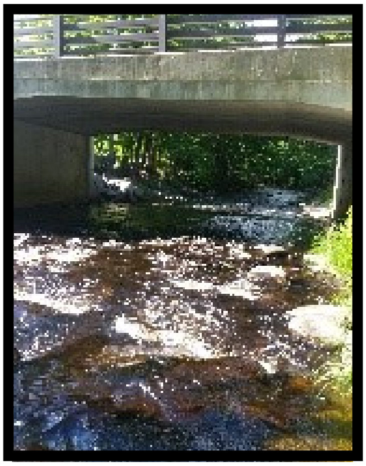
Located on Powers Rd, just east of the intersection of Catlin and Plank Rds. The surrounding land is predominately made up of forest and residential homes. The riparian zone is lined with trees. There is a bridge that passes over this site.

SITE COORDINATES:

42.67720 N, -73.51074 W

2017 Upstream View

2017 Downstream View



2019 Upstream View

2019 Downstream View

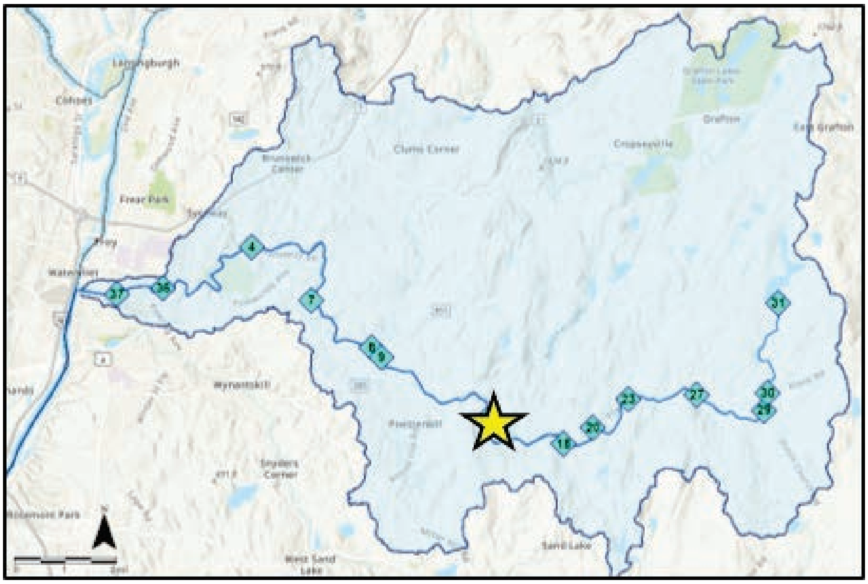
WQ	YEAR	
Measure	2017	2019
Temperature	20.21	17.33
Conductivity	56	50
pH	6.72	7.88
Turbidity	1	0
Dissolved oxygen	8.97	9.54

FISH SPP/COUNT	YEAR	
Species	2017	2019
Blacknose Dace	4	0
Brown Trout	1	1
Common shiner	0	3
Creek Chub	3	11
Golden Shiner	0	1
Longnose Dace	3	8
Shiner Spp.	1	0

FISH IBI	YEAR	
Measure	2017	2019
Abundance	12	24
Total Species Richness	5	5
Native Species Richness	4	4
Exotic Species Richness	1	1
Benthic Insectivore Species Richness	1	1
Water Column Species Richness	0	0
Terete minnow Species Richness	1	1
% Dominant	33.33	45.83
% White sucker	0.00	0.00
% Generalists	58.33	62.50
% Insectivores	25.00	33.33
% Top carnivore	8.33	4.17
Shannon Diversity	1.47	1.24
IBI Score	34	30
IBI Rating	Poor	Poor

INVERTEBRATES	YEAR	
Measure	2017	2019
Abundance	100	100
Richness	18	14
EPT Richness	13	11
NCO Richness	17	13
Diversity	2.33	1.35
Dominance-3	58	81
HBI	3.36	2.86
PMA	72	40
NBI-P	3.06	1.72
BAP	8.65	6.86
BAP Rating	Non	Slight

POESTEN KILL SAMPLING DATA: SITE #13



SITE DESCRIPTION:

Located on Plank Rd, just north of the intersection with Blue Factory Rd. Near the Barberville Falls Nature Preserved. The surrounding land is predominately residential homes. The riparian zone is lined with trees.

SITE COORDINATES:

42.68382 N, -73.54057 W

2017 Downstream View

2017 Upstream View

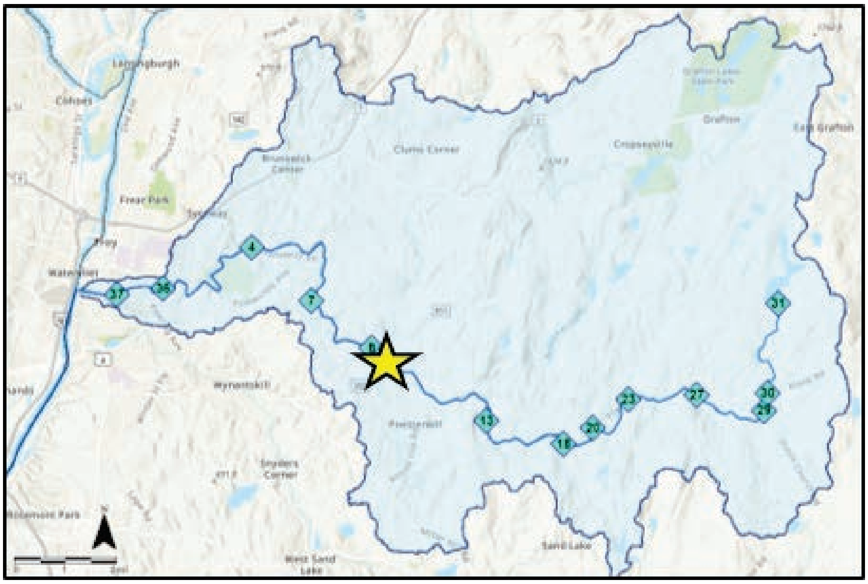
WQ	YEAR
Measure	2017
Temperature	20.69
Conductivity	69
pH	6.86
Turbidity	1.1
Dissolved oxygen	8.9

FISH SPP/COUNT	YEAR
Species	2017
Blacknose Dace	3
Creek Chub	1
Longnose Dace	13
Shiner Spp.	1

FISH IBI	YEAR
Measure	2017
Abundance	18
Total Species Richness	4
Native Species Richness	4
Exotic Species Richness	0
Benthic Insectivore Species Richness	1
Water Column Species Richness	0
Terete minnow Species Richness	1
% Dominant	72.22
% White sucker	0.00
% Generalists	22.22
% Insectivores	72.22
% Top carnivore	0.00
Shannon Diversity	0.85
IBI Score	30
IBI Rating	Poor

INVERTEBRATES	YEAR
Measure	2017
Abundance	100
Richness	19
EPT Richness	13
NCO Richness	18
Diversity	2.39
Dominance-3	56
HBI	3.75
PMA	65
NBI-P	3.13
BAP	8.53
BAP Rating	Non

POESTEN KILL SAMPLING DATA: SITE #9



SITE DESCRIPTION:

Located on Garfield Rd about 400 m north of Main St and the Poestenkill Fire Department. The surrounding land is predominately agricultural. The riparian zone is lined with trees and shrubs.

SITE COORDINATES:

42.70163 N, -73.58137 W

2017 Downstream View

2017 Upstream View

2019 - Chain Pickerel

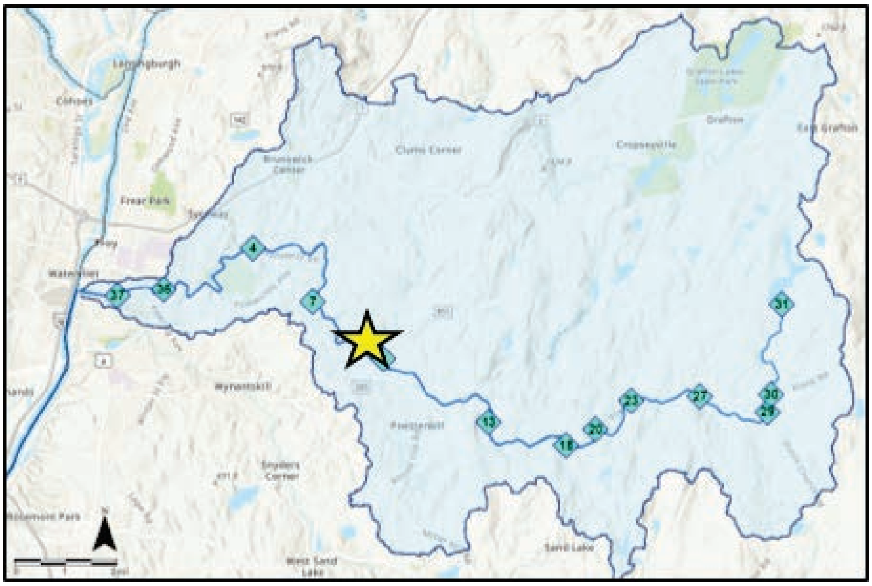
WQ	YEAR	
Measure	2017	2019
Temperature	20.49	17.58
Conductivity	75	86
pH	7.02	7.5
Turbidity	2.2	0
Dissolved oxygen	8.46	9.4

FISH SPP/COUNT	YEAR	
Species	2017	2019
American eel	1	2
Blacknose Dace	9	11
Brown Trout	0	2
Chain Pickerel	0	1
Common shiner	0	21
Creek Chub	5	3
Golden Shiner	0	1
Darter Spp.	2	0
Longnose Dace	14	4
Tessellated Darter	1	2

FISH IBI	YEAR	
Measure	2017	2019
Abundance	32	47
Total Species Richness	6	9
Native Species Richness	6	8
Exotic Species Richness	0	1
Benthic Insectivore Species Richness	3	2
Water Column Species Richness	0	0
Terete minnow Species Richness	1	1
% Dominant	43.75	44.68
% White sucker	0.00	0.00
% Generalists	43.75	76.60
% Insectivores	53.13	12.77
% Top carnivore	3.13	10.64
Shannon Diversity	1.39	1.65
IBI Score	38	34
IBI Rating	Fair	Poor

INVERTEBRATES	YEAR	
Measure	2017	2019
Abundance	100	100
Richness	11	11
EPT Richness	8	7
NCO Richness	10	10
Diversity	1.93	1.70
Dominance-3	60	75
HBI	3.22	4.07
PMA	36	51
NBI-P	4.00	2.62
BAP	6.65	6.39
BAP Rating	Slight	Slight

POESTEN KILL SAMPLING DATA: SITE #8



SITE DESCRIPTION:

This site is located at the Quacken Kill Public Fishing Access on Garfield Rd. Sampling occurred in Poesten Kill, immediately downstream of the confluence with Quacken Kill. The surrounding land is predominately agricultural. The riparian zone is lined with shrubs and trees.

SITE COORDINATES:

442.70457 N, -73.58498 W

2017 Downstream View

2017 Upstream View

2017 - American Eel

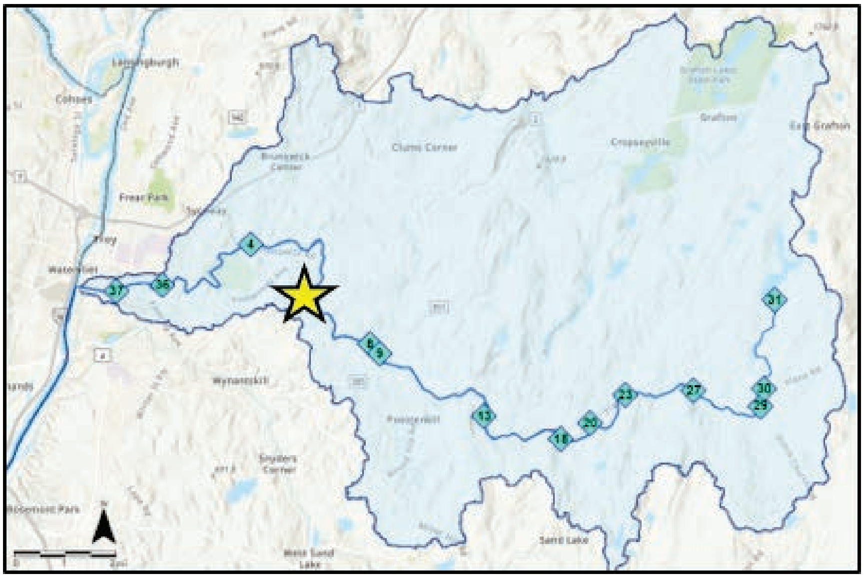
WQ	YEAR	
Measure	2017	2019
Temperature	19.06	18.29
Conductivity	119	118
pH	7.05	7.83
Turbidity	1.1	0.2
Dissolved oxygen	8.94	9.37

FISH SPP/COUNT	YEAR	
Species	2017	2019
American eel	2	0
Blacknose Dace	20	32
Brown Trout	0	10
Common shiner	3	0
Creek Chub	21	27
Longnose Dace	1	7
Pumpkinseed	3	0
Shiner Spp.	1	0
Tessellated Darter	11	3
White Sucker	6	0

FISH IBI	YEAR	
Measure	2017	2019
Abundance	68	79
Total Species Richness	9	5
Native Species Richness	9	4
Exotic Species Richness	0	1
Benthic Insectivore Species Richness	2	2
Water Column Species Richness	0	0
Terete minnow Species Richness	1	1
% Dominant	30.88	40.51
% White sucker	8.82	0.00
% Generalists	77.94	74.68
% Insectivores	17.65	12.66
% Top carnivore	2.94	12.66
Shannon Diversity	1.73	1.33
IBI Score	32	32
IBI Rating	Poor	Poor

INVERTEBRATES	YEAR	
Measure	2017	2019
Abundance	100	100
Richness	15	17
EPT Richness	9	12
NCO Richness	14	16
Diversity	2.07	2.08
Dominance-3	64	63
HBI	3.94	4.11
PMA	70	63
NBI-P	4.36	4.53
BAP	7.88	8.14
BAP Rating	Non	Non

POESTEN KILL SAMPLING DATA: SITE #7



SITE DESCRIPTION:

Located on Creek Rd, approximately 0.5 miles south of Brunswick Rd at a Public Fishing Access location. The surrounding land is predominately made up of agriculture and residential homes. This site has a very wide stream width and is shallow. The riparian zone of the stream is lined with trees.

SITE COORDINATES:

42.71778 N, -73.60834 W

2019 Downstream View

2019 Upstream View

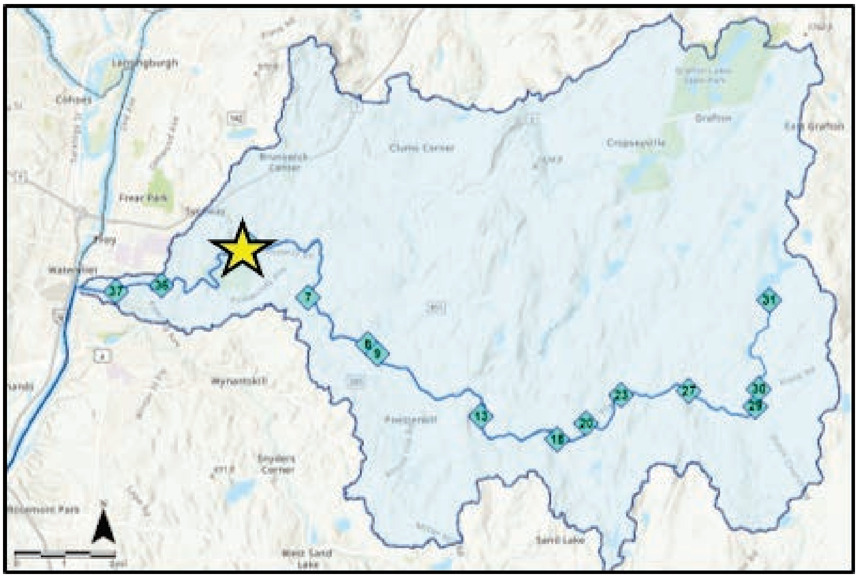
WQ	YEAR	
Measure	2017	2019
Temperature	20.87	18.99
Conductivity	105	110
pH	7.19	7.7
Turbidity	3.3	0.1
Dissolved oxygen	9.1	9.24

FISH SPP/COUNT	YEAR	
Species	2017	2019
Blacknose Dace	6	14
Brown Trout	0	1
Common shiner	0	5
Creek Chub	1	7
Longnose Dace	2	7
Pumpkinseed	1	0
Spotfin Shiner	0	12
Tessellated Darter	30	13
White Sucker	3	0

FISH IBI	YEAR	
Measure	2017	2019
Abundance	43	59
Total Species Richness	6	7
Native Species Richness	6	6
Exotic Species Richness	0	1
Benthic Insectivore Species Richness	2	2
Water Column Species Richness	0	1
Terete minnow Species Richness	1	2
% Dominant	69.77	23.73
% White sucker	6.98	0.00
% Generalists	25.58	44.07
% Insectivores	74.42	45.90
% Top carnivore	0.00	1.69
Shannon Diversity	1.02	1.78
IBI Score	32	40
IBI Rating	Poor	Fair

INVERTEBRATES	YEAR	
Measure	2017	2019
Abundance	100	100
Richness	10	18
EPT Richness	7	11
NCO Richness	10	17
Diversity	1.88	2.33
Dominance-3	70	57
HBI	3.29	5.09
PMA	28	87
NBI-P	3.98	4.91
BAP	6.16	8.36
BAP Rating	Slight	Non

POESTEN KILL SAMPLING DATA: SITE #4



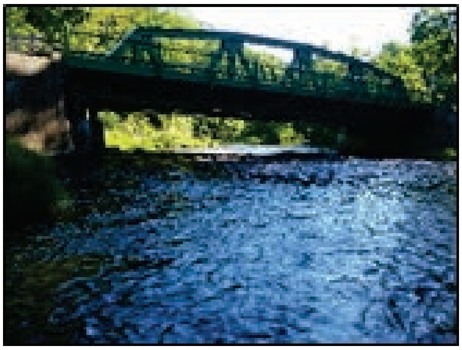
SITE DESCRIPTION:

Located north of the intersection of Brunswick Rd (Rte 2) and Shippey Lane. The surrounding land is predominately made up of forest and residential homes. The riparian zone is lined with trees.

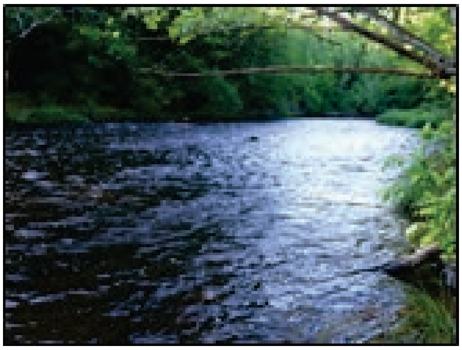
SITE COORDINATES:

42.73293 N, -73.63136 W

2017 Downstream View



2017 Upstream View



2019 - Brownhead Bull

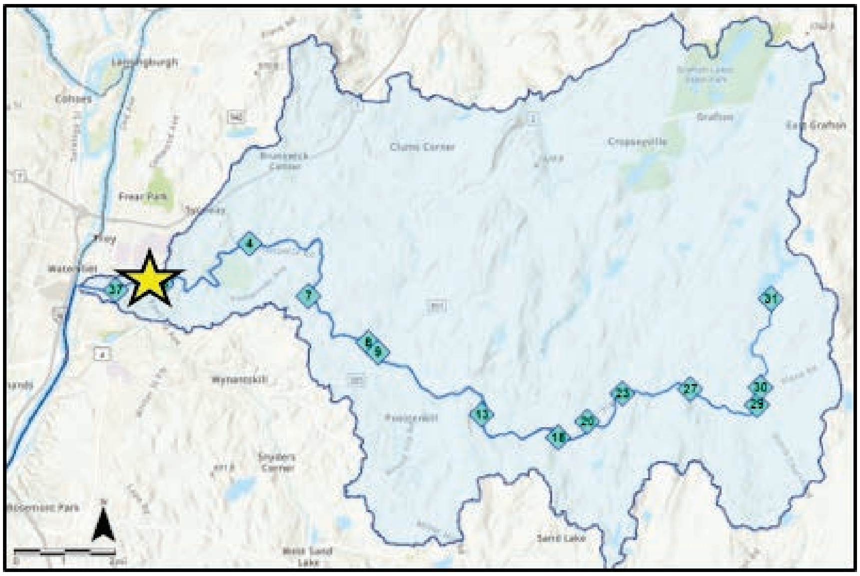
WQ	YEAR	
Measure	2017	2019
Temperature	21.49	19.07
Conductivity	110	116
pH	7.73	7.88
Turbidity	4.8	0
Dissolved oxygen	9.04	9.46

FISH SPP/COUNT	YEAR	
Species	2017	2019
American eel	1	0
Blacknose Dace	39	1
Brown Bullhead	0	1
Common shiner	0	2
Creek Chub	12	4
Longnose Dace	16	27
Pumpkinseed	2	0
Spotfin Shiner	1	1
Tessellated Darter	4	0
White Sucker	1	0
Yellow Perch	1	0

FISH IBI	YEAR	
Measure	2017	2019
Abundance	77	36
Total Species Richness	9	6
Native Species Richness	9	6
Exotic Species Richness	0	0
Benthic Insectivore Species Richness	2	1
Water Column Species Richness	1	1
Terete minnow Species Richness	1	2
% Dominant	50.65	75.00
% White sucker	1.30	0.00
% Generalists	70.13	22.22
% Insectivores	26.97	76.00
% Top carnivore	2.60	0.00
Shannon Diversity	1.43	0.92
IBI Score	34	34
IBI Rating	Poor	Poor

INVERTEBRATES	YEAR	
Measure	2017	2019
Abundance	100	100
Richness	14	14
EPT Richness	8	11
NCO Richness	13	13
Diversity	1.89	2.06
Dominance-3	67	61
HBI	3.91	5.27
PMA	39	75
NBI-P	6.32	5.62
BAP	8.28	9.35
BAP Rating	Non	Non

POESTEN KILL SAMPLING DATA: SITE #36



SITE DESCRIPTION:

Located immediately north of the Elmwood Hill Cemetery, located off of Pinewoods Ave. Access to the site occurred from the northern edge of the cemetery. The surrounding land is predominately forest. The riparian zone is lined with shrubs and trees. This site sits below a cemetery.

SITE COORDINATES:

42.72135 N, -73.66551 W

2017 Largemouth Bass

2019 Upstream View

2019 Rock Bass

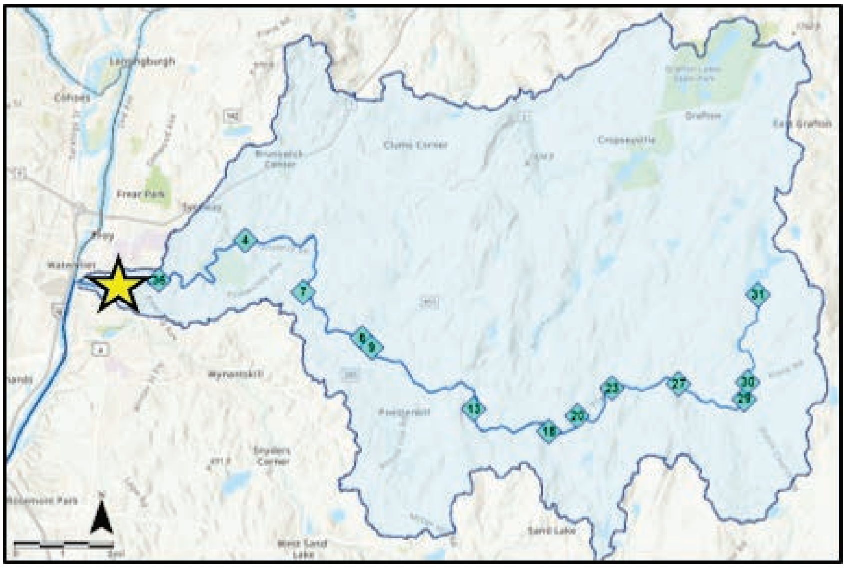
WQ	YEAR	
Measure	2017	2019
Temperature	21.26	17.8
Conductivity	123	134
pH	7.94	7.84
Turbidity	3.7	0
Dissolved oxygen	9.79	9.71

FISH SPP/COUNT	YEAR	
Species	2017	2019
American eel	1	0
Blacknose Dace	0	4
Bluegill	5	1
Common shiner	0	7
Creek Chub	1	7
Largemouth Bass	1	0
Longnose Dace	0	2
Pumpkinseed	4	0
Rock Bass	3	9
Spotfin Shiner	2	2
Tessellated Darter	3	4
White Sucker	0	1
Yellow Perch	1	0

FISH IBI	YEAR	
Measure	2017	2019
Abundance	21	37
Total Species Richness	9	9
Native Species Richness	9	9
Exotic Species Richness	0	0
Benthic Insectivore Species Richness	1	2
Water Column Species Richness	1	1
Terete minnow Species Richness	1	2
% Dominant	23.81	24.32
% White sucker	0.00	2.70
% Generalists	47.62	54.05
% Insectivores	16.29	18.22
% Top carnivore	28.57	24.32
Shannon Diversity	2.02	1.96
IBI Score	34	38
IBI Rating	Poor	Fair

INVERTEBRATES	YEAR	
Measure	2017	2019
Abundance	100	100
Richness	17	13
EPT Richness	12	7
NCO Richness	16	12
Diversity	2.23	1.72
Dominance-3	60	79
HBI	3.99	5.19
PMA	45	51
NBI-P	4.87	6.47
BAP	7.56	8.25
BAP Rating	Non	Non

POESTEN KILL SAMPLING DATA: SITE #37



SITE DESCRIPTION:

Located at end of Hill St, immediately northwest of Poesten Kill Gorge Park. The surrounding land is predominately made up of residential homes. This site marks the furthest downstream site closest to the Hudson River. The surrounding banks slope down at a very steep angle making this site difficult to access.

SITE COORDINATES:

42.71952 N, -73.68353 W

2017 Upstream View

2019 American Eel

WQ	YEAR	
Measure	2017	2019
Temperature	20.33	18.14
Conductivity	156	139
pH	7.65	7.86
Turbidity	2.1	0.9
Dissolved oxygen	9.42	9.66

FISH SPP/COUNT	YEAR	
Species	2017	2019
American eel	24	12
Rock Bass	0	1

FISH IBI	YEAR	
Measure	2017	2019
Abundance	24	13
Total Species Richness	1	2
Native Species Richness	1	2
Exotic Species Richness	0	0
Benthic Insectivore Species Richness	0	0
Water Column Species Richness	0	0
Terete minnow Species Richness	0	0
% Dominant	100.00	92.31
% White sucker	0.00	0.00
% Generalists	0.00	0.00
% Insectivores	0.00	0.00
% Top carnivore	100.00	100.00
Shannon Diversity	0.00	0.27
IBI Score	32	32
IBI Rating	Poor	Poor

INVERTEBRATES	YEAR	
Measure	2017	2019
Abundance	100	100
Richness	17	11
EPT Richness	14	9
NCO Richness	16	10
Diversity	2.34	1.46
Dominance-3	55	85
HBI	3.9	5.33
PMA	40	51
NBI-P	4.19	5.88
BAP	7.62	8.27
BAP Rating	Non	Non