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).

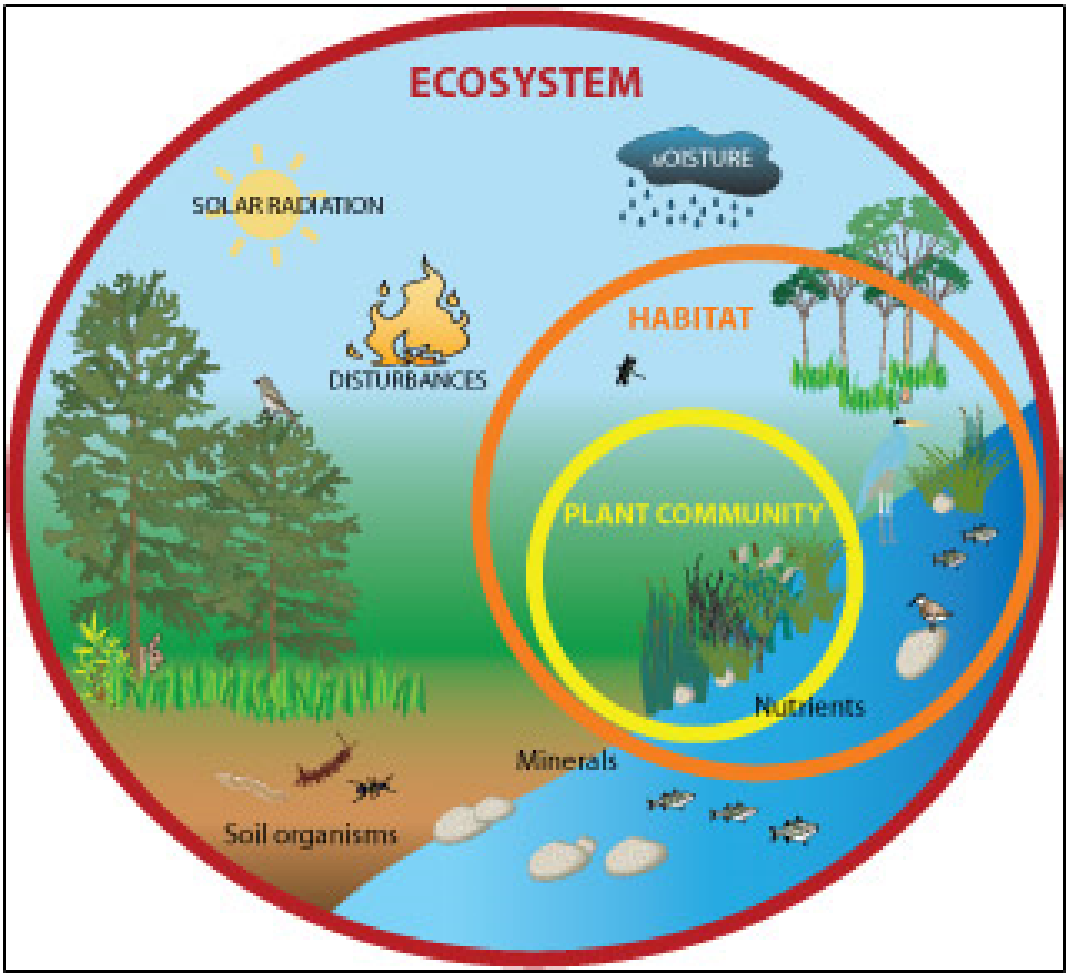

Figure 1. Example of an ecosystem with aquatic and terrestrial linkages. Habitat for a given species or community is a subset of an ecosystem. Image obtained from: Socratic.org.

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

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

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)

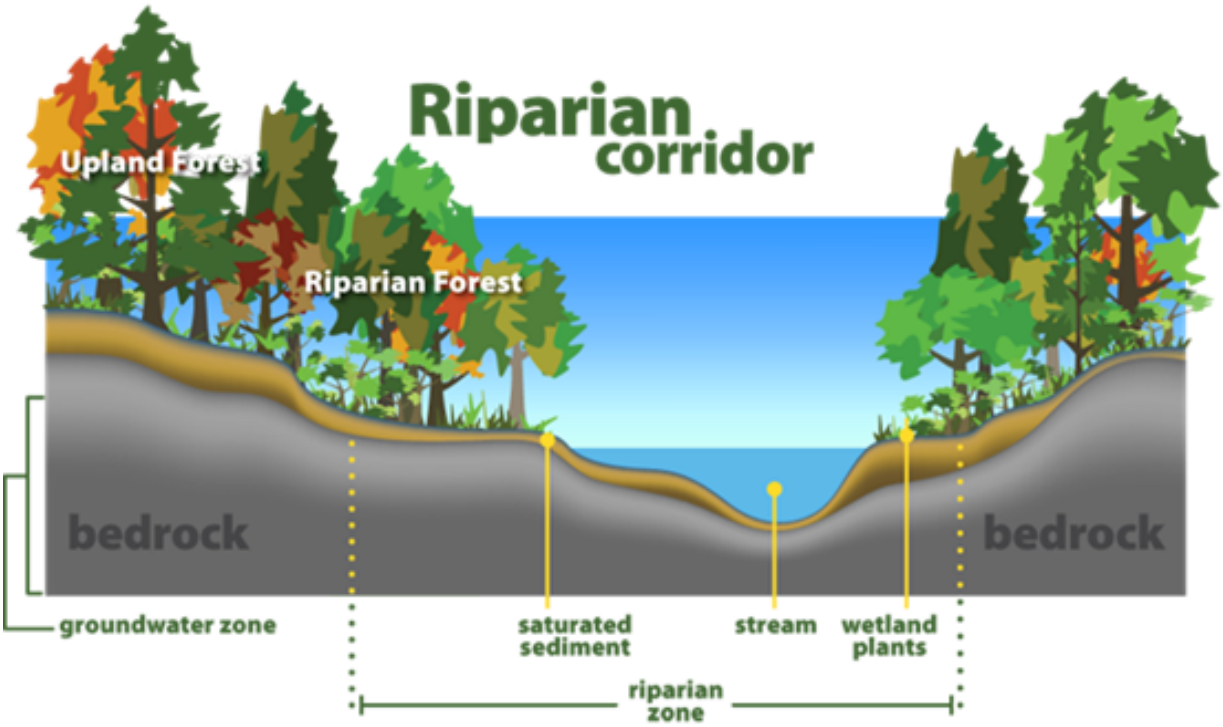

Figure 2. Riparian zone schematic. Image obtained from: Lakeconesteenaturepark.com

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.

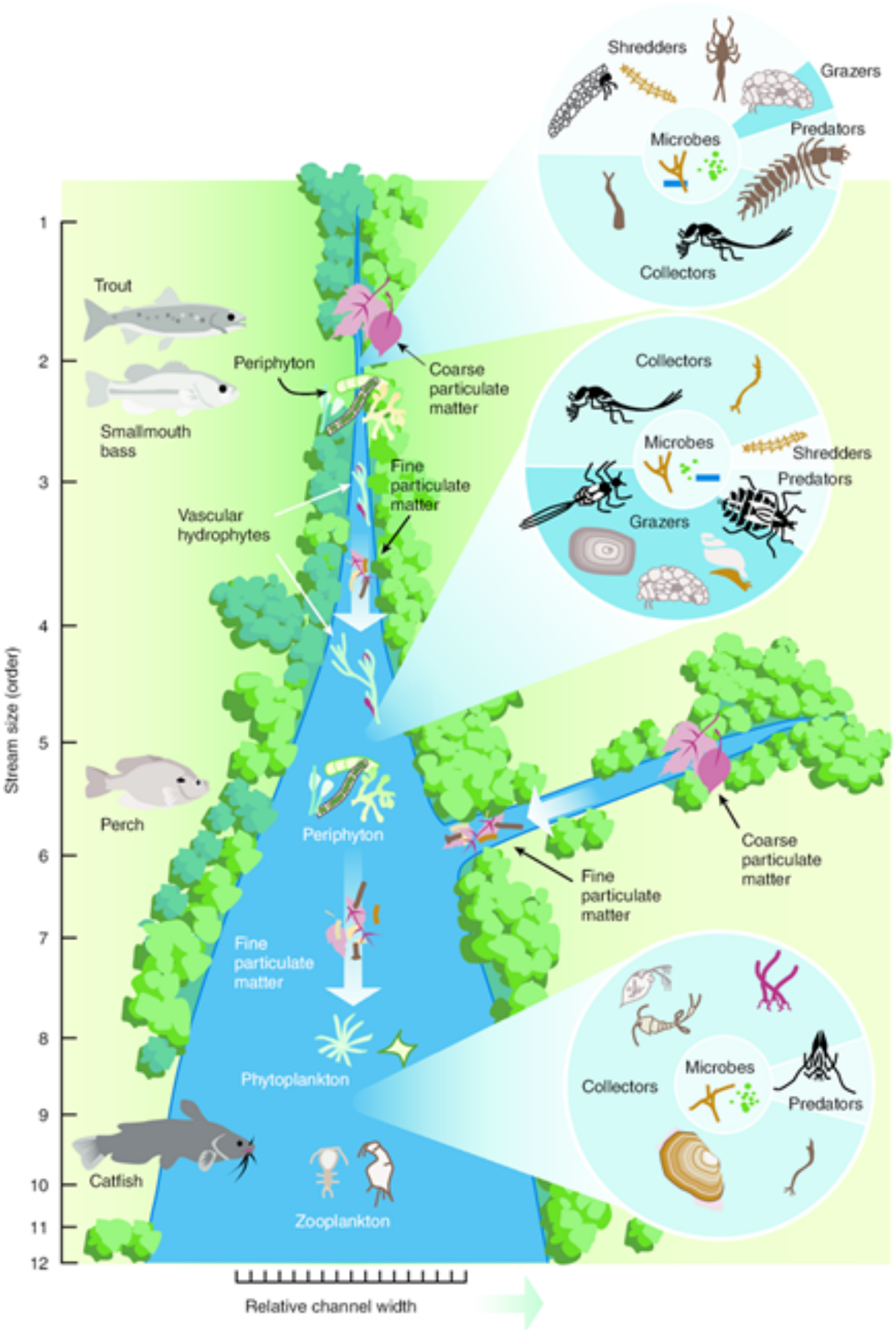

Figure 3. River Continuum Concept (Vannote et al. 1980). Image obtained from: Peters et al. 2011

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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