User's Manual And Data Guide To The Pennsylvania Aquatic Community Classification

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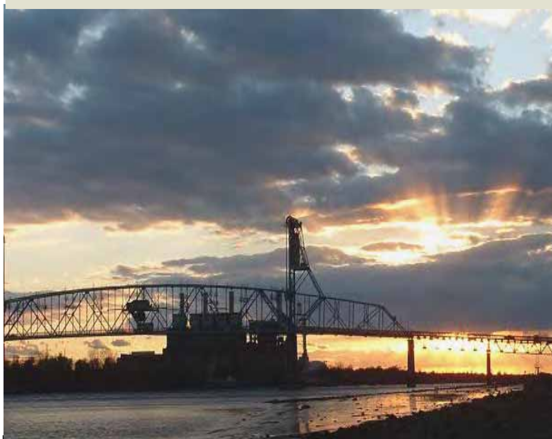

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1. Project Summary

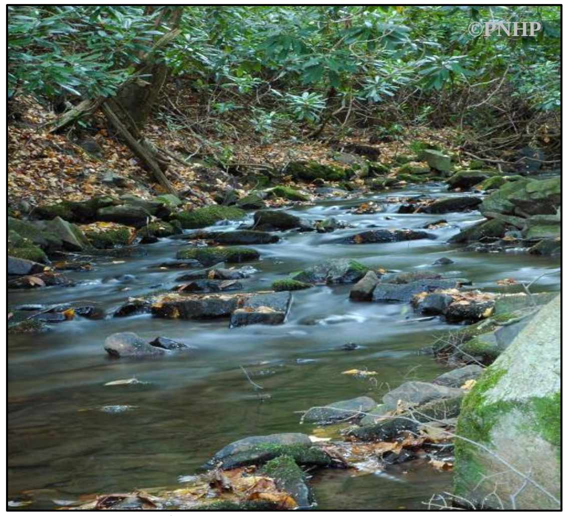
Threats to our region's aquatic habitats are numerous. About 39% of the nation's waters are classified as polluted according to assessments required by the Clean Water Act (Environmental Protection Agency 2002). Causes of aquatic habitat degradation include direct and indirect human influences on the streams and rivers and their natural processes. Common threats to streams and rivers in Pennsylvania include atmospheric acid and mercury deposition, channel alteration, dredging, runoff from urban centers and roads, siltation and nutrient loading from poorly managed agricultural and siliviculture practices, municipal and industrial wastewater effluent, and pollution from mine drainage. Many pollution sources present challenging remediation problems.

As a result of poor water quality and habitat loss, many freshwater species are facing serious imperilment. Globally, 69% of mussels, 51% of crayfish and 37% of fish species in freshwater habitats are extinct, critically imperiled, imperiled, or vulnerable in freshwater habitats (Master 2000). Habitat ranges are greatly declining in extent for many species. For example, healthy populations of brook trout currently exist in only 5% of sub-watersheds compared to their historical range (Trout Unlimited 2006).

Goals of the ACC

The goal of the Pennsylvania Aquatic Community Classification (ACC) project was to describe patterns in aquatic biodiversity for the purpose of prioritizing conservation activities and informing aquatic resource management. Although assessments and aquatic inventories are numerous and ongoing in Pennsylvania's waters, little public information for Pennsylvania and the surrounding region is available to natural resource managers, watershed groups, local government officials, conservation planners, and others about biodiversity and watershed quality.

In order to address immediate threats faced by our region's flowing waters, the Pennsylvania Aquatic Community Classification was designed to systematically identify stream community and habitat types for the freshwater mussels, macroinvertebrates, and fish that reside in



Roaring Run, Centre County, PA.

Pennsylvania's streams. Descriptions of biological communities and stream habitat types provide a baseline for monitoring and conserving flowing water systems. Stream community typing can be used to help assess the status of streams and rivers, restore waters in poor condition and preserve high quality aquatic habitats. The results of the ACC project provide information on biological community types, the condition of Pennsylvania's streams and rivers, and the physical habitats of these aquatic systems.

Contents of the *User's Manual* Document*:*

The project methods and results are described in this document and the *Classifying Lotic Systems for Conservation: Methods and Results of the PA Aquatic Community Classification* document. In this *User's Manual and Data Guide* document and the accompanying data files, we include:

- Suggested applications of the Pennsylvania Aquatic Community Classification (ACC) for conservation planning and natural resource management;
- Community descriptions that note the species and habitats associated with each community type;
- Information about physical stream types categorized by geology, gradient, and watershed area;

- Description of the accompanying data, including community locations, physical stream types, streams with the least amount of watershed disturbance (called "Least-Disturbed Streams"), Conservation Priority Watersheds, Restoration Priority Watersheds, and Enhancement Area Watersheds;

- Maps of Least-Disturbed Streams, Conservation Priority Watersheds, Restoration Priority Watersheds, and Enhancement Area Watersheds. Methods for determining stream and watershed categories are documented;

- The Pennsylvania Aquatics Database, which contains information on biological, physical habitat, and water chemistry survey data from numerous sources on the region's streams.

In the *Classifying Lotic Systems for Conservation: Methods and Results of the PA Aquatic Community Classification* document, detailed information on the project approach, data analysis, methods, statistical outcomes, and other project results are presented.

History of the Pennsylvania Aquatic Community Classification Project

The project began in 2000 when biologists in the Pennsylvania Natural Heritage Program recognized the need for a system to identify flowing water community types, akin to plant community types used by vegetation ecologists. The ACC was developed to stratify types of flowing waters based on biological gradients so that streams could be inventoried and surveyed in an ecologically meaningful way. A pilot study, *The Pennsylvania Aquatic Community Classification Project: Phase I Final Report*, was completed in 2004. This report documented the evaluation of our project approach and methods (Nightingale et al. 2004).

Agencies with jurisdictional authority relating to water quality and aquatic organisms also realized that an aquatic classification system was imperative for comparing ecologically similar waters. In the last decade, ideas for classifying the ecology of aquatic systems converged on concepts of biological and physical habitat schemas. Academic researchers, USGS GAP programs, NatureServe, The Nature Conservancy, and others have conceptualized broad-scale habitat types and ecological classifications of stream systems.

Methods for the classification analysis and applications for the ACC were discussed at roundtable meetings with aquatic experts. Collaboration and consultation with professionals at governmental agencies, conservation organizations, river basin commissions, conservation planning agencies, and universities was imperative during the project development to integrate scientifically accepted methods and maximize the project applications.

Major Accomplishments of the ACC:

- A database of biological, chemical, and habitat information for study area streams;

- A community classification system to identify types and categories of flowing waters based on stream-dwelling animals;

- Models of community habitats;

- A system of physical stream classes, describing major stream environments;

- A ranking of high quality streams (Least-Disturbed Streams) in the region having the least amount of disturbance in their watersheds;

- Categorization of watersheds by quality into Conservation Priority Watersheds, Restoration Priority Watersheds, and Enhancement Area Watersheds.

A filter feeding mucket mussel (Actinonaias ligamentina)

Other Project Highlights & Findings

Patterns in biodiversity applicable to freshwater conservation are detailed in other sections of this document. In brief, the project highlights are:

- We discovered that 13 mussel communities, 11 fish communities, and 12 genus-level macroinvertebrate communities (8 family-level) are found in Pennsylvania.
- Biodiversity in Pennsylvania streams follows a gradient of habitat from the headwaters to the larger lower river reaches.
- Some communities indicated specialized or relatively rare habitat; at least 13 communities have special conservation value. Communities indicative of high quality systems, particularly rare species, or occur in unique habitats are categorized as having high conservation value.
- Four community types were indicative of degraded water quality conditions. The primary associates of poor quality communities were abandoned mine drainage (AMD), acid deposition, poorly maintained agriculture, and urbanization.
- Large streams and rivers are often threatened by habitat or water quality degradation. For example, the lower portion of the Delaware River has more than 920 point sources of pollution and 260 dams in its upstream basin.
- Least-Disturbed Streams (LDS) were common in areas that are largely forested and have less human influence than other regions. Concentrations of LDS streams were found in the north-central region of Pennsylvania, the West Branch of the Susquehanna River Basin, the forested watersheds of Laurel Highlands, the upper Allegheny watershed, and the headwaters of the Delaware River watershed.
- Additional selection of LDS was applied to identify the best examples of quality habitats in areas facing much watershed disturbance; separate LDS streams were chosen from areas of calcareous geology, Waynesburg Hills Physiographic Section, and Piedmont Physiographic Province, French Creek (Ohio River Basin), and large river habitats.
- Watershed Conservation Priorities included watersheds with LDS, high quality communities, and community metrics indicative of high water quality. Watersheds nominated as Conservation Priorities were found mainly in north-central Pennsylvania and were associated with ridges in the Ridge and Valley province.
- Watersheds prioritized for restoration were concentrated around densely populated areas in southeast and southwest Pennsylvania, agricultural valleys of southeastern Pennsylvania, and the lower reaches of the Allegheny, Monongahela and Delaware Rivers. These results highlight the challenges in conservation of large rivers and watersheds that contain areas of intensive agriculture and urbanization.

The scenic upper Delaware River has relatively few human disturbances. Photo: George Gress

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Nightingale, B., M. Walsh, D. Homans, R. Evans, E. Bond, and J. Deeds. 2004. Pennsylvania Aquatic Community Classification Project: Phase I Final Report. PA Natural Heritage Program.

Trout Unlimited 2006. Eastern brook trout: Status and threats. 36 pp., Arlington, VA.

2. Introduction to the Pennsylvania Aquatic Community Classification (ACC) Products

Aquatic Communities

A community represents a group of organisms that occur together in a defined habitat. These organisms require similar habitat features, may be dependent on each other for food or other resources, and may be dependent on similar processes in their environment. The aquatic communities in this report refer to three types of organisms found in streams in our study area (Figure 2-1): freshwater mussels, macro-invertebrates, and fish. Aquatic communities for each type of organism can be used to describe the habitats and water quality of the streams in which they are found. The community types from each taxa group are described in detail in Chapters 4-7.

Figure 2-1. The ACC study area includes the entire Delaware, Susquehanna, Allegheny and Monongahela River Basins and parts of the Erie, Genessee, Potomac and Ohio River Basins.

Information about communities at large scales can reveal general patterns in biodiversity and habitat types. For instance, the most dominant communities can be examined across large basins, like the Schuylkill River watershed. In the Schuylkill basin, the most commonly occurring fish communities per 12-digit HUC (Hydrologic Unit Code) small watershed included the Coldwater Community, the Coolwater 2 Community, the Warmwater 2 Community and the River & Impoundment Community (Figure 2-2, see Chapter 7 for descriptions of fish communities). Some sub-watersheds of the Schuylkill like Perkiomen and French Creek watersheds mainly had habitats for warm-water communities; however the Coolwater 2 Community was also commonly found in the Little Schuylkill River basin. The lower main channel of the Schuylkill River and associated sub-basins primarily had fish found in the River & Impoundment Communities. Details in the community descriptions offer information about associated community species, habitats, community rarity, and conservation recommendations.

Further examination of communities at smaller scales could yield more specific information about stream habitat, condition and biological patterns. At the stream reach scale, community types determined by stream survey samples disclose the biological associations that are specific to a waterway. In French Creek State Park (also in the Schuylkill River watershed), a mix of habitats that support the Coldwater Community, Coolwater Community 2, Warmwater Community 1 and the River and Impoundment Community are found (Figure 2-3). The Coldwater Communities were found at the headwaters of French Creek and Six Penny Creek, where appropriate water quality and habitats are found. In contrast, sections of the lower parts of the French Creek watershed mainly have Coolwater Community 2 assemblages. The habitats in these reaches may be characterized by warmer waters and altered water chemistry.

Community types predicted for stream reaches where communities have not yet been sampled supply information about potential community types and habitats in a watershed. The prediction probability can be considered an index of likelihood for community occurrence; high prediction probabilities of > 60% are considered likely habitat reaches for the predicted assemblage. For example, the Coolwater Community predicted to occur in French Creek had a low prediction probability (30%), while the Warmwater 2 Community was predicted in the Schuylkill River with relatively high probability of occurrence (68%) (Figure 2-3).

The use of different taxonomic levels of macroinvertebrates in both community classification and biological monitoring are the subject of much debate in the aquatic science community (Reynoldson et al. 2001, Waite et al. 2004). An exploratory part of this project was to investigate differences between macroinvertebrate community classifications at two taxonomic levels: family and genus. These taxonomic levels are both commonly used in stream analyses for developing macroinvertebrate community groups and general aquatic research. Upon final analysis of the results from the communities at each taxonomic level, we determined that the genus macroinvertebrate classes were the most meaningful statistically and biologically. Therefore, we are endorsing our genus-level macroinvertebrate classification for use in applications related to ACC products and tools. In order to show the results of our community analyses and present users with the differences between classifications, both family and genus macroinvertebrate community classifications are described in the community descriptions (Chapters 5 & 6).

Physical Stream Types

We classified streams by physical, or "abiotic", characteristics to describe the physical diversity of flowing waters. Physical stream classes characterizing geology, stream slope (gradient), and watershed size were related to community habitats and represent environments supporting a variety of biological diversity. Stream classes can be used by conservationists, aquatic resource managers, and watershed planners to identify the range of aquatic environments in their area of interest. Stream types that are degraded in the majority of their range, like limestone streams in agricultural environments, may be considered for distinctive conservation actions. The physical stream type classification and its conservation and restoration applications are discussed further in Chapter 8.

Least-Disturbed Streams (LDS) Analysis

Information about the relative condition of community habitats and physical stream types can be used to prioritize management and protection actions for aquatic resource managers. We identified high-quality stream reaches (called Least-Disturbed Streams (LDS)) as those having little watershed disturbance in a landscape analysis. LDS reaches met criteria for having little non-point source pollution, point source pollution, and hydrologic alteration. In areas where streams face nearly ubiquitous disturbance (e.g., Piedmont streams), sliding scale LDS criteria were developed. The LDS criteria in these areas were relaxed to select the best examples of stream types.

High quality stream reaches have applications in biomonitoring, conservation, and restoration. Communities found in LDS reaches can be used as benchmarks for community restoration. Relatively undisturbed streams, such as those selected as LDS reaches, are used in biomonitoring; streams such as these are used as the standard against which polluted streams and biological assemblages evaluated. The LDS analysis is described in Chapter 9.

Watershed Conservation Prioritization

By combining data from many parts of the Aquatic Community Classification project, we are able to highlight unique riverine conditions that designate certain watersheds to be of greater conservation concern than others. Some watersheds may be of importance due to a single occurrence of a natural feature, such as the presence of a rare fish species or a high quality mussel community, but watersheds that hold multiple traits of conservation value should be set apart as a higher protection priority.

Information was combined from the biological community classification, the Least-Disturbed Stream (LDS) reach analysis, and biological metric scores calculated with fish and macroinvertebrate data from the ACC database. The metric calculations allowed us to assign metric scores to streams and watersheds and then rank them based on water quality and habitat condition (See Chapter 10 for more information on these metric calculations). The quantitative metric scores complement the community information, which provides qualitative information about the presence of certain community types and stream habitats. The watershed conservation prioritization is discussed in Chapter 10.

Watershed Restoration Prioritization

The goal of this portion of the study was to use all of the data compiled in the ACC project to determine which watersheds are in the worst shape and therefore a priority for habitat restoration. To do so, we combined information from our LDS reach analysis (see Chapter 9), biological metric scoring (see Chapter 10) and the locations of biological communities indicative of poor-quality stream habitat (Table 12-1). A multi-faceted approach such as this is more useful than simply examining developed land use or the occurrence of pollution-tolerant taxa; with the combination of both biotic and abiotic factors we are able to paint a picture of watersheds that are physically altered and the resident stream assemblages are experiencing the direct effects. The watershed restoration prioritization is detailed in Chapter 11.

Watershed Enhancement Areas

A third category of watersheds was developed for those areas that do not fall within either the Conservation or Restoration Prioritization categories. These intermediate quality "Watershed Enhancement Areas" represent watersheds that would likely benefit the most from restoration action, since they continue to hold some ecological value despite having some water quality issues. The same abiological and biological datasets were used in defining and describing these areas. This analysis is detailed in Chapter 12.

Combining ACC Tools

By combining the elements discussed above, we present unique ways to investigate stream resources and implement aquatic conservation practices. Utilizing these tools and methods should make conservation and restoration work in Pennsylvania more efficient, more measurable and more effective.

Stream conservation efforts can be easily streamlined with the use of the LDS and abiotic stream habitat tools. For example, after a project area (e.g., a watershed) has been identified, the habitat types within that project area may be determined. Determining which biological communities should be found in the various habitat types should help the monitoring and follow-up evaluation of these high quality watersheds.

ACC tools will make stream restoration efforts more efficient and measurable as well. Target conditions for degraded streams in need of restoration activity may be established by finding an LDS stream of the same abiotic habitat type and determining the biological community that exists there. The LDS stream will serve as a benchmark stream which will represent the goal condition of the stream in need of restoration. This will be a way to evaluate and measure the success of restoration work.

The utilities of all ACC tools are discussed further in the following chapters.

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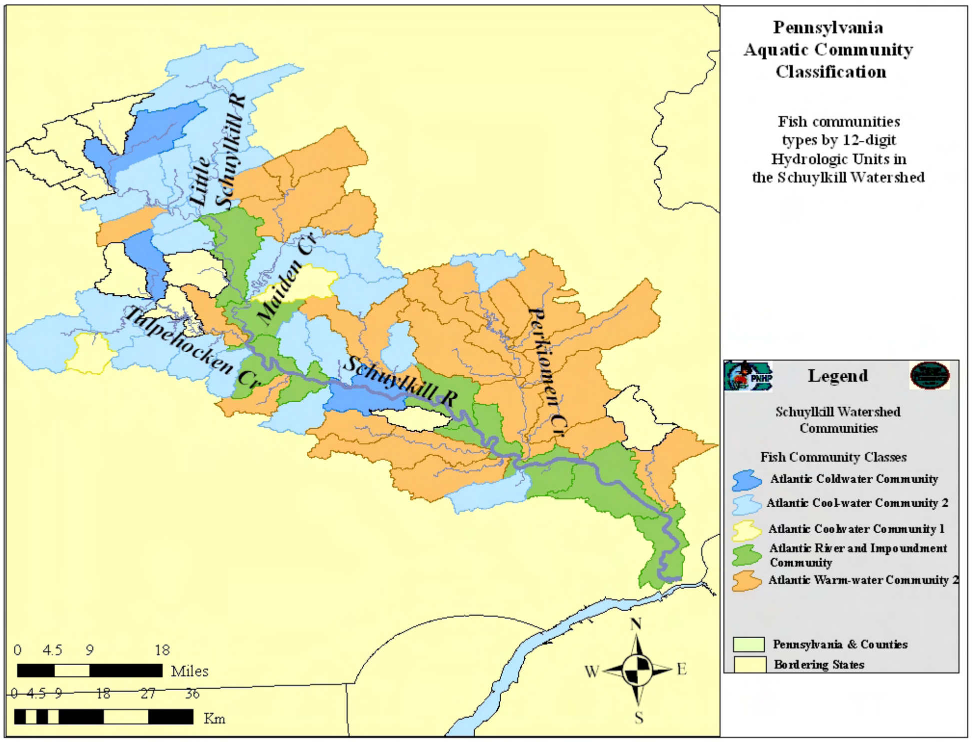

Figure 2-2. Watersheds in the Schuylkill Watershed, represented by their most commonly occurring fish communities.

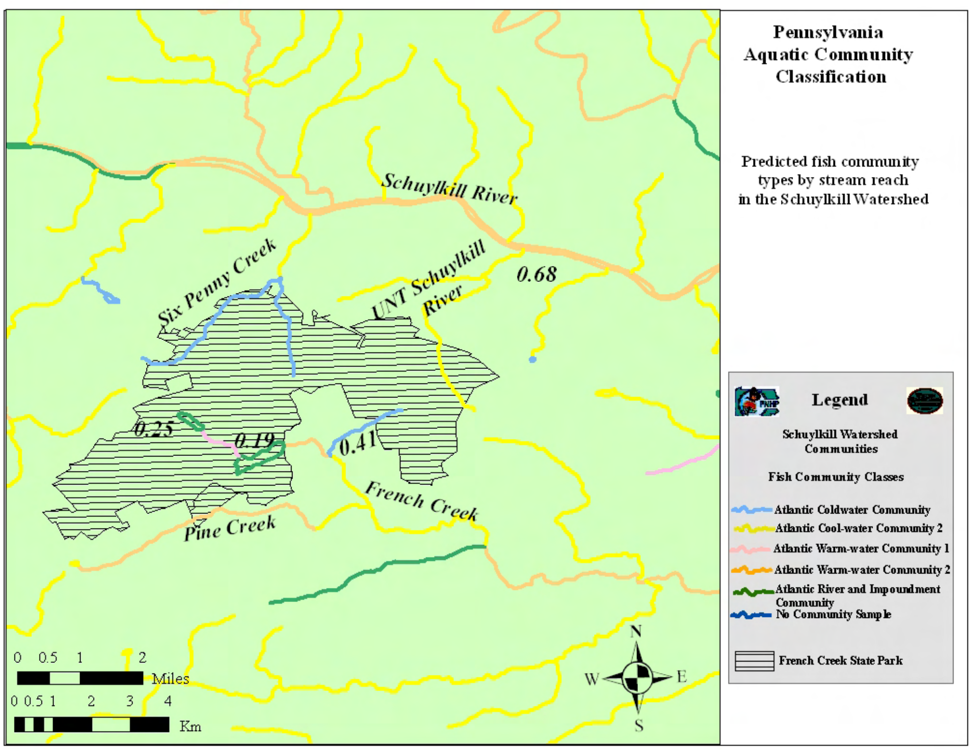

Figure 2-3. Actual and predicted fish communities classify stream reaches in and adjacent to the French Creek State Park in the Schuylkill River Watershed. The prediction probabilities for selected community reaches indicate that some communities are predicted with relatively high likelihood (>0.60), but others with lower prediction probabilities are less likely to occur.

3. Introduction to the Aquatic Communities of Pennsylvania

In the community description chapters (4-7), fish, mussel, and macroinvertebrate communities are described by the taxa that indicate each community type and the stream habitats the communities are commonly found in. Information about community rarity, threats and conservation recommendations is also included.

Due to zoogeographic differences associated with the multiple drainage basins in Pennsylvania, fish and mussel community classifications were segregated by major watersheds. Fish communities are described for two separate watersheds: Atlantic Basin (Delaware, Susquehanna and Potomac River watersheds) and the Ohio – Great Lakes Basins (Ohio River, Genesee River and Lake Erie watersheds). Mussel communities are described from three areas: 1) Delaware River Basin, 2) Susquehanna and Potomac River Basins and 3) the Ohio River and Lake Erie Basins (Figure 2-1).

Aquatic communities and watersheds

What is an aquatic community?

A biological community represents a group of organisms that occur together in a particular habitat. These organisms require similar habitats, may be dependent on each other for food or other resources, and likely depend on similar processes in their environment.

The aquatic communities in this report refer to three types of organisms found in streams: mussels, macroinvertebrates, and fish. All three groups were classified separately. Aquatic communities can be used to describe the habitats and water quality of the streams that they are found in.

Where do these aquatic communities occur?

The community types described here are restricted to flowing water habitats, such as rivers and streams. Communities are identified within watersheds, which are commonly defined as an area of land where all water drains to the same point (www.epa.gov). In watersheds, the water moves through a network of drainage pathways, both underground and on the surface. Generally, these pathways converge into streams and rivers, which become progressively larger as the water moves on downstream, eventually reaching an estuary and ultimately the ocean. All land is part of a watershed and every stream, tributary, or river has an associated watershed. Small watersheds join to become larger watersheds, just as small streams join to become larger streams.

In order to discuss watersheds in terms of community types and watershed conservation, we are using relatively small units of land known as Hydrologic Unit Code 12, or “HUC12”, watersheds (generally around 20,000 acres in size). The United States Geological Survey is responsible for delineating HUC watersheds of different sizes. For more information on HUC watersheds: http://water.usgs.gov/GIS/huc.html.

How were aquatic communities determined?

As a statewide project of the Pennsylvania Natural Heritage Program, researchers working on the Pennsylvania Aquatic Community Classification (ACC) project collected aquatic datasets from state and federal agencies, interstate basin commissions, universities and museums. The biological, habitat and water chemistry data were first centralized into a large database. The information was then analyzed with standard statistical methods in order to identify biological community types and stream habitat associations.

In some places, the most common community type in each small watershed was chosen to represent typical watershed organisms and habitats. Although other community types may exist in a particular watershed, the major community type is described.

What do mussels, macroinvertebrates and fish tell me about streams and watersheds?

All three of these types of organisms hold unique niches in Pennsylvania’s streams and rivers. Macroinvertebrates include aquatic insects, worms and crustaceans (e.g., crayfish and scuds), which generally occupy the lower levels of food webs in aquatic systems. The presence of certain macroinvertebrates reflects differences among stream locations in food availability, water quality and habitat type. Perhaps most importantly, macroinvertebrate communities provide an overall picture of stream health; macroinvertebrate taxa generally respond to environmental stress in predicable ways, based on their levels of tolerance to different stressors.

Macroinvertebrates are an important prey source for many fish. Food resources and spawning habitats can be specific for different species of fish as different species will have different habitat requirements and habitat needs. Just like macroinvertebrates, fish are influenced by stream quality and the condition of the watershed. For example, sediment from erosion at a mismanaged construction site near a stream may cover substrates that are necessary for fish such as brook trout to lay their eggs. Layers of fine particles from sedimentation such as this can also smother the habitats that developing fish require, preventing them from reaching adult life stages.

As filter feeders, which siphon water to extract particles of food, mussels also require relatively clean water to survive. They are particularly sensitive to industrial discharge, abandoned mine drainage and urban runoff pollution. Mussels generally require gravelly, sandy or muddy habitats where they can burrow into the stream bottom. They typically occur in larger streams and in rivers that contain sufficient nutrient levels to supply them with food.

Many factors influence the occurrence of aquatic communities, including natural variations in stream environments. Fast-flowing, cold streams flowing from ridge tops provide different habitat types than slow, warmer rivers meandering through valleys. Aquatic communities reflect these differences in stream type and environment. Geology varies widely across Pennsylvania, and flowing water may have unique chemical compositions based on the types of rocks that it contacts.

Human alterations to aquatic environments can exert much stronger effects than any type of natural variation discussed above. Many changes in a watershed can be detected within its streams and rivers. If implemented improperly, timber harvest, agriculture, urban development and road management are among some watershed alterations that may cause changes in water quality and stream habitats from non-point source pollution. Additionally, a number of pollutants can enter aquatic systems from point sources, such as discharges from sewage treatment plants, abandoned mines and other industrial sources.

Why are there two macroinvertebrate community classifications?

The use of different taxonomic levels of macroinvertebrates in both community classification and biological monitoring are subject of debate in the aquatic science community (Reynoldson et al. 2001, Waite et al. 2004). An exploratory part of this project was to investigate differences between macroinvertebrate community classifications at two taxonomic levels: family and genus. These taxonomic levels are both commonly used in stream analyses for developing macroinvertebrate community groups and general aquatic research. Upon final analysis of the results from the communities at each taxonomic level, we determined that the genus macroinvertebrate classes were the most statistically and biologically meaningful. Therefore, we are endorsing our genus-level macroinvertebrate classification for use in applications related to ACC products and tools. In order to show the results of our community analyses and present users with the differences between classifications, both family and genus macroinvertebrate community classifications are described in the community descriptions (Chapters 6 & 7).

A plain pocketbook mussel (*Lampsilis cardium*) in Conewango Creek, Warren Co., PA displaying its fish-mimicing egg lure in order to attract fish. Mussels release their larvae, or glochidia, onto the gills of fish in order to disperse their offspring.

How is an organism's rarity determined?

Species of conservation concern (considered state or globally rare) that may occur with each community type are listed (Table 3-1). State rankings refer to an animal's rarity status in Pennsylvania, and the global rankings refer to an organism's rarity on the world-wide scale.

NatureServe, the parent organization of Natural Heritage programs, works with Heritage biologists to assign these rankings to each species individually and use these rankings as a way to quantify the rarity, and therefore conservation priority, of all organisms. An organism can have any combination of state and global ranks; if an organism is rare in Pennsylvania, but its populations are secure worldwide, it may have a ranking of S3/G5. If an organism is rare worldwide and extremely rare in Pennsylvania, it may be assigned a ranking of S1/G3. More information on the state- and global-ranking system is available at: www.natureserve.org.

Table 3-1. State and Global ranks and definitions used by Natural Heritage programs to rank the rarity of organisms at the state and global levels.

State/Global Rank	Rank Description
SX/GX	**Extirpated** - Element is believed to be extirpated/extinct from the state/ its entire global range
SH/GH	**Historical** – Only known from historical records
S1/G1	**Critically Imperiled** - Critically imperiled because of extreme rarity or because vulnerability to extirpation.
S2/G2	**Imperiled** - Imperiled because of extreme rarity or because vulnerability to extirpation.
S3/G3	**Vulnerable** - Vulnerable because rare and uncommon, or found only in a restricted range
S4/G4	**Apparently Secure** - Uncommon but not rare, and usually widespread.
S5/G5	**Secure** - Demonstrably widespread, abundant, and secure

How does this classification compare to other classifications of Pennsylvania's streams?

The state of Pennsylvania protects aquatic life using a "designated use" classification system of waters in the Commonwealth under the federal Clean Water Act. Four types of aquatic life should be propagated and maintained based on their designation in Pennsylvania (PA Code 93.3; http://www.pacode.com/secure/data/025/chapter93/s93.3.html):

- **Cold Water Fishes (CWF)**: Fishes and associated aquatic flora and fauna preferring colder waters (trout species are included in the cold water fishes).
- **Warm Water Fishes (WWF)**: Fishes and associated aquatic flora and fauna preferring warmer waters.
- **Trout Stocked Fishes (TSF)**: Stocked trout species (maintained from Feb 15 to July 31) and warm-water flora and fauna.
- **Migratory Fishes (MF)**: Fishes (those having anadromous, catadromous or similar life histories) which must migrate through flowing waters to their breeding habitats.

Additionally, some waterbodies receive additional special protections as "Exception Value" or "High Quality" waters because they are especially valued for aquatic life, water quality, and/or recreation. Meeting relatively high water quality and other standards qualify the water bodies for additional protections from degradation beyond the aquatic life uses (PA Code 93.4b, www.pacode.com/secure/data/025/chapter93/s93.4b.html).

The purpose and meanings differ between the classes defined in Pennsylvania aquatic life use/special protection designations and aquatic fish assemblages from the Pennsylvania Aquatic Community Classification. The similar nomenclature of both classifications may be confusing, but in both cases it is meant to relatively define the organisms and aquatic habitats along a gradient of water temperatures (and associated stream size). The PA stream designations broadly encompass habitats occupied by several ACC fish assemblages (Table 3-2) and are used in water quality regulation. The ACC biological community descriptions generally offer more information about associated species, stream type and habitat condition than the classification systems currently used by Pennsylvania's state agencies. See Appendix C for more information.

What information is used to describe the communities and their habitats?

Community Indicators - The animals that are most commonly associated with each community type are listed. While not every organism described in a given community will occur in each location where this community is found, organisms listed in this section give a general account of which organisms to expect in that community's habitat.

Table 3-2. Pennsylvania aquatic life uses and special protection water designations and their occurrence with ACC fish assemblages. (EV = Exceptional Value Waters, HQ = High Quality waters, CWF= Cold Water fishes, WWF= Warm Water Fishes, TSF= Trout Stocked Fishes, MF= Migratory Fishes)

<table>
<tr><th rowspan="6">Increasing watershed area ↓</th><th>Atlantic Basin</th><th>Ohio – Great Lakes Basins</th><th>EV</th><th>HQ</th><th>CWF</th><th>WWF</th><th>TSF</th><th>MF</th></tr>
<tr><td>Coldwater</td><td>Coldwater</td><td>x</td><td>x</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Coolwater 1, Coolwater 2</td><td>Coolwater</td><td></td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td></tr>
<tr><td>Warmwater 1, Warmwater 2</td><td>Warmwater</td><td></td><td></td><td>x</td><td>x</td><td>x</td><td>x</td></tr>
<tr><td>River & Impoundment</td><td rowspan="2">Large River</td><td></td><td></td><td></td><td>x</td><td></td><td>x</td></tr>
<tr><td>Lower Delaware River</td><td></td><td></td><td></td><td>x</td><td></td><td>x</td></tr>
</table>

<u>*Species of Conservation Concern*</u> - For taxa groups that have rare species tracked (fish and mussels, in this study), any taxa that are associated with a community and are also tracked for their rarity (Table 3-1) are noted.

<u>*Habitat*</u> - Average values of the community characteristics across their entire range from a large dataset are presented. Size of the stream's watershed, gradient (slope) and elevation are a few habitat characteristics that may be important to the community type. Local conditions are also mentioned.

Some specific criteria about community types and their watersheds are included in the *Habitat* section of the community descriptions:

- *Land Use Composition* - Trends in land use patterns were also calculated for each stream reach as percentages of the entire contributing watershed. Different amounts of urban, agricultural or forested area in watersheds can directly influence stream habitat and resident organisms. For example, some organisms are only found in heavily forested (undisturbed) watersheds, while others can tolerate the altered habitat types that are found in heavily agricultural or urbanized settings.

In the Macroinvertebrate sections, some metrics are discussed in the *Habitat* sections that provide information about the health and ecological function of the streams:

- *EPT Richness* - Proportion of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) that make up a sample of aquatic macroinvertebrates. These three kinds of insects are generally the most sensitive to habitat alteration. The higher the EPT richness, the higher the quality of the water and habitat.

- *Taxa Richness* - The number of taxa present in a sample. Generally, the more species an assemblage has, the healthier and more naturally-functioning a stream is.

- *Pollution Tolerance* - Macroinvertebrate taxa have rankings on a scale of 0-10 that refer to their tolerance level to organic pollution. A score of zero indicates that a certain taxon is intolerant of any pollution, while a score of 10 signifies that the organism is capable of living in high levels of pollution. Since tolerance values can vary regionally, we used the Pennsylvania Department of Environmental Protection's rankings whenever possible.

Some water chemistry variables are also valuable in understanding the habitat conditions of a community:

- *pH* - The degree of acidity of the water, measured by the concentration of hydrogen ions in a solution. Stream water is generally near neutral, with a pH of around seven. The concentration of hydrogen ions determines the alkalinity ($pH > 7$) or acidity ($pH < 7$) of stream water.

- *Water Temperature* - This is important to stream organisms because it influences their metabolism and growth. Each aquatic animal species has a tolerance for specific temperature ranges and cannot survive temperatures outside of their range. Cool water temperatures are also related to high dissolved oxygen levels in streams.

- *Conductivity* - Defined as the capacity of the water to conduct an electrical current. It is expressed in microsiemens per centimeter (µS/cm) at 25 °C. Conductivity is determined by the types and quantity of dissolved substances (ions) in water. In streams, conductivity can be elevated because of pollution (generally from urbanization) or natural causes.

- *Alkalinity* - A measure of how well a waterbody resists or does not resist changes in acidity. If a stream has high alkalinity and can neutralize acids sufficiently, then it is subject to little change in pH. A stream with low alkalinity is less resistant to changes in acidity. In addition, a stream with low alkalinity is more susceptible to becoming acidic from acid precipitation or other causes.

Stream Quality Rating - Community types are generally ranked as low, medium, or high quality based on habitat, water chemistry and sensitivity of the community's organisms to pollution.

Community Rarity - Rarity was determined by examining the number and distribution of known community locations in Pennsylvania.

Threats - Where known, potential pollution sources or other threats that may alter the natural state of the community are described.

Conservation Recommendations - Issues for natural resource managers and land planners to consider in the protection, restoration, and management of watersheds and communities are described.

References

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Waite I.R., A.T. Herlihy, D.P. Larsen, N.S. Urquhart and D.J. Klemm. 2004. The effects of macroinvertebrate taxonomic resolution in large landscape bioassessments: an example from the Mid-Atlantic Highlands, USA. *Freshwater Biology*. 49 (4): 474-48.

Quick Reference: Definitions & Abbreviations Used in Community Descriptions

EPT Richness - Proportion of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) that make up a sample of aquatic macroinvertebrates.

Gradient (%) - Used to describe how steep the slope is for a stream segment, and therefore how fast the water moves. Measured as a percent change in elevation from the top of the reach to the bottom.

m - Abbreviation for 'meter'. One meter = 3.28 feet.

mg/l - Milligrams per liter. Here, it is the unit of measure used to quantify alkalinity.

mi^2 - Square miles; used here to describe the size of watersheds.

MI - Macroinvertebrate

µS/cm - Microsiemens per centimeter. Here, this is the unit of measure used to quantify the specific conductivity of stream water.

$\overline{x}$ - Symbol for "average of".