11. Watershed Restoration Prioritization

The goal of this portion of the study was to use data compiled in the ACC project to determine which watersheds are in the worst condition and are a priority for habitat restoration. To do so, we combined information from our Least-Disturbed Stream (LDS, Chapter 9) reach analysis, biological metric scoring (see Chapter 10) and locations of biological communities indicative of poor-quality stream habitat (Table 11-1). A multi-faceted approach such as this is more useful than simply examining developed land area in a watershed or the occurrence of pollution-tolerant taxa. By combining both biotic and abiotic features of the landscape we are able to highlight the watersheds where the functionality of biological assemblages is being altered by a variety of disturbances.

Table 11-1. Biological communities used in the watershed restoration prioritization analysis. These communities are indicative of poor quality stream habitat and various types of landscape disturbance.

Community Name	Representative Taxa
Macroinvertebrates	
Family-level	
Common Headwater Stream	Lepidostomatidae, Capniidae
Limestone/ Agricultural Stream	Amphipoda, Simuliidae
AMD Stream	Sialidae, Empididae
Genus-level	
Sluggish Headwater Stream	*Physidae, Hirudinea*
Limestone/ Agricultural Stream	Isopoda, Oligochaeta
Small Urban Stream	*Cheumatopsyche, Stenelimis*
Large Stream Generalist	Generalist Taxa
Fish	
Atlantic Basin	
Coolwater Community 1	Slimy sculpin, fathead minnow
Coolwater Community 2	Blacknose dace, white sucker
Ohio - Great Lakes Basins	
Coolwater community	Blacknose dace, creek chub

Methodology

A tiering system similar to that used in the watershed Conservation Prioritization analysis (Chapter 10) was used to indicate the state of impairment that each altered watershed is in. The 'Tier 1' category here represents the most disturbed watersheds that exist in Pennsylvania. There is much physical alteration in these watersheds, and the in-stream habitat supports only the most pollution-tolerant organisms. These watersheds are an immediate priority for restoration action. Watersheds that fall into the 'Tier 2' category are also impaired, but their need for restoration action may not be as immediate as those with 'Tier 1' status.

As in previously discussed sections of this document, HUC12 Watersheds (~30 mi^2) were used as sub-units of larger drainage basins. A watershed was categorized as a 'Tier 1' restoration priority if it had no LDS reaches, had multiple stream reaches that scored below the 20^{th} percentile for the fish or macroinvertebrate metric scores (Chapter 10), and had multiple occurrences of fish or macroinvertebrate communities (Chapters 4-7) that indicate poor-quality stream habitat (Table 11-1). Watersheds were classified as 'Tier 2' if they had no LDS reaches, one or more stream reaches that were below the 20^{th} percentile in either fish or macroinvertebrate metric scores and one or more occurrences of poor habitat fish or macro-invertebrate communities (Table 11-2).

Results & Discussion

In Pennsylvania, 83 watersheds were selected as a 'Tier 1' restoration priority and 140 were chosen as 'Tier 2'. The greatest concentrations of Tier 1 watersheds are found in the areas surrounding Pittsburgh and Philadelphia. The distribution of both types of restoration watersheds are aggregated around larger river systems, although there are some instances of these watersheds scattered across the state.

Interestingly, some of the Tier 1 restoration priority watersheds hold some of the Large-river reaches identified in the conservation priority analysis (Chapter 10). This duality may be because of a variety of habitats present in some of these watersheds. Where sections of the lower Allegheny River support quality biological assemblages and are examples of good large river habitat, in-stream mining of sand and gravel or point source discharges upstream may damage other sections. Furthermore, the Allegheny River receives much of the same insults to water quality as other large river systems, such as effluent from sewer treatment plants, runoff from urbanized areas and input of waters from many tributaries with water quality issues including AMD. However, the biological composition of the river remains remarkably intact, supporting diverse mussel and fish assemblages in many of its lower reaches (ACC database). It is apparent that the river is able to recover from various degradations to water and habitat quality, but the question remains of what makes rivers such as the Allegheny so resilient to disturbance. Further study and field research on large river systems may clarify some of these issues.

Table 11-2. Biotic and abiotic criteria used in the watershed restoration prioritization analysis. Tier 1 watersheds represent those that are in most immediate need of restoration action. Tier 2 watersheds may not need action as immediately, but should be strongly considered for restoration action. See text for description of variables. MI = Macroinvertebrate.

Variable	Tier 1 Criteria	Tier 2 Criteria
LDS	None of any size	None of any size
Biological Metric Score stream	Multiple stream reaches reaches below 20th percentile of fish or MI scores	One or more stream reaches reaches below 20th percentile of fish or MI scores
Fish & macro-invertebrate communities	Multiple stream reaches with poor quality fish or MI comm.	One or more reaches with poor quality fish or MI comm.

It is important to note that this analysis is meant to suggest which watersheds in the state may be in greatest need of restoration activity. The water quality issues that are affecting these watersheds may differ significantly; therefore the measures necessary to improve water quality will vary as well. Site visits and on-the-ground research by watershed managers and conservation planners will be help to explain the actions necessary in each watershed to fix the problems that are degrading water quality and stream habitat.

Common Water Quality Issues in Pennsylvania

Acidification of streams from abandoned mine drainage (AMD) and acid deposition are the most prominent water quality issues in Pennsylvania. Acidification of water pushes the pH outside the range that is acceptable to aquatic organisms. Additionally, AMD introduces a suite of toxic metals to ground and surface waters that further degrade aquatic habitat.

Treating AMD can reduce acidity and levels of dissolved metals in the water and greatly improve stream habitat quality. The application of alkaline materials, or "liming", streams raises the pH of the water to normal levels and decreases the solubility of the dissolved metals associated with AMD. This method can be expensive due to the costs of the materials and maintenance that is required post-liming; the alkaline materials used in liming produce a metal-laden sludge that must be removed from the stream and disposed of. Passive treatment of AMD, as in mitigated AMD wetlands, can offer a lower cost and maintenance alternative to active chemical application. For more information on AMD and its remediation, see the Pennsylvania DEP's Bureau of Abandoned Mine Reclamation webpage: http://www.dep.state.pa.us/dep/deputate/minres/bamr/bamr.htm.

Agricultural streams may be in extremely poor condition if improperly managed. In this example, note the absence of a vegetated riparian buffer, which would help keep livestock out of the stream and slow down the input of nutrients from the row crops in the background of the photo. Streams such as this usually have unsuitable habitat and nutrient levels for most aquatic organisms.

Acid deposition (or "acid rain") is precipitation that has unnaturally high levels of acidity. This leads to the acidification of soils, streams and lakes and can also cause the decay of buildings, bridges and other structures. Acid deposition can be a natural occurrence, originating from compounds released from volcanoes or decaying vegetation. However, the elevated levels of acid deposition generally are due to the release of compounds like sulfer dioxide (SO_2) and nitrogen oxides (NO_x) that are introduced into the air from the combustion of fossil fuels. In the United States, a large portion of these compounds is introduced into our environment from electric power plants, especially those that burn coal (EPA, 2007). There are many of these plants along the Ohio River downstream of Pittsburgh, and prevailing winds often bring these air pollutants up the river valley and into Pennsylvania.

It is difficult to remedy the effects of acid deposition, since the issue of air quality occurs on such a large scale. Temporary fixes, such as liming, may provide short-term alleviation of the effects of acid deposition but a solution to the greater problem of air pollution is a universal one. Stricter controls on fossil fuel emissions, promoting renewable energy sources or simply using less energy would all help reduce acidic deposition. For more information on acid deposition, its causes and effects, see the EPA's webpage on acid rain: http://www.epa.gov/airmarkets/acidrain/.

Other major water quality issues in Pennsylvania relate to non-point source pollution. Non-point source pollution comes from the greater watershed, such as urban areas or poorly buffered agricultural fields. In agricultural fields without adequate vegetative buffers protecting streams, the streams can be inundated with elevated levels of nutrients and sediments. Sedimentation, often related to poorly managed agricultural practices, is a considerable water quality problem in Pennsylvania. Not only does sedimentation introduce pollutants and nutrients to water the were once immobilized in soil, but it also smothers stream bottoms and eliminates important habitat between and under rocks and debris that many aquatic organisms depend on for various stages of their life cycle. Sedimentation and nutrient enrichment in heavily agricultural areas can be controlled by installing riparian buffers of an adequate width along pastures and crop fields and excluding livestock from streams and riparian zones.

In urban environments, runoff carries different pollutants and water quality problems. Storm-water runoff from urbanized areas often contains hydrocarbon compounds from vehicles, road salts and other domestic pollutants. The rate at which stormwater is introduced to streams is sharply elevated in urban settings, since the amount of impervious surface (roads, parking lots, buildings, etc.) in these areas is often great. As a result, rainwater cannot be retained as it slowly percolates into soils; rather it is often collected in drainage channels and diverted directly into streams. This unnatural high-energy pulse of water is often enough to wash away aquatic organisms and destroy in-stream habitats, displacing organisms and delaying recolonization. Management of stormwater from roads and urban developments and mitigation of any direct stream discharges are recommended to remediate these effects.

Point-source pollution, such as direct stream discharges from sewer treatment plants or waste products from factories, is common near urban centers. Stricter controls on discharge permits and better remediation of discharges would eventually help to restore water quality in these areas. In addition, keeping sewage treatment systems up-to-date would help to improve stream habitats that support aquatic communities.

The Ohio River at Merrill Station, Allegheny Co., Pa. Rivers near urban centers often receive point-source discharges associated with populated areas, such as sewer treatment effluent and industrial waste discharges. Combining these issues with non-point source pollution from impervious areas, urban areas often exert a suite of habitat and water quality alterations that are unique to populated areas.

References

Environmental Protection Agency, Office of Air and Radiation. 2007. www.epa.gov/airmarkets

Pennsylvania DEP, Bureau of Abandoned Mine Reclamation. 2007. http://www.dep.state.pa.us/dep/deputate/minres/bamr/bamr.htm.

Related Shapefiles:

Restoration_HUC12s.shp

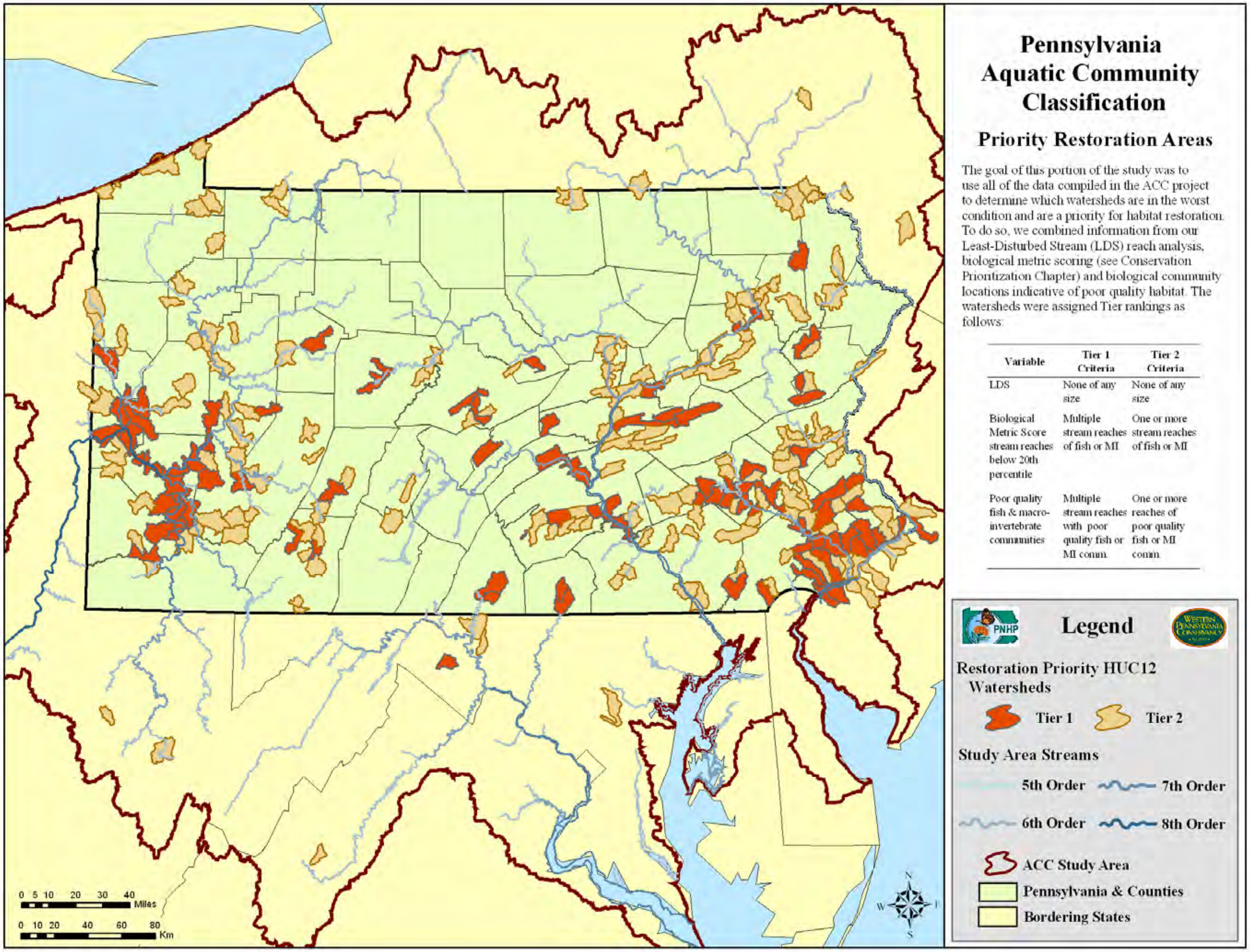

Figure 11-1. HUC12 watersheds that are a priority for restoration efforts. Although the entire study area was included, the analysis is focused on Pennsylvania's watersheds.