RESULTS FOR AQUATIC SYSTEMS AND SPECIES[*]

The HAL aquatics analysis did not deviate from the standard methodology documented in Olivero et al (2003)[1]. In fact, the hard work of the HAL aquatics assessment team significantly contributed to the formulation of this standard methodology for aquatic ecoregional assessments in the Northeast.

Major Rivers Within HAL

Allegheny River – The Allegheny River drains much of the region west of the Appalachians then flows westward to join the Mississippi. The river flows 325 miles and drains 11,778 square miles, flowing north from its source near Coudersport, PA, through Olean, NY, before turning south and entering the huge Allegheny Reservoir on the Pennsylvania/New York border. Below the reservoir, the river flows another 200 miles before it joins the Monongahela River in Pittsburgh to form the Ohio River, which empties into the Mississippi and eventually flows into the Gulf of Mexico below New Orleans, Louisiana.

Nearly 72 percent of the Allegheny River watershed is covered in forest. Along its course the river and its tributaries cross through both glaciated and unglaciated landforms. This journey gives the river much of its unique physical and biological characteristics. The Allegheny River also passes through 22 counties, 2 states, the Allegheny National Forest, Allegany State Forest (NY), thousands of acres of state game lands, and 85-miles of Allegheny National Wild and Scenic River corridor.

*Delaware Rive*r – The Delaware is the longest undammed river east of the Mississippi, extending 330 miles from the confluence of its East and West branches at Hancock, New York to the mouth of the Delaware Bay. Along its course, 216 tributaries feed the river, the largest being the Schuylkill and Lehigh Rivers in southeastern Pennsylvania. In all, the basin contains 13, 539 square miles, draining parts of Pennsylvania (6, 422 square miles or 50.3%); New York (2,3,62 square miles, 18.5%); New Jersey (2,969 square miles, or 23.3%) and Delaware (1,002 square miles, 7.9%).

Over 17 million people rely on the waters of the Delaware River Basin for drinking and industrial use and the Delaware Bay is but a day's drive away for about 40 percent of the people living in the United States. Yet the basin drains only four-tenths of one percent of the total land area of the continental United States. Three reaches of the Delaware have been included in the National Wild and Scenic Rivers System resulting in nearly three-quarters of the non-tidal Delaware River being included in the NWSRS (73 miles from Hancock, NY to Milrift, PA; 40 miles from Port Jervis, NY to Stroudsburg, PA and 65 miles from Delaware Water Gap, PA to Washington, Crossing, PA).

Susquehanna River – The Susquehanna River drains 27, 510 miles, covering half the land area of Pennsylvania and portions of New York and Maryland. The river flows 444 miles from its headwaters at Otsego Lake near Cooperstown, New York to Havre de Grace, Maryland, where

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[*] Schuler, G. (author) and Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for aquatic systems and species. Based on Zaremba, R.E. 2002. High Allegheny Plateau Ecoregional Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast and Caribbean Division, Boston, MA.

[1] See the chapter on standard methods for aquatics: Olivero, A.P. (author) and M.G. Anderson, and S.L. Bernstein (editors). 2003. Planning methods for ecoregional targets: Freshwater aquatic ecosystems and networks. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

the river meets the Chesapeake Bay. The Susquehanna represents the longest commercially non-navigable river in North America. It is also the largest river lying entirely in the United States that drains into the Atlantic Ocean (the river is nearly one mile wide at Harrisburg, PA).

Despite the fact that nearly 60% of the Susquehanna River Basin is forested the basin is one of the most flood-prone watersheds in the entire nation. Since the early 1800s, the main stem of the Susquehanna has flooded every 20 years, on average. Even the Native Americans who once lived in the area told of frequent floods.

The Susquehanna River comprises 43% of the Chesapeake Bay's drainage area and represents the largest tributary of the Chesapeake Bay, providing 90 percent of the freshwater flows to the upper half of the bay and 50 percent overall.

Selecting Ecoregional Targets

Developing Ecological Drainage Units (EDU)

Ecological Drainage Units (EDUs) are groups of watersheds (8-digit catalog units as defined by USGS) that share a common zoogeographic history and physiographic and climatic characteristics. It is expected that each EDU will contain sets of aquatic system types with similar patterns of drainage density, gradient, hydrologic characteristics, and connectivity. In the United States, ecoregional planning teams have defined EDUs based on two main sources of information: zoogeography from Hocutt and Wiley, World Wildlife Fund's aquatic ecoregions, and the US Forest Service; and ecoregional section and subsection attributes defined by the US Forest Service. Identifying and describing EDUs allows us to stratify ecoregions into smaller units so ecoregional planning teams can better evaluate patterns of aquatic community diversity. Furthermore, EDUs provide a means to stratify the ecoregion to set conservation goals.[2]

Within HAL, four Ecological Drainage Units (EDUs) were identified from east to west as follows: Upper Delaware, Upper Susquehanna, Western Susquehanna, and Upper Allegheny. Portions of 3 other EDUs cross into HAL but the HAL ecoregional planning team anticipates that these EDUs, which are mostly contained within neighboring ecoregions, will be included in the planning efforts for the appropriate ecoregion.

Species targets

The aquatic species targets for HAL were selected according to criteria established by the appropriate ecoregional planning sub-team. These criteria prioritized imperiled, endemic and declining species - those that warrant urgent attention. Species location information was obtained primarily from the Natural Heritage Program databases with additional information about fish coming from state fisheries databases and NatureServe's *Summary of National Fish Distribution by 8-digit Watershed.* The identification of regional- and intermediate-scale fish species targets (see Tables 1 and 2) is hoped to compliment data on imperiled, endemic and declining species and assure that common species are also captured in the ecoregional portfolio.

Table 1. Regional-Scale Fish Species Found In HAL

Regional Scale Fish Species	*Upper Delaware EDU*	*Upper Susquehanna EDU*	*Upper Allegheny EDU*	*Western Susquehanna EDU*

[2] Bryer and Smith, 2001.

Alewife	✔	✔		
American eel	✔	✔	✔	✔
American shad	✔	✔		
Sea lamprey	✔	✔		
Striped bass	✔			

**Source: Summary of National Fish Distribution by 8-digit Watershed. Larry Masters, ABI.*

Table 2. Intermediate-Scale Fish Species Found In HAL

Intermediate Scale Fish Species	*Upper Delaware EDU*	*Upper Susquehanna EDU*	*Western Susquehanna EDU*	*Upper Allegheny EDU*
Brook Trout	✔	✔	✔	✔
Creek chubsucker	✔	✔	✔	
Gizzard shad	✔			
White sucker	✔	✔	✔	✔
River redhorse				✔
Paddlefish				✔

**Source: Summary of National Fish Distribution by 8-digit Watershed. Larry Masters, ABI.*
Note: incomplete/DRAFT list requires review.

Coarse filter targets

Developing Aquatic Ecological Systems (AES) – Within HAL no freshwater community or ecosystem classification existed before The Nature Conservancy's ecoregional planning effort. The Nature Conservancy's Eastern Resources Office, with assistance from TNC's Freshwater Initiative and members of the HAL aquatic planning team, developed coarse-filter ecological system targets using a classification framework derived from ERO's Ecological Land Unit (ELU) analysis and the Freshwater Initiative's hierarchical approach. This multi-scale, landscape-based classification framework for freshwater ecosystems is based upon hierarchy theory, and several key principles of and empirical studies in freshwater ecology.[3] This GIS based platform, allowed the partitioning and mapping of environmental patterns from the stream reach to regional basins that strongly influence the distribution of freshwater biodiversity.

Aquatic Ecological Systems serve as a more general classification and stratification level for ecoregional planning purposes than The Nature Conservancy's stream reach macrohabitat classification. Aquatic Ecological Systems (AES) are defined as dynamic spatial assemblages of aquatic ecological communities that occur together in an aquatic landscape with similar geomorphological patterns, are tied together by similar ecological processes (e.g., hydrologic and nutrient regimes, access to floodplains) or environmental gradients (e.g., temperature, chemical and habitat volume), and form a robust, cohesive and distinguishable unit on a hydrography map. The Nature Conservancy's Eastern Resource Office, with assistance from other Conservancy staff and partners, identified AES within each Ecological Drainage Unit by developing a coarse-scale classification of riverine and lacustrine environments based on biophysical GIS data. This classification unit is intended to represent different aquatic environmental settings and serves to provide stratification across an Ecological Drainage Unit. Different aquatic communities are expected to currently occur or develop over evolutionary time within each system given the

[3] See Methods chapter and Bryer and Smith, 2001.

different environmental setting of each AES. AES thus serve as coarse filters for representation and conservation of all current and potential aquatic species and communities in the ecoregion.

In each HAL Ecological Drainage Unit, the Eastern Resource Office developed AES for size 1, 2, and 3 streams and rivers. Stream sizes are based on size classes developed for ERO's macrohabitat classification that provided the lowest level of detailed reach specific classification.

Setting Conservation Goals

The Nature Conservancy's assumption is that the conservation of multiple examples of each aquatic species target stratified across its geographic range is necessary to capture the variability of the target and its environment and to provide replication to insure persistence in the face of environmental stochasticity and the likely effects of climate change. The HAL aquatic planning team placed most of its efforts towards developing goals for the ecoregion's AES. Goals for species and natural communities, mostly based on data from the Association for Biodiversity Information and the PA and NY Natural Heritage Programs, were developed by the appropriate HAL plant, animal or natural community teams.

Goals for ecoregional planning can be divided into two categories – numeric goals and design goals. Numeric goals address issues of abundance and distribution of biological diversity. Design goals address issues of portfolio design.

> *Distribution Goals Objective:* Capture multiple occurrences of each aquatic ecological system within each Ecological Drainage Unit to ensure representative conservation of biodiversity.
>
> *Abundance Goals Objective:* Capture "sufficient" redundancy of ecological system types within each EDU. Redundancy of the EDUs at the scale of the ecoregion is irrelevant since each EDU considered independent and non-replicable.
>
> *Design Goals Objective:* Create a functional network of hydrologically connected aquatic ecological systems and other elements of biodiversity to ensure representative and functional conservation areas within *and across* terrestrial-based ecoregions.

Distribution goals

Aquatic ecological systems should capture "adequate representation" of macrohabitat types across major environmental gradients at the Ecological Drainage Unit level. The HAL aquatics planning team agreed upon the recommendation that the portfolio should contain macrohabitat types representing 100% of the following major environmental gradients at the EDU level: (1) elevation, (2) landform and (3) geology.

Abundance goals

Abundance goals for HAL aquatics are intended to capture multiple examples of each aquatic ecological system type within each EDU. The number of examples is determined by the relative increase in probability of environmental or stochastic events reducing the ecological integrity of these system types. As system size decreases, the number of replicates needed increases. Since no data or guidelines exist to inform the number of replicates needed, a conservative approach was taken – increasing by a single unit per level. See Table 3 for abundance (numeric) goals for HAL aquatic ecological systems.

Table 3. Abundance Goals for HAL Aquatic Ecological Systems.

Aquatic Ecological System Type	*Goal per EDU*
Headwater streams (size 1 system types)	Minimum of 3 examples per system type per EDU
Medium-sized tributaries (size 2 system types)	Minimum of 2 examples per system type per EDU
Small rivers (size 3 system types)	Minimum of 1 example per system type per EDU
Large rivers (size 4 system types)	1 per EDU

Design goals

The primary criteria driving the design goal for the HAL aquatic portfolio is to provide the best examples of connectivity for regional-scale fish species (Table 4) known to occur in each EDU. The goal will be to provide at least one connected suite of aquatic ecological systems (system sizes 4 through 1) within each EDU where each of the regional-scale fish species has current or historic distribution.

Table 4. Regional Scale Fish Species Found in HAL

Regional Scale Fish Species	*Upper Delaware EDU*	*Upper Susquehanna EDU*	*Upper Allegheny EDU*	*Western Susquehanna EDU*
Alewife	✔	✔		
American eel	✔	✔	✔	✔
American shad	✔	✔		
Sea lamprey	✔	✔		
Striped bass	✔			

**Source: Summary of National Fish Distribution by 8-digit Watershed. Larry Masters, ABI.*

A secondary criterion driving the design goal for the HAL aquatic portfolio is to provide the best pattern of connectivity for intermediate-scale fish species which occur in systems size 2, 3 and 1 systems. The goal will be to provide at least one connected suite of aquatic ecological systems within each EDU. See Table 5 for HAL intermediate scale species

Table 5. Intermediate Scale Fish Species Found in HAL

Intermediate Scale Fish Species	*Upper Delaware EDU*	*Upper Susquehanna EDU*	*Western Susquehanna EDU*	*Upper Allegheny EDU*
Brook Trout	✔	✔	✔	✔
Creek chubsucker	✔	✔	✔	
Gizzard shad	✔			
White sucker	✔	✔	✔	✔
River redhorse				✔
Paddlefish				✔

**Source: Summary of National Fish Distribution by 8-digit Watershed. Larry Masters, ABI.*
Note: *incomplete/DRAFT list requires review.*

Assessing Viability

Conservation targets are elements of biological diversity that are considered important for conservation. Conservation targets can occur at multiple levels of biological organization – including species, natural communities, and ecological systems. One of the most significant challenges to planning teams posed by aquatic conservation targets is the need for a more standardized language and methodology for describing non species-level aquatic conservation targets and their status. In particular, it has been especially challenging to develop an effective and credible method for estimating their viability (i.e., the probability of persistence over the long term).

Previously, assessing the viability of aquatic species (or the ecological integrity of communities and/or ecological systems), has presented unique challenges to ecoregional planning teams. Teams have often learned that their attempts to assess viability or integrity are little more than a screening process which they hope correlates with viability and/or integrity. Others have found, much more work is necessary to truly assess viability for a range of species, and there is little actual guidance on assessing the "viability" of communities and ecological systems. For now, The Conservancy is working on the assumption that through the use of informed estimates, our attempts characterize the status of biodiversity will correlate closely with more comprehensive viability assessments when the necessary information and resources become available. However, conservation efforts must move forward with a methodology that will at least make progress in the direction of more credible status assessments that will be used in an effective manner to inform our planning process.

Expert derived data

Use of external experts was a critical and necessary component of all HAL aquatic conservation assessments. To engage experts in a meaningful and effective manner, planning teams provided adequate direction and guidance to insure consistency and integrity in data collection. This was particularly critical in a) *defining* what is meant by the "status" of an occurrence, and b) *describing* the status of an occurrence so that the information can be used to "screen" conservation targets in order to set priorities.

Although initially developed by The Conservancy for terrestrial viability assessment, three useful descriptive categories have been used to describe and assess the status of conservation target occurrences at all scales: 1) size, 2) condition, and 3) landscape context. To do this effectively, descriptions of the varying status levels are required to set standards to minimize variability in interpretation among TNC and non-TNC staff and experts. The HAL aquatics planning team adopted a status assessment divided into four descriptive categories: "Very Good," "Good," "Fair," or "Poor." The team also developed general descriptions for each status rating to bring further consistency to the expert review process.

The Nature Conservancy publication titled "*The 5-S Framework for Site Conservation: A Practitioner's Handbook for Site Conservation Planning*"[4] provided the HAL aquatic planning team with a good starting point for defining the status of conservation targets. The following definitions are based on this work, and have been modified slightly for an aquatic focus.

Size – a measure of the area or abundance of the conservation target's occurrence.

- *For animal and plant species* size is the area of occupancy and/or the number of individuals in a population.
- *For ecological systems and natural communities* size is the patch size or geographic coverage. Assessments of size for natural communities and ecological systems should consider the area necessary to maintain the functionality of dominant ecological

[4] The 3rd edition of this publication can be found in http://www.conserveonline.org/2000/11/b/en/5-SVOL1.pdf.

processes considered in "Landscape Context," the area required to maintain area-sensitive species identified as key factors under "Condition," as well as the Minimum Dynamic Area of the target. The *Minimum Dynamic Area* is the size of the area needed for a conservation target to recover from natural disturbances, such as a hurricane, fire, or flood.

Size (roughly analogous to stream length) is the component with the weakest applicability in aquatic systems. It is useful to think of size in aquatic systems or communities in terms of the species-specific life history needs known to occur in these areas. For example, consider if headwater streams of a given system are large enough to conserve ample spawning habitat for trout, or are side channel wetlands large and numerous enough to support adequate annual recruitment of sturgeon nursery stock.

Condition – a measure of the biological composition, structure, and biotic interactions that characterize the target. This includes factors such as:

- Reproduction, dispersal, and age structure of specific populations of concern.
- Biological composition (e.g., presence of native versus exotic species, presence of various habitat/abiotic community types within a system).
- Structure (e.g., habitat composition – pool-riffle-run, substrate diversity, sediment load, bank erosion, riparian canopy, groundcover, etc.)
- Biotic interactions (e.g., competition, herbivory, predation, and disease).

Condition information from experts can be broken into two general categories: information on map-based assessment and information not accessible through map-based assessment. For example, a watershed condition analysis is provided to planning teams. This remotely-assessed, map-based approach requires substantial ground-truthing to be useful and effective. As is the case with most assessments of this nature, it is expected that such an assessment will work well for some systems and not for others. Expert input is needed to validate, and correct, this initial draft condition assessment.

In addition, it is known that some factors can dramatically alter condition assessments such as the degree of invasive species contamination, current condition or management of dams, extent of harvesting impacts from fisheries management, and the extent of pollution from non-point sources. Information on these topics is important to collect during expert review.

Landscape context – an integrated measure of two factors:

- *Dominant ecological processes and environmental regimes* that establish and maintain the target occurrence (e.g., hydrologic and water chemistry regimes, geomorphic processes, climatic regimes, fire regimes all within their natural ranges of variation and distribution)
- *Connectivity* that includes such factors as species having access to habitats/ resources needed for life cycle completion, fragmentation of ecological communities and systems, and the ability of any target to respond to environmental change through dispersal, migration, or re-colonization.

Of particular importance is consideration of the natural flow regime and its role in assessing the viability of many larger, impacted river systems. Even if formal analysis have not been performed (e.g., Index of Hydrologic Assessment (IHA) analyses), teams should consider how the hydrologic regime of aquatic systems has changed over time.

In addition, the influence of connectivity on the mobility of aquatic species is a topic that merits special consideration in any status assessment of aquatic systems. Barriers to movement (e.g., dams, inadequate water flow conditions), or impediments to habitat occupancy or passage (e.g., poor water quality or unsuitable physical habitat) should be taken into consideration when evaluating aquatic regions for viability. This is further complicated by the fact that many species have differing habitat or passage requirements depending on varying life history stages.

Furthermore, the HAL aquatics planning team also considered the following guidelines while working with TNC and non-TNC staff to evaluate the status of conservation targets:

- degree of habitat fragmentation of a community or system;
- degree of exotic or invasive species;
- extent of habitat conversion or long-term human disturbance;
- whether natural disturbance regimes are intact – especially seasonal or annual flooding and drought;
- proximity of other conservation sites or managed areas to a potential conservation site for a community or system;
- connectivity of community to other areas of natural habitat;
- watershed land use patterns that may effect the stream reach.

GIS aquatic condition analysis

The HAL assessment of viability also included a GIS condition analysis performed by the Eastern Resource Office. Such condition analysis for watersheds and stream reaches is a subject of considerable ongoing research. ERO developed a set of attributes for watersheds that facilitated a rapid assessment of watersheds in terms of their general potential aquatic condition. This condition analysis used 22 variables related to land cover, roads, dams, and point sources to calculate the overall condition for each size 1, size2, and size 3 watershed.
The variables are listed as follows:

Watershed % Natural (forested, shrubland, wetland)	Watershed % Total Agriculture
Watershed % Hay/Pasture	Watershed % Row Crops
Watershed % Developed	Watershed % Impervious Surface (derived from land cover, see data sources)
100m Stream Buffer: % Natural	100m Stream Buffer: Impervious
Watershed: % Managed Land	# Road/stream Crossings/stream mile
Miles of Roads/ watershed square miles	100m Stream Buffer: Miles of Roads/Miles of Streams
Total # Dams	# of Dams > 20ft or stores > 1000 acre/feet
Maximum Dam Height	Maximum Dam Storage in acre/feet
# Dams/Miles of Stream	Dam Storage in Acre/Feet / Stream Miles
# Drinking Water Supplies (DWS)	Total Population Served by DWS
# DWS / Stream Miles	DWS Population Served/Stream Miles

Total Point Sources (CERCLIS, IFD, PCS, TRI, MINES) # CERCLIS (Superfund)/Stream Mile # Mines / Stream Mile # TRI / Stream Mile	Total BASINS Point Sources/Stream Mile # Industrial Facilities Discharge/Stream Mile # PCS / Stream Mile

This condition analysis highlighted general areas of potential high condition for aquatic systems for use by the HAL planning team and non-TNC experts.

Portfolio Assembly

For the HAL aquatic assembly process, the *connectivity* of an aquatic ecological system occurrence was based on the presence of physical barriers to migration for both regional and intermediate-scale fish species. Each occurrence selected through the assembly process was categorized as either Priority 1 or Priority 2.

Priority 1**:** Priority 1 occurrences are in the portfolio. They are expert recommended systems that fall within the optimal condition analysis (% natural cover, road density, dams). Priority 1 occurrences count towards meeting ecoregional goals and can include “extra” occurrences which exceed goals).

Priority 2: Priority 2 occurrences are only *conditionally* in the portfolio. Priority 2 occurrences require more evaluation before being included in the portfolio as a Priority 1 occurrence. Priority 2 occurrences do not count towards meeting ecoregional goals.

The HAL aquatic assembly process was designed to provide connected networks of AES within each EDU. Connectivity was included at several scales for both the regional-scale and intermediate-scale fish species found within each EDU and across HAL. Since only one example of size 4 systems existed in each EDU each of these occurrences was automatically included in the portfolio, at least as a Priority 2 occurrence within its respective EDU.

The HAL aquatic planning team has highest confidence in the Priority 1 occurrences since they were established using a combination of best available expert information; available biological data sets, NHP information and GIS condition analysis. The HAL aquatic planning team strongly urges TNC Operating Units, partner organization and agencies to further gather and evaluate expert information and empirical and remote sensing data for Priority 2 occurrences. Further evaluation, in some cases, may result in a change in status for these occurrences, elevating them to Priority 1, or eliminating them from the portfolio altogether. It is the recommendation of the HAL aquatic planning team that there must be further rigorous evaluation of all Priority 2 occurrences before any decisions regarding conservation action or ecoregional goals are made.

Portfolio Results

Fine-filter targets: Species

Table 6. Fish Species Targets (Natural Heritage Program Data)

Scientific Name	Common Name	Distri-bution	Global Rank	HAL Goal	# Of EORs	# Viable EORs in HAL	Numeric Goal Met?
Etheostoma maculatum	Spotted Darter	L	G2	10	2	2	N
Etheostoma Tippecanoe	Tippecanoe Darter	L	G3	10	5	5	N
Ichthyomyzon bdellium	Ohio Lamprey	P	G3G4	5	15	9	Y
Ichthyomyzon greeleyi	Mountain Brook Lamprey	P	G3G4	5	5	0	N
Noturus stigmosus	Northern Madtom	W	G3	5	1	1	N
Percina macrocephala	Longhead Darter	W	G3	5	10	10	Y
Total					**38**	**27**	

Table 7. Invertebrate Species Targets (Natural Heritage Program Data)

Scientific Name	Common Name	Distri-bution	Global Rank	HAL Goal	# OF EO Records	# Viable EORs	Numeric Goal Met?
Alasmidonta heterodon	Dwarf wedgemussel	W	G1G2	5	8	8	Y
Alasmidonta varicosa	Brook floater	W	G3	5	8	7	Y
Cheumatopsyche helma	Helma's Net-Spinning Caddisfly	P	G1G3	5	1	1	N
Cicindela ancocisconensis	A Tiger Beetle	W	G3	5	3	3	N
Cicindela marginipennis	Cobblestone Tiger Beetle	W	G2G3	5	3	3	N
Enallagma laterale	New England Bluet	P	G3	5	3	2	N
Epioblasma torulosa rangiana	Nothern Riffleshell	L	G2T2	10	3	3	N
Gomphus quadricolor	Rapids Clubtail	W	G3G4	5	2	2	N
Gomphus septima	Septima's Clubtail	R	G2	20	0	0	N
Gomphus viridifrons	Green-faced Clubtail	W	G3	5	11	11	Y
Lasmigona subviridis	Green Floater	W	G3	5	27	7	Y
Ophiogomphus	Extra-Striped	W	G3	5	3	3	N

anomalus	Snaketail						
Ophiogomphus howei	Pygmy Snaketail	W	G3	5	1	1	N
Pleurobema clava	Clubshell	P	G4	5	3	3	N
Villosa fabalis	Rayed Bean	W	G1G2	5	1	1	N
Total					**77**	**55**	

Coarse-filter targets: Aquatic ecological systems

Abundance Goals: There are a total of 22, 098 miles of streams represented in size 1, 2, 3 and 4 systems in the four High Allegheny Plateau Ecological Drainage Units included in this plan. Table 8 shows the number of selected occurrences for each size system and the corresponding number of stream miles.

Table 8. Summary of Occurrences Selected for the four major EDUs by System Type.

Size and type	# Priority 1 Occurrences Selected	Miles	# Priority 2 Occurrences Selected	Miles	Total # of Priority 1 and 2 Occurrences	Total miles
All size 1	36	1834	19	721	55	2555
All size 2	39	520	40	435	79	913
All size 3	15	441	10	162	25	603
All size 4	3	468	0	0	3	468
TOTAL	**93**	**3263**	**69**	**1318**	**162**	**4581**

The High Allegheny Plateau selection process identified 3,263 out of 22, 098 total miles of stream as Priority 1 aquatic system occurrences across the four major EDUs within the ecoregion (Tables 8 and 9).

Distribution Goals: One note, while an analysis has been done for each EDU with regards to the abundance and design goals none has yet been done for the distribution goal. Further analysis should be completed for Priority 1 and 2 occurrences to evaluate what percentage of macrohabitat types across major environmental gradients (elevation, landform and geology) at the Ecological Drainage Unit level are captured by selected occurrences. The distribution goal for HAL is to capture macrohabitat types representing 100% of the major environmental gradients.

Design Goals: At least one connected suite of aquatic ecological systems (system sizes 4 through 1) was developed in each of the four ecological drainage units analyzed for the High Allegheny Plateau, to provide connectivity to each of the best examples of each system type for the appropriate regional-scale and intermediate fish species with current or historic distribution in that EDU.

The size 4 system in the Western Susquehanna EDU was not included in the portfolio by the HAL team working to assemble the portfolio in that drainage. This however appears to be an oversight. All size 4 systems should be included in the portfolio at least as Priority 2 occurrences. It is recommended that the appropriate TNC OUs should evaluate the size 4 system occurrence of the Western Susquehanna as Priority 2 until more information is gathered regarding the system's viability/integrity and its eventual inclusion in the portfolio as a Priority 1 occurrence or complete elimination from the portfolio.

Table 9. Percentage of Total System Miles of Priority 1 Aquatic System Occurrences.

EDU Name	Size Class	Total Miles	Total Miles Selected As Priority 1 Systems	% Of total selected
Upper Allegheny	1	4132	449	11
Upper Susquehanna	1	9179	831	9
Upper Delaware	1	3091	170	5
Western Susquehanna	1	2578	384	15
Upper Allegheny	2	341	116	34
Upper Susquehanna	2	933	200	21
Upper Delaware	2	315	108	34
Western Susquehanna	2	192	96	50
Upper Allegheny	3	197	113	57
Upper Susquehanna	3	326	118	36
Upper Delaware	3	150	79	53
Western Susquehanna	3	146	131	90
Upper Allegheny	4	81	82	100
Upper Susquehanna	4	268	268	100
Upper Delaware	4	118	118	100
Western Susquehanna	4	53	0	0
TOTAL		**22098**	**3263**	

Upper Allegheny EDU

Abundance Goals: In the Allegheny River EDU numerical goals were met for only 7 of the 14 aquatic ecological system types found in the EDU. Table 10 illustrates how these goals were met, or not met, for each of the aquatic system types. Goals for most of the size 1 system types were not met. No Priority 1 occurrences were identified for two of the EDU's system types, system 2-13 and system 3-12.

Table 10. Aquatic System Priority 1 Occurrences for the Upper Allegheny EDU.

System Size	System Type	# Priority 1 Occurrences	Miles	HAL Goal	Status of Goal
1	13	2	56	3	-1
1	14	1	174	3	-2
1	15	3	87	3	met
1	16	1	17	3	-2
1	17	1	115	3	-2
	Size 1 System Total		**449**		
2	16	2	46	2	met
2	17	2	29	2	met
2	18	2	8	2	met
2	19	4	33	2	+2
2	20	0	0	2	-2
	Size 2 System Total		**116**		

3	11	1	35	1	met
3	12	0	0	1	-1
3	13	1	78	1	met
	Size 3 System Total		**113**		
4		1	82	1	met
	Size 4 System Total		**82**		

Priority 2 occurrences, which currently do not count towards HAL goals, increase the number of total aquatic system occurrences in all but a few cases. Goals for all of size 2 and 3 systems can be met with the addition of Priority 2 occurrences (Table 11). Further evaluation with regard to the viability of these occurrences may warrant a change of status so that they count towards reaching ecoregional goals. Even with the inclusion of all currently identified Priority 2 occurrences only one of the size 1 system types reaches its numeric goal. The shortage of viable occurrences of size 1 systems within the Allegheny River EDU represents a priority information gap and certainly requires further investigation and analysis to fill.

Table 11. Total Aquatic System Occurrences (Priority 1 and 2) for the Upper Allegheny EDU.

System Size	System Type	# Priority 2 Occurrences	Total Priority Occurrences (1 and 2)	HAL Goal	Status of Goal WITH Priority 2 Occurrences Included
1	13	0	2	3	-1
1	14	0	1	3	-2
1	15	0	3	3	met
1	16	1	2	3	-1
1	17	0	1	3	-2
	Size 1 System Total		**9**		
2	16	1	3	2	+1
2	17	2	4	2	+2
2	18	1	3	2	+1
2	19	0	4	2	+2
2	20	5	5	2	+3
	Size 2 System Total		**19**		
3	11	0	1	1	met
3	12	2	2	1	+1
3	13	0	1	1	met
	Size 3 System Total		**4**		
4			1	1	met
	Size 4 System Total		**1**		

Distribution Goals: The distribution goal analysis for AES in the Upper Allegheny EDU has not been completed. Further analysis should be completed for both Priority 1 and 2 occurrences within the EDU to evaluate what percentage of macrohabitat types across major environmental gradients (elevation, landform and geology) are captured by selected occurrences.

Note: the distribution goal for HAL is to capture macrohabitat types representing 100% of the major environmental gradients within an EDU.

Design Goals: The design goal for HAL was to provide at least one connected suite of aquatic ecological systems (system sizes 4 through 1) within each EDU. For the Upper Allegheny EDU two 4-3-2-1 connected suites were constructed from Priority 1 streams which achieved design goals for the portfolio.

The connected networks include the:

- Allegheny River → Tionesta Cr./Coon Cr./Salmon Cr. drainage
- Upper Allegheny River → Potato Cr./Oswayo Cr./Johnson Cr. drainage

Unlike the Potato Creek sub-drainage, the Johnson and Oswayo Creek sub basins, however, did not have any size 1 systems selected either as Priority 1 or Priority 2 occurrences.

Table 12. Connected Suites w/in Upper Allegheny EDU which meet HAL design goals (Priority 1 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Upper Allegheny	(1) 4-3-2-1 suite/EDU	4-3-2-1	Yes	Allegheny River → Tionesta Cr./Coon Cr./Salmon Cr.
		4-3-2-1	Yes	Upper Allegheny River → Potato Cr./Oswayo Cr./Johnson Cr.
Total	2			

A 4-3-2 connected suite was created from Priority 2 occurrences for the Oil Creek/Caldwell Creek sub drainage and the Brokenstraw Creek sub drainage. No size 1 systems were identified for either of these drainages. Pithole Creek, Little Valley Creek, Sandy Creek and East Sandy Creek all create 4-2 connected drainages in the lower portion of the Upper Allegheny River.

Table 13. Smaller connected suites and unconnected systems w/in Upper Allegheny EDU which meet HAL design goals (Priority 2 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Upper Allegheny	(1) 4-3-2-1 suite/EDU	4-3-2	No	Allegheny River → Oil Creek/Caldwell Cr.
		4-3-2	No	Allegheny River → Brokenstraw Creek
		2-1	No	Bear Creek → Bear Cr. headwaters
		2	No	Tunungwant Creek
		2	No	Allegheny Portage Creek

The Bear Creek drainage represents a 2-1 connected suite of Priority 2 streams not connected to a size 3 or 4 system. Likewise, Tunungwant Creek and Allegheny Portage Creek represent Priority 2 size 2 systems not connected to any other aquatic systems.

Table 14. Priority 1 Occurrence Names in the Upper Allegheny EDU

Allegheny R	Hand Brook	Pithole Creek
Allender Run	Havens Run	Porky Run
Beaver Run	Hemlock Creek	Potato Creek
Beehunter Creek	Henderson Run	Prather Run
Blacksmith Run	Indian Run	Queen Creek
Bova Creek	Irish Brook	Red House Brook
Boyer Brook	Jacks Run	Red Mill Brook
Brewer Run	Jaybuck Run	Rice Brook
Caldwell Creek	Johnson Creek	Robbins Brook
Camp Run	Lick Run	Salmon Creek
Campbell Creek	Lyman Run	Schoolhouse Run
Carrollton Run	Marvin Creek	South Branch Cole Creek
Cherry Run	Marvin Creek	South Branch Tionesta Creek
Coalbed Run	Middle Branch West Branch Cald	Taylor Field Branch
Cole Creek	Middle Hickory Creek	Three Bridge Run
Colegrove Brook	Mud Lick Run	Tionesta Creek
Coon Creek	North Branch Cole Creek	Tyler Brook
Daly Brook	North Branch Colegrove Brook	Walcott Brook
Dunderdale Creek	Olean Creek	West Branch Caldwell Creek
Dunham Run	Oswayo Creek	West Branch Potato Creek
East Hickory Creek	Penoke Run	West Pithole Creek
Golby Run	Pierce Brook	Wolf Run
Guiton Run	Pine Creek	Woodcock Run
Hamlin Run	Piney Run	

Table 15. Priority 2 Occurrence Names in the Upper Allegheny EDU

Allegheny Portage Creek	Maple Run
Bear Creek	Oil Creek
Bennett Brook	Pigeon Run
Bloody Run	Pine Creek
Brokenstraw Creek	Pine Run
Caldwell Creek	Pithole Creek
Crooked Run	Pole Road Run
Davidson Run	Red Lick Run
E Sandy Creek	Sandy Creek
Little Bear Creek	Shanty Run
Little Brokenstraw Creek	Spring Creek
Little Otter Creek	Tunungwant Creek
Little Valley Creek	West Branch Tunungwant Creek

Upper Delaware EDU

Abundance Goals: In the Upper Delaware ecological drainage unit numerical goals were met or exceeded for only 6 of the 12 aquatic ecological system types found in the EDU. Table 16 illustrates how these goals were met, exceeded or not met, for each of the aquatic system types in the EDU. For most of the size 1 system types goals were not met. No Priority 1 occurrences were identified for three of the EDU's system types, 1-3, 2-2, and 3-2.

Table 16. Aquatic System Priority 1 Occurrences for the Upper Delaware EDU.

System Size	System Type	# Priority 1 Occurrences	Miles	HAL Goal	Status of Goal
1	1	2	86	3	-1
1	2	2	9	3	-1
1	3	0	0	3	-3
1	4	3	75	3	met
	Size 1 System Total		**170**		
2	1	2	27	2	met
2	2	0	0	2	-2
2	3	1	36	2	-1
2	4	3	45	2	+1
	Size 2 System Total		**108**		
3	1	3	56	1	+2
3	2	0	0	1	-1
3	3	2	23	1	+1
	Size 3 System Total		**79**		
4		1	118	1	met
	Size 4 System Total		**118**		

Priority 2 occurrences, which currently do not count towards HAL goals, increase the number of total aquatic system occurrences in all but one instance. All of system size 1, 3 and 4 goals are met with the inclusion of Priority 2 occurrences (Table 17). Further evaluation with regard to the viability of these occurrences may warrant a change of status so that they count towards reaching ecoregional goals. Even with the inclusion of all currently identified Priority 2 occurrences, system type 2-2 (system size 2, type 2) does not reach its numeric goal.

Table 17. Total Aquatic System Occurrences (Priority 1 and 2) for the Upper Delaware EDU.

System Size	System Type	Total Priority Occurrences (1 and 2)	Total miles	HAL Goal	Status of Goal WITH Priority 2 Occurrences Included
1	1	4	150	3	+1
1	2	4	66	3	+1
1	3	3	69	3	met
1	4	5	106	3	+2
	Size 1 System Total		**391**		
2	1	4	57	2	+2
2	2	1	9	2	-1
2	3	5	72	2	+3
2	4	6	72	2	+4
	Size 2 System Total		**210**		

3	1	3	56	1	+2
3	2	1	20	1	met
3	3	2	23	1	+1
	Size 3 System Total		**99**		
4		1	118	1	met
	Size 4 System Total		**118**		

Distribution Goals: The distribution goal analysis for AES in the Upper Delaware EDU has not been completed. Further analysis should be completed for both Priority 1 and 2 occurrences within the EDU to evaluate what percentage of macrohabitat types across major environmental gradients (elevation, landform and geology) are captured by selected occurrences.

Design Goals: The design goal for HAL was to provide at least one connected suite of aquatic ecological systems (system sizes 4 through 1) within each EDU. For the Upper Delaware EDU two 4-3-2-1 connected suites of aquatic systems were constructed from Priority 1 occurrences which exceeds design goals for the portfolio (Table 18).

The connected networks included the:

- Delaware River → Neversink River → Bashakill Creek drainage
- Delaware River → E. Branch Delaware R. → Beaverkill River/Little Beaverkill drainage.

Table 18. Connected Suites w/in Upper Delaware EDU (Priority 1 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Upper Delaware	(1) 4-3-2-1 suite/EDU	4-3-2-1	Yes	Delaware River → Neversink River → Neversink R./Bashakill Cr.
		4-3-2-1	Yes	Delaware River → E. Branch Delaware R. → Beaverkill River/Little Beaverkill R.
		4-2-1	No	Delaware R. → Bushkill Cr. → headwaters
		4-2-1	No	Delaware R. → Flat Brook Cr. → headwaters
		4-3	No	Delaware R. → McMichael Cr.
Total	2			

The Broadhead Creek portion of the 4-3-2 Delaware River → Broadhead Creek connected suite listed in Table 19 is a Priority 2 occurrence. The size 3 system which connects Broadhead Creek to the Delaware River to create a potential 4-3-2-1 connected suite is a Priority 1 occurrence (McMichael Creek). The aquatic ecological systems within the Delaware River → Broadhead Creek drainage require more evaluation before including them in the portfolio as a connected suite.

Table 19. Connected suites and unconnected systems w/in Upper Delaware EDU (Priority 2 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Upper Delaware	(1) 4-3-2-1 suite/EDU	4-3-2	No	Delaware R. → Lackawaxan R. → Middle Cr.
		4-2-1	No	Delaware R. → Calicoon Cr.
		4-2-1	No	Delaware R. → Equinunk Cr.
		4-2	No	Delaware R. → Shohola Cr.
		4-2-1	No	Delaware R. → Pocono Cr.
		4-3-2*	No	Delaware R. → Broadhead Cr.
		2	No	Oquaga Cr.
		2-1	No	Little Delaware R.
		2-1	No	E. Branch Delaware R. → Dry Brook

Table 20. Priority 1 Occurrence Names in the Upper Delaware EDU

Alder Creek	High Falls Brook
BASHER KILL	LITTLE BEAVER KILL
BEAVER KILL	Little Flat Brook
Beerskill	MCMICHAEL CR
Biscuit Brook	NEVERSINK R
BUSH KILL	Parker Brook
Cattail Brook	Pigeon Brook
Criss Brook	Shandelee Brook
DELAWARE R	Stony Brook
Fall Brook	Tarkill Creek
FLAT BROOK	Willowemoc Creek
Forked Brook	Willsey Brook
Gumaer Brook	

Table 21. Priority 2 Occurrence Names in the Upper Delaware EDU

Alder Marsh Brook	Kinneyville Creek
BRODHEAD CR	LACKAWAXEN R
Brush Brook	LITTLE DELAWARE R
Buck Brook	Little Equinunk Creek
Bulgers Run	MCMICHAEL CR
Butz Run	MIDDLE CR
Calkins Creek	OQUAGA CR
CALLICOON CR	Paradise Creek
Cherry Creek	Pocono Creek
Coulter Brook	Riley Creek
Cranberry Creek	Rose Pond Branch
Crooked Creek	Salt River Brook
DELAWARE R	Sand Spring Run
DRY BK	Scot Run
Dry Sawmill Run	SHOHOLA CR

East Branch Dyberry Creek	Transue Run
EQUINUNK CR	Tyler Brook
Factory Creek	WALLENPAUPAUK CR
Gulf	Wolf Swamp Run

Upper Susquehanna EDU

Abundance Goals: For the Upper Susquehanna ecological drainage unit numerical goals were met or exceeded for 14 of the 19 aquatic ecological system types found in the EDU. Table 22 illustrates how these goals were met, exceeded or not met, for each aquatic system type. Numeric goals for only one of the size 3 system types was not met or exceeded and for system type 3-8, no Priority 1 occurrences were identified in the portfolio. No Priority 1 occurrence was identified for system type 2-12 either.

Table 22. Aquatic System Priority 1 Occurrences for the Upper Susquehanna EDU.

System Size	System Type	# Priority 1 Occurrences	Miles	HAL Goal	Status of Goal
1	5	4	125	3	+1
1	6	2	27	3	-1
1	7	4	105	3	+1
1	8	2	401	3	-1
1	9	2	173	3	-1
	Size 1 System Total		**831**		
2	5	2	48	2	Met
2	6	2	28	2	Met
2	7	2	28	2	Met
2	8	1	46	2	-1
2	9	2	34	2	Met
2	10	1	9	2	-1
2	11	1	7	2	-1
2	12	0	0	2	-2
	Size 2 System Total		**200**		
3	4	1	64	1	Met
3	5	1	32	1	Met
3	6	1	15	1	Met
3	7	0	0	1	-1
3	8	1	7	1	Met
	Size 3 System Total		**118**		
4		1	268	1	Met
	Size 4 System Total		**268**		

Priority 2 occurrences, which currently do not count towards HAL goals, increase the number of total aquatic system occurrences and would help to reach numeric goals in all but one instance (system type 1-9) (Table 23). Further evaluation with regard to the viability of these occurrences may warrant a change of status so that they count towards reaching ecoregional goals.

Table 23. Total Aquatic System Occurrences (Priority 1 and 2) for the Upper Susquehanna EDU.

System Size	System Type	Total Priority Occurrences (1 and 2)	Total miles	HAL Goal	Status of Goal
1	5	9	154	3	+6
1	6	2	27	3	-1
1	7	6	237	3	+3
1	8	3	418	3	met
1	9	2	173	3	-1
	Size 1 System Total		**1009**		
2	5	5	81	2	+3
2	6	4	41	2	+2
2	7	2	28	2	met
2	8	2	46	2	met
2	9	3	44	2	met
2	10	3	31	2	+1
2	11	5	75	2	+3
2	12	3	44	2	+1
	Size 2 System Total		**390**		
3	4	3	102	1	+2
3	5	1	32	1	met
3	6	2	22	1	+1
3	7	2	27	1	+1
3	8	2	46	1	+1
	Size 3 System Total		**229**		
4		1	268	1	met
	Size 4 System Total		**268**		

Distribution Goals: The distribution goal analysis for AES in the Upper Susquehanna EDU has not been completed. Further analysis should be completed for both Priority 1 and 2 occurrences within the EDU to evaluate what percentage of macrohabitat types across major environmental gradients (elevation, landform and geology) are captured by selected occurrences.

Design Goals: The design goal for HAL was to provide at least one connected suite of aquatic ecological systems (system sizes 4 through 1) within each EDU. For the Upper Susquehanna EDU four 4-3-2-1 connected suites of aquatic systems were constructed from Priority 1 occurrences exceeding the design goals for the ecoregion.

Table 24. Connected Suites w/in Upper Susquehanna EDU (Priority 1 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Upper Susquehanna	(1) 4-3-2-1 suite/EDU	4-3-2-1	Yes	Susquehanna R. → Tunkhannock Cr. → Martins Cr.
		4-3-2-1	Yes	Susquehanna R.→ Towanda Cr. → Schrader Cr.
		4-3-2-1	Yes	Susquehanna R. → Chenango R. → Genaganslet R. → Sangerfield R.
		4-3-2-1	Yes	Susquehanna R. → Unadilla R. → Butternut Cr./Beaver Cr.
		4-2-1	No	Susquehanna R. → Mehoopny Cr.
		2-1	No	E. BranchTioughnioga R.
		2-1	No	Catatonk Cr.
Total	4			

Table 25. Connected suites and unconnected systems w/in Upper Susquehanna EDU (Priority 2 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Upper Susquehanna	(1) 4-3-2-1 suite/EDU	4-3-2-1	No	Susquehanna R. → Owego Cr.
		4-3-2	No	Susquehanna R.→ Cohocton R. → Mud Cr./Five Mile Cr./Upper Cohocton R.
		4-3-2	No	Susquehanna R. → Canesteo R. → Bennettes Cr.
		4-2	No	Susquehanna R. → Nanticoke Cr.
		4-2	No	Susquehanna R. → Wysox Cr.
		2-1	No	Susquehanna R. → Wyalusing Cr.
		4-2-1	No	Otselic Cr. → Brakel Cr. Susquehanna R. → Wappasening Cr.
		3*	No	Tioghnioga R.

The Priority 2 occurrence of the Size 3 Tioghnioga River listed in Table 25 is unconnected as a Priority 2 occurrence, however, it provides connectivity for the P1 occurrence of the East Branch Tioghnioga River thereby creating a 4-3-2-1 connected to the Susquehanna River. These Priority 2 occurrences require more evaluation before including them in the portfolio and assembling them as a connected suite.

Table 26. Priority 1 Occurrence Names in the Upper Susquehanna EDU

Ackerly Creek	Five Streams	Millstone Creek	Sulphur Springs Creek
Albright Creek	GENEGANTSLET CR	Monroe Creek	SUSQUEHANNA R
BEAVER CR	Haights Creek	Nates Run	Thomas Run
Becker Brook	Handsome Brook	Nine Partners Creek	Tinker Creek
Bell Creek	Horton Creek	Number Six Brook	TIOUGHNIOGA CR
Bellas Brook	Hunt Creek	Oxbow Creek	TIOUGHNIOGA R
Billings Mill Brook	Idlewild Creek	Partners Creek	TOWANDA CR
Bliven Creek	Jones Creek	Pine Swamp Run	Tower Branch
Bull Run	Kasson Brook	Pond Brook	Tunkhannock Creek
Butler Creek	Kennedy Creek	Red Brook	UNADILLA R
BUTTERNUT CR	Kenney Brook	Rhiney Creek	Utley Brook
Carbon Run	LABRADOR CR	Rock Creek	White Brook
CATATONK CR	Leslie Creek	Rollinson Run	Willow Brook
Catlin Brook	Little Butler Creek	SANGERFIELD R	Wolf Run
CHEMUNG R	Little Creek	Schrader Creek	
CHENANGO R	Little Rhiney Creek	Sciota Brook	
CHENINGO CR	Little Schrader Creek	Shackham Brook	
Chilson Run	Lye Run	Silver Creek	
Coal Run	Martins Creek	Smith Cabin Run	
Dry Creek	McCraney Run	Snake Creek	
Dundaff Creek	MEHOOPANY CR	Somer Brook	
East Branch Field Brook	MICHIGAN CR	South Brook	
Fall Brook	Mill Creek	Sterling Brook	
Falls Creek	Millard Creek	Stony Brook	
Field Brook	Miller Brook	Sugar Run	

Table 27. Priority 2 Occurrence Names in Upper Susquehanna EDU

Babcock Run	NEILS CR
BENNETTES CR	OAKS CR
BRAKEL CR	OTSELIC R
Canisteo	OWEGO CR
CATATONK CR	Pendleton Creek
Chaffee Run	Prince Hollow Run
COHOCTON R	Russell Run
Corbin Creek	TIOGA R
FIVEMILE CR	TIOUGHNIOGA R
Little Falls Creek	TOWANDA CR
MESHOPPEN CR	Wappasening Creek
MUD CR	WYALUSING CR
NANTICOKE CR	WYSOX CR

Western Susquehanna EDU

Abundance Goals: For the Western Susquehanna ecological drainage unit numerical goals were met or exceeded for 3 of the 7 aquatic ecological system types identified. Table 28 illustrates how these goals were met, exceeded or not met, for each aquatic system. Numeric goals for the size 4 system type was not met, no Priority 1 or Priority 2 occurrences were identified.

Due to the assembly rules that were developed by the aquatic planning team for this ecoregion, this appears to be an oversight. All size 4 systems should be included in the portfolio at least as Priority 2 occurrences. It is recommended that the appropriate TNC OUs should evaluate the size 4 system of the Western Susquehanna as Priority 2 occurrences until more information is gathered regarding the system's viability/integrity and its eventual inclusion in the portfolio as a Priority 1 occurrence or complete elimination from the portfolio.

Table 28. Aquatic System Priority 1 Occurrences for the Western Susquehanna EDU.

System Size	System Type	# Priority 1 Occurrences	Miles	HAL Goal	Status of Goal
1	11	1	7	3	-2
1	12	6	377	3	+3
	Size 1 System Total		**384**		
2	13	11	93	2	+9
2	14	1	3	2	-1
	Size 2 System Total		**96**		
3	9	0	0	1	-1
3	10	4	131	1	+3
	Size 3 System Total		**131**		
4		0	0	1	-1
	Size 4 System Total		**0**		

The Priority 2 occurrences selected for the Western Susquehanna EDU, which currently do not count towards HAL goals, increase the number of total aquatic system occurrences and would help to reach numeric goals in two instances; systems type 2-14 and 3-9 (Table 29). Again, no Priority 2 occurrences were identified for the size 4 system in this EDU. Further evaluation with regard to the viability of these occurrences may warrant a change of status so that they count towards reaching ecoregional goals.

Table 29. Total Aquatic System Occurrences (Priority 1 and 2) for the Western Susquehanna EDU.

System Size	System Type	Total Priority Occurrences (1 and 2)	Total miles	HAL Goal	Status of Goal
1	11	1	7	3	-2
1	12	7	652	3	+4
	Size 1 System Total		**659**		
2	13	15	145	2	+13
2	14	2	10	2	Met
	Size 2 System Total		**155**		
3	9	1	4	1	Met
3	10	4	131	1	+3

	Size 3 System Total	**135**		
4	0	0	1	-1
	Size 4 System Total	**0**		

Distribution Goals: The distribution goal analysis for AES in the Western Susquehanna EDU has not been completed. Further analysis should be completed for both Priority 1 and 2 occurrences within the EDU to evaluate what percentage of macrohabitat types across major environmental gradients (elevation, landform and geology) are captured by selected occurrences.

Design Goals: The design goal for HAL was to provide at least one connected suite of aquatic ecological systems (system sizes 4 through 1) within each EDU. For the Western Susquehanna EDU two 4-3-2-1 connected suites of aquatic systems were constructed from Priority 1 occurrences which exceeds the design goals for the portfolio.

Table 30. Connected Suites w/in Western Susquehanna EDU (Priority 1 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Western Susquehanna	(1) 4-3-2-1 suite/EDU	4-3-2-1	Yes	W. Susquehanna R. → Pine Cr. → Slate Run/Cedar Run
		4-3-2-1	Yes	W. Susquehanna R.→ Kettle Cr. → Cross Fk./ Hammersley Fk.
		4-3-2*	No	W. Susquehanna R. → Sinnemahoning R. → Driftwood Cr.
		2	No	Left Br. Young Womans Cr.
		2	No	Bakers Run
Total	2			

The 4-3-2 connected suite of the W. Susquehanna R. → Sinnemahoning R. → Driftwood Creek becomes a complete 4-3-2-1 connected suite with the addition of the size 1 system occurrences contained in an adjacent matrix forest block. This would bring the total of connected suites which meet the ecoregion's design goals to three. However, none of the occurrences of these size 1 systems were selected during the aquatics assembly process and require significant further evaluation by TNC OUs and partners before inclusion into the aquatics portion of the portfolio.

Table 31. Connected suites and unconnected systems w/in Western Susquehanna EDU (Priority 2 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Western Susquehanna	(1) 4-3-2-1 suite/EDU	4-3-2	No	W. Susquehanna R. → Mosquito Cr./Black Moshannon Cr./Trout Run
		2-1*	No	Little Pine Cr. → Block House Run
		2-1*	No	Babbs Cr.
		2*	No	Upper Pine Cr.

The 2-1 connected suites of Little Pine Cr./Block House Run and Babbs Creek and the size 2 system of Upper Pine Creek listed in Table 31 all become part of a potential 4-3-2-1 connected suite when assembled with the Priority 1 occurrence of the size 3 system, Pine Creek. These Priority 2 occurrences require more evaluation before including them in the portfolio and assembling them as a connected suite.

Table 32. Priority 1 Occurrence Names in Western Susquehanna EDU

Baker Run	East Mine Hole Run	Left Fork Green Branch	Short Run
Bear Run	Elk Lick Run	Little Daugherty Run	SINNEMAHONING CR
Beaverdam Run	Elm Camp Run	Little Fourmile Run	SINNEMAHONING PORTAGE CR
Bell Branch	English Run	Little Indian Run	Slate Run
BENNETTE BR	Fahnestock Run	Little Kettle Creek	Sliders Branch
Big Spring Brook	First Big Fork	Little Lyman Run	Solomon Run
Billings Branch	FIRST FK	Little Slate Run	Spicewood Run
Boedler Branch	Fourmile Run	Lloyd Run	Straight Run
Bohen Run	Francis Branch	Lock Branch	Sulphur Run
Bolich Run	FREEMAN RUN	Long Run	SUSQUEHANNA R
Browns Run	Frying Pan Run	Lower Pine Bottom Run	Trout Run
Bruner Branch	Gamble Run	McClure Run	Upper Pine Bottom Run
Buck Run	Germania Branch	McCoy Run	Veley Fork
Bunnell Run	Gravel Lick Run	Miller Run	Walters Run
Cedar Run	Greene Branch	Mine Hole Run	WEST CR
Cherry Run	Hammersley Fork	Naval Run	Windfall Run
Cow Run	Hevner Run	Nelson Branch	Wingerter Run
CROSS FK	Hogstock Run	Page Run	Wykoff Branch
Cushman Branch	Hopper Run	PINE CR	Yochum Run
Daugherty Branch	Indian Camp Run	Red Rock Run	Young Womans Creek
Daugherty Run	Indian Run	Red Run	
DRIFTWOOD BR	KETTLE CR	Rexford Branch	
Driftwood Branch Sinnemahoning	Left Branch Fourmile Run	Right Branch Fourmile Run	
Dyke Run	Left Branch Young Womans Creek	Sawmill Run	
East Branch Cedar Run	Left Fork Beaverdam Run	Shanty Run	

Table 33. Priority 2 Occurrence Names in the Western Susquehanna EDU

BABB CR	English Run	Opossum Run
Bark Cabin Run	Flicks Run	Otter Run
Bear Run	Fourmile Run	PINE CR
Bennys Run	Hackett Fork	Pine Run
Big Run	Harrison Run	Ramsey Run
Black Moshannon Creek	Jacobs Run	Right Fork Mill Run
Blacks Creek	Lick Creek	Rock Run
BLOCK HOUSE CR	LICK RUN	Rogers Run
Blockhouse Creek	Lick Run	Sand Run
Bonnell Run	Little Fall Creek	Sebring Branch
Bonnell Run	LITTLE PINE CR	Shingle Mill Branch
Boone Run	Love Run	Silver Branch
Buckeye Run	McKees Run	South Creek
Bull Run	Mill Run	Steam Valley Run

Callahan Run	MOSHANNON CR	SUSQUEHANNA R
Carsons Run	Mosquito Creek	TEXAS CR
Custard Run	Muddy Run	Three Springs Run
Dam Run	Naval Run	Tombs Run
Dixie Run	Nickel Run	Trout Run
Dyke Creek	North Fork Tombs Run	Truman Run
		Wolf Run

How to interpret these results

All of the occurrences of Priority 1 and Priority 2 aquatic ecological systems identified in this plan as part of the ecoregional portfolio signify The Nature Conservancy's attempt to identify the best examples of aquatic biodiversity across the ecoregion. These occurrences should serve as a first iteration starting point for conserving the best examples of representative biodiversity throughout the High Allegheny Plateau. The aquatics portion of the HAL ecoregion plan presents a framework for thinking about conservation of aquatic systems, particularly in an ecoregion with heavily fragmented and disconnected aquatic systems.

Next Steps

Most, if not all, of the occurrences of aquatic ecological systems noted in this section of the HAL plan require a significant amount of additional assessment and evaluation with regards to the biodiversity represented by these coarse filter targets.

The following are some recommended next steps for filling data gaps and further analysis:

- Compile additional ecological data sources (macroinvertebrate, herptile atlases, fishery data sets, etc.) to develop a more complete list of species and community targets as well as improve understanding of AES
- Complete analysis of distribution goals for each EDU
- Better define/describe the biological, physical, and process components of HAL AES to better assess their significance in representing aquatic biodiversity at the EDU and ecoregional scales.
- Develop more ecologically based viability criteria and goals for HAL AES

Moreover, it is recommended that TNC and actively involved partners hold additional meetings and workshops with experts/partners to:

- Further evaluate the validity of and refine HAL AES and coarse-filter goals
- Refine GIS condition analysis and coordinate its use as a planning tool and as an adaptive tool to measure success at conservation areas and across the ecoregion for TNC and partners
- Review portfolio occurrence selection,
- Gather additional expert opinion data on aquatic systems throughout the ecoregion
- Refine and further implement use of HAL aquatic information database

The current condition and landscape context for each of the AES occurrences should be further documented and evaluated. Much of this work could be completed by additional expert workshops and interviews that could add information about stresses, sources of stress, conservation work currently underway, partners and potential partners within each EDU and across the ecoregion.

Additional planning needs include:

- Continue to assemble uniform data sets for use in ecoregional and conservation area planning which can be distributed to TNC OUs and partners working throughout the ecoregion *and* routinely updated with new information
- Detailed, multi-scale stresses and sources analysis
- Ecoregion, EDU and state-wide multi-scale strategies
- Develop a uniform criteria based process for prioritization of all ecoregional portfolio priorities (information gaps, conservation strategies, etc.)
- Identify, and include in future revisions of the HAL ecoregional plan, conservation work currently underway on aquatic targets (species, communities and ecological systems)
- Develop methodology and protocol for adding new information to the ecoregional data sets and rerunning analysis, and portfolio selection,
- Develop a series of impact (impact of specific conservation actions on the target occurrences) and process "measures of success" for the ecoregion
- Develop a timeline for next evaluation of at least the aquatics portion of the HAL ecoregional plan and portfolio.

The HAL aquatic planning team urges consideration of two broad recommendations for the next iteration of the aquatic portion of the HAL ecoregional plan: (1) more partner involvement to achieve significant buy-in to The Conservancy's process and product(s) and (2) a standardized process for ecoregional aquatics planning across HAL so that data and decisions are comparable across EDU, ecoregion and state boundaries.

The ecoregional planning process is inherently iterative and dynamic in nature; as new data become available and ecological conditions change in the ecoregion, the portfolio must change to reflect these and ensure conservation happens with the best available knowledge.