

Aquatic Resource Management Plan

Pennsylvania Department of Conservation and Natural Resources

Bureau of Forestry



pennsylvania
DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES

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Aquatic Resource Management Plan

Vision

Healthy aquatic resources with suitable habitat, functional buffers, good water quality, connectivity, and naturally occurring fluvial geomorphological processes to ensure overall healthy aquatic communities.

Introduction & Background

Aquatic resources include riparian ecosystems, aquatic ecosystems (surface waters), and groundwater systems. The scope and complexity of aquatic systems necessitates the need for managing water resources within the broader context of ecosystem management on state forest lands. The commonwealth began protecting watersheds in 1897 when the Legislature passed an act authorizing the purchase of unseated lands for forest reservations in the headwaters of each of the main rivers. The original purpose of the legislation was to enable land preservation to minimize flooding, assure suitable levels of water for navigation and power generation, and protect public water sources. One of the original purposes for establishing the state forest system was to protect forested watersheds, which remains a major part of the Bureau of Forestry's current mission. With 2.2 million acres of land, the bureau has the potential to benefit Pennsylvania's extensive water resources. This document focuses on surface water features including streams, rivers, lakes, and ponds. The purpose of this document is to give clear guidance on prioritizing and managing aquatic resources on State Forest Land.

Rivers and Streams

The water quality of densely forested watersheds is determined largely by the underlying geology, which influences the character of groundwater discharge into streams, especially at base flow, when nearly all the surface water is from groundwater discharge, or springs, into the stream bed. Forested land typically yield the highest surface water quality. Land uses other than forest can introduce a myriad of impacts into ecosystems that change the character of the water cycling through it and the manner with which it cycles. Streams are dynamic in nature, and should be allowed to undergo natural fluvial geomorphological processes. Streams should not be held in a static state since they are dynamic in nature. Adding artificial structures to lock the stream in place is detrimental to these natural processes. An exception where these artificial structures should be considered is where streams threaten infrastructure. It should be expected that there are areas of natural erosion, and areas of natural sedimentation in any stream. This allows the stream to move within the floodplain, meander, and form multi-threaded channels. Without these processes, we would not have a diversity of stream habitats including wetlands, oxbow lakes, meanders, undercut banks, and braided channels. Undercut banks resulting from erosion at bends in the stream provide habitat for multiple organisms such as fish, turtles, and salamanders. Streams in mature forests naturally have a large woody material component, which is vital to aquatic habitat and floodplain dynamics.

Major impacts to state forest streams include abandoned mine drainage, legacies of acidic precipitation, barriers to aquatic organism passage, and lack of habitat. The lack of longitudinal connectivity is a particularly widespread issue. The majority (83%) of assessed stream crossings on state forest land impede aquatic organism passage (AOP) to some extent. Additionally, dams restrict AOP altogether.

Approximately 23% of Pennsylvania's Species of Greatest Conservation Need (SGCN) utilize flowing waters as primary habitat, including 114 invertebrates, 44 fish, 1 reptile, and 2 amphibians. In addition to the fish commonly associated with streams and rivers, hellbenders, mudpuppies, watershrews, and the Louisiana waterthrush also depend on clean streams as habitat. By following the *Aquatic Habitat Buffer Guidelines* (AHBG), erosion and sedimentation control (E&S) Best Management Practices (BMPs), AOP at stream crossings, removing unneeded dams, and improving instream habitat where appropriate with large woody material (LWM), many species within the community will benefit.

Stream Miles on State Forest Land

| Total | EV | HQ | CWF | HQ-TSF | TSF | WWF |
|-------|------|------|-----|--------|-----|-----|
| 4996 | 1528 | 2699 | 639 | 3 | 90 | 36 |

Note: WWF = warm water fisheries

Lakes and Ponds

State forest lands contain numerous natural and human-made lakes and ponds. These bodies of water are valuable for both aquatic and terrestrial wildlife, and provide habitat for aquatic plants.

Approximately 10% of SGCN utilize lakes and ponds as primary habitat, including 39 invertebrates, 19 birds, and 10 fish. The bureau plans to take an active role in its management of lakes and ponds.

Examples include the improvement of wood duck and other waterfowl habitat, and warm water fisheries habitat on impoundments. By following the AHBG, E&S BMPs, and improving habitat where appropriate, the entire ecosystem including the SGCN will benefit.

Aquatic Resource Protection

Stream Classifications

One way protections are granted to streams is due to their DEP Chapter 93 classifications. Some streams may be upgraded simply because they were never assessed before, but have recently been assessed via the PFBC Unassessed Waters Program and wild trout were found to be present. This process can offer more regulatory protection for these streams. For instance, all wetlands that are hydrologically connected to a wild trout stream are considered Exceptional Value (EV) and are granted more protection. If a sufficient biomass of trout are found that equal or exceed PFBC Class A trout biomass designations, the stream can be further petitioned for classification as HQ-CWF (High Quality – Cold Water Fishery) with DEP, which further protects the stream. These assessments do not necessarily mean water quality has improved, but simply that these streams have been assessed and now have a more appropriate designation.

Shale Gas Water Quality Monitoring

The Bureau of Forestry has a Shale Gas Monitoring Team that monitors water quality in the core gas districts in north-central Pennsylvania. The main concerns regarding water quality in areas subject to gas development are from inadvertent discharges of chemicals and salts, and soil erosion and sedimentation from infrastructure. Streams are monitored using grab samples, continuous instream monitoring devices, and macro-invertebrate sampling to detect water quality changes through time. Lastly, erosion

potential is assessed at the source by examining conditions on the ground such as vegetative cover and the effectiveness of erosion and sedimentation control measures. The bureau partners with the Susquehanna River Basin Commission (SRBC), USGS, and DEP in this monitoring effort.

Aquatic Habitat Buffer Guidelines

The bureau has established aquatic habitat buffer guidelines to protect areas around wetlands, vernal ponds, spring seeps, streams, lakes, ponds, and impoundments from management activities that might affect such ecosystems. These guidelines provide a standard set of operating procedures to be followed when conducting management activities in or near aquatic habitats on state forest land. The aim is to promote terrestrial factors that will positively influence aquatic health. Management efforts are intended to focus on providing connectivity, wildlife habitat, and protecting water quality. The following guidelines apply to all aquatic habitat buffers:

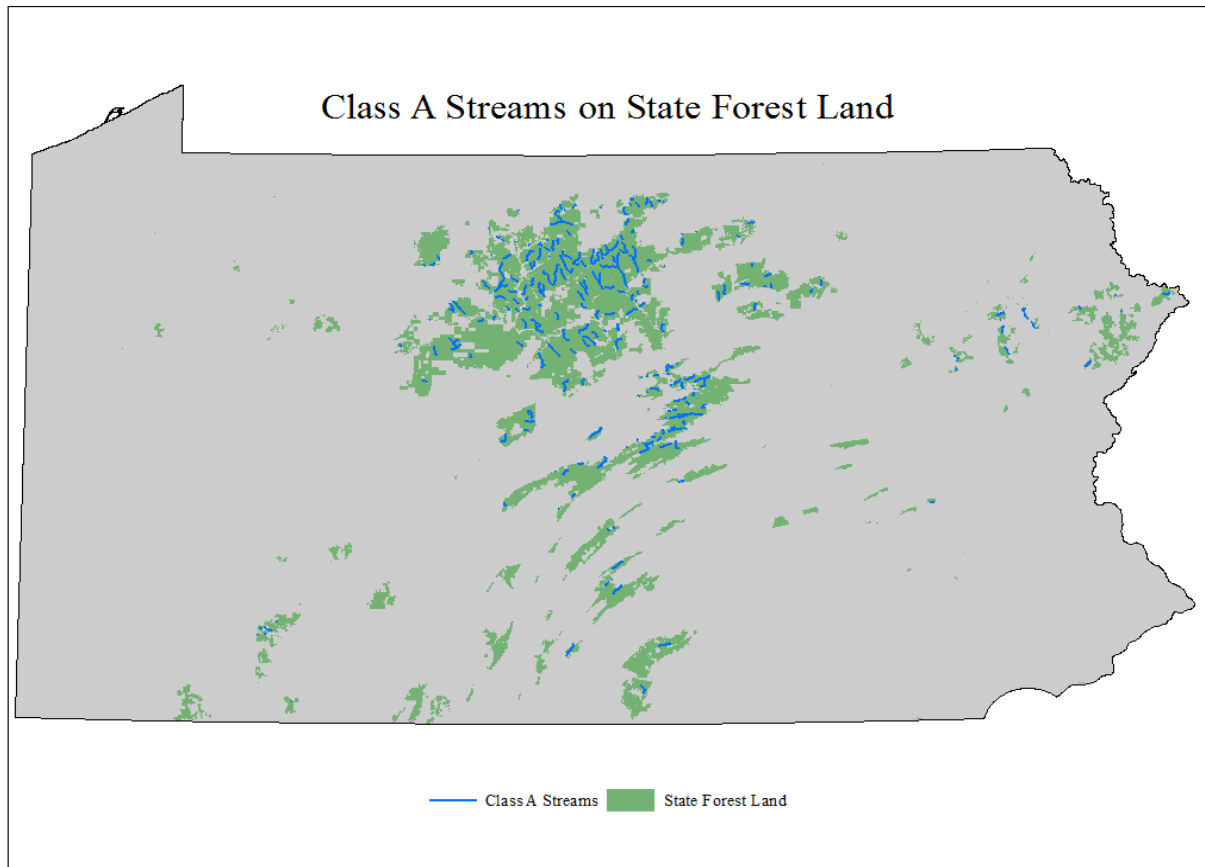
- Earth disturbance activities should be avoided whenever possible.
- Snags and cavity trees should be retained as they provide exemplary habitat for bats, woodpeckers, and other cavity nesters.
- Dead and downed woody material should be retained. It creates critical microhabitat for many species and provides large reservoirs of organic matter needed for nutrient cycling.
- Downed woody material in the stream provides critical habitat for the aquatic community
- Downed woody material on the floodplain slows flood waters and helps restore floodplain hydrology

The width of aquatic habitat buffers varies for different habitat types. For example, widths are greater for Exceptional Value versus High Quality streams. Each buffer has both an inner zone and outer zone. The inner zone functions as a core area of protection that allows minimal human disturbance. For instance, tree cutting is only permitted in the inner zone for the protection of property or human safety or to occasionally recruit habitat factors that will positively affect the aquatic ecosystem. The outer zone functions as a transition area. The goal of this zone is to maintain a diverse community of tree, shrub, and herbaceous plants and vertical stratification.

Non-forested or understocked riparian areas should be planted unless it is a natural, functioning wetland. Stream banks can be stabilized by live-staking riparian shrubs and trees along the stream bank. This practice is explained in the Bureau's *Planting and Seeding Guidelines*. Consideration should also be given to the future of hemlock dominated riparian areas. With the decline due to hemlock wooly adelgid (HWA), many of these riparian areas are at risk. These areas should at a minimum be surveyed and treated for invasive species. Proactive tree planting of native riparian trees under declining canopies can ameliorate the effects of dying hemlock.

Brook Trout Conservation Plan

Brook trout are indicators of superior water quality. The thousands of stream miles on state forest lands provide quality habitat for brook trout, a species that has already been extirpated from 70 percent of its historic range. Species whose fragility has been documented often need specific strategies to ensure long-term survival; therefore, the bureau has a unique responsibility to conserve this keystone species on state forest lands. The bureau has developed a *Brook Trout Conservation Plan* that establishes goals and objectives for brook trout conservation, provides an assessment of the most important threats, and recommends management actions for goal achievement.



Map showing Class A Trout Streams on State Forest Land

Erosion and Sedimentation Control

Erosion and sedimentation is a concern for aquatic ecosystems. New disturbances that remove existing vegetation, such as gas pads, parking lots and in particular, dirt and gravel roads, if not managed properly can be a source of increased runoff, erosion, and ultimately sedimentation. Surface water that is diverted from its natural course changes the adjacent soil moisture regimes potentially impacting vegetation, invertebrate, amphibian and reptile demographics. Lastly, sediment generated from erosion ultimately migrates to and impacts aquatic habitats.

The bureau addresses erosion and sedimentation control in the *Silviculture Manual* to minimize impacts of forest management on aquatic resources. The bureau is examining how surface water management, including Post-Construction Stormwater Best Management Practices, may be impacting aquatic and terrestrial ecosystems. The bureau works closely with the Penn State Center for Dirt and Gravel Road Studies to develop and implement environmentally sensitive maintenance practices in order to greatly reduce the risk of erosion and sedimentation while maintaining natural surface flow patterns. These practices can also be used in the bureau's management of trails and other infrastructure. The Dirt and Gravel Roads Program was started to address road issues that were impacting streams. With this in mind, an emphasis should be placed on projects such as application of Driving Surface Aggregate (DSA) or stream crossing replacements where the problem roads are impacting streams or blocking aquatic

organism passage on state forest land. High Quality (HQ) and Exceptional Value (EV) streams should get priority when considering Dirt and Gravel roads projects.

Pipeline Stream Crossing BMPs

Stream habitat is abundant across DCNR lands and provides habitat for an entire community of organisms. This includes, but is not limited to, invertebrates, reptiles, amphibians, and fish. Riparian areas are critical to stream health as they provide stream bank stability, shade for the stream, filter capabilities of runoff, food input to stream ecosystem (foliage and terrestrial insect input), nesting habitat for songbirds, food for wildlife (mast/berries), and a visual screen. Care must be taken when considering a pipeline-stream crossing to minimize impacts to the aquatic community. The bureau has established best management practices to help ensure ecological integrity at pipeline stream crossings including, but not limited to:

- Reduce Right-of-Way (ROW) width in the riparian area
- Re-establish native riparian vegetation along the stream



Pipeline stream crossing

Stream Restoration and Enhancement

The bureau has a goal of providing healthy cold-water streams with suitable habitat, functional buffers, good water quality, and connectivity to ensure an overall healthy native aquatic community. In order to maintain stream health, the ecosystem approach must be taken at the watershed level. This includes maintaining and improving forested riparian areas, removing barriers to migration, treating invasive species, minimizing anthropogenic erosion and sedimentation, and improving habitat where it is lacking (**SFRMP Water Goal 2: To conserve and enhance riparian, wetland, and aquatic ecosystems and their ecological function, DCNR Common Waters Goal 2: Conserve, protect and restore surface water**

resources and aquatic ecosystems on DCNR lands, and share best practices). When considering aquatic restoration, the following priorities can help plan activities. Due to the sensitive nature of cold-water streams, they are a high priority for restoration. Cool-water streams and rivers are lower priority due to their inherent tolerance to disturbance such as temperature alteration. Dam removal is especially critical for cold-water streams supporting wild trout, with an emphasis on Class A brook trout streams and EV streams.

Efforts can also be made to improve streams to the point where they can then be reclassified to the next higher DEP or PFBC classification (**SFRMP Water Goal 5: *To remediate impaired water resources due to point- and non-point source pollution***). With this objective in mind, efforts should be made to improve HQ streams to EV, and improve Cold Water Fisheries (CWF) where possible, as well as improve trout biomass in wild trout streams to Class A biomass. Impaired streams should be identified and evaluated for rehabilitation. This could include addressing erosion and sedimentation issues (E&S), conducting riparian buffer plantings, performing stream bank stabilization, and treating acidified streams.

Treating Acid Precipitation Impacted Streams

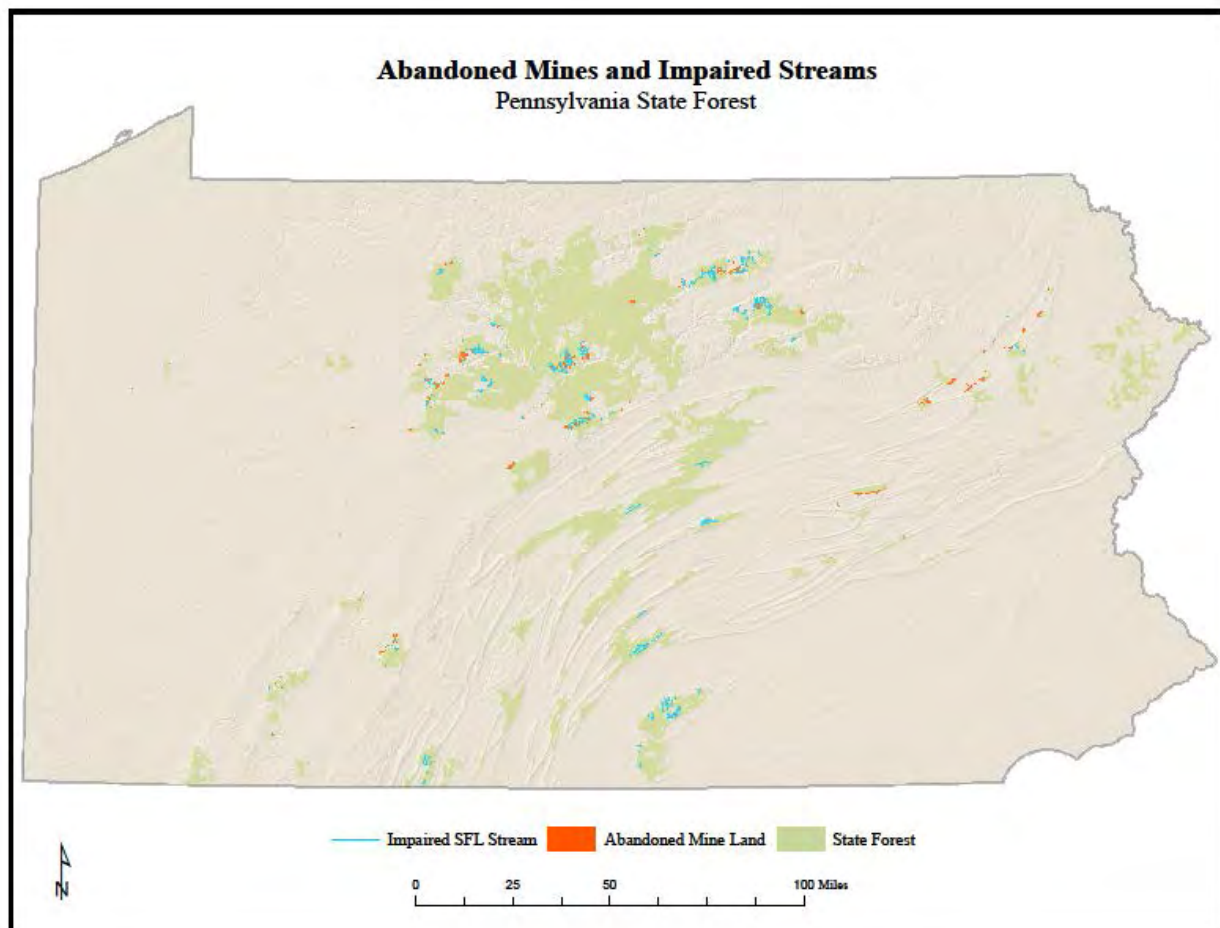
Acid precipitation has impaired an estimated 215 miles of streams on state forest land, resulting in lower pH and a loss of base cations in the soils of the watershed. Streams are a product of watersheds. To properly treat streams impacted by acid precipitation, the watershed must be treated. This can be done by liming within the cation depleted watershed. By liming the watershed, aluminum hydroxides and sodium aluminosilicates are kept in the soil instead of precipitating out in the stream. Soil tests are needed to determine the amount of limestone required to restore a watershed. Limestone based Driving Surface Aggregate (DSA) also has a positive impact on stream pH. Dosing streams with lime sand is a temporary solution to a symptom with some negative impacts to stream health, and should be avoided when possible. Lime sand covers available substrate, and allows toxic metals to drop out of solution and cover stream substrate and habitat. A query of the Clean Water Act 303b layer in FIMS will indicate whether the stream is impaired from acid precipitation, abandoned mine drainage, or other reasons.

Treating Abandoned Mine Drainage Streams

Abandoned Mine Drainage (AMD) has many detrimental impacts to Pennsylvania's streams. Characteristics of AMD impacted streams are high levels of dissolved metals such as iron, aluminum, manganese, or sulfate, and impaired pH. AMD impacted streams can be completely devoid of aquatic life, but typically have reduced productivity, lack macro-invertebrate diversity and abundance, and reduced or absent fish populations. There are currently 226 estimated stream miles of AMD impaired streams on state forest land. A query of the Clean Water Act 303b layer in FIMS will indicate whether the stream is impaired from abandoned mine drainage.

Streams impacted by AMD can be treated by various methods. The preferred method is to treat the actual source by restoring Abandoned Mine Lands (AML), particularly if these AMLs are exposed to the surface. Locations of AML sites can be found by investigating the AML layers in FIMS. Restoration of AML sites is typically accomplished by removing residual coal and spoil piles, removing the spoil, isolating spoil piles from runoff reaching the spoil piles, re-grading the topography, applying basic material, capping spoil piles with soil, reducing compaction, revegetating the area with native plants, or a combination of the above techniques. The Surface Mining Control and Reclamation Act prioritizes funding reclamation projects as follows: (1) public health and safety from extreme danger, (2) public health and safety from

adverse effects, and **(3)** natural resource and environmental concerns. The Watershed Manager at the DEP District Mining Office and the County Conservation District can help with restoration planning. Restoring the AML is the best option since it addresses the source of water quality issues and results in improved stream water quality and aquatic habitat down-stream. Restoring AML sites also provides a great opportunity to improve terrestrial habitat by providing early successional and pollinator habitat by using a native seed mix of native warm season grasses and wildflowers, especially legumes. Refer to the Bureau of Forestry's *Planting and Seeding Guidelines* for information on seed mixes. These areas can also be reforested in addition to the use of a native seed mix application. When restoring the AML or source of water quality degradation is not an option, or AMD is still an issue after AML restoration, passive treatment at the source is preferred. The treatment method is highly dependent on equipment accessibility, land available, topography, water chemistry, water quantity, and the ability to maintain the structure. Most passive treatment methods have estimated lifespans of 15 – 20 years or longer, and require periodic maintenance. Dosing streams with lime sand is a temporary solution to a symptom with some negative impacts to stream health, and should be avoided. Lime sand covers available substrate, and allows toxic metals to drop out of solution and cover stream substrate.



Map showing Abandoned Mine Lands and Impaired Streams on State Forest Land

Introduction of Large Woody Material

Due to timber harvesting practices in the 1800s, many of the streams on state forest land lack the large woody material component normally found within mature, forested landscapes. Healthy old-growth forest streams often have around 60 pieces of large woody material per 300 feet of stream. With maturing stream buffers, this is the long-term target for woody material in streams on state forest land. This woody material can be a beneficial habitat component for the aquatic community, including brook trout and wood turtles. Large woody material can increase habitat diversity in a homogenous stream reach by creating scour and plunge pools, providing cover for trout and wood turtles, and providing substrate and food for aquatic invertebrates on which the trout feed. Large woody material will naturally accumulate in streams, given sufficient time for riparian trees to mature, die, and eventually fall into the stream. Until then, large woody material can be added to streams where habitat diversity is lacking by directionally felling trees into the stream channel. The bureau has guidelines for projects that introduce large woody debris into streams that lack habitat diversity. These guidelines provide an option for improving stream habitat that emulates natural disturbance. The purpose of this practice is not to reach baseline levels of woody material found in streams within old growth forests, but rather to give the stream a head start by adding key pieces of woody material that will then collect other material. A target of 30 pieces of large woody debris per 300 feet of stream is suitable for large woody material projects. Stream selection for habitat improvement is based on the PFBC Priority 1 Streams for Habitat Improvement with an emphasis on brook trout streams. This practice can also be implemented in association with culvert replacements both upstream and downstream of the crossing to ameliorate the impacts of potential stream downcutting. In general, log vane deflectors should be avoided on state forest land unless stream bank erosion is threatening infrastructure. Log vane deflectors essentially channelize streams, and may hamper efforts to restore the hydrology of the floodplain. Also, naturally undercut banks provide habitat for multiple organisms including fish, turtles, and salamanders, while bank swallows can utilize vertical banks for nest sites. Naturally meandering streams also creates critical habitat such as oxbow lakes and wetlands.



Large woody material added to a stream on State Forest Land

Hellbender Habitat Improvement

Eastern Hellbenders, Pennsylvania's largest salamander species, are fascinating creatures. This totally aquatic salamander requires clean, cold water and feeds primarily on crayfish. They also need large, unburied rocks within the stream to hide under and lay eggs. Hellbender reproduction occurs under large nest rocks with females laying eggs from late August through September and hatch in late October, which are guarded by the male through hatching and early development. Hellbenders are usually nocturnal and rarely seen except during breeding season. Hellbender populations have declined over the years, but protecting water quality, ensuring Aquatic Organism Passage (AOP), and providing in-stream habitat can help this salamander. Following the Aquatic Habitat Buffer Guidelines (AHBG) helps maintain high water quality, and utilizing the Culvert BMPs ensures AOP. The following activities can also improve the habitat for Eastern Hellbenders.

To improve stream habitat for Hellbenders, large, flat sedimentary rocks are placed into streams where they are not already abundant. The focus is on 2nd to 4th order streams at least 20 feet wide (bankfull width). Streams with fine substrate, siltation issues, or pool areas in gravel/cobble substrate streams should be avoided due to the risk of being smothered. This practice can also be incorporated into fish habitat improvement and bank stabilization projects. By implementing this, we will be providing Hellbenders with additional places to hide and reproduce, potentially sustaining or boosting their populations. In addition to Hellbenders, this practice benefits Mudpuppies, coolwater fish such as Darters, Sculpins, and Minnows, and aquatic invertebrates as well.

Streambank Stabilization

Accelerated or human induced erosion of streambanks can be stabilized by many techniques. Where infrastructure is threatened, log vane or stone deflectors can be used to direct the thalweg away from the bank. Soil bioengineering to include live-staking is another option to protect the streambank. Guidance on live-staking is included in the *Planting and Seeding Guidelines*. Protecting, enhancing, or planting forest buffers will also improve streambank stability. Implementing Large Woody Material projects upstream of problem areas will reduce stream velocity and flood peaks at the problem area. Rip-rap should be considered as a last resort, and used in combination with the already mentioned practices. At a minimum, rip-rap should also incorporate live-staking between joints.

Riparian Forest Buffers

Riparian forest buffers are critical to stream health. These buffers shade the stream, act as filters, contribute food to the stream ecosystem, are sources of future LWM for the stream, and help stabilize stream banks. The bureau maintains buffers by following the *Aquatic Habitat Buffer Guidelines*. In addition to this, understocked riparian buffer areas should be planted unless it is a natural functioning wetland. Declining riparian hemlock stands should be evaluated for underplanting with native species as described in the guiding document: *Mitigating Hemlock Loss in Riparian Areas*. Invasive plants in the riparian buffer should be monitored and treated with an aquatic labeled herbicide. Invasive plants displace native riparian vegetation and do not benefit the stream as native vegetation does. Maintaining healthy riparian forest buffers is especially critical to stream temperatures and erosion control with concerns of climate change impacts on streams.

Stream Crossings and Aquatic Organism Passage

Aquatic organism passage (AOP) through stream corridors, including intermittent streams, is vital to the health of aquatic communities by providing connectivity. Connectivity is important for dispersal and access to suitable habitat such as spawning areas and colder water refugia.

Aquatic organisms, including fish, invertebrates, reptiles, and amphibians can experience difficulty in passing road culverts depending on the characteristics of the culvert. Common problems with culverts are blockages, undersized structures, and incorrect installation typically resulting in a perched outlet. Desired stream crossings are not perched, undersized, and have substrate throughout the crossing. The bureau has Culvert Best Management Practices that will minimize the impacts of stream culverts on aquatic ecosystems. Bottomless structures are the preferred method for stream crossings due to minimal disturbance of the streambed. The goal is to have a streambed and stream banks throughout the stream crossing that resembles existing stream conditions. Sizing stream crossings to accommodate AOP also typically results in larger structures than the minimum regulatory requirement. These larger AOP compliant structures have the added benefit of being more resilient to storm and flood events, a major concern of climate change impacts. When replacing a culvert that restricts AOP with a structure allowing AOP, there is a risk of stream downcutting upstream of the structure. Implementing a LWM project upstream and downstream of the crossing can ameliorate the risk of potential downcutting.

The Bureau of Forestry also conducts stream culvert assessments using the North Atlantic Aquatic Connectivity Collaborative (NAACC) protocol. Assessed culverts yield data on the condition of stream crossings on state forest land in regards to AOP. The data is used to determine if the crossing is a barrier to organism passage, and if so, to what extent. This information assists the bureau prioritize culverts for replacement or repair. The end goal is for the road to not impact the stream. The following is a list of priorities to consider when replacing stream crossings, from highest to lowest priority.



Culvert being assessed for Aquatic Organism Passage

Priorities for Culvert Replacement

1. Failing critical infrastructure
2. Assessed as No AOP
 1. Class A brook trout streams
 2. Exceptional Value (EV) streams
 3. Wild brook trout streams
 4. High Quality (HQ) streams
 5. PFBC Stream Priority 1 for habitat improvement
 6. NAACC priority tool (length of stream reconnected)

| District | Count of Stream Crossings |
|--------------------|---------------------------|
| 1 – Michaux | 307 |
| 2 – Buchanan | 90 |
| 3 – Tuscarora | 106 |
| 4 – Forbes | 95 |
| 5 – Rothrock | 191 |
| 6 – Gallitzin | 36 |
| 7 - Bald Eagle | 218 |
| 8 - Clear Creek | 27 |
| 9 – Moshannon | 235 |
| 10 – Sproul | 333 |
| 11 – Pinchot | 55 |
| 12 – Tiadaghton | 125 |
| 13 – Elk | 293 |
| 14 – Cornplanter | 15 |
| 15 – Susquehannock | 258 |
| 16 – Tioga | 236 |
| 17 - William Penn | 4 |
| 18 – Weiser | 10 |
| 19 – Delaware | 69 |
| 20 – Loyalsock | 189 |
| Grand Total | 2892 |

Table of estimated crossings per district using FIMS to find road and stream intersections

Dirt and Gravel Roads Program

The Dirt and Gravel Roads Program was initiated to address road issues that were impacting streams.

“The purpose of the Program is to create a better public road system with a reduced environmental impact. The program focuses on Environmentally Sensitive Road Maintenance Practices that reduce the impact of road runoff and sediment to local streams, while reducing long term road maintenance costs.”

This statement corresponds with the bureau’s goals of protecting and improving water resources. “Only

projects that provide some form of environmental benefit, typically by reducing sediment and concentrated drainage to waterways, should be considered for funding.” With this in mind, an emphasis was historically, and still is being placed on projects where the problem roads are impacting streams on state forest land. Prioritizing projects that impact HQ and EV streams and wild trout streams benefits these streams dramatically. It must be understood that the source of the problem must be addressed. This includes looking at topography and designing the project to extend to the source of the problem, which may be some distance uphill of where the road is close to the stream. The Recreation Section can provide more guidance on the Dirt and Gravel Roads Program.

Human-made Dams

The Bureau has 39 human-made dams, some of which no longer serve the purpose they were designed to provide. This number fluctuates as some dams are removed periodically, and some dams are gained through acquisitions. Removing dams that no longer serve a useful purpose is a priority for the Bureau of Forestry and the DCNR. These unneeded dams should be identified and prioritized for removal to restore natural stream flow and connectivity. Dams create barriers to aquatic organism passage, result in higher water temperatures, decrease dissolved oxygen, and alter the flow and sediment regime of the stream. These impacts can drastically alter the aquatic community. In addition to the ecological impacts, dams may pose a threat to human populations or the economy. Dams are classified by DEP in respect to hazard potential ranging from 1 being the highest risk, to 4 being the lowest risk. Removing unneeded dams can help restore the aquatic ecosystem, reduce unwanted risk, and relieve the bureau of unwanted liability. The restoration phase should incorporate the *Dam Breeches/Repairs Native Seed Mix* (on Intraforestry Eco site) followed by native tree and shrub plantings. Where dam removal is not an option, alternatives to provide aquatic organism passage, such as bypass channels, should be explored. If a dam is retained, tree buffer plantings should be used to protect water quality and shade the water, minimizing the impacts of the impoundment on stream temperatures. These plantings can either be focused in one area, such as the south side to shade the impoundment, or planted at wide enough intervals to not interfere with recreational use of the lake or pond. The following list illustrates priorities for dam removal, from highest priority to lower priority.

Priorities for Dam Removal

1. High hazard dams
2. EV Streams
3. Class A brook trout streams
4. Wild brook trout streams
5. PFBC Stream Priority 1 for habitat improvement

Legacy Sediments

Legacy sediments are the silt, sand, and clay that are left behind after a dam is removed. Some of these are obvious in the case of recent dam removals. Other legacy sediments are a relic from the colonial mill dams. These legacy sediments are a source of erosion and sedimentation, and nutrient input to receiving waters. Where practical, legacy sediments should be addressed by following the *Floodplain Restoration BMP* in the *DEP Pennsylvania Stormwater Best Management Practices Manual*. Any legacy sediment removal projects must be followed up with a native seed mix applied to the exposed soil. In addition, the streambank should be live-staked, and appropriate native shrubs and trees should be planted in the riparian buffer.

Beaver Dams

Beaver dams on streams provide unique and valuable habitat diversity. Turtles, amphibians, snakes, wetland birds, ducks, and wetland vegetation all benefit from beaver dams. Our stream communities have co-evolved with beaver presence. Beaver dams should not be breached unless they are threatening infrastructure. Beaver dams typically do not act as a barrier to fish passage, and do not increase water temperature beyond the short term lethal threshold for trout. Most beaver dams are relatively small and temporary in nature, and provide pond and wetland habitat. The wet meadows resulting from abandoned beaver dams are also valuable and under-represented habitat.



Diversity created by a beaver dam

Lake and Pond Enhancement

State forest lands contain numerous natural and human-made lakes and ponds. These bodies of water are valuable for both the aquatic and terrestrial wildlife, provide habitat for aquatic plants, and are utilized for various recreational activities. Lakes and ponds typically support coolwater to warmwater fisheries. The bureau is taking an active role in its management of lakes and ponds (**SFRMP Goal 3: To manage lakes for their ecological and recreational values, DCNR Common Waters Goal 2: Conserve, protect and restore surface water resources and aquatic ecosystems on DCNR lands, and share best practices**).

Waterfowl Habitat Improvement

Puddle ducks, such as the mallard, American black duck, gadwall, northern pintail, green-winged and blue-winged teals, wigeon, and the northern shoveler may inhabit lakes and ponds on state forest land. By restoring native wetland vegetation for food and cover, and providing nesting opportunities, puddle ducks and other wetland birds and mammals will benefit.

Wood Duck Habitat Improvement

Wood ducks are our most colorful ducks, and are a popular gamebird. They are associated with forests and nest in cavities. Common habitat includes wooded areas along wetlands and waterbodies such as lakes and rivers. Wood ducks inhabit areas with abundant shrub and herbaceous cover. Lakes or ponds at least 1 acre in size within 100 feet of a stream or wetlands that already provide habitat should be the focus for habitat improvement. Creating habitat where none already exists may not be practical or feasible. The Bureau of Forestry has established *Wood Duck Habitat Improvement Guidelines* entailing vegetation management and nest box placement.

Impoundment Fish Habitat Improvement

Fisheries habitat can be improved in impoundments by applying the principals contained in the *PFBC Lake and Pond Habitat Improvement Guide*. Habitat improvement in impoundments can provide shelter for forage fish on which game fishes feed. The PFBC Division of Habitat can provide technical guidance if necessary.

Aquatic Invasive Plant Management

Aquatic invasive plants pose a threat to the aquatic ecosystem, and may limit recreational activities on lakes and ponds. Examples of common aquatic invasive plants in Pennsylvania include: Curly-leaf Pondweed (*Potamogeton crispus*), Eurasian Watermilfoil (*Myriophyllum spicatum*), Narrowleaf Cattail (*Typha angustifolia*), Hydrilla (*Hydrilla verticillata*), Water Chestnut (*Trapa natans*), Common Reed (*Phragmites australis*), and Purple Loosestrife (*Lythrum salicaria*).

Preventing invasive plant colonization is the first step in invasive plant management. Educational signs explaining prevention steps can help this effort. Existing populations of aquatic invasive plants are often managed by mechanical removal and the use of aquatic labeled herbicides. Contact Ecological Services for more information.

Summary

The Bureau of Forestry is taking a proactive approach to enhance and maintain its aquatic resources. It is important to remember that streams and other surface water features are a product of their watersheds. This indicates many stream issues will require land management techniques. This ties in very well with ecosystem management, and the ties between terrestrial and aquatic systems. By following existing guidelines to protect aquatic resources, addressing threats such as barriers to migration and AMD, and providing habitat where it is lacking, the bureau will have a positive impact on aquatic habitat in Pennsylvania.