2016

Brook Trout (*Salvelinus fontinalis*) Conservation Plan

Pennsylvania Department of Conservation and Natural Resources

Bureau of Forestry

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pennsylvania

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

EXECUTIVE SUMMARY

Brook trout are the official state fish and are important to the Commonwealth for numerous reasons. They are indicators of superior water quality, provide recreational angling opportunities, and are a symbol of our state's outdoor traditions. The brook trout is a char, and is the only salmonid native to the cold water streams of Pennsylvania.

This conservation plan provides the framework for conserving brook trout (*Salvelinus fontinalis)* and the associated habitat on Pennsylvania State Forest land. The Bureau of Forestry, through sound ecosystem management, maintains a healthy, viable forest for many species of plants and wildlife. However, some species may need specific strategies for long-term survival, such as keystone species or those whose populations are in decline. Prioritizing the conservation of brook trout on Pennsylvania's State Forest lands is consistent with conservation efforts throughout its native range in the eastern United States as evidenced by the Eastern Brook Trout Joint Venture, as well as the Pennsylvania Fish and Boat Commission's (PFBC) listing of the brook trout in its State Wildlife Action Plan as a species of greatest conservation need (PFBC 2007, PGC & PFBC 2015).

The Pennsylvania Bureau of Forestry's 2.2 million acres of Forest Stewardship Council (FSC) certified "well-managed and sustainable" land provide thousands of stream miles critical for brook trout. This is especially important considering that brook trout have been extirpated or greatly reduced from over 70% of the sub-watersheds in which they historically occurred (EBTJV 2005). The Pennsylvania Bureau of Forestry therefore, has a unique responsibility to conserve and protect this keystone species.

While the contents of this plan are designed for use on State Forest lands, the principles and recommendations are equally applicable to private forestlands, and can be promoted and adopted by forestland owners and forestry consultants wherever possible. It is also recommended that individuals contact the PFBC if they have questions regarding brook trout management or habitat requirements.

This conservation plan presents 1) an identification of the conservation goal and objective targeted by the plan 2) an assessment of the threats believed to be the most current and important to the status of brook trout on State Forest Land, and 3) recommended conservation and management actions whose implementation would help attain that goal.

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Section I

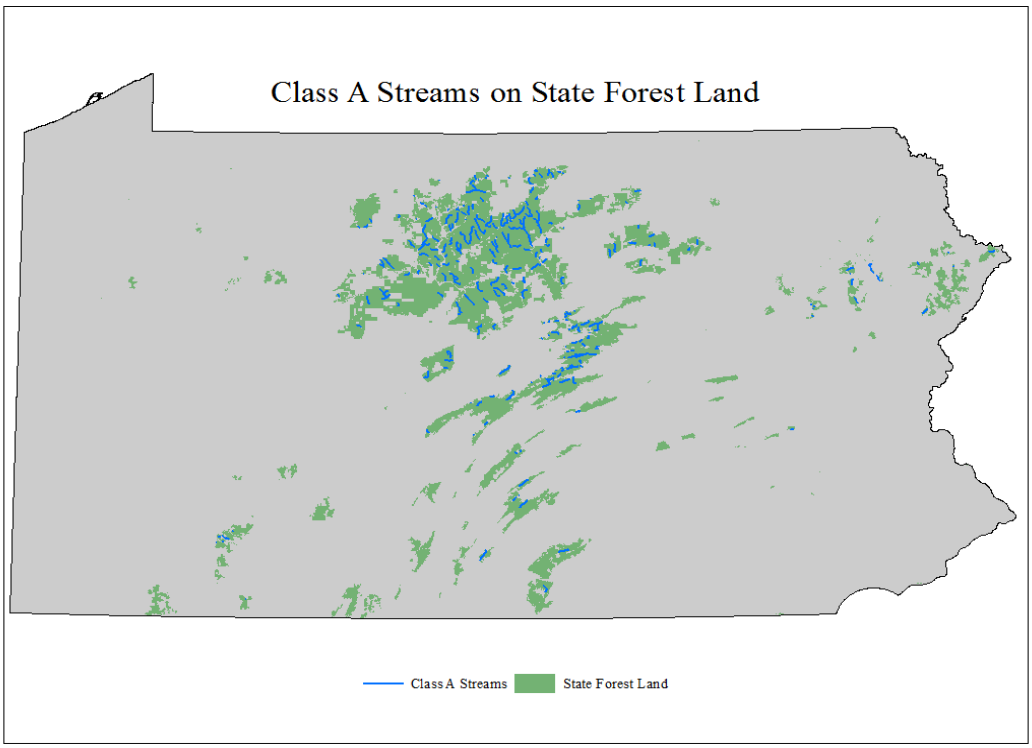
ROLE OF STATE FOREST IN BROOK TROUT CONSERVATION

The brook trout (*Salvelinus fontinalis)* is the only salmonid native to the cold water streams of Pennsylvania and is the Commonwealth's official state fish. Brook trout serve as indicators of high water quality and the health of the watersheds they inhabit and can provide early warning that the health of the entire system is at risk. The brook trout is a recreationally and culturally important species.

Although Pennsylvania supports a considerable wild brook trout resource, many of the historic threats persist and new challenges place additional stresses on the landscape and its remaining brook trout habitat. The Bureau of Forestry sustainably manages 2.2 million acres of forestland in Pennsylvania, which contains many miles of brook trout habitat. This represents large blocks of contiguous forest where many high quality brook trout streams exist. Prioritizing the conservation of brook trout on Pennsylvania's State Forest Lands is consistent with conservation efforts throughout its native range in the eastern United States as evidenced the Pennsylvania Fish and Boat Commission's (PFBC) listing of the brook trout in its State Wildlife Action Plan as a species of greatest conservation need (PFBC 2007, PGC & PFBC 2015). It is imperative that the Bureau of Forestry continually evaluates and implements effective brook trout conservation strategies and practices.

The goal of the Pennsylvania Bureau of Forestry Brook Trout Conservation Plan is to:

- *Maintain and implement strategies to sustain and enhance healthy, naturally reproducing brook trout populations on State Forest Lands.*



Section II

BROOK TROUT HISTORY

Brook trout are members of the family Salmonidae, represented by salmon, trout, char, whitefish, and cisco. The chars, such as the brook trout, evolved from the salmon and true trout. Chars had a slightly different physiology from their contemporaries, allowing them to move into and successfully colonize waters colder than other fish could tolerate as glaciers began to infringe upon the Northern Hemisphere (Karas 1997).

Brook trout distributions were profoundly impacted by glaciers. During glacial periods, the ice front advanced and retreated in pulses, each lasting thousands of years. During advances, ice sheets flowed south to the northern border in the center of Pennsylvania and about halfway south into the northeast and northwest corners of the Commonwealth (Karas 1997).

The glaciers that reached the northeast and northwest corners of Pennsylvania filled the valleys with glacial till and smothered their streams. The tops of the rest of the mountains in Pennsylvania were spared the glacial movement. When the southern periphery of the glaciers in New York began to melt, water emptied into the headwaters of the Susquehanna River. This became a temporary highway for the northward recolonization of the brook trout from Virginia and Maryland, giving brook trout in Pennsylvania the opportunity to start moving up the state's numerous river systems. At this time brook trout were distributed everywhere over the state (Karas 1997).

BACKGROUND

Pennsylvania has some of the finest trout fishing in the country (Karas 1997). Currently, 370 stream sections, with over 930 miles of stream, have been identified by biologists as having exceptional populations of wild brook trout and have been designated by the PFBC as Class A Wild Trout Streams (PFBC 2016). The reason Pennsylvania can lay claim to so many brook trout streams is because of its northerly latitude and unique geology. The Appalachian Mountain range, running through the state, consists of long, steep, parallel ridges with deep, river-filled valleys between them.

Historically, brook trout were present in nearly every cold water stream and river in the eastern United States (MacCrimmon and Campbell 1969). Unfortunately, historical land uses altered the landscape, greatly diminishing the presence of brook trout across Pennsylvania. The result of widespread timbering led to the decrease in forested riparian buffers, increased erosion, and elevated water temperatures, causing many streams to become unsuitable for brook trout. Pennsylvania is also a producer of coal which often resulted in chronic pollution from acid mine drainage. Unable to thrive in poor water quality or degraded habitats, the decline in brook trout populations mirrored the broader decline in the health of the region's lands and waters. Although reduced from historical population levels, brook trout continue to be distributed across a broad range of the state.

There are approximately 3,774 wild brook trout stream sections (9,858 miles) across Pennsylvania (D. Nihart, PFBC personal communication). This is a conservative number and only includes those waters where stream surveys have been conducted. Much of this resource is fragmented and largely exists in first through third order headwater streams. The primary strongholds for wild brook trout populations occur within the Northern Tier and center regions of the state, which contain the largest blocks of State Forest Land. Although Pennsylvania supports a considerable wild brook trout resource, stressors continue to persist and threaten the landscape and its remaining brook trout habitat. Therefore, it is more important than ever to ensure adequate measures are implemented to sustain healthy, naturally reproducing populations of brook trout on state forest land and across the state.

LIFE HISTORY

General Habitat

Brook trout are the most generalized and adaptable of all *Salvelinus* species (Raleigh 1982, Karas 1997). Brook trout habitat in Pennsylvania is typically first, second and third order headwater streams, especially silt-free, spring-fed, riffle-run areas that usually contain mixed gravels, cobbles and sand bottoms (Heft 2006, Raleigh 1982). Well vegetated and stable stream banks are important in the formation and protection of in-stream conditions found along undercut banks and under woody debris or large rock ledges used for resting, feeding, and escape cover. Habitat type varies with the size of the stream and local geology.

Cover Requirements

Cover is one of the most essential components of brook trout streams, directly influencing the population size a stream can support. Cover can consist of in-stream objects (large rocks, stumps, logs, and roots), overhanging vegetation, submerged vegetation, rocky substrate, depth, and water surface turbulence (Giger 1973, Raleigh 1982, Heft 2006). Cover for adult brook trout should be located in areas with low stream bottom visibility, suitable water depth, and low current velocity. Canopy cover is critically important in maintaining shade for stream temperature control and in providing terrestrial materials, such as woody debris and leaf litter, to the stream. In addition, a well vegetated riparian area protects the stream against watershed degradation.

Salmonids travel up and down stream to occupy different habitats in winter and summer. The amount of adequate overwintering habitat rather than summer rearing habitat has been indicated as a major limiting factor in salmonid densities in some streams (Raleigh 1982, Heft 2006). Bustard and Narver (1975) indicated that winter water temperatures between 4-8 °C trigger hiding behavior. By hiding within or near cover, trout are protected from physical damage from ice and conserve metabolic energy.

Instream Flow

Another critical habitat parameter in trout habitat is the annual flow regime. The most critical period is typically during late summer and winter when the lowest flows are usually detected. A base flow ≥ 55% of the average annual daily flow is considered excellent, a base flow of 25-50% is considered fair, and < 25% is considered poor for maintaining quality brook trout habitat (Binns and Eiserman 1979, Raleigh 1982). Brook

trout often inhabit streams that receive ground water discharge (Threinen and Poff 1963) which helps to maintain suitable water temperatures and flow throughout the summer.

Water Quality

Brook trout appear to be more tolerant than other trout species of low pH (Heft 2006) and low alkalinity. The optimal pH range for brook trout appears to be 6.5-8.0, with a tolerance range of 4.0-9.5. Although fingerlings have been identified in Pennsylvania waters with a pH less than 4.75 (Dunson and Martin 1973), Menendez (1976) demonstrated that continued exposure to pH below 6.5 resulted in decreased hatching and growth in brook trout.

Brook trout are sight feeders and can be impaired by high or persistent water turbidity. Raleigh (1982) indicated that optimum turbidity values for brook trout growth are approximately 0-30 Jackson Turbidity Units. An accelerated rate of sediment deposition in streams may reduce local brook trout production because of the negative effects on production of food organisms, smothering of eggs and embryos, and the loss of escape and overwintering habitat (Raleigh 1982).

Temperature Tolerance

Temperature plays a very important role in fish growth, and summer stream temperatures are likely the single most important factor limiting the distribution and production of brook trout (MacCrimmon and Campbell 1969). Water temperature is directly related to respiration rate and, therefore, metabolic rate. If metabolism is low fish growth is poor due to longer foraging times and more consumption (Flebbe et al. 2006, Heft 2006). Indirect influence of water temperature on fish affects growth rate by limiting food abundance, altering toxicity of water borne pollutants, and changing oxygen concentration and biochemical demand (Heft 2006).

Brook trout are generally found in waters with a temperature range between 32-70° F, with an optimal range of 51.8-60.8 ° F for growth and survival (Raleigh 1982, Drake and Taylor 1996). Brook trout can tolerate brief exposure to water temperatures up to 71.6° F, but populations are more stable and productive when water temperatures don't exceed 66.2° F (Heft 2006). For reproduction, a mean temperature of 48.2° F is required for optimal development and hatching success, while the reported temperature for maximum growth of juvenile brook trout was 58° F (Heft 2006).

Food Habits

Brook trout are opportunistic in their feeding habits. Larger brook trout have been found to feed on a wide range of organisms including fish (Heft 2006). Small to medium size brook trout rely more heavily upon aquatic insect larvae and terrestrial invertebrates (Heft 2006). Common insect prey include species of stoneflies, mayflies, caddisflies, and midges. Other food items include leeches, worms, spiders, ants, clams, snails, amphipods, crayfish, diatoms and any number of associated stream fishes, including juvenile trout (Heft 2006).

Reproduction

In most areas of the United States spawning begins by mid-October and is usually over by early December. Brook trout typically begin migrating upstream in late-summer, seeking gravel-bottomed areas in cold, spring-fed tributaries, and spawn in late October and early November (Heft 2006).

Redd (nest) building is done by the female and is defended for a time by both the male and the female. Brook trout generally select areas of upwelling spring water for spawning under natural conditions (Webster and Eiriksdottir 1976). During the egg laying process, the female brook trout brushes the eggs into interstitial spaces in the gravel after each egg release and fertilization by the male, and then excavates another pit immediately upstream of the previously constructed pit (Heft 2006). Males may spawn with multiple females. The female remains at the redd for a short time after the eggs are fertilized and the male has left.

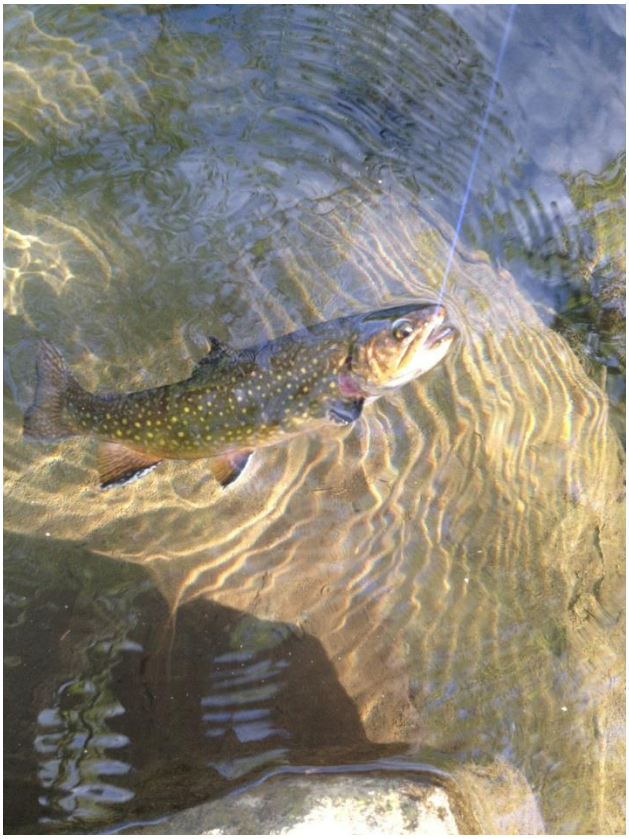


Photo by Jeff Woleslagle

Section III

AQUATIC CLASSIFICATIONS

In Pennsylvania several regulatory authorities including the Department of Environmental Protection (DEP), Pennsylvania Fish and Boat Commission (PFBC), and Department of Conservation and Natural Resources (DCNR) determine the special protection designations of waters.

Department of Environmental Protection:

- High Quality Waters (**HQ**). **HQ** waters include a stream or watershed which has excellent quality waters and environmental or other features that require special water quality protection.
- Exceptional Value Waters (**EV**). **EV** waters include a stream or watershed which constitutes an outstanding national, state, regional or local resources, such as waters which are used as a source of unfiltered potable water supply, or waters of wildlife refuges or State Game Lands, or waters which have been characterized by the PFBC as "**Wilderness Trout Streams**" and other waters of substantial recreational and ecological significance.

Pennsylvania Fish and Boat Commission:

- **Pennsylvania Class A Wild Brook Trout streams**, support populations of naturally produced brook trout of sufficient abundance and biomass to support a rewarding long-term sport fishery. These waters represent the best of Pennsylvania's naturally reproducing brook trout populations. State Forest land contains about half of the total miles of **Class A** Wild Brook Trout Streams statewide.
- **Pennsylvania Wilderness Trout Streams**, are areas where wild trout fishing is located in a remote, natural, unspoiled environment that is of superior quality. All streams in this classification qualify for **EV** designation.
- Naturally Reproducing Trout Stream List (Listing of Wild Trout Streams) documents all assessed streams that have natural reproduction of trout in them (**Class A, B, C, D** streams). Wetlands that are hydraulically connected to these streams qualify for **EV** Wetland Protection under Chapter 105 and qualify for **EV** wetland protection.

Department of Conservation and Natural Resources:

- A wild or scenic river shall be free flowing and supportive of native fish and wildlife with the shoreline being pristine in character.
- A recreational and modified recreational river's recreational use must be compatible with the resource to support that use without degradation

SIGNIFICANCE of WATER CLASSIFICATION to RESOURCE PROTECTION

All commonwealth waters are protected for a designated aquatic life use as well as a number of water supply and recreational uses. The DEP applies criteria based on use designations to permit development activities in watersheds. In addition, streams with excellent water quality may qualify for special protection as **HQ** or **EV**. The water quality of **HQ** streams should be maintained and protected, unless a person seeking a permit or approval that affects water quality is able to successfully demonstrate that a lower water quality is necessary to accommodate an important economic or social development (25 Pa. code Chapter 93.4a(c)). **EV** waters are to be protected by DEP at

their existing quality; water quality shall not be lowered. Permits issued for designated **EV** streams must be conditioned to maintain their existing level of water quality.

Wilderness Trout Streams qualify for the **EV** designation. The Wilderness Trout Streams program emphasizes trout angling in a relatively natural and remote setting.

Class A Wild Trout Streams represent the best of the Commonwealth's naturally reproducing trout fisheries and at a minimum qualify for the **HQ-CWF** designation. They receive special protection afforded by the antidegradation provisions of the federal Clean Water Act. This indicates that any activity that proposes to discharge to a **Class A** stream must comply with more stringent standards than those applied to other non-special protection waters.

Streams designated as Wild Trout Streams are protected at a minimum under the Cold Water Fishes (**CWF**) designation in 25 Pa. Code Chapter 93 Water Quality Standards because of their ability to support or maintain a population of wild trout. Wetlands that are hydraulically connected to these streams qualify for EV Wetland Protection under Chapter 105.

Stream sections classified as biomass **Class A, B, C**, or **D** have significance in how streams are managed with respect to instream flow protection. DEP also typically follows these same criteria in its water allocation permit reviews.

PFBC Stocked Trout Waters are protected by a range of designations including **EV, HQ-CWF, CWF** and Trout Stocking Fisheries (**TSF**) aquatic life use designations. Trout waters designated **CWF** are designed to protect all of the stream's coldwater aquatic life uses. Trout waters designated **TSF** are designed to protect stocked trout during spring. Stream and wetland encroachment permits in these watersheds often include a seasonal restriction to minimize conflicts with trout fishing.

Recognizing the appropriate use designations to all streams that contain or impact potential brook trout habitat on State Forest Lands is an important step towards developing appropriate habitat management goals. Existing buffer guidelines are designed to avoid degradation to aquatic resources from management activities such as timber harvesting and road/trail building.

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

Section IV

EXISTING GUIDELINES

The Bureau of Forestry implements practices that promote the long-term health of the forested systems in Pennsylvania. The aim is to maintain ecosystem integrity from a landscape perspective, which includes aquatic ecosystems. The Bureau of Forestry currently employs many strategies across the landscape to protect streamside forests and brook trout populations on State Forest Land. The following are a list of the most relevant guiding documents used by the Bureau of Forestry which assist in meeting our goal.

Aquatic Habitat Buffer Guidelines

The Aquatic Habitat Buffer Guidelines provide a standard set of operating procedures to be followed when conducting management activities in or near aquatic habitats on State Forest Land. This guidance includes information such as buffer widths and what activities are allowed within the buffer for a given aquatic resource in order to protect water quality and habitat. Areas around wetlands, vernal ponds, spring seeps, streams, lakes, ponds, and impoundments should be designated as aquatic habitat buffers.

Silviculture Manual

The Silviculture Manual provides information about buffers, Erosion and Sedimentation Control Plans, and a chapter about water resources.

State Forest Resource Management Plan

The State Forest Resource Management Plan contains a chapter addressing water resources on state forest land, and how the Bureau of Forestry addresses issues pertaining to water.

Oil and Gas Guidelines

The Bureau of Forestry Oil and Gas Guidelines provide information about stream crossings and water withdrawals as it pertains to oil and gas development on State Forest Land.

Planting and Seeding Guidelines

The Bureau of Forestry Planting and Seeding Guidelines contain information about proper seed mixes and application practices in order to minimize erosion and sedimentation. The document also provides information about what trees and shrubs are suitable for riparian plantings.

Stream Crossing Culvert Practices for Aquatic Organism Passage

This document provides guidance on how to properly size and install culverts to ensure aquatic organism passage at stream crossings.

Improving Stream Habitat on State Forest Land by Adding Large Woody Debris

This guidance addresses aquatic ecosystem restoration and habitat improvement by adding large woody debris to streams.

Pipeline Stream Crossing BMPs

These Best Management Practices (BMPs) provide information on how to minimize impacts to the stream community when pipelines must cross streams.

SFER Guidelines

Projects such as instream alterations on State Forest Lands require State Forest Environmental Review. This is a formal written project review addressing environmental factors.

Photo by Seth Cassell

Section V

STRESSORS AND CONSERVATION MEASURES

Although brook trout are still present in many of Pennsylvania's watersheds, their distribution is much reduced compared to historic levels. In order for the Bureau of Forestry to successfully reach its goal to M*aintain and implement strategies to sustain and enhance healthy, naturally reproducing brook trout populations on State Forest Lands,* it is important to understand what factors are most impacting the brook trout's current status. Some of the major threats/stressors impacting brook trout on State Forest Land include residual effects from past land management practices, increases in water temperature, introduced species, sedimentation and erosion, in-stream flow, pollutants, inadequate water quality protection on unassessed streams, and recreational activities (Hudy et al. 2008; EBTJV 2005; PFBC 2009; Personal Communication with PFBC, Trout Unlimited, Department of Environmental Protection, EBTJV, and Coldwater Heritage Partnership).

Issue 1: Land Management

The lumbering era during the late 1800's and early 1900's resulted in the clearing of the landscape including streamside vegetation leaving poor riparian conditions, which elevated water temperature and increased erosion. This caused many streams to become unsuitable for brook trout.

Another threat is development related to oil and gas extraction. The areas most likely to be impacted by natural gas development are rich in high quality wild trout streams. Natural gas exploration has the potential to negatively impact the Commonwealth's aquatic resources from well pad and right-of-way development (i.e. improper erosion and sedimentation control, habitat fragmentation, increased impervious surface, stream crossings), water withdrawals, and the possibility of ground water contamination.

Goal: Minimize impacts of land management on watersheds

Objectives:

a. Conversion of forest habitat will be minimized
b. State Forest Land will be managed in an ecologically sound manner with aquatic systems being a critical component of the forest ecosystem.
c. Abide by *Aquatic Habitat Buffer Guidelines*
d. Utilize the Bureau of Forestry's *Pipeline Stream Crossing BMPs* to minimize impacts on streams
e. Acquire land to protect watersheds and streams
f. Petition DEP to re-designate streams from HQ to EV where appropriate

Issue 2: Increasing Water Temperatures

A change in water temperatures is a serious threat to sensitive fishes such as brook trout, with narrow thermal ranges and generally intolerant of habitat perturbations.

Water temperature is an important factor in fish growth and reproductive success, as well as an important factor limiting the brook trout's geographic distribution. Many factors affect water temperatures in Pennsylvania streams. Some major factors include any land use activity that removes vegetative cover, disturbs the soil, reduces infiltration rates, decreases soil moisture storage, or increases overland flow. Barriers, such as dams and poorly designed culverts or bridges can also impound water, causing water temperature to increase.

It is also possible that if the climate change predictions are realized, significant amounts of trout habitat would be lost, as well as an increase in fragmentation, leaving wild brook trout populations vulnerable to extirpations (Flebbe et al. 2006). Water withdrawals by power plants, natural gas extraction and other activities may also impact water temperatures if decreases in water levels occur during summer months and other times with low stream depths.

Goal: Prevent increasing stream temperatures; promote cooling where possible

Objectives:

a. Identify low head dam locations on brook trout streams
b. Low-head dams that no longer serve a useful purpose should be considered for dam removal where feasible and when funds or opportunities exist
c. Restore forested riparian buffers with native species where needed
d. Retain forested riparian buffers during forest activities by following the *Aquatic Habitat Buffer Guidelines*

Issue 3: Introduced Species

Introduced species can have negative impacts on brook trout populations by altering habitat, such as the algae *Didymosphenia geminate*, which can interrupt the life cycle of aquatic invertebrates which brook trout feed upon. Non-native/invasive vegetation, such as Japanese knotweed (*Fallopia japonica*), along the riparian zone can cause changes in macro-invertebrate community structure that affects trout food availability, and changes in distribution of other fish species that alter interactions with the stream fish community (Flebbe et al. 2006). Hemlock woolly adelgid (*Adelges tsugae*), an exotic insect that feeds on the fluid of hemlock trees, often killing the trees, may have significant impacts on brook trout. Several studies indicate there could be a significant reduction in aquatic diversity and brook trout abundance should hemlock succumb to hemlock woolly adelgid (Ross et al. 2003, Snyder et al. 2002). Introduced fish, such as brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*), can negatively impact brook trout through competition and displacement (DeWald and Wilzbach 1992, Larson and Moore 1985, Fausch and White 1981). The non-native rusty crayfish (*Orconectes rusticus*) competes with native crayfish and can reduce populations of other native macroinvertebrates on which the brook trout feed. These are just a few examples of how introduced species can become stressors to brook trout populations.

Goal: Avoid introductions of non-native species

Objectives:

a. Stocking of any stream by private hatcheries on Bureau of Forestry lands should be based on prior consultation with the appropriate District Forester, Ecological Services section of the Bureau of Forestry, and the PFBC Area Fisheries Manager (See PFBC Area Fisheries Management Offices Contact Information).
b. Active management should occur to remove invasive plant species from riparian areas and replace them with **native** species along brook trout streams

Issue 4: Sedimentation and Erosion

Sedimentation build up from poorly designed or maintained roads can effect feeding and reproduction for brook trout. Sedimentation negatively impacts aquatic macroinvertebrates, which are the main food source of brook trout. Additionally, brook trout are sight feeders so an increase in turbidity from sedimentation can make feeding more difficult. A reduction in riparian vegetation or an increase in development near riparian areas can increase sedimentation levels from rain runoff as well. The resulting siltation can destroy spawning habitat.

Goal: Prevent human caused erosion and sedimentation

Objectives:

a. Work with the PFBC to construct log/stone deflectors during road rehabilitation to provide long-term road stabilization while improving aquatic habitat, where appropriate
b. When possible, maintain herbaceous vegetation in road ditches, to stabilize ditches and reduce sediment being transported to streams
c. Follow Bureau of Forestry culvert guidelines on all wild trout streams to ensure fish passage, which maintains habitat and population connectivity
d. Utilize the Bureau of Forestry's Pipeline Stream Crossing BMPs to minimize impacts on streams

Issue 5: Pollutants

Pollution from acid mine drainage (AMD), acidic deposition, agriculture and other industrial practices have had and often continue to have detrimental impacts on the health and survival of brook trout populations and other aquatic life. Acid deposition results from the release of nitrogen oxide, sulfur dioxide and ammonia into the atmosphere. The Maryland Biological Stream Survey Program reports that acidic deposition is the most common source of stream acidification in Maryland. AMD is the other main source of acidification impacting brook trout streams in Pennsylvania. Acidic deposition and AMD alter the water quality by increasing acidity and allowing the release of naturally occurring metals such as iron, aluminum, and manganese which are toxic to aquatic organisms (Susquehanna River Basin Commission 2008). Heavy metals decrease the pH tolerance of brook trout and negatively influence the growth rate, development, and behavior of brook trout. In addition, heavy metals may also adversely affect macro-invertebrate populations and habitat quality, indirectly influencing brook trout. Applying lime to watersheds can ameliorate the impacts of acidified streams since streams are a

result of the watershed. Applying limestone sand to the stream itself is discouraged as it smothers existing substrate, causes aluminum to precipitate in the stream bed, and is a temporary measure. Another potential threat to Pennsylvania's water resources includes Marcellus and other unconventional gas development, and the potential for contaminated fluid spills.

Goal: Prevent pollutants from impacting streams

Objectives:

a. Work with DEP's Bureau of Abandoned Mine Reclamation (BAMR) and partners to identify candidates for Priority III funding to improve water quality for brook trout and other cold-water species, and advocate to make water quality restoration a high priority for Surface Mine Control Reclamation Act Title IV funds in Pennsylvania
b. Work with DEP's BAMR and partners to combine the restoration of Priority I and II Health and Safety Abandoned Mine Drainage sites with the elimination, treatment, or improvement of adjacent Priority III sites
c. Once water quality has been improved, determine if stream habitat improvement is needed and work with PFBC Habitat Management Division and Ecological Services section of the Bureau of Forestry
d. Consider liming in watersheds where stream pH is low due to acidification

Issue 6: Lack of Instream Habitat

A lack of instream habitat limits the distribution and expansion of wild brook trout in some streams. Streams can be assessed to determine the suitability of the habitat for wild brook trout.

Goal: Improve in-stream habitat where appropriate

Objectives:

a. After determining brook trout streams, Bureau of Forestry personnel will assess stream reaches for potential limiting habitat factors using the PFBC Trout Stream Habitat Assessment (Lutz 2007)
b. If a potential limiting habitat factor is determined, the PFBC Habitat Management Division and the Ecological Services Section of the Bureau of Forestry should be contacted for further analysis.
c. Habitat will be improved where it may be the limiting factor. This may involve placing fish habitat enhancement structures, woody debris, or boulders into streams to increase in-stream habitat (See Lutz 2007 and the Bureau of Forestry document: Improving Stream Habitat on State Forest Land by Adding Large Woody Debris)

Issue 7: Barriers to Fish Passage

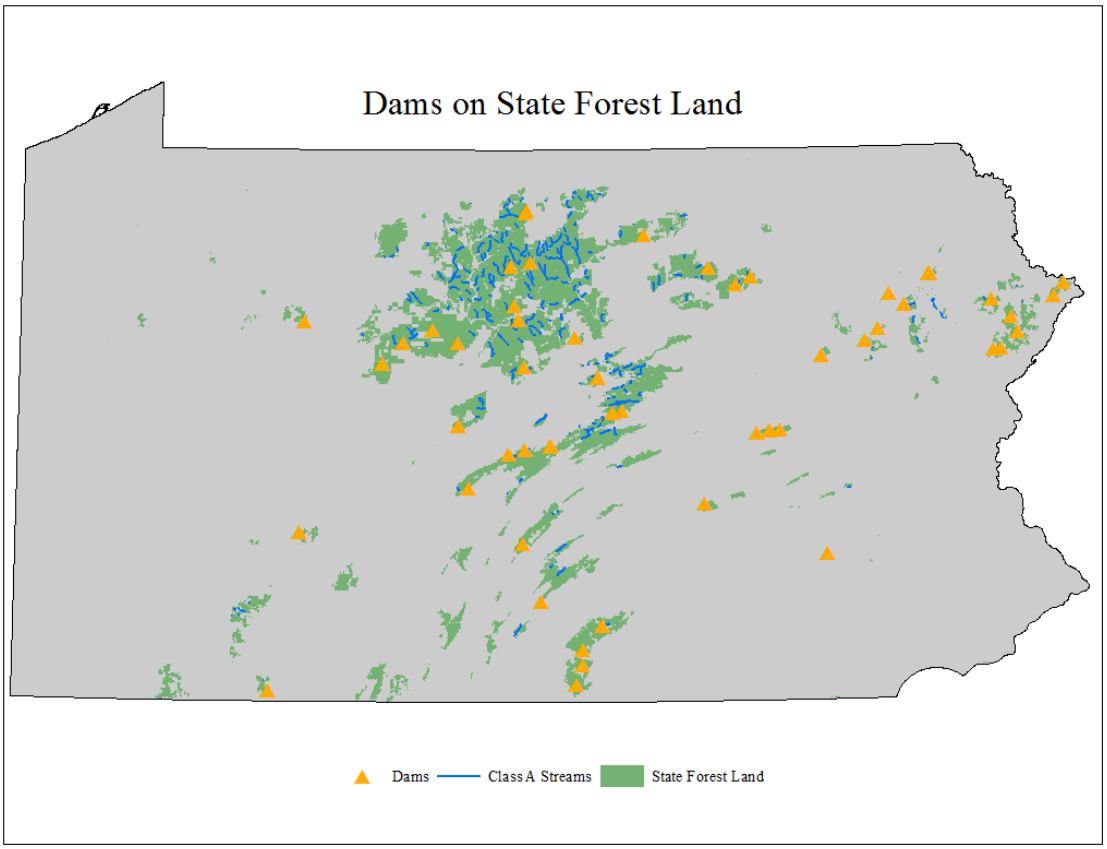
Manmade barriers to fish passage prevent connectivity within the aquatic ecosystem. Connectivity is important for dispersal and access to suitable habitat such as

spawning areas, and colder water refugia. Low-head dams create a physical barrier to fish passage. Improperly placed culverts can lead to excessive erosion, act as barriers to aquatic organism passage, and can cause the stream crossing to fail. Common problems with culverts are blockages, being undersized, and not being installed properly.

Goal: Remove barriers to fish passage

Objectives:

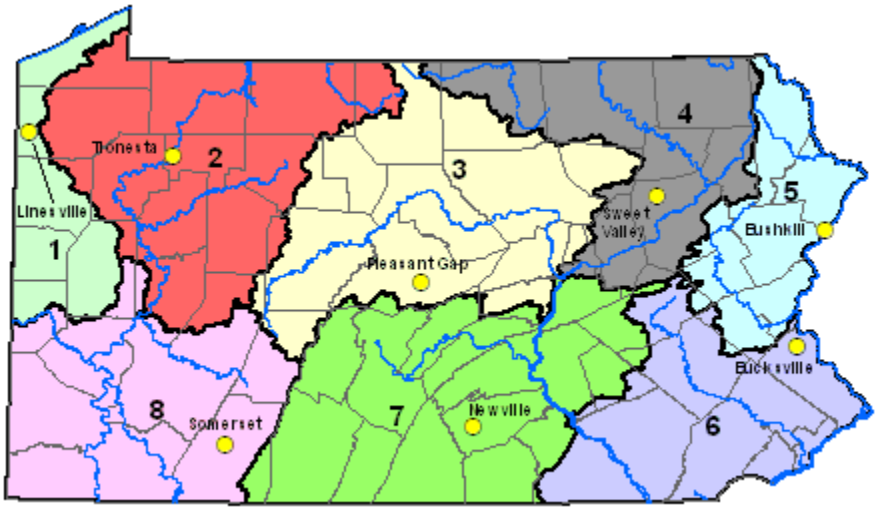
a. Follow Bureau of Forestry Culvert Guidelines on all wild trout streams to ensure fish passage and instream flow
b. Inventory and assess stream/road crossings on State Forest Land for Aquatic Organism Passage (AOP)
c. Look for funding and opportunities to replace existing culverts to improve fish passage on wild brook trout streams on State Forest Lands
d. Identify low head dams on high priority brook trout streams on State Forest land
e. Low-head dams that no longer serve a useful purpose should be considered for dam removal where feasible and when funds or opportunities exist



APPENDICES

PFBC Contact Information

PFBC Fisheries Management Areas



The Fish & Boat Commission has nine (9) area fisheries management offices. Fishery managers conduct surveys (biologist reports) of Pennsylvania waters, document the status of fisheries, and develop comprehensive plans for managing fishery resources that are consistent with the protection, conservation and enhancement of the quality and diversity of the resource.

PFBC Habitat Management Contact Information

Division of Habitat Management
450 Robinson Lane
Bellefonte, PA 16823-9620
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Bureau of Forestry Ecological Services Section and Field Office

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