Brook Trout Outcome

Management Strategy

2015–2025, v.1

I. Introduction

Brook Trout symbolize healthy waters because they rely on clean, cold stream habitat and are sensitive to rising stream temperatures, thereby serving as an aquatic version of a "canary in a coal mine". Brook Trout are also highly prized by recreational anglers and have been designated as the state fish in many eastern states. They are an essential part of the headwater stream ecosystem, an important part of the upper watershed's natural heritage and a valuable recreational resource. Land trusts in West Virginia, New York and Virginia have found that the possibility of restoring Brook Trout to local streams can act as a motivator for private landowners to take conservation actions, whether it is installing a fence that will exclude livestock from a waterway or putting their land under a conservation easement. The decline of Brook Trout serves as a warning about the health of local waterways and the lands draining to them. More than a century of declining Brook Trout populations has led to lost economic revenue and recreational fishing opportunities in the Bay's headwaters.

II. Goal, Outcome and Baseline

This management strategy identifies approaches for achieving the following goal and outcome:

Vital Habitats Goal

Restore, enhance and protect a network of land and water habitats to support fish and wildlife, and to afford other public benefits, including water quality, recreational uses and scenic value across the watershed.

Brook Trout Outcome

Restore and sustain naturally reproducing Brook Trout populations in Chesapeake Bay headwater streams, with an eight percent increase in occupied habitat by 2025.

Priority Brook Trout Conservation Strategies

- Protect highly functional Wild Brook Trout Only patches from detrimental changes in land use and water use practices.
- Connect habitats that have a high likelihood of sustaining stable wild Brook Trout populations.
- Improve access to Brook Trout spawning and seasonally important habitats (e.g., coldwater refugia, wintering areas).
- Improve Brook Trout habitats that have been impacted by poor land and water use practices.
- Mitigate factors that degrade water quality.
- Enhance or restore natural hydrologic regimes.
- Prevent and mitigate the spread of invasives/exotic species into patches containing wild Brook Trout only.
- Re-introduce wild Brook Trout into catchments within Wild Brook Trout Only patches, where the species has been extirpated or an increase in genetic fitness of the population is needed.

Baseline and Current Condition

The wild Brook Trout populations in the Chesapeake Bay watershed have been significantly reduced over the last 150 years and continue to face ongoing and future threats from land use changes, invasive species, loss of genetic integrity, climate change, and a myriad of other anthropogenic impacts (Hudy et al. 2008). In this region of the country, most wild Brook Trout are relegated to headwater streams, where human disturbance is minimal and forest cover is still prevalent.

A 2005 assessment of Brook Trout status in 1,443 subwatersheds (sixth-level hydrologic unit) located in the Chesapeake Bay watershed, resulted in 16 percent being classified as Intact (Brook Trout are present in more than 50 percent of the streams); 38 percent were classified as Reduced (Brook Trout are present in 50 percent of the streams or fewer); 20 percent were classified as Extirpated (Brook Trout no longer exist in the streams); and 27 percent were not classified because either the historical presence of Brook Trout is not known or the species was never known to occur in these subwatersheds (Hudy et al. 2008) (Figure 1).

Additionally, an approach was developed that assists with prioritizing subwatersheds with the greatest potential for successful Brook Trout protection, enhancement or restoration actions (Hanson et al. 2014) based on how intact they are and how intact neighboring watersheds are. In the Chesapeake Bay watershed, there are 103 Intact subwatersheds and 43 Reduced subwatersheds that are assigned high priority scores (0.79 or more) (Appendix Table I). These should serve as a cross-outcome focus for anti-degradation and maintenance (Healthy Watersheds Management Strategy)

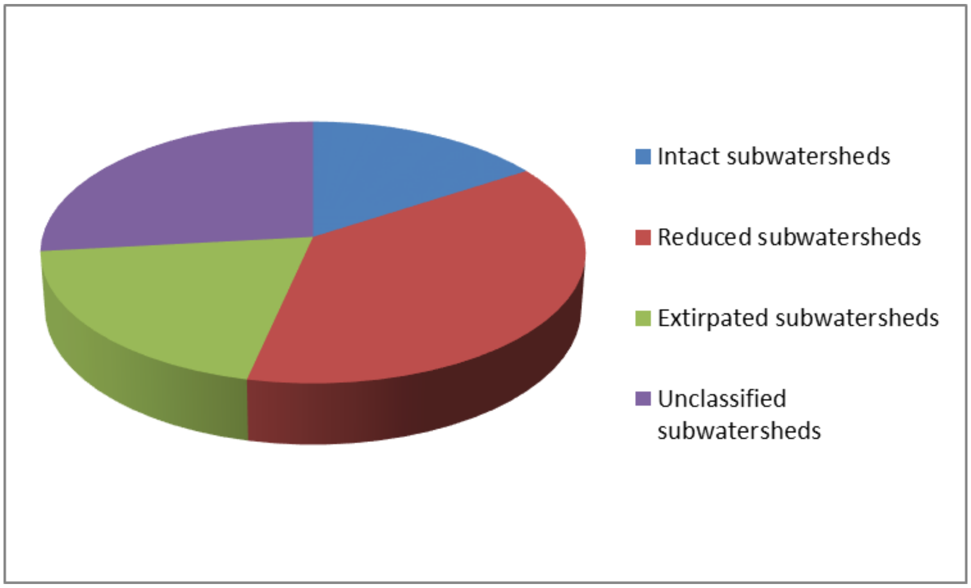


Figure 1. Brook Trout classification of subwatersheds located in the Chesapeake Bay watershed.

A finer scale assessment of Brook Trout populations in the Chesapeake Bay watershed was recently (2012-2014) completed by the Eastern Brook Trout Joint Venture in an effort to provide natural resource managers with better tools for detecting population changes and setting conservation priorities. This assessment entailed determining wild Brook Trout occupancy at the catchment scale, which was then used to identify Brook Trout patches and classify them as being Wild Brook Trout Only (i.e. allopatric), Wild Brook Trout with Brown Trout present, Wild Brook Trout with Rainbow Trout present or Wild Brook Trout with Rainbow Trout and Brown Trout present (Hudy et al. 2013a). A "patch" is defined as a group of contiguous catchments occupied by wild Brook Trout. Patches are not connected physically (i.e., they are separated by a dam, unoccupied warm water habitat, downstream invasive species, etc.) and are generally assumed to be genetically isolated. While findings from this assessment indicate there are 1,552 Wild Brook Trout patches in the Chesapeake Bay watershed, with a combined area of 34,431 square kilometers (Table 1), there are 952 "Wild Brook Trout Only" patches and the area of these patches is 13,495 square kilometers (Table 2).

Additionally, Downstream Strategies, LLC is in the process of completing development of a Boosted Regression Tree (BRT) model that uses widely available landscape variables to predict the presence of Brook Trout in catchments located in the Chesapeake Bay watershed. One of the model outputs is baseline information on the optimal potential condition of a catchment, which is presented as a natural habitat quality index (HQI). The HQI is defined as the maximum probability of Brook Trout presence under a zero-stress situation; essentially, the highest attainable condition in the catchment (Martin et al. 2012). Preliminary results from the Chesapeake Bay Brook Trout pilot model indicate that 54 percent of the catchments within the Chesapeake Bay watershed have an HQI greater than or equal to 0.50 (Appendix Table II).

Baseline

This management strategy is focused on conserving “Wild Brook Trout Only” patches and therefore is using the current area of occupancy (13,495 square kilometers) as the baseline for measuring progress toward achieving the Brook Trout outcome. To be successful, the total amount of “Wild Brook Trout Only” patch area needs to reach 14,575 square kilometers (an 8 percent increase) by 2025 (Table 3).

III. Participating Partners

The following partners have pledged to help implement this strategy:

Team Lead: Vital Habitats Goal Team

Opportunities for Cross-Goal Team Collaboration:

- Fisheries Goal Team
- Water Quality Goal Team
- Healthy Watersheds Goal Team

Participating Signatories:

- Maryland
- New York
- Pennsylvania
- Virginia
- West Virginia

Other Participating Partners:

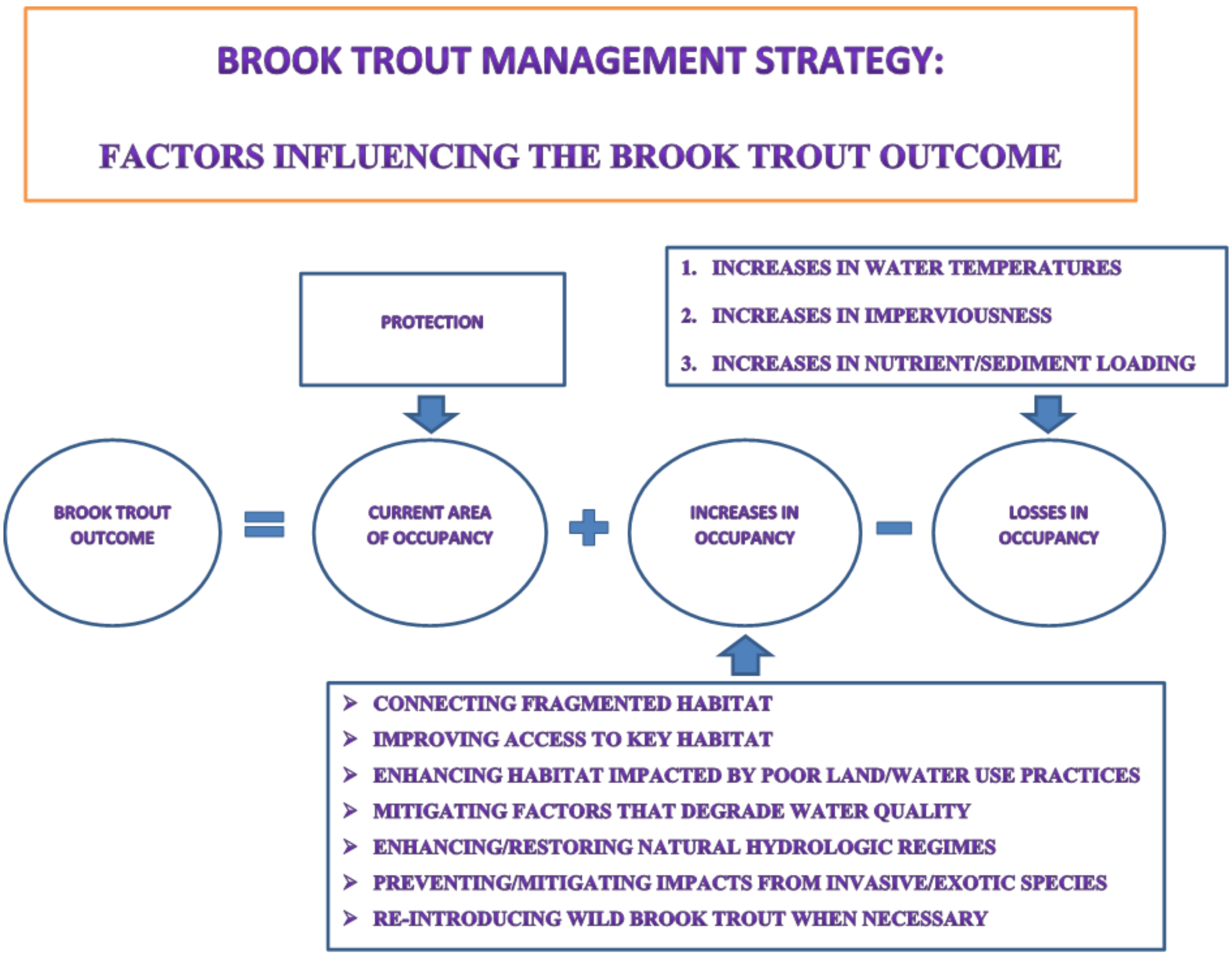
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- National Park Service
- USDA Forest Service
- USDA Natural Resource Conservation Service
- Trout Unlimited
- Eastern Brook Trout Joint Venture

Local Engagement

Engaging the community in tree plantings, water quality, habitat, and macroinvertebrate monitoring. Being able to articulate the community/watershed wide benefits of brook trout from a recreational and economic perspective is also important for local buy-in.

IV. Factors Influencing Success

A variety of activities, both on the land and in the water, will influence the ability to meet the brook trout outcome. Land development, roads, culverts, and unconventional oil and gas drilling all result in three root causes of decreased brook trout occupancy in streams: increased water temperature, increased imperviousness, and increased nutrient/sediment loading. Well pads and access roads associated with shale gas drilling, for example, lead to loss of tree canopy and increased sediment shown to affect stream quality and temperatures.



An output of Downstream Strategy's BRT modeling approach is a list of the predictor variables used in the model, ordered and scored by their relative importance (Martin et al. 2012). The relative importance values are based on the number of times a variable is selected for splitting, weighted by the squared improvement to the model as a result of each split, and averaged over all trees. The relative influence score is scaled so that the sum of the scores for all variables is 100, where higher numbers indicate higher influence. Downstream Strategies used ten predictor variables in the Chesapeake Bay Brook Trout BRT Model (Table 4). The most influential predictor, which accounted for almost 43 percent of the total influence in the model, was predicted mean July water temperature. The three predictor variables that were identified as anthropogenic stressors (network mean imperviousness, network percent agriculture, and network percent mined, non-active) accounted for approximately 34 percent of the total influence.

Thieling (2006) also developed a predictive model for determining Brook Trout population status in the eastern United States using classification trees (CART 5.0 Modeling Program), which determined that six core subwatershed and subwatershed water corridor metrics (percentage of forested lands, combined sulfate and nitrate deposition, percentage of mixed forests in the water corridor, percentage of agriculture, road density, and latitude) were useful predictors of Brook Trout distribution and status. One finding from this modeling effort was that 94 percent of the subwatersheds classified as Intact had more than 68 percent of their land base covered by forests (Protected Lands Management Strategy). Additionally, when a subwatershed has a combined NO_3 and SO_4 deposition greater than 24 kg/ha, this stressor exerts a negative influence on Brook Trout populations (Thieling 2006); as does having the percentage of agricultural land in the subwatershed in the 12-19% range or higher and a road density value greater than 1.8-2.0 km/km^2.

In addition to compiling data on Brook Trout populations over a 17 state region, Hudy et al. (2005) interviewed regional fisheries managers and asked them to rank perturbations and threats to all subwatersheds that historically supported wild Brook Trout populations. Perturbations and threats were separated into three categories of severity: (1) eliminates Brook Trout life cycle component; (2) reduces Brook Trout populations; and (3) potentially impacts Brook Trout populations. Across the entire study region (eastern U.S), the top five perturbations listed as category 1 or 2 severity for streams were high water temperature, agriculture, riparian condition, the presence of one or more non-native fish species, and urbanization. While their relative influence has not been quantified at a watershed or landscape scale, changes in water quality, modification of hydrologic regime, altered stream flows, and fish passage barriers are other factors affecting the viability of wild Brook Trout populations (EBTJV 2005).

DeWeber and Wagner (2015) utilized hierarchical logistic regression with Bayesian estimation to predict Brook Trout occurrence probability, which concluded that predicted water temperature had a strong negative effect on Brook Trout occurrence probability at the stream reach scale, and was also negatively associated with the ecological drainage unit (EDU) average probability of Brook Trout occurrence. The effect of soil permeability was positive but decreased as EDU mean soil permeability increased. Brook Trout were less likely to occur in stream reaches surrounded by agricultural or developed land cover, and an interaction suggested that agricultural land cover also resulted in an increased sensitivity to water temperature.

V. Current Efforts

Maryland Department of Natural Resources

The Department of Natural Resources Fisheries Service is responsible for managing commercial and recreational fishing. Fishery Management Plans (FMPs) are developed to outline agreed upon management goals, objectives, strategies, and actions. Freshwater, estuarine and migratory fish stocks are managed for sustainable fisheries, to enhance and restore fish or shellfish species in decline, to promote ethical fishing practices, and to ensure public involvement in the fishery management process.

The mission of the Fisheries Service is to: develop a management framework for the conservation and equitable use of fishery resources; manage fisheries in balance with the ecosystem for present and future generations; monitor and assess the status and trends of fisheries resources; and provide high quality, diverse and accessible fishing opportunities. The statewide Brook Trout Fisheries Management Plan was developed in 2006 by the Fisheries Services' Inland Fisheries Division, with a goal to "to restore and maintain healthy brook trout populations in Maryland's freshwater streams and provide long-term social and economic benefits from a recreational fishery."

New York State Department of Environmental Conservation

The mission of the New York State Department of Environmental Conservation is "to conserve, improve and protect New York's natural resources and environment and to prevent, abate and control water, land and air pollution, in order to enhance the health, safety and welfare of the people of the state and their overall economic and social well-being." The New York State Department of Environmental Conservation, Division of Fish, Wildlife and Marine Resources, Bureau of Fisheries delivers a diverse program and annually conducts a wide array of activities to conserve and enhance New York State's abundant and diverse populations of freshwater fishes while providing the public with quality recreational angling opportunities.

Pennsylvania Fish and Boat Commission

The mission of the Pennsylvania Fish and Boat Commission (PFBC) is to protect, conserve, and enhance the Commonwealth's aquatic resources and provide fishing and boating opportunities. Within the PFBC, the Division of Fisheries Management, Bureau of Fisheries, oversees PFBC efforts in the management of Pennsylvania fisheries. A key strategy for the PFBC is "provide high quality resource management and protection to reduce the impacts of current and increasing threats to aquatic resources."

Virginia Department of Game and Inland Fisheries

The mission of the Virginia Department of Game and Inland Fisheries (VDGIF) is to manage Virginia's wildlife and inland fish to maintain optimum populations of all species to serve the needs of the Commonwealth; provide opportunity for all to enjoy wildlife, inland fish, boating and related outdoor recreation and to work diligently to safeguard the rights of the people to hunt, fish and harvest game as provided for in the Constitution of Virginia; promote safety for persons and property in connection with boating, hunting and fishing; and provide educational outreach programs and materials that foster an awareness of and appreciation for Virginia's fish and wildlife resources, their habitats, and hunting, fishing and boating opportunities. VDGIF monitors brook trout distribution in all areas of the Virginia portion of the Chesapeake Bay Watershed except sub-watersheds within the Shenandoah National Park. The National Park Service monitors those brook trout habitats. VDGIF maintains a Coldwater Stream Database that classifies individual brook trout streams and documents spatial distribution of brook trout. Through VDGIF's monitoring program and database, changes in brook trout distribution and population health can be documented and measured. Currently, VDGIF has sufficient resources to monitor brook trout populations in Virginia. The National Park Service has a monitoring program in place that has the same capabilities. The VDGIF is adding brook trout to the list of species of "Greatest Conservation Need" in the Virginia Wildlife Action Plan and is partnering with Trout Unlimited to restore brook trout to streams in the Shenandoah River Watershed.

West Virginia Division of Natural Resources

It is the statutory mission of the West Virginia Division of Natural Resources (WV DNR) to provide and administer a long-range comprehensive program for the exploration, conservation, development, protection, enjoyment and use of the natural resources of the State of West Virginia. The WV DNR's Wildlife Resources Section (WRS) is responsible for the management of the state's wildlife resources for the use and enjoyment of its citizens. The primary objective of the section is to maintain and perpetuate fish and wildlife at levels compatible with the available habitat, while providing maximum opportunities for recreation, research and education.

U.S. Fish and Wildlife Service

The mission of U.S. Fish and Wildlife Service (FWS) is to work with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. The FWS Northeast Region Fisheries Program is designed to support the conservation and management of aquatic species by maintaining, restoring, and recovering populations of species of conservation and management concern to self-sustaining levels; and, conservation and management of aquatic ecosystems by maintaining and restoring the ecological composition, structure, and function of natural and modified aquatic ecosystems to ensure the long-term sustainability of populations of species of conservation and management concern.

U.S. Geological Survey

USGS is providing decision-relevant science related to restoring and sustaining naturally reproducing brook trout populations and their habitat. USGS studies are focusing on better understanding several factors that affect brook trout populations including: (1) role of groundwater in sustaining stream temperatures, (2) effects of climate and land change on elevated stream temperature and altered hydrology, (3) competition of invasive species on brook trout populations, and (4) effects of unconventional oil and gas development on brook trout populations and habitat."

National Park Service

The fundamental purpose of the National Park Service (NPS) "is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The NPS covers more than 84 million acres and is comprised of 401 sites. These include 125 historical parks or sites, 78 national monuments, 59 national parks, 25 battlefields or military parks, 18 preserves, 18 recreation areas, 10 seashores, four parkways, four lakeshores, and two reserves.

USDA Forest Service

The mission of the Forest Service is to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations. The Forest Service is a multi-faceted agency that protects and manages 154 national forests and grasslands in 44 states and Puerto Rico and is the world's largest forestry research organization. Their experts provide technical and financial help to state and local government agencies, businesses, private landowners to help protect and manage non-federal forest and associated range and watershed lands. They develop partnerships with many public and private agencies to augment their work planting trees, improving trails, providing education on conservation and fire prevention, and improve conditions in wildland/urban interfaces and rural areas. Their team also promotes sustainable forest management and biodiversity conservation internationally.

USDA Natural Resource Conservation Service

The mission of the USDA Natural Resource Conservation Service (NRCS) is to improve the health of our Nation's natural resources while sustaining and enhancing the productivity of American agriculture. They achieve this by providing voluntary assistance through strong partnerships with private landowners, managers, and communities to protect, restore, and enhance the lands and waters upon which people and the environment depend. NRCS is "Helping People Help the Land" by ensuring productive lands in harmony with a healthy environment is their priority. The NRSC staffs State Offices in the five Chesapeake Bay states (MD, NY, PA, VA, and WV).

Trout Unlimited

Trout Unlimited (TU) is a non-profit organization dedicated to the conservation of North America's coldwater fisheries and their watersheds—places where trout and salmon thrive. Within the Chesapeake Bay watershed, TU has over 70 local chapters and 5 state councils, representing over 16,000 members, and a staff of 15 that work in the watershed's headwaters protecting, reconnecting, and restoring brook trout habitat. At all levels of government, TU advocates for native trout conservation. In addition this advocacy, TU's role in this strategy will be as an on-the-ground implementer of the priority conservation actions described below, specifically those related to the reconnection and restoration of brook trout habitat.

Eastern Brook Trout Joint Venture

The Eastern Brook Trout Joint Venture (EBTJV) is a diverse group of partners, including state fish and wildlife agencies, federal resource agencies, Indian tribes, regional and local governments, businesses, conservation organizations, academic institutions, scientific societies, and private citizens working to conserve wild Brook Trout resources across their native range in the eastern portion of the U.S. The EBTJV facilitates collaboration among the conservation community by completing landscape-level scientific assessments on the status of wild Brook Trout, along with identifying the major threats they face, and using the results of these assessments to establish key priorities that serve as the framework for the coordination of strategic conservation actions.

VI. Gaps

It is imperative to know where Brook Trout are and where they are not (WV has identified some streams containing Brook Trout that are missing from the EBTJV data set). An understanding of springs and the influence of groundwater on current and suitable Brook Trout habitat needs to be looked into further. If the goal is for an 8% increase in occupied habitat need to look closely at the potential for extirpated spring creeks to be restored and repopulated with wild Brook Trout. Given climate change projections if these streams have the coldwater necessary for trout despite climate change and all that is lacking is habitat they may give a good bang for the buck in terms of restoring extirpated catchments and providing climate change resiliency. It may cost a bit more to restore a spring creek but if there is strong confidence it will persist (temperature wise) in the face of climate change it may be worth the investment. Likewise incorporating springs and groundwater influences into a decision support tool to identify culverts for replacement would be beneficial to make sure limited resources are going towards removing barriers that create connectivity to thermal refugia.

- Tools or technologies are needed to help correlate terrestrial habitat restoration to improvements in Brook Trout population health.
- Continued or increased funding of terrestrial habitat restoration or conservation programs.
- Creative or innovative ways to incentivize private landowner participation.
- Improved understanding of how the rate of genetic exchange among populations of Brook Trout affects population persistence in the presence of environmental stressors.

Maryland is unique among the other bay states in that its geographic area is relatively small and so the existing and potential Brook Trout habitat is much reduced. Because of this Maryland has the ability to census all known, historic, and/or suspected Brook Trout populations and habitat. Additionally the geography of Maryland is such that the habitat available to Brook Trout is highly diverse statewide and representative of the range wide northern and southern conditions. Maryland Inland Fisheries is currently conducting a statewide census, from 2014 to 2018, that will sample all historic/current/suspected Brook Trout populations and additional habitats that modeling or physical proximity suggest may be suitable candidates for Brook Trout reintroduction. High priority for restoration in Maryland is in the mountainous western portion of the state where mitigating legacy mining impacts has the greatest potential for population re-establishment. The most difficult and challenging area for Brook Trout conservation and restoration in Maryland is in the eastern portion of the Brook Trout range in the state. This is where the greatest human population occurs and is increasing and where exotic trout encroachment, severe population fragmentation and impervious surface increases are putting tremendous stressors on Brook Trout populations; losses of Brook Trout in this area have occurred this century and more are anticipated.

For the purpose of helping to achieve the Bay Agreement outcome for Brook Trout Maryland's existing sampling program should be useful in achieving the needs outlined in the "Monitoring Progress" section of this strategies document. A dire need to ensure the success of this monitoring program is annual seasonal help ($10,000/year) when surveys are done and repair/replacement costs of survey equipment ($7,500/year). An additional need will be funding ($15,000/year) for the annual genetic analysis for the N_b for sampled "patches" which is a vital component of the patch monitoring plan proposed.

As part of the 2014 Bay Agreement and EBTJV led partnership, Maryland Inland Fisheries Division and its sister DNR agency, the Maryland Biological Stream Survey through their sentinel site surveys, will be able to provide substantial annual sampling effort and genetic data collection as part of already planned sampling, helping to meet the monitoring needs of the strategy without having to duplicate/create new sampling efforts.

VII. Management Approaches

The Partnership will work together to carry out the following actions and strategies to achieve the Brook Trout outcome. These approaches seek to address the factors affecting our ability to meet the goal and the gaps identified above.

Identify Priority Focal Areas for Brook Trout Conservation

In order to assist with strategic decision-making on where to focus Brook Trout conservation actions, the Wild Brook Trout Only patches in the Chesapeake Bay watershed have been sorted into three priority levels. Wild Brook Trout Only patches that occur in and around current Brook Trout strongholds, which are defined as being located in subwatersheds with a priority score ≥0.79, have been assigned priority Level 1 since these subwatersheds offer the best potential for sustaining wild Brook Trout populations and capitalizing on increased habitat connectivity (Hanson et al. 2014). Priority Level 1 Wild Brook Trout Only patches occurs in 146 subwatersheds; 77 of these subwatersheds are located in Pennsylvania, 65 are in Virginia, 3 are in West Virginia, and 1 is in Maryland (Table 5 and Appendix Table III).

Wild Brook Trout Only patches that occur in subwatersheds having priority scores < 0.79, but have ≥60% of their catchments with an HQI ≥0.50, have been given a Level 2 priority because they possess habitat that exhibits good potential for attaining favorable conditions when stressors are lessened. Priority Level 2 Wild Brook Trout Only patches occur in 238 subwatersheds; 152 of these subwatersheds are in Pennsylvania, 44 are in New York, 22 are in Virginia, 14 are in Maryland, and 6 are in West Virginia (Table 5 and Appendix Table IV). Streams in these areas may have lost their ability to support Brook Trout due to logging, farming and loss of riparian cover. Restoration techniques exist to mitigate such land use impacts and bring Brook Trout back to these areas of reduced habitat value.

Wild Brook Trout Only patches that occur in subwatersheds having priority scores < 0.79 and have <60% of their catchments with an HQI ≥0.50 have been given a Level 3 priority. Priority Level 3 Wild Brook Trout Only patches occur in 216 subwatersheds; 82 of these subwatersheds are in Pennsylvania, 68 are in New York, 32 are in Virginia, 21 are in West Virginia, and 13 are in Maryland (Table 5 and Appendix Table V).

The specific locations of Wild Brook Trout Only patches can be viewed at the Brook Trout Integrated Spatial Data and Tools website, which was developed in part to display the data associated with the EBTJV's Brook Trout status assessment at the catchment scale. Enabling the HUC 12, EBTJV Classified Catchments, and Brook Trout Habitat Patches GIS data layers in conjunction with turning on the Feature ID function will result in pertinent data being displayed whenever a patch is clicked.

Consider Climate Change in Determining Priorities

Regardless of a Wild Brook Trout Only patch's priority level, added considerations need to be given to those locations where Brook Trout have a lower vulnerability to the effects of climate change because their populations are less likely to disappear under various climate change scenarios (Trumbo et al. 2014). While the data layer does not cover the entire Chesapeake Bay watershed, the Brook Trout Integrated Spatial Data and Tools website has a GIS data layer (Brook Trout Patch Vulnerability) that identifies Wild Brook Trout patches with low exposure (predicted change in water temperature per unit increase in air temperature) and sensitivity (predicted frequency, magnitude and duration of water temperature averaged over a range of temperatures). Groundwater exchange may also mitigate stream thermal sensitivity to air temperature change (Snyder et al. *in press*) and spatial models are needed to predict the role of groundwater for Brook Trout spawning, feeding and refugia across stream networks.

Downstream Strategies has incorporated a climate change assessment into the Chesapeake Bay Brook Trout PilotModel that quantifies potential changes in the probability of Brook Trout presence that may result from a projected future climate scenario (Jason Clingerman, personal communication). It should be noted that these are “generalized” projections since broad scale modeling is being performed and the predictor variables being used are annual (precipitation) or seasonal (stream temperatures). Therefore, the impacts of local extremes to climate (drought, flood) may have impacts on Brook Trout populations that are beyond the scope of the model. Future air temperature projections were obtained from the regional downscaled climate model ECHAM5 described by Hostetler et al. (2011). All projections are based on the A2 scenario described in the Intergovernmental Panel on Climate Change AR4 report (IPCC 2007). Predictions of the probability of Brook Trout presence under this future scenario were made and then compared to the model’s original outputs. Under this future scenario, decreases in the probability of Brook Trout presence are due mainly to increased temperatures, while increases occurred when increased precipitation moderates the impacts of increased temperatures. Appendix Table VI summarizes at the HUC 8 level, the percentage of catchments that have a decreased probability of Brook Trout presence under the ECHAM5 A2 2042 climate scenario.

Apply Decision Support Tools

In addition to the Brook Trout Integrated Spatial Data and Tools website, there are several other decision support tools available that will assist the conservation community in refining their efforts to conserve Chesapeake Bay Brook Trout resources at the local level.

Chesapeake Bay Fish Passage Prioritization – This web-mapping platform is designed to be a screening-level tool that can be used to help investigate potential fish passage projects in the context of many ecological factors (Martin and Apse 2013). However, results do not incorporate important social, economic or feasibility factors and are not intended to be a replacement for site-specific knowledge nor a prescription for on-the-ground action. This platform includes a Brook Trout-specific scenario, though this scenario is limited to dams on small streams (those draining <100 km^2). Users of this tool can view results in the context of other relevant data including project data and various base maps, query results, download tabular data, search for a dam interactively or by name, annotate a map and print or save a map. (Fish Passage Management Strategy)

Riparian Restoration for Climate Change Resilience Tool – This tool enables users to dynamically locate areas (within the selected region) in the riparian zone that would benefit most from increased shading produced by planting of trees. The tool operates on a 200 meter stream buffer (100 on each side), and requires the user to specify values for maximum percent canopy cover and minimum solar gain percentile. The user can additionally choose to include minimum elevation (meters) and maximum percent impervious surface values in the analysis.

Downstream Strategies will produce a web-based GIS visualization and decision support application for the Chesapeake Bay Brook Trout BRT Model. The model’s statistical outcomes are used to generate the post modeling indices of anthropogenic stress and natural habitat quality (Martin et al. 2012). These indices are derived directly from the measures of variable influence and their functional relationships with the response. The individual predictors that are anthropogenic in nature are used to generate anthropogenic stress metrics and the cumulative anthropogenic stress index (CASI), whereas predictors that are of natural origin are used to generate natural quality metrics and the cumulative natural quality index (CNQI). These metrics and indices are generated at the 1:100k NHD catchment scale so they can be used to generate and visualize restoration and protection priorities at a fine scale. For example, areas of high natural quality (i.e., high CNQI score) and low stress (i.e., low CASI score) could represent protection priorities, whereas areas of high natural quality and high stress may represent restoration priorities. You can also rank catchments within a selected HUC 8 based on user selection and weighting of stressors based on “importance”. These variables include modeling results and additional socioeconomic variables. The tool displays catchments ranked on the users’ criteria. Another component of this web-tool is futuring, which allows the user to examine the natural quality and stress that is relevant to a specific catchment. This process includes the ability to modify existing conditions through a user interface and predict changes in overall CASI index score for a selected catchment based on local changes in stressors.

VIII. Monitoring Progress

Monitoring the Status of Wild Brook Trout Only Patches

A cluster analysis will be used to subsample the existing number of Wild Brook Trout Only patches to determine changes in status (Hudy et al. 2013b). A panel design will be developed where “x” patches are sampled every year (sentinel samples) and others are sampled every 5 years. Sentinel samples are intended to capture year-to-year and fast changes while the once every five year samples will capture long-term trends. For example, 250 sites are selected by cluster analysis for monitoring (cluster based on patch size, elevation, climate vulnerability, eco-region, regional interest, etc.). A total of 25 of the 250 sites will be designated as sentinel sites and sampled every year. An additional 45 of the remaining sites will be sampled every year on a rotating basis so that each site is visited once every 5 years. This equates to 70 sites being monitored in the Chesapeake Bay watershed each year.

Number of patches, number of patches with increasing size/connectivity (i.e., additional downstream/upstream catchments occupied by wild Brook Trout only), number of patches decreasing in size (loss of occupancy of downstream/upstream catchments), average patch size, and genetic diversity contained within these patches (defined as heterozygosity and allelic diversity) will be used to determine the status of Wild Brook Trout Only patches. These metrics will be calculated using standard electrofishing occupancy sampling and fin clips will be taken from young of the year Brook Trout collected during electrofishing samples to determine genetic diversity using the methods described in Whiteley et al. (2012a).

The effective number of individual Brook Trout (regardless of age) contributing to a year class or cohort (N_b) will also be monitored because N_b estimates represent the entire “patch” or population and not just a representative reach (Whiteley et al. 2012b). Nb is closely linked to reproductive potential and recruitments within a patch because it provides an estimate of the amount and quality of reproductive habitat. N_b values for a patch are always less than N (typically 10%-50%), and thus require fewer samples for accurate estimation than estimates of N using depletion or mark-recapture estimates (Tallmon et al. 2010) making them better suited for determining trends for numerous sites. Comparison of values of N_b across populations will provide a reliable ‘at risk’ evaluation that integrates year-to-year variation in N within each patch. Analysis of the genetic data can also provide information about the genetic diversity within a patch, which is an indication of past population size and population resilience to future environmental change, population structure, and archiving data for future genomics analyses.

IX. Assessing Progress

To achieve the Brook Trout outcome, there is a need to increase the amount of wild Book Trout only occupied patch area by 1,080 km^2. This equates to expanding occupancy by 108 km^2 per year over a ten year period. To assess progress, pertinent jurisdictions will annually report the amount of habitat (km^2) occupied by wild Brook Trout only that was added to the baseline figure through conservation actions. These annual gains will be combined with the outputs of the monitoring protocol (i.e., sentinel sampling sites) to determine overall progress. Then, after every five year period, when all monitoring sites have been sampled at least once and assuming adequate continued funding for monitoring/evaluation, a status report will be developed that summarizes the gains and/or losses of area occupied by wild Brook Trout only over that time period and contains recommendations for making adjustments to maintain progress toward the outcome (i.e. managing adaptively). Such adjustments will likely take the form of interim geographic targets identified by the pilot model and articulated in biennial workplans.

Table 1. The number and area of all wild Brook Trout patches (allopatric and sympatric) in the Chesapeake Bay watershed.

State	Number of Wild Brook Trout Patches	Wild Brook Trout Patch Area (km^2)
Maryland	110	1,017
New York	256	5,904
Pennsylvania	867	19,870
Virginia	240	6,042
West Virginia	79	1,598
Totals	**1,552**	**34,431**

Table 2. The number and area of patches classified as Wild Brook Trout Only (allopatric) in the Chesapeake Bay watershed.

State	Number of Patches Classified as Wild Brook Trout Only	Wild Brook Trout Only Patch Area (km^2)
Maryland	75	604
New York	158	2,537
Pennsylvania	408	4,671
Virginia	213	4,651
West Virginia	71	1,032
Totals	**925**	**13,495**

Table 3. Additional area needed to increase the amount of Wild Brook Trout Only (allopatric) patches by 8% during the next 10 years.

State	2014 Area (km^2) of Wild Brook Trout Only Patches	Area (km^2) Needed to Achieve an 8% Increase	Projected 2025 Area (km^2) of Wild Brook Trout Only Patches
Maryland	604	48	652
New York	2,537	203	2,740
Pennsylvania	4,671	374	5,045
Virginia	4,651	372	5,023
West Virginia	1,032	83	1,115
Totals	13,495	1,080	14,575

Table 4. Relative influence of all predictor variables used in the Chesapeake Bay Brook Trout BRT Model.

Predictor Variable Description	Predictor Variable Code	Relative Influence
Predicted mean July water temperature	mnjuly	42.7
Network mean imperviousness	IMP06C	21.6
Network percent agriculture	Ag_pc	9.7
Catchment slope of flowline	SLOPE_fix	7.5
Catchment mean annual precipitation	Precip	6.6
Nework percent grassland (log transformed)	Log_Grass_pc	2.6
Catchment mean soil pH	SoilpH	2.5
Network percent acidic bedrock geology	Acid_geol_pc	2.5
Network percent mined, non-active (log transformed)	Log_past_minepc	2.3
Network percent wetlands (log transformed)	Log_Wet_pc	2.1

Table 5. The distribution of HUC 12s containing Wild Brook Trout Only (allopatric) patches sorted by priority level and States.

State	Number of Priority Level 1 HUC 12s	Number of Priority Level 2 HUC 12s	Number of Priority Level 3 HUC 12s	Totals
Maryland	1	14	13	**28**
New York	0	44	68	**112**
Pennsylvania	77	152	82	**311**
Virginia	65	22	32	**119**
West Virginia	3	6	21	**30**
Totals	**146**	**238**	**216**	**600**

X. Adaptively Managing

Information needed.

XI. Biennial Workplan

Biennial workplans for each management strategy will be developed by April 2016. It will include the following information:

- Each key action
- Timeline for the action
- Expected outcome
- Partners responsible for each action
- Estimated resources

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Appendix

Appendix Table I. Subwatersheds within the Chesapeake Bay watershed that have a priority score ≥ 0.79.

HUC 12 Code	HUC 12 Name	HUC 12 Priority Score	Classification
020501060202	Millstone Creek-Schrader Creek	0.86	Intact
020501061302	Upper Bowman Creek	0.87	Intact
020501070401	Little Nescopeck Creek-Nescopeck Creek	0.83	Intact
020501070501	Headwaters Huntington Creek	0.97	Intact
020501070502	Kitchen Creek	0.92	Intact
020501070701	East Branch Fishing Creek	0.86	Intact
020501070702	West Branch Fishing Creek	0.98	Intact
020502010504	Cold Stream	0.89	Intact
020502010505	Sixmile Run	0.94	Reduced
020502010602	Gifford Run-Mosquito Creek	0.88	Reduced
020502010702	Trout Run	0.88	Intact
020502010704	Deer Creek	0.87	Reduced
020502010710	Sterling Run	0.91	Reduced
020502010711	Birch Island Run	1.24	Intact
020502010712	Lower Three Runs-West Branch Susquehanna River	0.99	Intact
020502020102	Sinnemahoning Portage Creek-Driftwood Branch Sinnemahoning Creek	1.03	Intact
020502020203	North Creek	1.06	Reduced
020502020204	West Creek	1.19	Intact
020502020205	Hunts Run	0.99	Intact
020502020206	Sterling Run	1.15	Reduced
020502020301	Upper Bennett Branch Sinnemahoning Creek	1.07	Intact
020502020302	Kersey Run	0.84	Intact
020502020303	Laurel Run	0.93	Reduced
020502020306	Spring Run	1.13	Intact
020502020310	Hicks Run	0.94	Reduced
020502020311	Mix Run	1.19	Intact
020502020312	Lower Bennett Branch Sinnemahoning Creek	1.13	Intact
020502020403	Upper First Fork Sinnemahoning Creek	0.96	Reduced
020502020405	East Fork Sinnemahoning Creek	0.95	Intact
020502020406	Middle First Fork Sinnemahoning Creek	1.20	Reduced
020502020407	Lower First Fork Sinnemahoning Creek	1.02	Intact
020502020501	Wykoff Run	1.16	Intact
020502020502	Sinnemahoning Creek-West Branch Susquehanna River	1.16	Intact
020502030101	Little Kettle Creek	1.13	Intact
020502030102	Upper Kettle Creek	1.22	Intact

HUC 12 Code	HUC 12 Name	HUC 12 Priority Score	Classification
020502030103	Cross Fork	1.12	Intact
020502030104	Hammersley Fork	1.35	Intact
020502030105	Middle Kettle Creek	1.30	Reduced
020502030106	Lower Kettle Creek	1.17	Reduced
020502030201	Cooks Run	1.12	Intact
020502030202	Fish Dam Run-West Branch Susquehanna River	1.28	Intact
020502030203	Drury Run	1.05	Intact
020502030205	Hall Run-West Branch Susquehanna River	0.80	Intact
020502030301	Left Branch Young Womans Creek	1.22	Reduced
020502030302	Young Womans Creek-West Branch Susquehanna River	1.34	Intact
020502030401	Hyner Run	1.35	Intact
020502030402	Rattlesnake Run-West Branch Susquehanna River	1.35	Intact
020502030404	Baker Run	1.18	Intact
020502030405	North Fork Tangascootack Creek	0.94	Intact
020502030408	Ferney Run-West Branch Susquehanna River	1.17	Intact
020502030409	Queens Run	0.99	Intact
020502040201	South Fork Beach Creek	0.96	Reduced
020502050101	Lyman Run	1.06	Intact
020502050102	Wetmore Run-West Branch Pine Creek	1.12	Intact
020502050201	Ninemile Run	0.89	Intact
020502050203	Genesee Forks	0.87	Intact
020502050205	Phoenix Run	0.98	Intact
020502050208	Lick Run-Pine Creek	0.84	Intact
020502050506	Little Pine Creek-Pine Creek	0.82	Reduced
020502050601	Trout Run-Pine Creek	0.92	Reduced
020502050602	Cedar Run	1.12	Intact
020502050603	Slate Run	1.33	Intact
020502050604	Mill Run-Pine Creek	1.11	Reduced
020502050605	Trout Run	1.28	Intact
020502060101	Second Fork Larrys Creek	0.81	Reduced
020502060102	First Fork Larrys Creek	0.81	Reduced
020502060203	Rock Run	0.81	Intact
020502060204	Pleasant Stream	0.87	Reduced
020502060205	Grays Run	0.86	Intact
020502060302	Glass Creek-Loyalsock Creek	0.82	Reduced
020502060304	Little Loyalsock Creek-Loyalsock Creek	0.95	Intact
020502060503	Ogdonia Creek-Loyalsock Creek	0.87	Reduced
020502060504	Plunketts Creek	0.91	Intact
020502061201	White Deer Creek-Lower West Branch Susquehanna River	0.83	Reduced
020503010902	Rattling Creek	0.84	Reduced

HUC 12 Code	HUC 12 Name	HUC 12 Priority Score	Classification
020503020701	Laurel Run	0.80	Reduced
020700010102	Big Run	0.81	Intact
020700010104	Headwaters Seneca Creek	0.83	Intact
020700010105	Outlet Seneca Creek	0.91	Intact
020700010309	Briggs Run-South Branch Potomac River	0.82	Reduced
020700010107	Zeke Run-North Fork South Branch Potomac River	0.91	Reduced
020700020207	Piney Swamp Run-North Branch Potomac River	0.91	Intact
020700050102	Buffalo Branch-Middle River	1.37	Intact
020700050103	Jennings Branch	0.93	Intact
020700050703	Inch Branch-Back Creek	0.95	Intact
020700050801	Big Run-South Fork Shenandoah River	0.82	Intact
020700050805	South Branch-Naked Creek	1.10	Intact
020700051001	Jeremys Run-South Fork Shenandoah River	1.24	Intact
020700051002	Brown Hollow Run-South Fork Shenandoah River	1.19	Reduced
020700051003	Gooney Run	1.17	Reduced
020801030102	Jordan River	1.10	Intact
020801030301	Piney River-Thornton River	1.30	Intact
020801030302	Covington River	1.31	Intact
020801030401	Hughes River	1.10	Intact
020801030402	Sams Run-Hazel River	1.16	Intact
020801030701	Garth Run-Rapidan River	1.21	Intact
020801030702	Conway River	1.16	Intact
020801030703	South River-Rapidan River	0.84	Intact
020801030901	Rose River-Robinson River	1.24	Intact
020802010102	Bolar Run-Jackson River	1.02	Reduced
020802010103	Warm Springs Run-Jackson River	1.11	Reduced
020802010202	Jim Dave Run-Back Creek	0.93	Intact
020802010203	Little Back Creek	0.92	Intact
020802010302	Cove Run-Dunlap Creek	1.19	Reduced
020802010401	South Fork Potts Creek-North Fork Potts Creek	0.93	Reduced
020802010403	Mill Branch-Potts Creek	1.13	Intact
020802010404	Cast Steel Run-Potts Creek	1.12	Intact
020802010405	Hays Creek-Potts Creek	1.04	Intact
020802010501	Hot Springs Run-Cedar Creek	1.08	Reduced
020802010502	Falling Spring Creek-Jackson River	0.99	Reduced
020802010503	Indian Draft-Jackson River	1.04	Reduced
020802010505	Karnes Creek-White Rock Creek	1.04	Intact
020802010506	Wilson Creek	1.16	Intact
020802010507	Smith Creek-Jackson River	1.29	Intact
020802010603	Benson Run-Cowpasture River	1.02	Intact

HUC 12 Code	HUC 12 Name	HUC 12 Priority Score	Classification
020802010605	Crab Run-Bullpasture River	0.93	Reduced
020802010703	Thompson Creek-Cowpasture River	1.13	Intact
020802010704	Lick Run-Stuart Run	1.13	Intact
020802010801	Mill Creek-Cowpasture River	1.15	Intact
020802010802	Pads Creek	1.09	Reduced
020802010902	Sinking Creek	1.04	Intact
020802010903	Smith Branch-Mill Creek	0.98	Intact
020802011101	Upper Johns Creek	1.01	Reduced
020802011102	Lower Johns Creek	1.09	Reduced
020802011202	Barbours Creek	1.14	Intact
020802011203	Mill Creek-Craig Creek	1.03	Reduced
020802011502	North Creek-Jennings Creek	0.94	Reduced
020802020102	Ramseys Draft	0.84	Intact
020802020103	Holloway Draft-Calfpasture River	1.09	Intact
020802020105	Fridley Branch-Calfpasture River	1.12	Intact
020802020106	Cabin Creek-Mill Creek	1.13	Intact
020802020107	Brattons Run	1.08	Intact
020802020108	Guys Run-Calfpasture River	1.03	Intact
020802020201	Upper Little Calfpasture River	1.03	Intact
020802020202	Lower Little Calfpasture River	1.00	Intact
020802020403	Irish Creek	0.93	Intact
020802020502	South Buffalo Creek	0.94	Intact
020802030101	Otter Creek-James River	0.93	Reduced
020802030201	Lynchburg Reservoir-Pedlar River	0.96	Intact
020802030202	Browns Creek-Pedlar River	1.02	Intact
020802030501	South Fork Tye River-North Fork Tye River	1.03	Intact
020802030502	Cub Creek-Tye River	1.07	Intact
020802030505	Little Piney River-Piney River	1.07	Intact
020802030601	North Fork Buffalo River-Buffalo River	1.06	Intact
020802040104	Doyles River	0.88	Intact

Appendix Table II. Number and percentage of catchments within the Chesapeake Bay watershed that have a HQI ≥ 0.50, summarized by 8-digit HUCs.

HUC 8 Code	HUC 8 Name	Total Number of Catchments in the HUC 8	Number of Catchments in the HUC 8 with a HQI ≥ 0.50	Percentage of Catchments in the HUC 8 with a HQI ≥ 0.50
02050101	Upper Susquehanna	2,280	1,295	56.8%
02050102	Chenango	1,840	1,611	87.6%
02050103	Owego-Wappasening	1,491	767	51.4%
02050104	Tioga	930	486	52.3%
02050105	Chemung	976	444	45.5%
02050106	Upper Susquehanna-Tunkhannock	2,511	1,349	53.7%
02050107	Upper Susquehanna-Lackawanna	1,942	1,255	64.6%
02050201	Upper West Branch Susquehanna	1,691	1,504	88.9%
02050202	Sinnemahoning	1,548	1,394	90.1%
02050203	Middle West Branch Susquehanna	836	718	85.9%
02050204	Bald Eagle	644	459	71.3%
02050205	Pine	1,010	760	75.2%
02050206	Lower West Branch Susquehanna	2,008	1,301	64.8%
02050301	Lower Susquehanna-Penns	1,772	1,013	57.2%
02050302	Upper Juniata	1,004	604	60.2%
02050303	Raystown	1,165	567	48.7%
02050304	Lower Juniata	1,783	891	50.0%
02050305	Lower Susquehanna-Swarta	1,898	906	47.7%
02050306	Lower Susquehanna	2,540	1,268	49.9%
02060002	Chester-Sassafras	415	137	33.0%
02060003	Gunpowder-Patapsco	1,523	630	41.4%
02060004	Severn	51	7	13.7%
02060006	Patuxent	576	155	26.9%
02070001	South Branch Potomac	1,854	775	41.8%
02070002	North Branch Potomac	1,592	832	52.3%
02070003	Cacapon-Town	1,404	437	31.1%
02070004	Conococheague-Opequon	2,489	801	32.2%
02070005	South Fork Shenandoah	861	381	44.3%
02070006	North Fork Shenandoah	485	155	32.0%
02070007	Shenandoah	353	59	16.7%
02070008	Middle Potomac-Catoctin	1,686	609	36.1%
02070009	Monocacy	1,117	568	50.9%
02070010	Middle Potomac-Anacostia-Occoquan	1,464	398	27.2%
02070011	Lower Potomac	247	45	18.2%
02080103	Rapidan-Upper Rappahannock	689	274	39.8%
02080106	Pamunkey	13	0	0.0%
02080201	Upper James	2,720	1,683	61.9%

HUC 8 Code	HUC 8 Name	Total Number of Catchments in the HUC 8	Number of Catchments in the HUC 8 with a HQI ≥ 0.50	Percentage of Catchments in the HUC 8 with a HQI ≥ 0.50
02080202	Maury	818	395	48.3%
02080203	Middle James-Buffalo	1,034	494	47.8%
02080204	Rivanna	218	132	60.6%
	Totals	**51,478**	**27,559**	**53.5%**

Appendix Table III. Level 1 Priority Subwatersheds Containing Wild Brook Trout Only (allopatric) Patches.

State	HUC 12 Code	HUC 12 Name	HUC 12 Priority Score	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
PA	020501060202	Millstone Creek-Schrader Creek	0.86	67.3%	104.0
PA	020501061302	Upper Bowman Creek	0.87	84.6%	56.8
PA	020501070401	Little Nescopeck Creek-Nescopeck Creek	0.83	60.8%	76.9
PA	020501070501	Headwaters Huntington Creek	0.97	92.0%	32.0
PA	020501070502	Kitchen Creek	0.92	75.0%	26.4
PA	020501070701	East Branch Fishing Creek	0.86	100.0%	48.2
PA	020501070702	West Branch Fishing Creek	0.98	100.0%	26.6
PA	020502010504	Cold Stream	0.89	92.0%	1.4
PA	020502010505	Sixmile Run	0.94	100.0%	12.4
PA	020502010602	Gifford Run-Mosquito Creek	0.88	100.0%	105.8
PA	020502010702	Trout Run	0.88	100.0%	63.9
PA	020502010704	Deer Creek	0.87	88.0%	53.5
PA	020502010710	Sterling Run	0.91	90.0%	28.8
PA	020502010711	Birch Island Run	1.24	100.0%	43.6
PA	020502010712	Lower Three Runs-West Branch Susquehanna River	0.99	85.3%	40.9
PA	020502010713	Burns Run-West Branch Susquehanna River	1.03	88.1%	48.1
PA	020502020102	Sinnemahoning Portage Creek-Driftwood Branch	1.06	95.8%	32.5
PA	020502020203	North Creek	1.19	100.0%	7.1
PA	020502020204	West Creek	0.99	82.8%	27.5
PA	020502020205	Hunts Run	1.15	100.0%	12.7
PA	020502020206	Sterling Run	1.07	100.0%	40.7
PA	020502020301	Upper Bennett Branch Sinnemahoning Creek	0.84	100.0%	45.6
PA	020502020302	Kersey Run	0.93	91.9%	41.9
PA	020502020303	Laurel Run	1.13	91.9%	77.2
PA	020502020306	Spring Run	0.94	100.0%	30.8
PA	020502020310	Hicks Run	1.19	100.0%	2.9
PA	020502020311	Mix Run	1.13	94.7%	38.1
PA	020502020312	Lower Bennett Branch Sinnemahoning Creek	0.96	75.9%	32.5
PA	020502020403	Upper First Fork Sinnemahoning Creek	0.95	89.7%	11.5
PA	020502020405	East Fork Sinnemahoning Creek	1.20	88.5%	51.6
PA	020502020406	Middle First Fork Sinnemahoning Creek	1.02	80.3%	53.0
PA	020502020407	Lower First Fork Sinnemahoning Creek	1.16	78.7%	48.9
PA	020502020501	Wykoff Run	1.16	95.5%	46.9
PA	020502020502	Sinnemahoning Creek-West Branch Susquehanna R.	1.13	69.2%	84.5
PA	020502030101	Little Kettle Creek	1.22	100.0%	18.3
PA	020502030102	Upper Kettle Creek	1.12	93.5%	64.5
PA	020502030103	Cross Fork	1.35	98.1%	17.7
PA	020502030104	Hammersley Fork	1.30	95.3%	32.4
PA	020502030105	Middle Kettle Creek	1.17	82.5%	57.5

State	HUC 12 Code	HUC 12 Name	HUC 12 Priority Score	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
PA	020502030106	Lower Kettle Creek	1.12	88.7%	65.4
PA	020502030201	Cooks Run	1.28	100.0%	52.7
PA	020502030202	Fish Dam Run-West Branch Susquehanna River	1.05	80.0%	18.2
PA	020502030203	Drury Run	0.80	100.0%	21.4
PA	020502030205	Hall Run-West Branch Susquehanna River	1.22	61.8%	67.4
PA	020502030301	Left Branch Young Womans Creek	1.34	100.0%	5.0
PA	020502030302	Young Womans Creek-West Branch Susquehanna R.	1.35	100.0%	19.1
PA	020502030401	Hyner Run	1.35	100.0%	36.5
PA	020502030402	Rattlesnake Run-West Branch Susquehanna River	1.18	56.5%	60.5
PA	020502030404	Baker Run	1.20	100.0%	7.8
PA	020502030405	North Fork Tangascootack Creek	0.94	100.0%	27.8
PA	020502030408	Ferney Run-West Branch Susquehanna River	1.17	55.2%	20.6
PA	020502030409	Queens Run	0.99	100.0%	35.4
PA	020502040201	South Fork Beach Creek	0.96	83.3%	10.0
PA	020502050101	Lyman Run	1.06	100.0%	9.7
PA	020502050102	Wetmore Run-West Branch Pine Creek	1.12	91.3%	42.6
PA	020502050201	Ninemile Run	0.89	100.0%	11.7
PA	020502050203	Genesee Forks	0.87	100.0%	2.2
PA	020502050205	Phoenix Run	0.98	92.3%	14.3
PA	020502050208	Lick Run-Pine Creek	0.84	32.1%	28.9
PA	020502050506	Little Pine Creek-Pine Creek	0.82	87.1%	87.7
PA	020502050601	Trout Run-Pine Creek	0.92	38.6%	103.3
PA	020502050602	Cedar Run	1.12	96.6%	31.3
PA	020502050603	Slate Run	1.33	94.3%	18.4
PA	020502050604	Mill Run-Pine Creek	1.11	69.4%	45.2
PA	020502050605	Trout Run	1.28	100.0%	7.2
PA	020502060101	Second Fork Larrys Creek	0.81	94.1%	20.0
PA	020502060102	First Fork Larrys Creek	0.81	85.7%	4.8
PA	020502060203	Rock Run	0.81	92.9%	20.1
PA	020502060204	Pleasant Stream	0.87	94.3%	22.4
PA	020502060205	Grays Run	0.86	75.0%	28.2
PA	020502060302	Glass Creek-Loyalsock Creek	0.82	74.7%	111.3
PA	020502060304	Little Loyalsock Creek-Loyalsock Creek	0.95	79.6%	59.3
PA	020502060503	Ogdonia Creek-Loyalsock Creek	0.87	54.9%	35.2
PA	020502060504	Plunketts Creek	0.91	100.0%	29.6
PA	020502061201	White Deer Creek-Lower West Branch Susquehanna R.	0.83	95.5%	4.2
PA	020503010902	Rattling Creek	0.84	100.0%	27.6
PA	020503020701	Laurel Run	0.80	78.9%	8.2
WV	020700010102	Big Run	0.81	100.0%	73.5
VA	020700010104	Headwaters Seneca Creek	0.83	96.9%	38.2
VA	020700010105	Outlet Seneca Creek	0.91	84.2%	67.8

State	HUC 12 Code	HUC 12 Name	HUC 12 Priority Score	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
WV	020700010309	Briggs Run-South Branch Potomac River	0.82	29.4%	16.2
WV	020700010107	Zeke Run-North Fork South Branch Potomac River	0.91	38.1%	27.3
MD	020700020207	Piney Swamp Run-North Branch Potomac River	0.91	46.7%	26.9
VA	020700050102	Buffalo Branch-Middle River	1.37	40.0%	60.3
VA	020700050103	Jennings Branch	0.93	50.0%	45.5
VA	020700050703	Inch Branch-Back Creek	0.95	83.5%	76.1
VA	020700050801	Big Run-South Fork Shenandoah River	0.82	45.2%	64.0
VA	020700050805	South Branch-Naked Creek	1.10	81.3%	83.3
VA	020700051001	Jeremys Run-South Fork Shenandoah River	1.24	0.0%	48.0
VA	020700051002	Brown Hollow Run-South Fork Shenandoah River	1.19	12.1%	48.4
VA	020700051003	Gooney Run	1.17	40.0%	70.7
VA	020801030102	Jordan River	1.10	28.6%	60.0
VA	020801030301	Piney River-Thornton River	1.30	42.9%	76.7
VA	020801030302	Covington River	1.31	0.0%	107.8
VA	020801030401	Hughes River	1.10	46.2%	33.2
VA	020801030402	Sams Run-Hazel River	1.16	33.3%	41.3
VA	020801030701	Garth Run-Rapidan River	1.21	84.2%	88.0
VA	020801030702	Conway River	1.16	72.7%	15.4
VA	020801030703	South River-Rapidan River	0.84	65.0%	25.1
VA	020801030901	Rose River-Robinson River	1.24	75.0%	38.6
VA	020802010102	Bolar Run-Jackson River	1.02	60.0%	148.4
VA	020802010103	Warm Springs Run-Jackson River	1.11	73.3%	24.2
VA	020802010202	Jim Dave Run-Back Creek	0.93	77.8%	121.9
VA	020802010203	Little Back Creek	0.92	66.7%	70.4
VA	020802010302	Cove Run-Dunlap Creek	1.19	73.5%	31.5
VA	020802010401	South Fork Potts Creek-North Fork Potts Creek	0.93	92.3%	19.2
VA	020802010403	Mill Branch-Potts Creek	1.13	61.5%	49.5
VA	020802010404	Cast Steel Run-Potts Creek	1.12	54.8%	35.6
VA	020802010405	Hays Creek-Potts Creek	1.04	62.5%	4.1
VA	020802010501	Hot Springs Run-Cedar Creek	1.08	84.2%	77.9
VA	020802010502	Falling Spring Creek-Jackson River	0.99	45.8%	28.3
VA	020802010503	Indian Draft-Jackson River	1.04	41.5%	45.1
VA	020802010505	Karnes Creek-White Rock Creek	1.04	76.9%	40.3
VA	020802010506	Wilson Creek	1.16	88.5%	42.1
VA	020802010507	Smith Creek-Jackson River	1.29	59.3%	32.5
VA	020802010603	Benson Run-Cowpasture River	1.02	100.0%	23.2
VA	020802010605	Crab Run-Bullpasture River	0.93	61.5%	113.1
VA	020802010703	Thompson Creek-Cowpasture River	1.13	45.5%	42.4
VA	020802010704	Lick Run-Stuart Run	1.13	100.0%	24.0
VA	020802010801	Mill Creek-Cowpasture River	1.15	58.8%	43.2
VA	020802010802	Pads Creek	1.09	72.6%	11.4

State	HUC 12 Code	HUC 12 Name	HUC 12 Priority Score	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
VA	020802010902	Sinking Creek	1.04	80.0%	27.9
VA	020802010903	Smith Branch-Mill Creek	0.98	86.4%	9.0
VA	020802011101	Upper Johns Creek	1.01	84.8%	50.8
VA	020802011102	Lower Johns Creek	1.09	91.5%	28.9
VA	020802011202	Barbours Creek	1.14	92.3%	51.6
VA	020802011203	Mill Creek-Craig Creek	1.03	53.6%	51.4
VA	020802011502	North Creek-Jennings Creek	0.94	76.9%	12.2
VA	020802020102	Ramseys Draft	0.84	100.0%	55.6
VA	020802020103	Holloway Draft-Calfpasture River	1.09	66.7%	82.0
VA	020802020105	Fridley Branch-Calfpasture River	1.12	36.4%	84.2
VA	020802020106	Cabin Creek-Mill Creek	1.13	67.9%	61.7
VA	020802020107	Brattons Run	1.08	93.0%	50.5
VA	020802020108	Guys Run-Calfpasture River	1.03	69.4%	19.9
VA	020802020201	Upper Little Calfpasture River	1.03	80.0%	93.9
VA	020802020202	Lower Little Calfpasture River	1.00	36.8%	4.4
VA	020802020403	Irish Creek	0.93	75.0%	62.1
VA	020802020502	South Buffalo Creek	0.94	37.5%	1.7
VA	020802030101	Otter Creek-James River	0.93	51.3%	37.8
VA	020802030201	Lynchburg Reservoir-Pedlar River	0.96	64.5%	43.5
VA	020802030202	Browns Creek-Pedlar River	1.02	60.3%	29.3
VA	020802030501	South Fork Tye River-North Fork Tye River	1.03	97.5%	80.9
VA	020802030502	Cub Creek-Tye River	1.07	61.3%	47.2
VA	020802030505	Little Piney River-Piney River	1.07	78.6%	83.7
VA	020802030601	North Fork Buffalo River-Buffalo River	1.06	39.7%	37.6
VA	020802040104	Doyles River	0.88	81.5%	29.7

Appendix Table IV. Level 2 Priority Subwatersheds Containing Wild Brook Trout Only (allopatric) Patches.

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
NY	020501010201	Pleasant Brook	81.8%	58.4
NY	020501010202	Upper Cherry Valley Creek	80.0%	60.0
NY	020501010301	Upper Schenevus Creek	69.4%	31.6
NY	020501010302	Elk Creek	82.1%	23.9
NY	020501010401	Center Brook	100.0%	41.1
NY	020501010403	Upper Charlotte Creek	77.6%	96.3
NY	020501010404	Kortright Creek	100.0%	72.7
NY	020501010501	West Branch Otego Creek	63.2%	3.5
NY	020501010502	Upper Otego Creek	62.5%	26.7
NY	020501010504	Lower Otego Creek	66.7%	73.1
NY	020501010604	Red Creek-Susquehanna River	66.7%	76.7
NY	020501010802	Middle Butternut Creek	60.7%	93.0
NY	020501010803	Lower Butternut Creek	69.8%	105.9
NY	020501010906	Center Brook	92.3%	59.8
NY	020501010907	Great Brook	90.0%	66.9
NY	020501011001	Upper Ouleout Creek	100.0%	25.0
NY	020501011002	Treadwell Creek	95.0%	25.6
NY	020501011004	Handsome Brook	84.0%	9.9
NY	020501011101	Otsdawa Creek	100.0%	28.7
NY	020501011103	Sand Hill Creek-Susquehanna River	61.9%	28.1
NY	020501011104	Carrs Creek	92.3%	11.4
NY	020501011201	Bennettsville Creek	82.2%	69.4
NY	020501011202	Kelsey Brook	77.1%	2.8
NY	020501011204	Wylie Brook	90.3%	56.5
NY	020501011207	Ouaquaga Creek-Susquehanna River	60.6%	45.0
PA	020501011301	Shadigee Creek	62.1%	19.6
PA	020501011303	Middle Starrucca Creek	87.5%	6.5
PA	020501011304	Lower Starrucca Creek	71.9%	31.3
NY	020501011307	Trowbridge Creek	100.0%	29.1
PA	020501011309	Silver Creek	62.5%	16.1
NY	020501020302	Mud Creek	66.7%	5.3
NY	020501020306	Merrill Creek	80.0%	43.2
NY	020501020405	Culver Creek-Dudley Creek	83.3%	27.2
NY	020501020502	Middle Sangerfield River	61.5%	26.5
NY	020501020601	Pleasant Brook	69.2%	3.6
NY	020501020609	Turner Creek-Fly Meadow Creek	79.3%	4.9
NY	020501020702	Upper Genegantslet Creek	60.0%	10.6

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
NY	020501030304	Middle Catatonk Creek	60.6%	14.3
NY	020501030401	Headwaters East Branch Owego Creek	96.8%	28.6
NY	020501030405	Upper West Branch Owego Creek	80.0%	28.8
PA	020501030501	Apalachin Creek	66.0%	4.1
NY	020501030603	Upper Cayuta Creek	62.2%	5.4
PA	020501030701	Upper Wappasening Creek	60.0%	37.5
NY	020501040101	McHenry Valley Creek	100.0%	30.6
NY	020501040103	Upper Canacadea Creek	80.0%	50.7
NY	020501040202	Upper Bennetts Creek	100.0%	34.6
PA	020501040801	Headwaters Cowanesque River	80.0%	84.0
PA	020501040804	Jemison Creek	80.0%	20.6
PA	020501040901	Headwaters Tioga River	96.8%	43.2
PA	020501040904	Upper Tioga River	64.6%	24.8
NY	020501050102	Twelvemile Creek	84.2%	10.0
NY	020501050104	Reynolds Creek-Cohocton River	66.7%	28.8
NY	020501050402	Cutler Creek-Chemung River	60.0%	23.7
NY	020501050502	Upper Newtown Creek	71.1%	13.7
PA	020501060201	Little Schrader Creek	83.3%	96.3
PA	020501060303	South Branch Towanda Creek	69.0%	70.7
PA	020501060702	Gaylord Creek	66.7%	48.1
PA	020501060703	North Branch Wyalusing Creek	66.7%	40.4
PA	020501060901	Upper Mehoopany Creek	75.0%	84.1
PA	020501060903	Lower Mehoopany Creek	88.6%	61.9
PA	020501061001	Upper East Branch Tunkhannock Creek	89.5%	41.0
PA	020501061102	Lower South Branch Tunkhannock Creek	64.1%	16.0
PA	020501061201	Upper Tunhannock Creek	69.0%	61.0
PA	020501061202	Butler Creek	60.0%	50.8
PA	020501061203	Nine Partners Creek	65.4%	21.7
PA	020501061204	Middle Tunkhannock Creek	60.0%	26.4
PA	020501061207	Horton Creek	76.9%	37.8
PA	020501061408	Gardner Creek	80.0%	2.3
PA	020501070102	East Branch Lackawanna River	64.7%	19.4
PA	020501070104	Rush Brook-Lackawanna River	73.7%	24.3
PA	020501070107	Roaring Brook	70.3%	25.7
PA	020501070108	Spring Brook	66.7%	26.8
PA	020501070110	Lackawanna River-Susquehanna River	81.8%	4.6
PA	020501070202	City of Wilkes-Barre-Mill Creek	77.1%	53.6
PA	020501070204	Sugar Notch Run-Solomon Creek	78.6%	47.2
PA	020501070301	Harveys Lake-Harveys Creek	83.6%	42.5

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
PA	020501070302	Hunlock Creek	76.7%	27.7
PA	020501070402	Black Creek	72.7%	154.4
PA	020501070503	Pine Creek	68.4%	8.1
PA	020501070704	Raven Creek	71.2%	4.9
PA	020501070801	Little Catawissa Creek	86.7%	7.7
PA	020501070802	Tomicken Creek	90.5%	46.9
PA	020501070803	Messers Run-Catawissa Creek	78.3%	95.8
PA	020501070901	Mugser Run-South Branch Roaring Creek	62.1%	9.5
PA	020502010101	Upper Chest Creek	94.3%	6.6
PA	020502010103	Lower Chest Creek	84.2%	29.0
PA	020502010201	Upper Anderson Creek	100.0%	68.8
PA	020502010202	Lower Anderson Creek	90.9%	22.6
PA	020502010303	Glendale Dam-Beaverdam Run	65.7%	18.5
PA	020502010304	Upper Clearfield Creek	91.8%	117.4
PA	020502010305	South Witmer Run-North Witmer Run	88.1%	66.8
PA	020502010306	Muddy Run	100.0%	5.9
PA	020502010307	Middle Clearfield Creek	70.0%	44.9
PA	020502010308	Lower Clearfield Creek	92.7%	42.4
PA	020502010309	Little Clearfield Creek	97.6%	20.0
PA	020502010310	Morgan Run-Lower Clearfield Creek	94.2%	40.0
PA	020502010401	Headwaters West Branch Susquehanna River	100.0%	56.7
PA	020502010403	Beaver Run-West Branch Susquehanna River	94.4%	13.6
PA	020502010404	Bear Run	100.0%	5.0
PA	020502010405	Bell Run	100.0%	15.1
PA	020502010406	Deer Run-West Branch Susquehanna River	79.6%	31.3
PA	020502010407	Montgomery Creek	85.7%	6.9
PA	020502010408	Curwensville Dam-West Branch Susquehanna River	76.2%	38.1
PA	020502010502	Upper Moshannon Creek	100.0%	35.9
PA	020502010503	Laurel Run	92.3%	9.6
PA	020502010506	Middle Moshannon Creek	71.9%	15.1
PA	020502010507	Black Moshannon Creek	85.1%	58.5
PA	020502010601	Headwaters Mosquito Creek	88.9%	28.7
PA	020502010701	Lick Run	100.0%	56.9
PA	020502010703	Moravian Run	100.0%	30.0
PA	020502010705	Sandy Creek	100.0%	24.4
PA	020502010707	Millstone Run-West Branch Susquehanna River	74.5%	15.0
PA	020502010708	Upper Three Runs	93.3%	43.9
PA	020502020207	Driftwood Branch Sinnemahoning Creek	75.4%	12.6
PA	020502020304	Medix Run	100.0%	44.5

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
PA	020502020305	Middle Bennett Branch Sinnemahoning Creek	90.8%	26.9
PA	020502020308	Dents Run	100.0%	24.1
PA	020502020309	East Branch Hicks Run	100.0%	8.0
PA	020502020401	Big Moores Run	100.0%	9.3
PA	020502020402	South Woods Branch	96.3%	8.4
PA	020502020404	Freeman Run	100.0%	23.9
PA	020502030406	Tangascootack Creek	100.0%	42.1
PA	020502030410	McElhattan Creek	60.7%	6.7
PA	020502030411	Chatham Run	85.7%	36.7
PA	020502040202	North Fork Beach Creek	100.0%	54.1
PA	020502040203	Sandy Run-Beech Creek	100.0%	33.4
PA	020502040204	Big Run	100.0%	5.8
PA	020502040205	Beech Creek-Bald Eagle Creek	92.5%	56.9
PA	020502040301	Bull Run-Fishing Creek	77.6%	12.5
PA	020502040302	Little Fishing Creek	77.3%	16.1
PA	020502040305	Cherry Run-Fishing Creek	65.9%	27.5
PA	020502040401	Laurel Run-Bald Eagle Creek	95.9%	2.0
PA	020502040402	Dicks Run-Bald Eagle Creek	79.6%	5.5
PA	020502050204	West Branch Pine Creek-Pine Creek	100.0%	39.8
PA	020502050206	Elk Run	95.5%	8.4
PA	020502050302	Asaph Run	90.9%	22.0
PA	020502050401	Headwaters Babb Creek	69.8%	71.7
PA	020502050403	East Branch Stony Fork	61.5%	18.1
PA	020502050405	Long Run-Babb Creek	62.5%	31.3
PA	020502050502	Texas Creek	77.8%	29.8
PA	020502050504	Blockhouse Creek	70.6%	27.5
PA	020502050505	Otter Run	100.0%	58.4
PA	020502050606	Upper Pine Bottom Run-Pine Creek	79.2%	29.4
PA	020502060103	Larrys Creek-West Branch Susquehanna River	94.6%	32.0
PA	020502060202	Mill Creek-Lycoming Creek	62.5%	35.0
PA	020502060207	Hoagland Run	87.5%	21.1
PA	020502060301	Lopez Creek	81.0%	51.5
PA	020502060303	Birch Creek	66.7%	6.1
PA	020502060401	Lick Creek	84.2%	9.3
PA	020502060402	Black Creek-Little Loyalsock Creek	76.2%	15.1
PA	020502060501	Porter Creek-Hoagland Branch	95.2%	12.9
PA	020502060502	Elk Creek	61.8%	15.4
PA	020502060506	Wallis Run	94.3%	18.9
PA	020502060508	Mill Creek-West Side of Loyalsock Creek	90.5%	12.4

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
PA	020502060509	Little Bear Creek-Loyalsock Creek	68.7%	15.1
PA	020502060601	Antes Creek	77.5%	27.1
PA	020502060702	Big Run	68.5%	4.2
PA	020502060801	Big Run-Muncy Creek	92.3%	53.8
PA	020502061001	North Branch Buffalo Creek	77.8%	8.7
PA	020502061002	Rapid Run	92.9%	22.3
PA	020502061102	Upper Branches Chillisquaque Creek	64.8%	16.8
PA	020503010202	Voneida Run-Pine Creek	86.0%	19.3
PA	020503010303	North Branch Middle Creek	79.2%	5.0
PA	020503010304	Beaver Creek-Middle Creek	73.8%	5.2
PA	020503010401	Colyer Lake-Sinking Creek	66.7%	2.6
PA	020503010402	Headwaters Penns Creek	66.7%	2.0
PA	020503010403	Upper Penns Creek	72.9%	13.5
PA	020503010501	Upper Mahanoy Creek	76.1%	6.6
PA	020503011005	Powell Creek	67.6%	18.1
PA	020503020201	Blair Gap Run	73.5%	16.7
PA	020503020502	Upper Little Juniata River	76.6%	21.2
PA	020503030202	Bobs Creek-Dunning Creek	82.0%	14.9
PA	020503030702	Great Trough Creek	69.2%	10.1
PA	020503030801	Shoup Run	100.0%	24.2
PA	020503030802	Sixmile Run-Raystown Branch Juniata River	76.3%	7.4
PA	020503040101	Saddler Creek	61.1%	48.1
PA	020503040201	Upper Sideling Hill Creek	67.6%	13.7
PA	020503040403	Three Springs Creek	60.5%	2.5
PA	020503040601	Treaster Run	84.4%	1.9
PA	020503050102	Bull Run	78.6%	24.9
PA	020503050105	Laurel Run	78.6%	2.5
PA	020503050301	Thompson Creek-Burd Run	71.4%	51.6
PA	020503050602	Good Spring Creek-Upper Swatara Creek	78.1%	10.1
PA	020503050603	Lower Little Swatara Creek	79.4%	12.3
PA	020503050604	Mill Creek	82.4%	37.1
PA	020503050702	Upper Little Swatara Creek	73.0%	4.5
PA	020503051003	Stony Creek	92.0%	39.5
PA	020503060301	Latimore Creek	85.7%	23.2
PA	020503060801	Upper Chickies Creek	60.0%	4.6
PA	020503060901	Little Cocalico Creek-Cocalico Creek	72.7%	11.7
MD	020503061603	Middle Deer Creek	63.3%	14.4
MD	020600030301	South Branch Gunpowder Falls-Gunpowder Falls	74.1%	35.6
MD	020600030401	Little Falls	79.1%	5.6

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
MD	020600031004	Piney Branch-South Branch Patapsco River	64.9%	13.2
VA	020700010101	Laurel Fork-North Fork South Branch Potomac River	91.8%	77.9
WV	020700010103	Red Lick Run-North Fork South Branch Potomac River	68.4%	11.4
WV	020700010201	Headwaters Lunice Creek	67.3%	15.0
VA	020700010301	Frank Run-South Branch Potomac River	60.0%	9.2
VA	020700010302	Strait Creek	100.0%	69.7
WV	020700010304	Whitehorn Creek-Thorn Creek	86.7%	118.4
MD	020700020101	Upper Savage River	91.2%	107.0
MD	020700020102	Crabtree Creek	90.9%	44.5
MD	020700020103	Lower Savage River	89.5%	105.9
MD	020700020201	Shields Run-North Branch Potomac River	89.5%	43.9
WV	020700020202	Mount Storm Lake-Stony River	70.9%	125.9
MD	020700020203	Buffalo Creek-North Branch Potomac River	91.1%	48.7
WV	020700020204	Abram Creek	86.7%	58.1
MD	020700020205	Lostland Run-North Branch Potomac River	96.8%	57.4
MD	020700020206	Bloomington Lake-North Branch Potomac River	75.6%	52.7
MD	020700020301	Upper Georges Creek	97.0%	41.1
MD	020700020302	Lower Georges Creek	74.2%	37.2
PA	020700020502	Laurel Run	84.2%	23.3
PA	020700020503	Little Wills Creek	67.6%	11.0
PA	020700020504	Gladdens Run	63.6%	34.5
PA	020700020505	Jennings Run	90.3%	25.1
MD	020700020507	Braddock Creek-Wills Creek	66.7%	27.5
WV	020700030601	Meadow Run-North River	60.6%	5.9
PA	020700040801	Rocky Mountain Creek	89.5%	42.8
PA	020700040802	Headwaters Conococheague Creek	61.1%	29.8
VA	020700050401	Skidmore Fork-North River	76.9%	72.8
VA	020700050402	Little River	87.5%	65.7
VA	020700050501	Skidmore Fork-Dry River	79.6%	100.6
VA	020700050502	Black Run-Dry River	84.6%	88.5
VA	020700050902	Pitt Spring Run-Cub Run	100.0%	39.8
VA	020700060104	Little Dry River	84.8%	64.3
VA	020700060601	Paddy Run-Cedar Creek	69.0%	71.3
VA	020802010101	Dry Branch-Jackson River	100.0%	125.2
VA	020802010205	Lake Moomaw-Jackson River	63.0%	27.5
VA	020802010604	Davis Run-Bullpasture River	88.9%	148.6
VA	020802010702	Dry Run	100.0%	69.8
VA	020802011504	Spring Gap Creek-Cedar Creek	94.1%	8.8
VA	020802020101	Chair Draft-Calfpasture River	66.7%	58.1

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
VA	020802020104	Hamilton Branch	100.0%	32.7
VA	020802020401	Saint Marys River	94.7%	40.8
VA	020802030902	South Fork Rockfish River	68.6%	33.8
VA	020802040103	North Moormans River-Moormans River	100.0%	20.2
VA	020802040301	Lynch River-North Fork Rivanna River	70.0%	31.2
VA	020802040302	Swift Run	62.9%	36.7

Appendix Table V. Level 3 Priority Subwatersheds Containing Wild Brook Trout Only (allopatric) Patches.

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
NY	020501010102	Herkimer Creek-Canadarago Lake	17.5%	22.0
NY	020501010103	Oaks Creek	44.8%	50.7
NY	020501010203	Middle Cherry Valley Creek	56.0%	51.5
NY	020501010204	Lower Cherry Valley Creek	48.1%	51.5
NY	020501010303	Middle Schenevus Creek	44.8%	37.6
NY	020501010304	Lower Schenevus Creek	52.9%	38.9
NY	020501010402	Middle Brook	40.0%	91.5
NY	020501010405	Middle Charlotte Creek	30.8%	92.7
NY	020501010406	Lower Charlotte Creek	25.0%	35.2
NY	020501010503	Middle Otego Creek	35.7%	18.2
NY	020501010602	Shadow Brook	44.0%	7.3
NY	020501010603	Hayden Creek-Ostego Lake	29.1%	6.8
NY	020501010605	Goodyear Lake-Susquehanna River	47.4%	51.3
NY	020501010606	Oneonta Creek-Susquehanna River	41.7%	20.2
NY	020501010701	Upper Wharton Creek	36.8%	36.5
NY	020501010702	Middle Wharton Creek	53.6%	68.6
NY	020501010703	Lower Wharton Creek	57.7%	82.9
NY	020501010801	Upper Butternut Creek	50.0%	66.7
NY	020501010902	West Branch Unadilla River	50.0%	8.6
NY	020501010903	Headwaters Unadilla River	40.5%	33.1
NY	020501010904	Beaver Creek	44.4%	43.8
NY	020501010905	Upper Unadilla River	56.0%	86.6
NY	020501010908	Middle Unadilla River	41.7%	130.7
NY	020501010910	Lower Unadilla River	48.1%	44.0
NY	020501011005	Lower Ouleout Creek	40.0%	1.8
NY	020501011102	Brier Creek-Susquehanna River	35.7%	70.3
NY	020501011203	Yaleville Brook-Susquehanna River	44.2%	8.8
NY	020501011205	Cornell Creek-Susquehanna River	46.3%	24.2
NY	020501011206	Belden Brook-Susquehanna River	41.5%	9.3
PA	020501011305	Canawacta Creek-Susquehanna River	46.3%	9.1
PA	020501011308	Mitchell Creek-Susquehanna River	56.3%	42.6
NY	020501020102	Upper East Branch Tioughnioga Creek	51.8%	13.5
NY	020501020105	Cheningo Creek	25.9%	6.4
NY	020501020106	Lower East Branch Tioughnioga Creek	57.1%	17.7
NY	020501020205	Dry Creek-West Branch Tioughnioga River	34.6%	11.8
NY	020501020301	Headwaters Otselic River	54.8%	2.5
NY	020501020303	Upper Otselic River	51.0%	31.8

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
NY	020501010102	Herkimer Creek-Canadarago Lake	17.5%	22.0
NY	020501010103	Oaks Creek	44.8%	50.7
NY	020501010203	Middle Cherry Valley Creek	56.0%	51.5
NY	020501010204	Lower Cherry Valley Creek	48.1%	51.5
NY	020501020401	Trout Brook	56.1%	95.2
NY	020501020403	Upper Tioughnioga River	31.9%	5.5
NY	020501020501	Upper Sangerfield River	40.9%	17.4
NY	020501020503	Lower Sangerfield River	38.5%	23.9
NY	020501020504	Callahan Brook-Chenango River	23.5%	13.0
NY	020501020505	Payne Brook	28.6%	5.1
NY	020501020506	Eaton Brook-Chenango River	28.6%	18.4
NY	020501020508	Crooked Brook-Pleasant Brook	59.1%	59.2
NY	020501020509	Stone Mill Brook-Chenango River	36.8%	21.5
NY	020501020602	Handsome Brook	53.8%	28.7
NY	020501020603	Mad Brook-Chenango River	42.9%	46.3
NY	020501020605	Fly Creek-Chenango River	19.0%	26.1
NY	020501020607	Thompson Creek-Chenango River	56.3%	19.5
NY	020501020703	Middle Genegantslet Creek	50.6%	19.3
NY	020501020804	Wheeler Brook-Chenango River	28.2%	26.2
NY	020501020805	Spring Brook-Chenango River	57.5%	3.8
NY	020501030303	Willseyville Creek	53.3%	25.8
NY	020501030407	Doolittle Creek	59.3%	25.7
NY	020501030408	Lower West Branch Owego Creek	53.3%	28.5
NY	020501030409	Lower East Branch Owego Creek-Owego Creek	31.9%	8.5
NY	020501030502	Little Nanticoke Creek	48.7%	8.6
NY	020501040102	Karr Valley Creek	33.3%	40.9
NY	020501040104	Lower Canacadea Creek	25.0%	7.6
NY	020501040203	Middle Bennetts Creek	56.3%	13.7
NY	020501040401	Lime Kiln Creek	33.3%	15.0
NY	020501040403	Seeley Creek	53.8%	10.3
PA	020501040602	Norris Brook	66.7%	22.4
PA	020501040608	Lower Crooked Creek	53.3%	18.5
PA	020501040703	Painter Run-Mill Creek	42.1%	9.3
PA	020501040805	Upper Cowanesque River	51.5%	60.7
PA	020501040902	Johnson Creek	52.0%	30.4
PA	020501040903	Elk Run	51.6%	24.1
PA	020501040907	Middle Tioga River	37.7%	4.1
NY	020501050101	Punky Hollow-Cohocton River	54.2%	6.4
NY	020501050103	Neils Creek	40.0%	18.3

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
NY	020501010102	Herkimer Creek-Canadarago Lake	17.5%	22.0
NY	020501010103	Oaks Creek	44.8%	50.7
NY	020501010203	Middle Cherry Valley Creek	56.0%	51.5
NY	020501010204	Lower Cherry Valley Creek	48.1%	51.5
NY	020501050105	Goff Creek	50.0%	17.6
NY	020501050106	Tenmile Creek-Cohocton River	43.8%	46.7
NY	020501050204	Campbell Creek	33.3%	39.7
NY	020501050305	Dry Run	42.9%	31.1
NY	020501050306	Meads Creek	37.5%	27.5
PA	020501060803	Thomas Creek-Meshoppen Creek	51.9%	7.5
PA	020501060902	North Branch Mehoopany Creek	53.7%	42.0
PA	020501061208	Lower Tunkhannock Creek	46.6%	17.3
PA	020501061303	Lower Bowman Creek	57.8%	36.9
PA	020501061401	Sugar Run	44.4%	92.1
PA	020501061402	Sugar Run Creek	55.2%	51.1
PA	020501061409	Obendoffers Creek-Susquehanna River	50.0%	1.8
PA	020501070101	West Branch Lackawanna River	57.1%	19.5
PA	020501070103	Lees Creek-Lackawanna River	57.1%	56.8
PA	020501070106	Grassy Island Creek-Lackawanna River	56.3%	6.9
PA	020501070109	City of Scranton-Lackawanna River	53.1%	29.9
PA	020501070201	Abrahams Creek	45.5%	4.4
PA	020501070205	City of Wilkes-Barre-Susquehanna River	35.0%	3.2
PA	020501070304	Little Wapwallopen Creek	58.5%	21.2
PA	020501070403	Nescopeck Creek-Susquehanna River	41.1%	88.2
PA	020501070804	Beaver Run-Catawissa Creek	46.9%	70.8
PA	020501070805	Catawissa Creek-Susquehanna River	42.9%	8.8
PA	020502030412	Reeds Run-West Branch Susquehanna River	38.9%	14.2
PA	020502040102	Slab Cabin Run	40.0%	16.1
PA	020502040106	Spring Creek-Bald Eagle Creek	34.8%	13.4
PA	020502040304	Long Run	57.1%	16.6
PA	020502040407	Bald Eagle Creek-West Branch Susquehanna River	38.5%	14.3
PA	020502050303	Marsh Creek-Pine Creek	44.1%	47.2
PA	020502050404	Stony Fork	36.4%	12.3
PA	020502050607	Pine Creek-West Branch Susquehanna River	52.9%	19.8
PA	020502060206	Trout Run-Lycoming Creek	55.8%	47.3
PA	020502060602	Quenshukeny Run	40.8%	4.2
PA	020502060604	Millers Run	55.9%	4.6
PA	020502060802	Rock Run-Muncy Creek	56.0%	4.5
PA	020502060803	Gregs Run-Muncy Creek	47.4%	8.0

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
NY	020501010102	Herkimer Creek-Canadarago Lake	17.5%	22.0
NY	020501010103	Oaks Creek	44.8%	50.7
NY	020501010203	Middle Cherry Valley Creek	56.0%	51.5
NY	020501010204	Lower Cherry Valley Creek	48.1%	51.5
PA	020502061005	Buffalo Creek-West Branch Susquehanna River	19.4%	11.6
PA	020503010305	Middle Creek-Penns Creek	43.8%	7.2
PA	020503010405	Middle Penns Creek	38.8%	1.3
PA	020503020106	Oldtown Run-Frankstown Branch Juniata River	42.1%	3.5
PA	020503020202	Mill Run-Beaverdam Branch	59.6%	16.9
PA	020503020601	Upper Shaver Creek	43.8%	17.7
PA	020503020703	East Branch Standing Stone Creek	57.1%	11.1
PA	020503030102	Headwaters Raystown Branch Juniata River	46.8%	31.1
PA	020503030303	Lower Dunning Creek	33.3%	11.3
PA	020503030501	Cove Creek	45.8%	9.5
PA	020503030505	Sandy Run-Raystown Branch Juniata River	52.3%	21.2
PA	020503030603	Lower Yellow Creek	57.7%	19.8
PA	020503030701	Little Trough Creek	57.4%	1.4
PA	020503040202	Wooden Bridge Creek	55.2%	25.2
PA	020503040302	Blacklog Creek	18.2%	90.6
PA	020503040401	North Branch Little Aughwick Creek	56.5%	1.6
PA	020503040906	East Licking Creek	54.9%	6.3
PA	020503041204	Juniata River-Susquehanna River	43.3%	5.5
PA	020503050101	Shultz Creek-Sherman Creek	58.0%	42.0
PA	020503050203	Trout Run-Conodoguinet Creek	51.7%	37.1
PA	020503050306	Three Square Hollow Run-Conodoguinet Creek	57.0%	3.6
PA	020503050307	Doubling Gap Creek	46.7%	8.0
PA	020503050501	Headwaters Yellow Breeches Creek	34.6%	6.6
PA	020503050504	Middle Yellow Breeches Creek	15.5%	4.5
PA	020503050605	Middle Swatara Creek	56.9%	26.3
PA	020503051005	Fishing Creek-Perry County	45.5%	20.5
PA	020503060502	Davidsburg Run-Conewago Creek	59.6%	1.2
PA	020503060902	Middle Creek	55.6%	18.0
PA	020503060903	Hammer Creek	45.0%	2.5
PA	020503061103	Upper Conestoga River	52.4%	7.1
PA	020503061106	Muddy Run-Mill Creek	16.9%	2.4
PA	020503061201	Headwaters Pequea Creek	46.5%	4.9
PA	020503061202	Eshleman Run-Pequea Creek	38.8%	6.1
PA	020503061204	Climbers Run-Pequea Creek	57.1%	17.2
MD	020503061602	Upper Deer Creek	54.5%	23.5

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
NY	020501010102	Herkimer Creek-Canadarago Lake	17.5%	22.0
NY	020501010103	Oaks Creek	44.8%	50.7
NY	020501010203	Middle Cherry Valley Creek	56.0%	51.5
NY	020501010204	Lower Cherry Valley Creek	48.1%	51.5
PA	020503061708	Muddy Run-Susquehanna River	36.4%	4.2
MD	020600030302	Prettyboy Reservoir-Gunpowder Falls	47.4%	35.9
MD	020600030501	Little Gunpowder Falls	44.1%	14.4
MD	020600030805	Deep Run-Liberty Lake-North Branch Patapsco River	59.6%	6.6
MD	020600030806	Falls Run-Liberty Lake-North Branch Patapsco River	40.0%	6.7
MD	020600040201	Severn Run	18.4%	5.8
WV	020700010106	Mill Creek-North Fork South Branch Potomac River	39.6%	19.2
WV	020700010108	Jordan Run-North Fork South Branch Potomac River	36.8%	41.0
WV	020700010310	Hoglan Run-South Branch Potomac River	17.6%	9.4
WV	020700010501	Brushy Fork-South Fork South Branch Potomac River	33.3%	56.8
WV	020700010502	Little Fork-South Fork South Branch Potomac River	50.0%	9.9
WV	020700010505	Rough Run-South Fork South Branch Potomac River	35.5%	25.9
WV	020700010506	Kettle Creek-South Fork South Branch Potomac River	25.8%	18.0
WV	020700010607	McDowell Run-South Branch Potomac River	30.0%	11.8
WV	020700020401	New Creek	58.6%	30.6
MD	020700020403	Mill Run-North Branch Potomac River	28.8%	4.6
PA	020700020506	Shaffers Run-Wills Creek	40.0%	11.8
MD	020700020602	Rocky Gap Run-Evitts Creek	23.8%	5.1
WV	020700020702	Middle Fork Patterson Creek-Patterson Creek	26.5%	8.5
WV	020700020703	Mikes Run	39.1%	8.3
WV	020700020705	Mill Creek-Patterson Creek	41.5%	11.5
PA	020700030104	Sweet Root Creek-Town Creek	37.1%	27.9
WV	020700030201	North Fork-Little Cacapon River	38.5%	1.7
WV	020700030502	Upper Cove Run-Lost River	36.4%	32.1
WV	020700030504	Kimsey Run-Lost River	18.5%	56.8
WV	020700030505	Three Springs Run-Lost River	34.6%	8.3
WV	020700030701	Trout Run	54.5%	48.1
WV	020700030702	Waites Run-Cacapon River	30.2%	46.1
WV	020700030703	Capon Springs Run-Cacapon River	39.5%	8.4
WV	020700030706	Bloomery Run-Cacapon River	33.3%	25.3
WV	020700030802	Rockwell Run-Potomac River	5.8%	8.0
PA	020700040101	Little Tonoloway Creek	54.0%	21.5
VA	020700040201	Upper Sleepy Creek	14.1%	12.2
PA	020700040603	Middle West Branch Conococheague Creek	53.8%	15.5
PA	020700040803	Mountain Creek-Conococheague Creek	36.1%	49.4

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
NY	020501010102	Herkimer Creek-Canadarago Lake	17.5%	22.0
NY	020501010103	Oaks Creek	44.8%	50.7
NY	020501010203	Middle Cherry Valley Creek	56.0%	51.5
NY	020501010204	Lower Cherry Valley Creek	48.1%	51.5
PA	020700041002	East Branch Antietam Creek	39.2%	17.8
PA	020700041003	West Branch Antietam Creek	25.9%	57.2
MD	020700041004	Little Antietam Creek	24.0%	15.5
VA	020700050101	Edison Creek-Middle River	0.0%	59.5
VA	020700050403	Briery Branch	54.5%	103.3
VA	020700050504	Honey Run-Dry River	0.0%	13.6
VA	020700050701	Stony Run-South River	47.0%	13.2
VA	020700050702	Canada Run-South River	45.5%	24.8
VA	020700050704	Porterfield Run-South River	29.6%	22.9
VA	020700050705	Paine Run-South River	33.3%	46.1
VA	020700050803	Hawksbill Creek-South Fork Shenandoah River	54.5%	75.2
VA	020700050804	Boone Run-Elk Run-South Fork Shenandoah River	53.3%	63.3
VA	020700050901	Fultz Run-South Fork Shenandoah River	42.1%	10.6
VA	020700050904	Hawksclaw Creek-South Fork Shenandoah River	42.9%	8.6
VA	020700050906	East Hawksbill Creek-Hawksbill Creek	0.0%	84.6
VA	020700050907	Pass Run-Hawksbill Creek	33.3%	35.9
VA	020700060101	German River	58.8%	80.6
VA	020700060102	Crab Run	38.5%	44.9
VA	020700060103	Capon Run-North Fork Shenandoah River	28.6%	81.0
VA	020700060105	Shoemaker River	56.3%	64.4
VA	020700060202	Mountain Run-Smith Creek	56.3%	12.7
VA	020700060401	Riles Run-Stony Creek	15.0%	109.9
VA	020700060402	Yellow Spring Run-Stony Creek	50.0%	39.9
VA	020700060602	Duck Run-Cedar Creek	22.2%	23.8
VA	020700060603	Fall Run	50.0%	3.2
VA	020700060702	Lower Passage Creek	33.3%	15.1
VA	020700070105	Spout Run	0.0%	55.5
MD	020700080101	Upper Catoctin Creek	23.5%	8.9
PA	020700090201	Little Marsh Creek	36.7%	15.2
MD	020700090505	Hunting Creek	52.8%	12.3
MD	020700090601	Tuscarora Creek-Monocacy River	43.4%	36.7
MD	020700090703	Bennett Creek	55.3%	3.6
VA	020802010803	Simpson Creek-Cowpasture River	42.1%	54.2
VA	020802011205	Roaring Run-Craig Creek	38.2%	0.2
VA	020802011505	Elk Creek-James River	55.6%	16.0

State	HUC 12 Code	HUC 12 Name	% of Catchments in HUC 12 w/HQI ≥0.50	Amount of HUC 12 Area (km^2) Classified as Wild Brook Trout Only
NY	020501010102	Herkimer Creek-Canadarago Lake	17.5%	22.0
NY	020501010103	Oaks Creek	44.8%	50.7
NY	020501010203	Middle Cherry Valley Creek	56.0%	51.5
NY	020501010204	Lower Cherry Valley Creek	48.1%	51.5
VA	020802020402	Upper South River	50.0%	22.7
VA	020802020501	Bennetts Run-Maury River	44.4%	47.3
VA	020802020506	Poague Run-Maury River	40.9%	5.0
VA	020802030901	North Fork Rockfish River	33.3%	19.9

Appendix Table VI. Number and percentage of catchments within the Chesapeake Bay watershed with predicted negative effects from climate change, summarized by 8-digit HUCs.

HUC 8 Code	HUC 8 Name	Total Number of Catchments in HUC 8	Number of Catchments in HUC 8 with a Predicted Negative Effects from Climate Change	Percentage of Catchments in HUC 8 with a Predicted Negative Effects from Climate Change
02050101	Upper Susquehanna	2,280	1,543	67.7%
02050102	Chenango	1,840	1,135	61.7%
02050103	Owego-Wappasening	1,491	603	40.4%
02050104	Tioga	930	724	77.8%
02050105	Chemung	976	701	71.8%
02050106	Upper Susquehanna-Tunkhannock	2,511	1,474	58.7%
02050107	Upper Susquehanna-Lackawanna	1,942	950	48.9%
02050201	Upper West Branch Susquehanna	1,691	1,013	59.9%
02050202	Sinnemahoning	1,548	879	56.8%
02050203	Middle West Branch Susquehanna	836	649	77.6%
02050204	Bald Eagle	644	444	68.9%
02050205	Pine	1,010	608	60.2%
02050206	Lower West Branch Susquehanna	2,008	1,220	60.8%
02050301	Lower Susquehanna-Penns	1,772	845	47.7%
02050302	Upper Juniata	1,004	520	51.8%
02050303	Raystown	1,165	372	31.9%
02050304	Lower Juniata	1,783	1,195	67.0%
02050305	Lower Susquehanna-Swarta	1,898	943	49.7%
02050306	Lower Susquehanna	2,540	1,081	42.6%
02060002	Chester-Sassafras	415	116	28.0%
02060003	Gunpowder-Patapsco	1,523	454	29.8%
02060004	Severn	51	3	5.9%
02060006	Patuxent	576	249	43.2%
02070001	South Branch Potomac	1,854	1,292	69.7%
02070002	North Branch Potomac	1,592	781	49.1%
02070003	Cacapon-Town	1,404	424	30.2%
02070004	Conococheague-Opequon	2,489	1,108	44.5%
02070005	South Fork Shenandoah	861	462	53.7%
02070006	North Fork Shenandoah	485	179	36.9%
02070007	Shenandoah	353	172	48.7%
02070008	Middle Potomac-Catoctin	1,686	665	39.4%
02070009	Monocacy	1,117	349	31.2%
02070010	Middle Potomac-Anacostia-Occoquan	1,464	311	21.2%
02070011	Lower Potomac	247	72	29.1%

HUC 8 Code	HUC 8 Name	Total Number of Catchments in HUC 8	Number of Catchments in HUC 8 with a Predicted Negative Effects from Climate Change	Percentage of Catchments in HUC 8 with a Predicted Negative Effects from Climate Change
02080103	Rapidan-Upper Rappahannock	689	268	38.9%
02080106	Pamunkey	13	0	0.0%
02080201	Upper James	2,720	1,614	59.3%
02080202	Maury	818	443	54.2%
02080203	Middle James-Buffalo	1,034	497	48.1%
02080204	Rivanna	218	106	48.6%
	Totals	51,478	26,464	51.4%