Eastern Brook Trout: Status and Threats

Produced by Trout Unlimited for the Eastern Brook Trout Joint Venture

Eastern Brook Trout
JOINT VENTURE

DAVID ANDERSON

Eastern Brook Trout: Status and Threats

Background: Brook trout (*Salvelinus fontinalis*) are the only trout native to much of the eastern United States. They have inhabited the East's coldwater streams and lakes ever since the retreat of the continental glaciers across New York and New England, and they have thrived in the ancient valleys of the Appalachians for the last several million years. Arguably the most beautiful freshwater fish, brook trout survive in only the coldest and cleanest water. In fact, brook trout serve as indicators of the health of the watersheds they inhabit. Strong wild brook trout populations demonstrate that a stream or river ecosystem is healthy and that water quality is excellent. A decline in brook trout populations can serve as an early warning that the health of an entire system is at risk.

In pre-Colonial times, brook trout were present in nearly every coldwater stream and river in the eastern United States. Sensitive to changes in water quality, wild brook trout began to disappear as early agriculture, timber and textiles economies transformed the eastern landscape by stripping the region's protective forests and filling the streams with sediment and pollution. As streams gained value as highways for log drives, water sources for farming, and prime locations for factories and mills, the resulting loss in brook trout populations mirrored the broader decline in the health of the region's lands and waters.

Many of these threats to water quality and wild brook trout persist today, as our population and resource needs increasingly expand. New challenges associated with urbanization place additional stresses on the eastern landscape and its remaining brook trout habitat.

A Partnership to Conserve Brook Trout

For many years, the solution to declining brook trout populations was stocking more fish to ensure that fishing opportunities did not suffer. In recent decades, however, state and federal fisheries managers and organizations such as Trout Unlimited have focused on restoring the habitat that brook trout require for their survival. In 2004, in recognition of the need to address regional and range-wide threats to brook trout, a group of public and private entities formed the Eastern Brook Trout Joint Venture (EBTJV) to halt the decline of brook trout and restore fishable populations.

The Eastern Brook Trout Joint Venture is comprised of:

- Fish and wildlife agencies from 17 states
- Federal support from U.S. Geological Survey, U.S. Forest Service, U.S. Fish & Wildlife Service, National Park Service and Office of Surface Mining
- Conservation organizations including Association of Fish & Wildlife Agencies, Trout Unlimited, Izaak Walton League of America, Trust for Public Land and The Nature Conservancy
- Academic institutions including Conservation Management Institute at Virginia Tech and James Madison University

Members of the Eastern Brook Trout Joint Venture are deeply committed to maintaining and restoring brook trout and the watersheds upon which they depend. This summary report describes the first stage of the Joint Venture's efforts to spearhead a collaborative process to improve brook trout habitat and return one of our most beautiful gamefish to its native range.

The maps and data in this publication are based on "Distribution, Status and Perturbations to Brook Trout within the Eastern United States," a technical report by the Joint Venture's assessment team that will be published later in 2006. This first-of-its-kind assessment paints a comprehensive picture of the condition of brook trout populations across their native range from Ohio to Maine to Georgia. The technical report categorizes a variety of threats to brook trout and their habitat and helps to identify restoration and protection priorities. Using satellite imagery and statistical analysis, the report predicts the status of brook trout in areas that lack population data and identifies different levels of environmental stress that brook trout are able to tolerate before they are likely to disappear.

The technical report identifies where wild brook trout populations remain strong, where they are struggling and where they have vanished. Most importantly, it provides state and federal agencies, anglers and community leaders with the tools to identify local rivers and streams that are priorities for protection and restoration. Partners in the Eastern Brook Trout Joint Venture are using the technical report and ongoing analyses to develop a comprehensive strategy for state and the federal agencies to protect and restore brook trout on regional and range-wide scales. This will involve advancing data collection, promoting policies necessary for success, and establishing on-the-ground projects to protect and restore brook trout habitat and populations. The data included in the technical report also will serve as a baseline for tracking and measuring the success of protection and restoration efforts over time. This summary report provides an overview of the data and findings included in the full technical report.

Brook Trout Assessment - Key Findings

The following points summarize the key findings of the technical report:

- Intact stream populations of brook trout (where wild brook trout occupy 90-100% of their historical habitat) exist in only 5% of subwatersheds.
- Wild stream populations of brook trout have vanished or are greatly reduced in nearly half of subwatersheds.
- The vast majority of historically occupied large rivers no longer support self-reproducing populations of brook trout.
- Brook trout survive almost exclusively as fragmented populations relegated to the extreme headwaters of streams.
- Poor land management associated with agriculture ranks as the most widely distributed impact to brook trout across the eastern range.
- Non-native fish rank as the largest biological threat to brook trout.
- Intact subwatersheds of wild brook trout in lakes and ponds are almost exclusively located in Maine, but self-reproducing populations remain in some lakes and ponds in New York, New Hampshire and Vermont.
- More data collection is needed to determine the status of brook trout in various parts of the eastern range, particularly in Maine, New Hampshire, New York, Massachusetts and Pennsylvania.

Brook Trout Status and Distribution

This summary report presents information on the status of brook trout populations in 17 states in the Appalachian region, an area that represents 70% of the historical range of brook trout in the United States. This report also identifies the principal threats identified by regional experts to the continued viability of brook trout populations on a state-by-state basis.

Assessment Methodology:

The assessment team collected existing electronic data on brook trout populations from state and federal agencies in 17 states. The team then traveled to each state and met personally with fisheries biologists to review and classify each individual subwatershed. The team used a consistent classification method based on the percentage of historically occupied habitat still maintaining self-reproducing populations of brook trout. Fisheries biologists then used their expert knowledge to list the greatest local threats to wild, self-reproducing brook trout and their habitat.

In total, the assessment team evaluated 11,400 subwatersheds to determine the strength of brook trout populations. While subwatersheds vary in size, they typically contain 25 to 75 miles of streams. Approximately half (5,563) of those subwatersheds historically supported brook trout. The following table presents the current status of brook trout populations in those subwatersheds where brook trout historically thrived.

Brook Trout Subwatershed Status in the Eastern Range

(See following page and pages 18-19 for full map)

Color	Classification	Description	%
	Intact	90-100% historical habitat occupied by self-reproducing brook trout	5%
	Reduced	50-90% historical habitat occupied by self-reproducing brook trout	9%
	Greatly Reduced	1-50% historical habitat occupied by self-reproducing brook trout	27%
	Present, Qualitative Data	Present, but no quantitative data available on populations	19%
	Extirpated	Brook trout have vanished from this subwatershed	21%
	Absent, Unclear History	No brook trout currently present, historical presence unknown	6%
	Unknown, No Data	No quantitative or qualitative data exists	13%

The assessment data tells a somber story of brook trout decline across their range, but the data also offers hope for restoration and recovery in many areas. Strong, healthy subwatersheds do exist, but they are rare. The majority of these intact subwatersheds are located in Maine, New Hampshire, New York, Vermont and Virginia. Pennsylvania, Maryland, West Virginia and the other New England states each possess only a handful of these intact subwatersheds. Brook trout are extirpated from over 20% of the subwatersheds across the Eastern range and have vanished from all streams and rivers within those areas.

Based on scientific, on-the-ground information gathered within the last ten years, the following table shows the states with the greatest percentage of intact and extirpated subwatersheds.

States with Highest Percentage of Intact and Extirpated Subwatersheds

State	Number of Intact Subwatersheds	Percentage of Total Subwatersheds
Maine	147	14%
Vermont	33	14%
Virginia	36	9%
New Hampshire	21	8%
New York	62*	5%

State	Number of Extirpated Subwatersheds	Percentage of Total Subwatersheds
Georgia	53	58%
Maryland	83	57%
South Carolina	12	44%
North Carolina	95	40%
New Jersey	94	38%

** New York figure was calculated by multiplying the number of watersheds (5th level hydrologic unit) x 2.5, since subwatershed (6th level hydrologic unit) data is not yet available for the state. On average, there are 2.5 subwatersheds within any given watershed in New York.*

Threats to Brook Trout and Their Habitat

Eastern brook trout reside in the most heavily populated and intensely industrialized region of the United States. Land use decisions made over the past several hundred years have severely impacted the quality of brook trout streams and rivers--largely by removing streamside trees and increasing sedimentation and nutrient runoff. While some sections of the East have regained forest cover and are healing from the widespread clearing of the eastern forests, other areas are undergoing rapid change as our population, road network and water needs continue to grow.

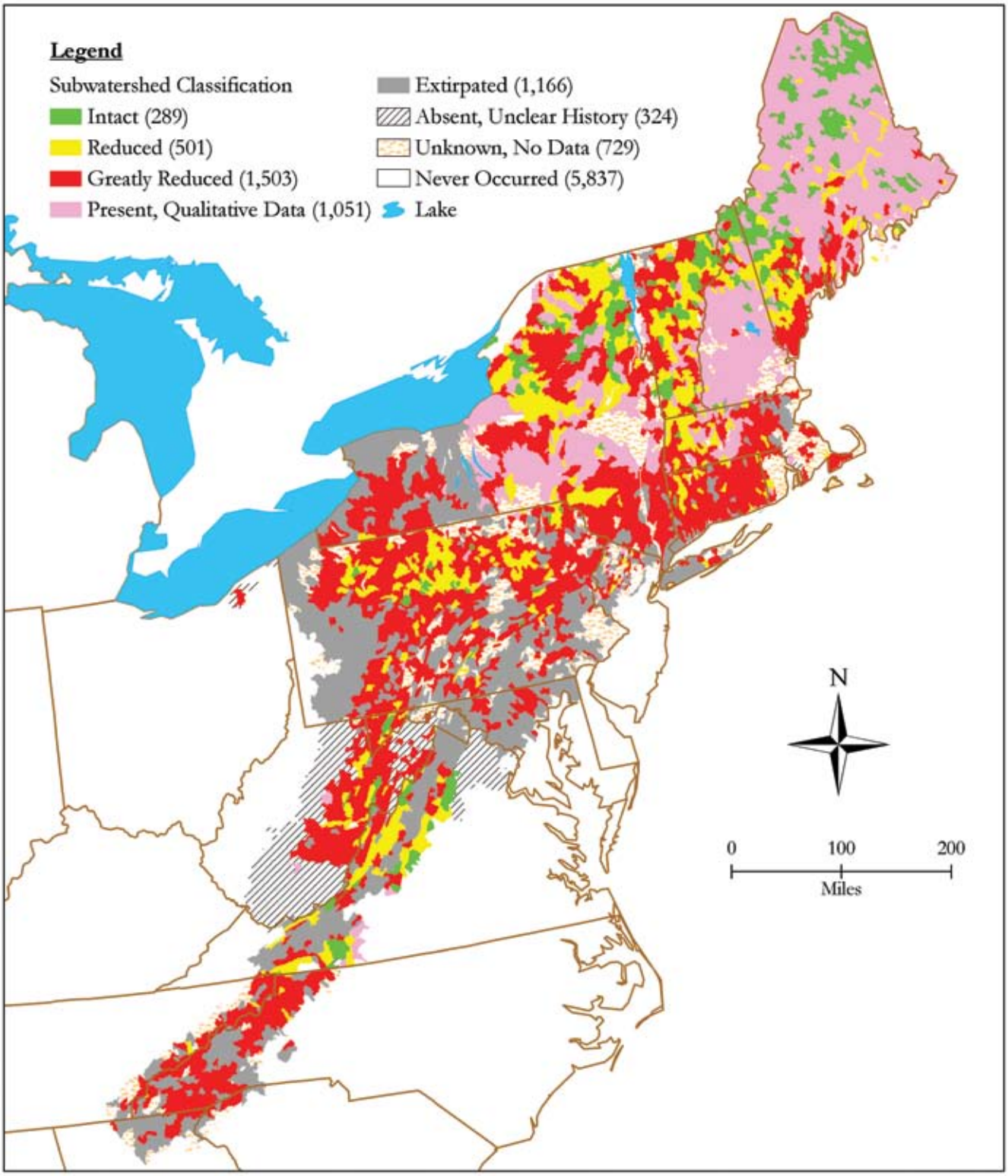
Primary Threats to Brook Trout

Rank	Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
1	Poor Land Management	1647	37%
2	High Water Temperature	1629	36%
3	Sedimentation (Roads)	1225	27%
4	One or More Non-Native Fish Species	1189	26%
5	Urbanization	1141	25%
6	Riparian Habitat	1029	23%
7	Brown Trout	853	19%
8	Stream Fragmentation (Roads)	767	17%
9	Dam Inundation/Fragmentation	705	16%
10	Forestry	642	14%

Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

Brook Trout Population Status in the Eastern U.S. Range by Subwatershed

(See pages 18-19 for a larger map)



Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the Eastern United States, 2006*. Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

Regional experts listed poor land management associated with agriculture as the most widespread impact on brook trout habitat in the Eastern United States. Poor land management can involve clearing streamside vegetation, over-grazing sensitive areas, ineffectively managing nutrients and ditching small streams. While these practices cause direct damage to water quality, they also contribute to higher water temperatures and degraded streamside areas – the second and sixth greatest disturbances across the study area.

Roads can have a variety of damaging effects on streams. Sedimentation is listed as the third largest impact to brook trout. Runoff of sand and silt from poorly designed or maintained roads can smother brook trout eggs and the aquatic insects that fish eat. In addition, dams and poorly designed culverts or bridges can act as barriers to fish movement. Streams can quickly become fragmented into sections, isolating brook trout populations from each other and limiting their ability to move and find areas of clean gravel to spawn or colder waters in the summer. Dams also increase water temperatures by slowing down flowing water and exposing it to the air and sun.

Non-native species (such as smallmouth bass, rainbow trout and brown trout) are the only disturbance not related to habitat in the top ten regional impacts to brook trout. These fish can out-compete brook trout in high quality habitat by eating them and forcing them out of the more favorable parts of a stream or lake. Non-native fish also can thrive in lower quality waters that once supported brook trout.

Impacts on water quality and stream health are often complex and interrelated. For example, actions such as removing trees from stream banks, allowing livestock in streams or poorly planning urban development can all cause higher water temperatures, increased sediment and impaired habitat. All of these factors make it more difficult for brook trout to reproduce and survive. In most cases, a combination of negative changes to the surrounding land and stream banks--rather than a single disturbance--causes brook trout to decline or vanish from a particular subwatershed.

Conservation and Restoration Opportunities

Despite their sensitivity to declines in water quality and the introduction of non-native fish, brook trout have managed to persist in countless headwater streams across the eastern United States. Many opportunities currently exist for the restoration of brook trout habitat. For example, working with farmers and other landowners to replant streamside shrubs and trees and fence livestock away from streams can dramatically improve water temperatures and water quality in a relatively short period of time. Many private landowners are currently partnering with federal and local agencies and non-governmental organizations to protect streams on private land. Because farmers and ranchers own so much land throughout the historical range of eastern brook trout, they have a unique opportunity to be at the forefront of the effort to safeguard water quality and restore brook trout populations through cooperative, incentive-based programs.

A host of other opportunities exist for improving brook trout habitat and restoring populations. Liming and other acid abatement techniques can neutralize acid deposition and abandoned mine drainage and make thousands of miles of streams fishable. Protecting forested watersheds can ensure healthy populations and water quality far into the future. Selective removal of non-native fish where appropriate to protect brook trout is an effective management tool that is gaining increasing popularity among biologists. Replacing poorly designed culverts and removing old dams that block fish movement can reconnect fragmented habitat and strengthen or extend brook trout populations downstream.

CLINT FERGUSON

People value brook trout not only for their beauty, their delicious taste, and their sportfish qualities, but also as indicators of the broader health of the watersheds where they live. A sentinel of superior water quality, the brook trout will always mirror the health of the Appalachians and the waters that drain from these landscapes. The assessment information summarized in this report provides new perspectives on the status of brook trout and water quality across the East, allowing analysis at range-wide, regional, state and local scales. This assessment sets a benchmark for fisheries managers, policy makers and citizens to track and assess progress in protecting and restoring eastern waters and their native trout. Collective efforts to restore the brook trout will enable us to protect human health, assure clean and sustainable water supplies and preserve our quality of life for generations to come.

Georgia & South Carolina:

In Georgia and South Carolina, the genetically distinctive Southern Appalachian brook trout has largely retreated into isolated headwater streams on public lands managed by the U.S. Forest Service. These states contain no remaining intact or reduced subwatersheds. While poor land management, roads, and urbanization impact over 75% of brook trout subwatersheds in Georgia, rainbow trout are the most pervasive impact.

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Intact (>90% habitat occupied)	0	0%
Reduced (50-90% habitat occupied)	0	0%
Greatly Reduced (<50% occupied)	29	25%
Present, Qualitative Data Only	0	0%
Extirpated	65	55%
Absent, Unknown History	0	0%
Unknown, No Data	24	20%
Total	118	100%

Population Status: Southern Appalachian brook trout are present at greatly reduced levels in only 25% of their native range in Georgia and South Carolina. Over 55% of subwatersheds are confirmed or suspected to be extirpated, and population status is unknown in approximately 20%. All remaining brook trout populations exist in isolated headwater streams. In Georgia, all but one of the remaining brook trout subwatersheds are located on national forest lands. Similarly, in South Carolina, three of the seven subwatersheds that support brook trout are located in national forests.

Threats: The Southeast mountains endured harsh land use practices over the past several centuries. Timbering, instream log-drives and poor land use practices increased stream erosion and opened the shaded streams to the sun, degrading waters with silt and raising water temperatures. In response, brook trout retreated to small, headwater streams. To fill the void, many streams were stocked with non-native rainbow trout and brown trout. As the landscape healed and water quality improved, these non-native trout expanded their range and now compete with brook trout for food and space. Rainbow trout now thrive in 96% of Georgia's subwatersheds that have brook trout data.

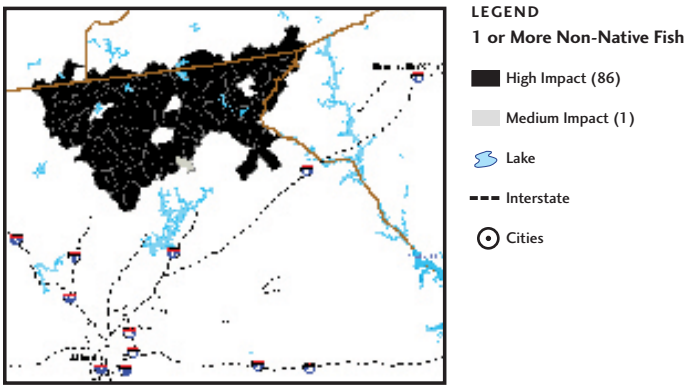
Regional experts identified poor land management, road sediment and urbanization as current impacts to brook trout habitat. These disturbances are widespread throughout the brook trout's southern range, and they result in increased sedimentation that suffocates trout eggs and aquatic insects. Because Georgia and South Carolina represent the extreme southern limit of brook trout, local habitat is particularly sensitive to land use changes that raise water temperatures.

The majority of remaining brook trout streams in Georgia and South Carolina are located in the Chattahoochee and Sumter national forests, where they are protected from future land use changes. The protection and connection of these small, fragmented populations to lower elevation rivers will ensure their long term survival in the face of droughts and floods. The restoration of streamside areas, improvement of stream habitat and the selective removal of non-native fish can strengthen existing populations and restore others to other portions of their original range.

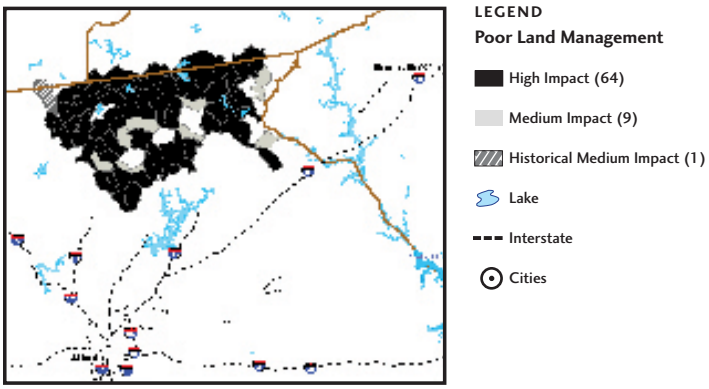
Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
Rainbow Trout	87	96%
Historical Forestry	83	91%
Poor Land Management	74	81%
Road Sediment	79	87%
Urbanization	76	84%

Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

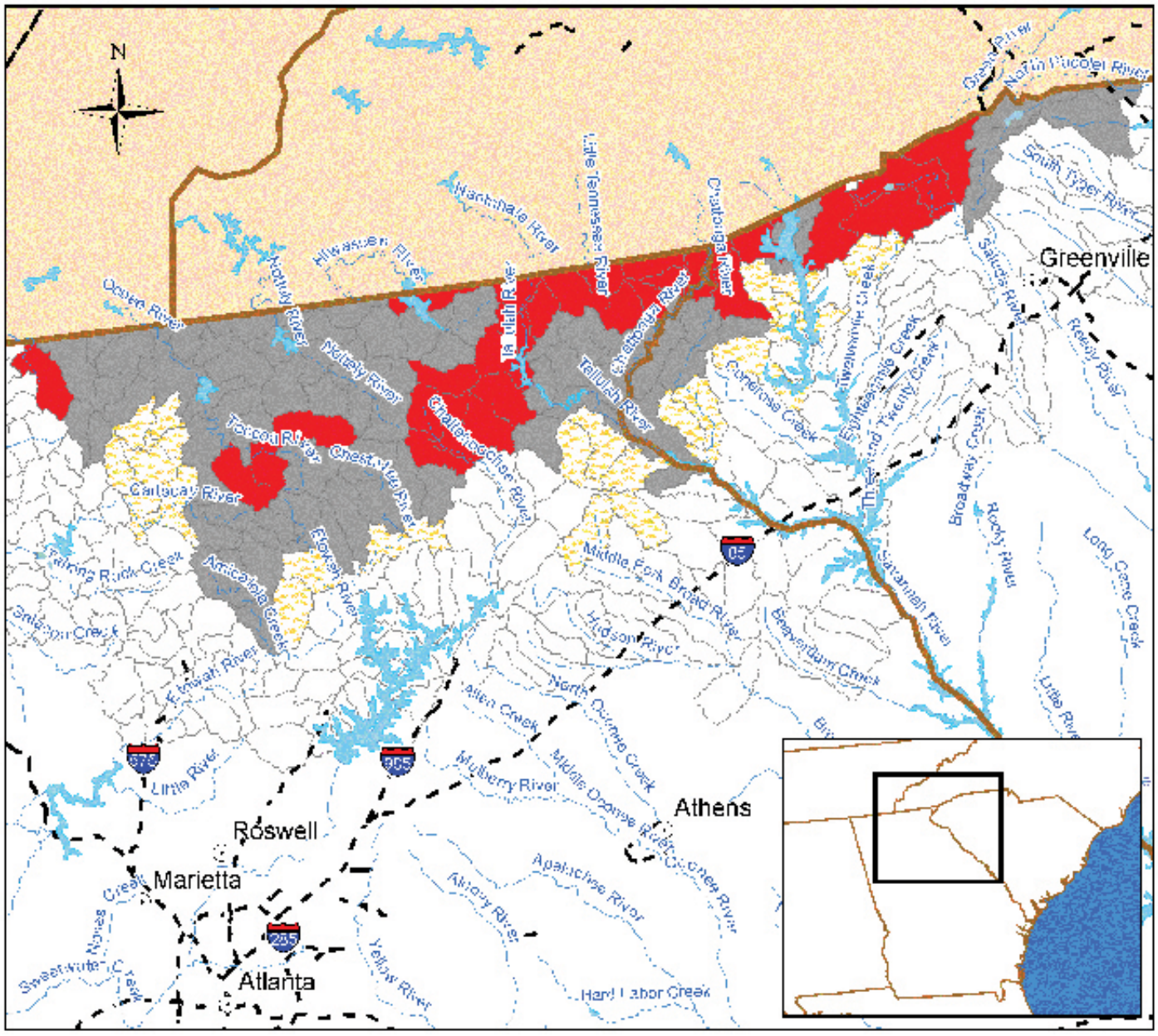
Non-Native Fish Impacts to Brook Trout in Georgia by Subwatershed



Poor Land Management Impacts to Brook Trout in Georgia by Subwatershed



Georgia & South Carolina Brook Trout Population Status by Subwatershed



Legend

Subwatershed Status

- Greatly Reduced (29)
- Extirpated (65)
- Unknown, No Data (24)
- Never Occurred (201)

- Rivers
- Lake
- Interstate
- Cities

0 10 20
Miles

Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

Tennessee & North Carolina:

Brook trout native to the Southern Appalachians are genetically distinctive. Only a handful of subwatersheds in Tennessee and North Carolina still support 50% or more of the brook trout they once did. Many of the largest remaining populations occur on federal lands in headwater streams that escaped previous habitat destruction. Competition with non-native rainbow and brown trout threatens many existing brook trout populations.

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Intact (>90% habitat occupied)	1	<1%
Reduced (50-90% habitat occupied)	5	2%
Greatly Reduced (<50% occupied)	149	47%
Present, Qualitative Data Only	0	0%
Extirpated	113	36%
Absent, Unknown History	0	0%
Unknown, No Data	49	15%
Total	317	100%

Population Status: Tennessee and North Carolina boast the only remaining intact and reduced subwatersheds in the Southeast, representing less than 3% of the historical subwatersheds where the genetically distinct Southern Appalachian brook trout historically thrived. Almost half of the subwatersheds in these two states are greatly reduced. Where brook trout do persist, populations within greatly reduced subwatersheds often contain considerably less than 50% of historical populations. Brook trout are extirpated in 36% of subwatersheds, and 95 of these 113 extirpated subwatersheds occur in North Carolina. Brook trout data currently is not available for 15% of the total historical subwatersheds in these states.

Threats: The Southeast mountains have suffered from poor land use practices over the past several centuries. Large-scale logging, instream log-drives and poor land management associated with agriculture increased erosion and opened the shaded streams to the sun. As water quality declined and brook trout disappeared, rainbow trout and brown trout were introduced. As forests returned and aquatic habitat improved, these non-native fish expanded their range and now compete with brook trout for food and space. Most remaining high-quality trout habitat is occupied by non-native fish. Rainbow trout are specifically recognized as a threat to brook trout in over 70% of the subwatersheds with brook trout data in these states.

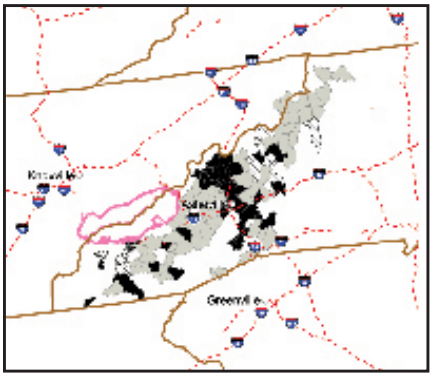
Poor land management continues to contribute to increased water temperatures, sedimentation and nutrient pollution. Regional experts specifically identified urbanization, poor land management and degraded streamside habitat as major threats to brook trout habitat.

Great Smoky Mountains National Park and Cherokee and Nantahala national forests host some of the highest quality trout habitat remaining in the Southeast. Protection and connection of these small, fragmented brook trout populations to lower elevation rivers will ensure their long-term survival in the face of droughts and floods. Continued protection of forested land, cooperative restoration of streamside areas on private land and selective removal of non-native fish can restore healthy populations of brook trout.

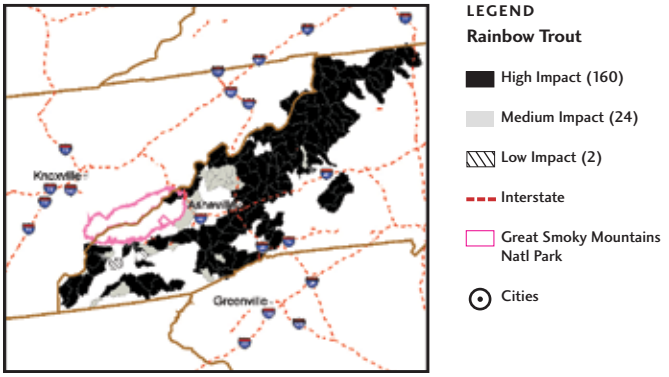
Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
1 or more Non-Native Fish	185	69%
Rainbow Trout	184	69%
Urbanization	111	41%
Brown Trout	101	38%
Poor Land Management	99	37%
Riparian Habitat	99	37%

Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

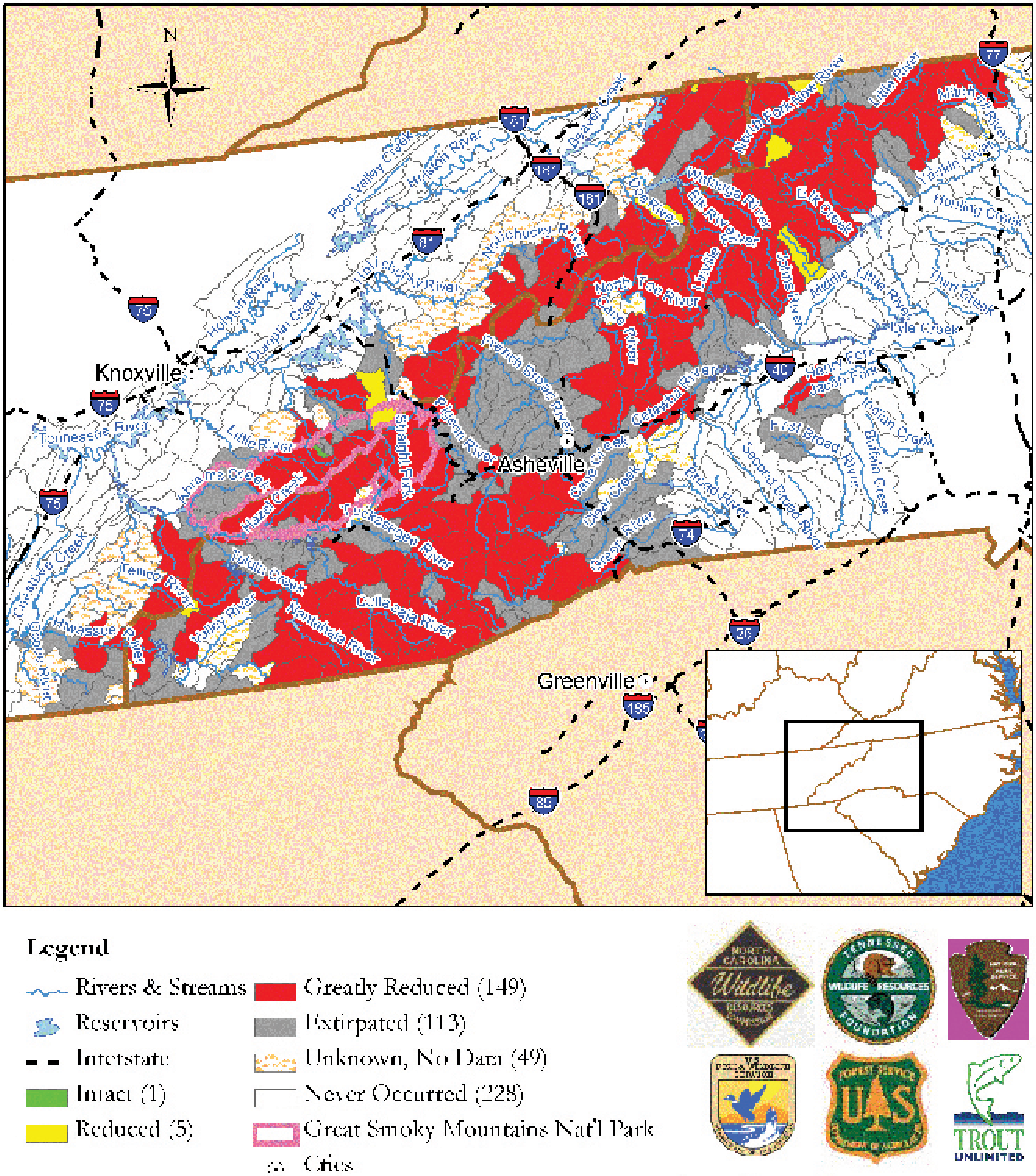
Urbanization Impacts to Brook Trout in Tennessee and North Carolina by Subwatershed



Rainbow Trout Impacts to Brook Trout in Tennessee and North Carolina by Subwatershed



Tennessee & North Carolina Brook Trout Population Status by Subwatershed



Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

USGS science for a changing world

Virginia: **The mountains of Virginia, many of them protected under federal ownership, provide the largest stronghold for wild brook trout south of the Mason-Dixon line. Brook trout, however, have been largely extirpated from lower elevations of the state where poor land management, outdated grazing practices, roads and other human changes have degraded water quality and streamside conditions.**

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Intact (>90% habitat occupied)	36	9%
Reduced (50-90% habitat occupied)	80	20%
Greatly Reduced (<50% occupied)	56	14%
Present, Qualitative Data Only	8	2%
Extirpated	148	38%
Unknown, No Data	0	0%
Absent, Unclear History	64	16%
Total	392	100%

Population Status: The Commonwealth of Virginia retains the strongest brook trout populations south of the Mason-Dixon Line, and supports subwatersheds with intact populations (9%) and reduced populations (20%). Brook trout are concentrated in steep mountain streams, where the Shenandoah National Park and the George Washington and Jefferson National Forests protect a large number of these healthy populations. Virginia has excellent data available for brook trout populations; only 2% of subwatersheds lack quantitative data on brook trout.

Despite this relatively strong reservoir, Virginia has lost all populations in 38% of its historical brook trout subwatersheds, an area nearly the size of Connecticut. Brook trout no longer live along a contiguous swath of land stretching from Winchester south through the Shenandoah Valley and continuing south of Roanoke into southwestern Virginia. Brook trout across this area once inhabited valley-bottom spring creeks, which over time have become degraded by farming, timber harvest, and other land use practices that alter water quality and stream habitat.

In Northern Virginia, the majority of subwatersheds were identified as absent, unclear history. This classification indicates that experts are uncertain whether brook trout ever occupied these streams and/or whether they vanished years ago. Elevation and hydrology data suggest that brook trout most likely never occurred in the majority of these absent subwatersheds.

Threats: Regional experts listed high water temperature as the greatest disturbance to brook trout populations across the state. The next three impacts all contribute to high water temperatures as well as to increased sedimentation: poor land management, degraded streamside (riparian) habitat and grazing in sensitive areas. Partnership efforts are underway to restore streamside vegetation and reduce water temperatures and decrease sediment and nutrient inputs in a number of creeks that formerly held brook trout.

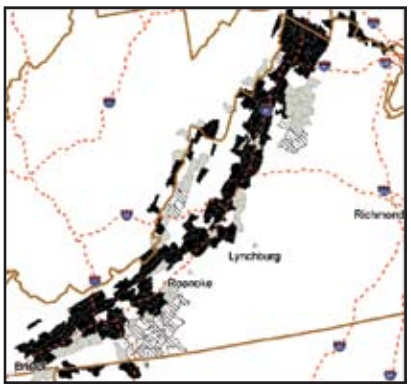
In addition, road and culvert fragmentation of streams are problematic statewide. These threats are attributable to both suburban development and poor road planning for forestry.

The low buffering geology of much of the Appalachian mountains confines acid deposition impacts largely to higher elevations. Regional biologists identified acid deposition as affecting 76 subwatersheds, located largely on federal lands. While not as widespread as other disturbances, acid deposition threatens a large portion of remaining brook trout streams.

Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
High Water Temperature	253	77%
Poor Land Management	214	65%
Riparian Habitat	209	64%
Grazing	205	63%
Stream fragmentation (Roads)	198	60%

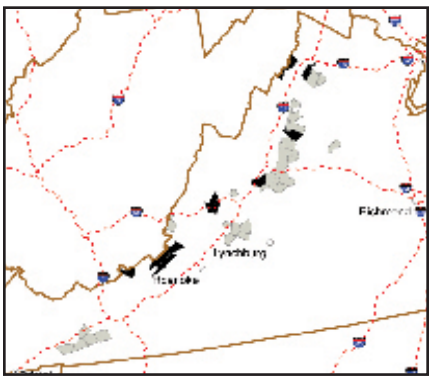
Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

Poor Land Management & Grazing Impacts to Brook Trout in Virginia by Subwatershed



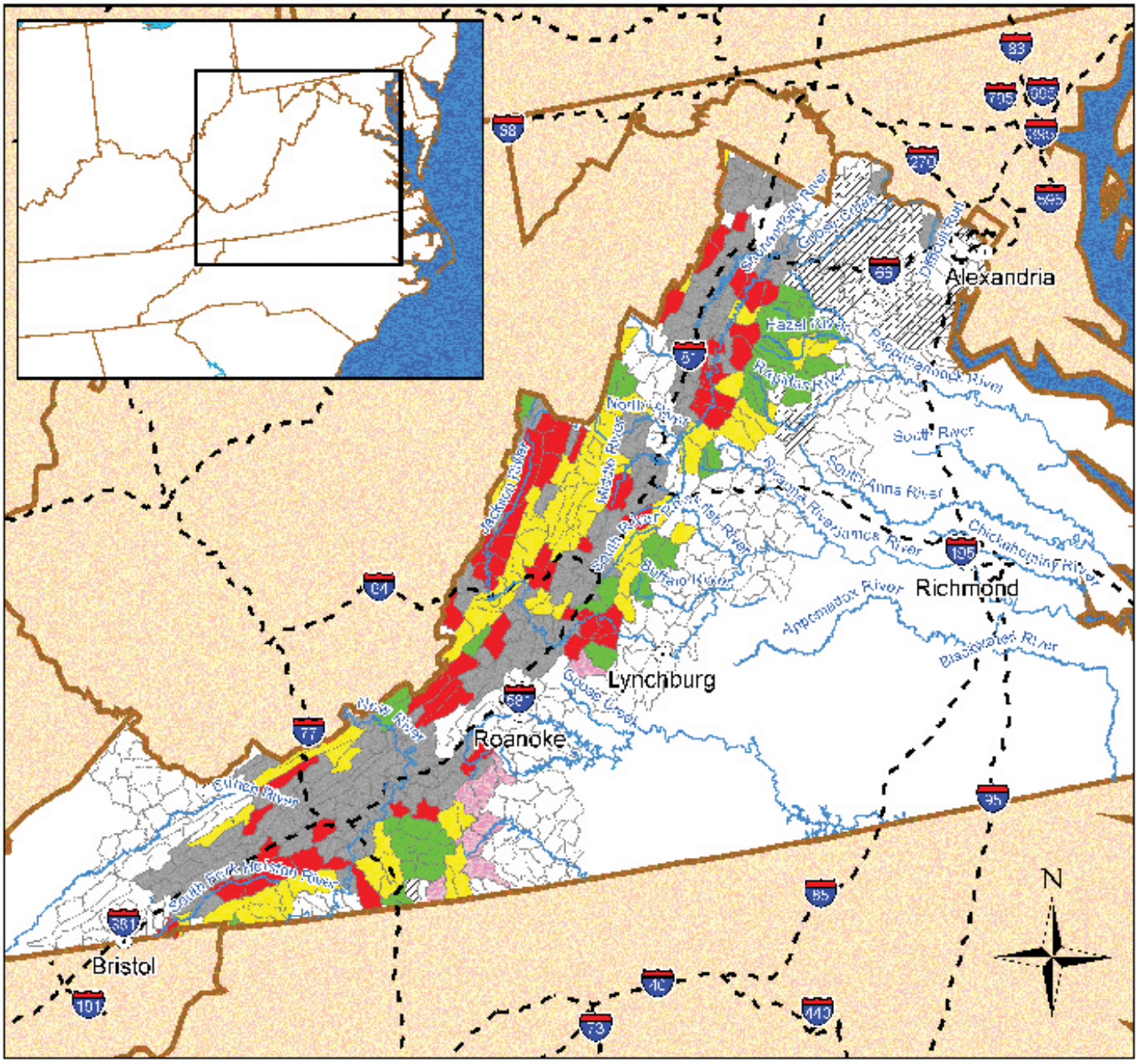
LEGEND
Agriculture and Grazing
- High Impact (171)
- Medium Impact (48)
- Low Impact (35)
- Interstate
- Cities

Acid Deposition Impacts to Brook Trout in Virginia by Subwatershed



LEGEND
Acid Deposition
- High Impact (11)
- Medium Impact (29)
- Interstate
- Cities

Virginia Brook Trout Population Status by Subwatershed



Legend

- Rivers
- Interstate
- Intact (36)
- Reduced (80)
- Greatly Reduced (56)
- Qualitative Presence (8)
- Extirpated (148)
- Absent: Unclear History (64)
- Never Occurred (194)
- Cities

0 37.5 75
Miles

Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

West Virginia:

The majority of West Virginia's remaining brook trout subwatersheds are greatly reduced largely due to poor water quality associated with a long history of poor land management, forestry and mining. In addition, acid deposition and abandoned mine drainage each impair approximately 25% of available brook trout habitat. Further information is required in over half of the state's subwatersheds to determine whether brook trout historically thrived in areas where they are currently absent.

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Intact (>90% habitat occupied)	4	1%
Reduced (50-90% habitat occupied)	16	4%
Greatly Reduced (<50% occupied)	130	30%
Present, Qualitative Data Only	4	1%
Extirpated	24	6%
Absent, Unclear History	249	57%
Unknown, No Data	7	2%
Total	434	100%

Population Status: West Virginia has very few healthy brook trout subwatersheds -- 1% remain intact and 4% are reduced. The majority of existing brook trout subwatersheds are greatly reduced (30%). While only 6% of the subwatersheds are extirpated, brook trout were documented to be absent from 57% of subwatersheds within the study area. Experts know that brook trout are not living in those subwatersheds, but they are not able to determine whether brook trout historically occurred there or disappeared some time ago. Further investigation is needed to determine if the native range of brook trout is much smaller than previous research indicated, or if the extent of brook trout losses are much more severe than biologists can measure at this point in time.

Threats: West Virginia fisheries experts determined that poor land management and forestry ranked as the two most widespread disturbances to brook trout populations across the state. Both of these land uses can degrade riparian habitat (5th ranked impact) by removing streamside vegetation. Increased nutrients, sediment and higher water temperatures are generally the result of poor land management. Forestry practices can reduce water quality and raise water temperatures, typically due to poorly designed and maintained dirt roads and skid trails, and loss of streamside trees.

Acid deposition was identified as currently affecting 30% of subwatersheds with documented brook trout habitat. Acid deposition often exerts a greater proportional impact on higher elevation areas, precisely where brook trout have retreated in the face of water quality declines in the valleys.

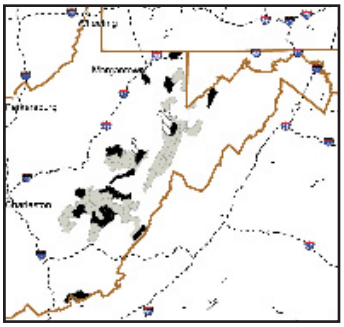
Abandoned mine drainage (AMD) affects almost one quarter of West Virginia's subwatersheds that have brook trout data. AMD often renders entire sections of stream lifeless from toxic, acidic water leaching from mines.

Expanding the state's successful lime dosing program to neutralize acid streams and revive aquatic life can make hundreds of miles of rivers habitable for brook trout. Increasing voluntary programs to protect and replant streamside trees holds great potential for brook trout restoration on private lands throughout the state.

Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
Poor Land Management	104	59%
Forestry	96	54%
Acid Deposition	53	30%
Abandoned Mine Drainage	43	24%
Riparian Habitat	37	21%
Mining	30	17%

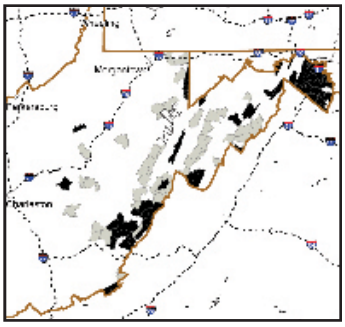
Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

Acid Deposition Impacts to Brook Trout in West Virginia by Subwatershed



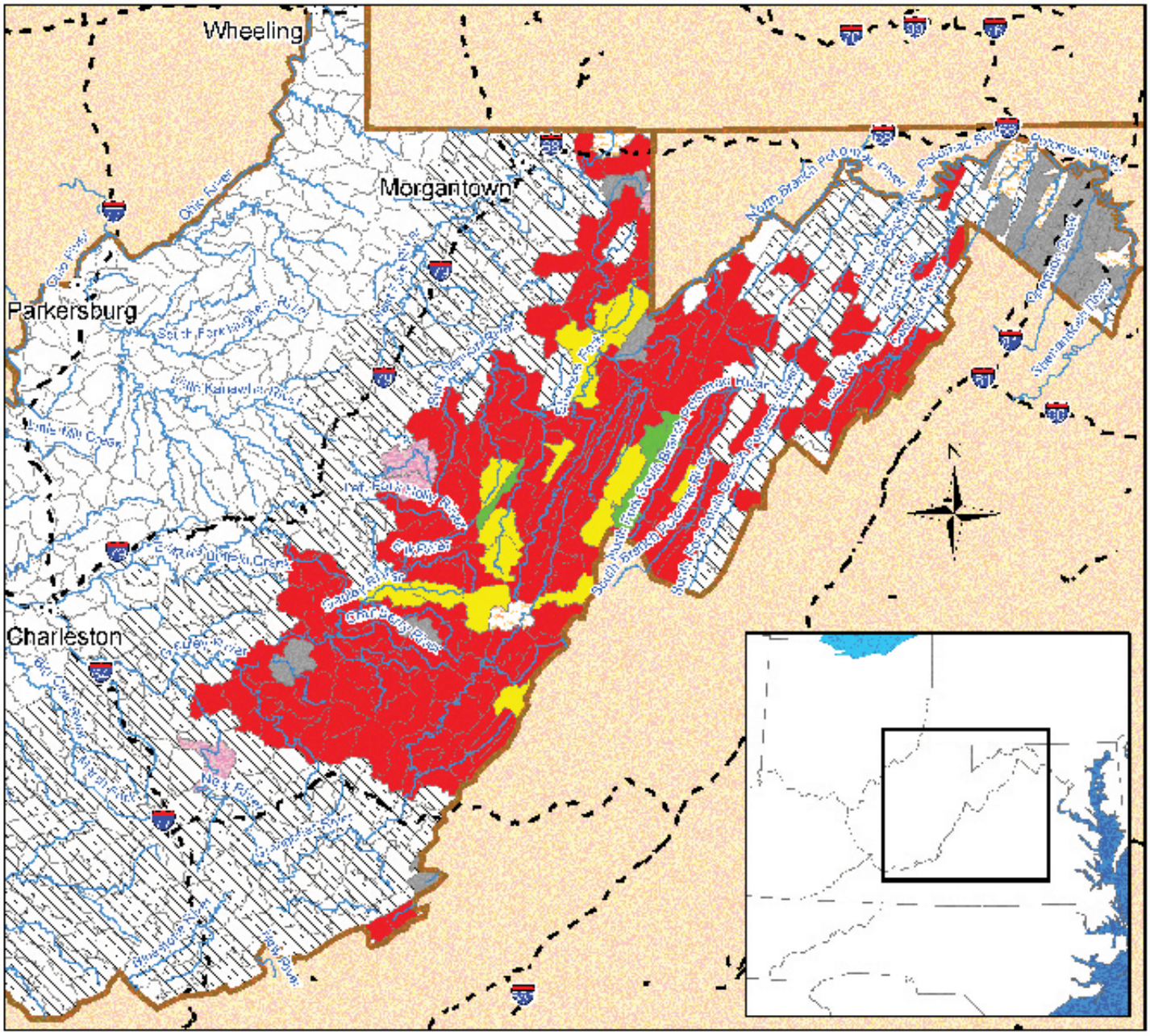
LEGEND
Acid Deposition
- High Impact (18)
- Medium Impact (37)
- Low Impact (3)
- Interstate
- Cities

Poor Land Management Impacts to Brook Trout in West Virginia by Subwatershed



LEGEND
Poor Land Management
- High Impact (54)
- Medium Impact (50)
- Low Impact (4)
- Interstate
- Cities

West Virginia Brook Trout Population Status by Subwatershed



Legend

- Streams
- Interstate
- Intact (4)
- Reduced (16)
- Greatly Reduced (130)
- Qualitative Presence (4)
- Extirpated (24)
- Absent, Unclear History (249)
- Unknown, No Data (7)
- Never Occurred (283)
- Cities

0 20 40
Miles

Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

Maryland:

Maryland's brook trout populations are greatly diminished from their historical range, with only three intact subwatersheds remaining in the western panhandle. Over 55% of subwatersheds across the state have lost brook trout entirely, and almost 30% contain only small, headwater populations. High water temperature, poor land management, urbanization and water withdrawals exert the greatest impact on brook trout in the state.

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Present, Intact	3	2%
Present, Reduced	5	3%
Present, Greatly Reduced	42	30%
Present, Qualitative Data	0	0%
Extirpated	83	57%
Absent, Unclear History	0	0%
Unknown, No Data	12	8%
Total	145	100%

Population Status: The state of Maryland has very few healthy brook trout subwatersheds, concentrated in the western panhandle in the more mountainous Appalachian terrain. The Savage River headwaters and a handful of other subwatersheds along the Pennsylvania and West Virginia border represent the remaining strong populations of brook trout in the state. Only 2% of the subwatersheds are intact, and 3% of the subwatersheds are reduced. 29% of the state's subwatersheds are greatly reduced. Brook trout populations are extirpated from 57% of the state's subwatersheds.

Maryland possesses relatively complete data on brook trout. Only 8% of the 145 subwatersheds within the historical range have no brook trout information available, located primarily north of the West Virginia boundary between Hagerstown and Cumberland.

Threats: Regional experts identified high water temperature as a disturbance in a staggering 79% of Maryland subwatersheds with brook trout data. High water temperatures result primarily from urbanization, poor land management and groundwater withdrawals. In the rolling piedmont and coastal plain, historical clearing of forests, insufficient streamside vegetation and ineffective nutrient management have helped usher the brook trout from many of its native waters. Groundwater withdrawals for irrigation and residential use are particularly damaging to stream ecosystems, since groundwater plays a key role in moderating stream temperatures and maintaining flows during droughts.

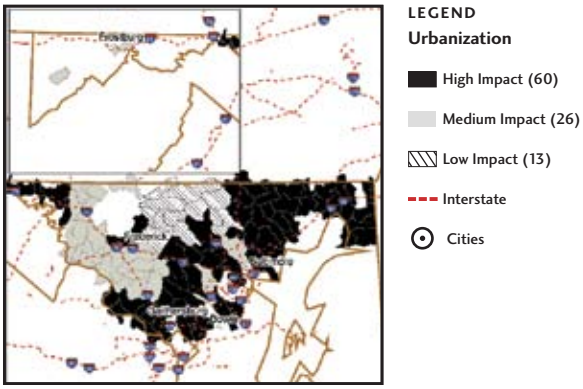
The state's western panhandle is comprised of rugged mountains where poor land management also impacts stream habitat. Other localized impacts threaten the survival of brook trout populations, most notably abandoned mine drainage, acid deposition and road sedimentation. Regional experts cited historical forestry practices as a factor in the loss of brook trout across much of this region.

Protecting the few intact subwatersheds and expanding brook trout populations in the western panhandle and in the Catoctin Mountains will help ensure the long-term health of brook trout in Maryland. A surprising number of brook trout streams survive near Baltimore. Maintaining these populations will be an extraordinary challenge. As forests regrow and the state pursues more creative ways to reduce stormwater runoff, reestablish streamside forests and improve water quality in the Chesapeake Bay watershed, the potential for restoring brook trout in Maryland is strong.

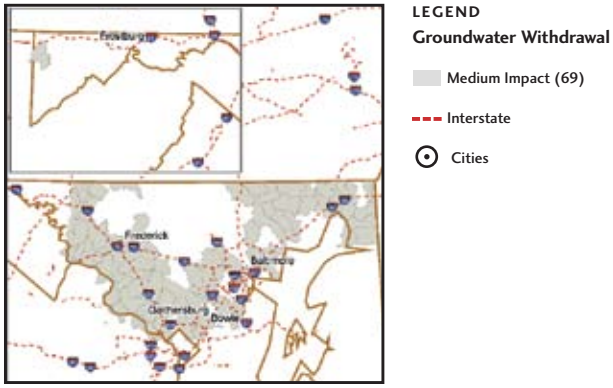
Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
High Water Temperature	106	79%
Urbanization	100	75%
Poor Land Management	91	68%
Groundwater Withdrawals	75	56%
Surface Water Withdrawals	53	40 %

Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

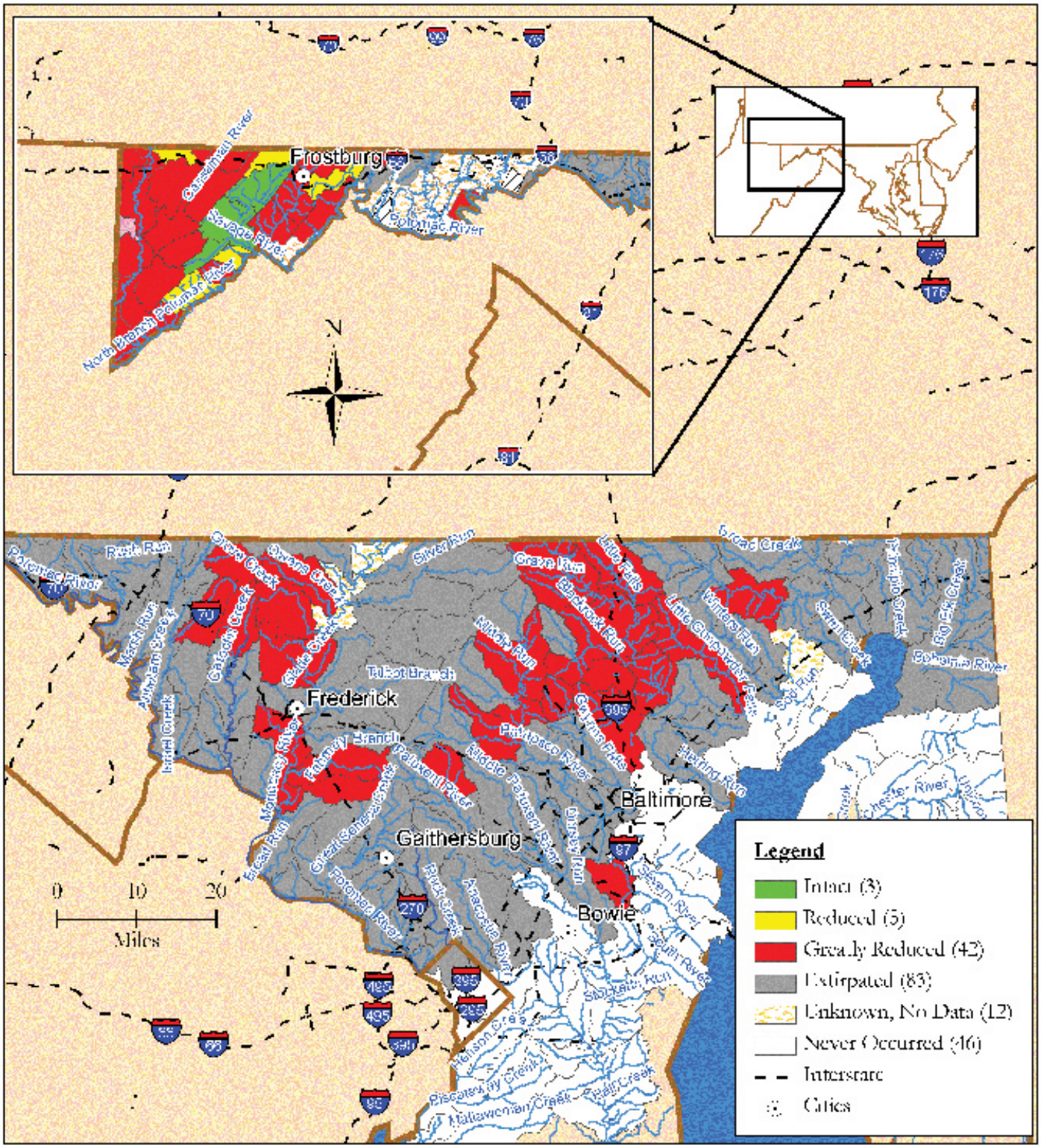
Urbanization Impacts to Brook Trout in Maryland by Subwatershed



Groundwater Withdrawal Impacts to Brook Trout in Maryland by Subwatershed



Maryland Brook Trout Population Status by Subwatershed



Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

Pennsylvania & Ohio: Brook trout populations remain intact in very few subwatersheds in Pennsylvania, located primarily in the Allegheny Mountains, Potter and Clinton counties, and the northeastern corner of the state. Brook trout survive mostly in isolated, headwater populations. High water temperatures and sedimentation from poor land management, roads and urbanization impact the most subwatersheds. A few small brook trout populations still survive in Ohio.

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Intact (>90% habitat occupied)	16	1%
Reduced (50-90% habitat occupied)	118	9%
Greatly Reduced (<50% occupied)	507	39%
Present, Qualitative Data Only	5	<1%
Extirpated	449	34%
Absent, Unclear History	0	0%
Unknown, No Data	218	17%
Total	1313	100%

Population Status: Brook trout historically thrived across Pennsylvania, with the exception of areas in the extreme western and southwestern portion of the state. Today, 1% of the state's historical subwatersheds remain intact, while 9% are reduced. Most of these relatively healthy brook trout subwatersheds are located in the west-central portion of Allegheny National Forest, in the God's Country region including the Genessee River headwaters, Kettle Creek and other tributaries to the West Branch Susquehanna River, and in the state's northeast corner between the Delaware and North Branch Susquehanna Rivers. In 39% of subwatersheds, brook trout are greatly reduced and typically occupy only small, headwater streams. Brook trout have vanished from 34% of historical brook trout subwatersheds. A significant portion of the state (17%) lacks any data on the presence of brook trout.

Until a recent discovery of several remnant populations, brook trout were believed to be extirpated from Ohio. Due to conservation and management efforts, however, brook trout now survive at greatly reduced levels in three subwatersheds. Seven other surrounding subwatersheds have suitable habitat but lack brook trout populations, and no data exists to determine their historical presence. Brook trout are confirmed to be extirpated from one subwatershed in Ohio.

Threats: Regional experts ranked poor land management associated with agriculture as the most widespread disturbance to brook trout habitat across Pennsylvania, impacting almost 50% of subwatersheds with brook trout data. Traditional land uses that remove streamside trees directly contribute to high water temperature, the second most widespread disturbance. Increased partnerships on private lands to reduce water temperature, nutrient runoff and sedimentation could greatly benefit Pennsylvania's water quality and brook trout populations.

Regional experts cited competition and predation from brown trout as the third highest ranked impact across the state. Urbanization and associated road sedimentation ranked among the top five disturbances statewide.

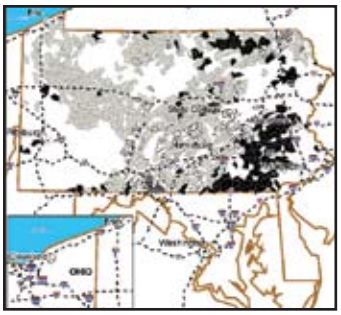
While not as widespread as the top five disturbances, acid deposition impairs clusters of subwatersheds (123 total) with poor buffering geology. Abandoned mine drainage impacts are localized and severe, affecting a group of subwatersheds larger than all of Connecticut. Expanding ongoing efforts to mitigate these water quality impacts could restore many miles of brook trout habitat that currently support little or no aquatic life.

Ohio's few brook trout populations are disturbed by urbanization and poor instream habitat, which lead to higher water temperatures. Dams and impassable culverts contribute to fragmented streams in these subwatersheds.

Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
Poor Land Management	532	49%
High Water Temperature	463	42%
Brown Trout	296	27%
Sedimentation (Roads)	248	23%
Urbanization	233	21%

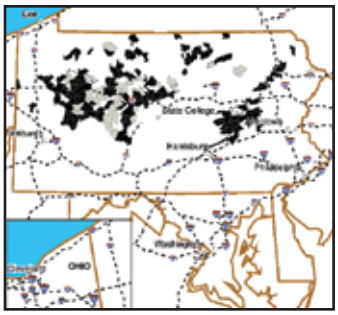
Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

Poor Land Management Impacts to Brook Trout in In Pennsylvania and Ohio by Subwatershed



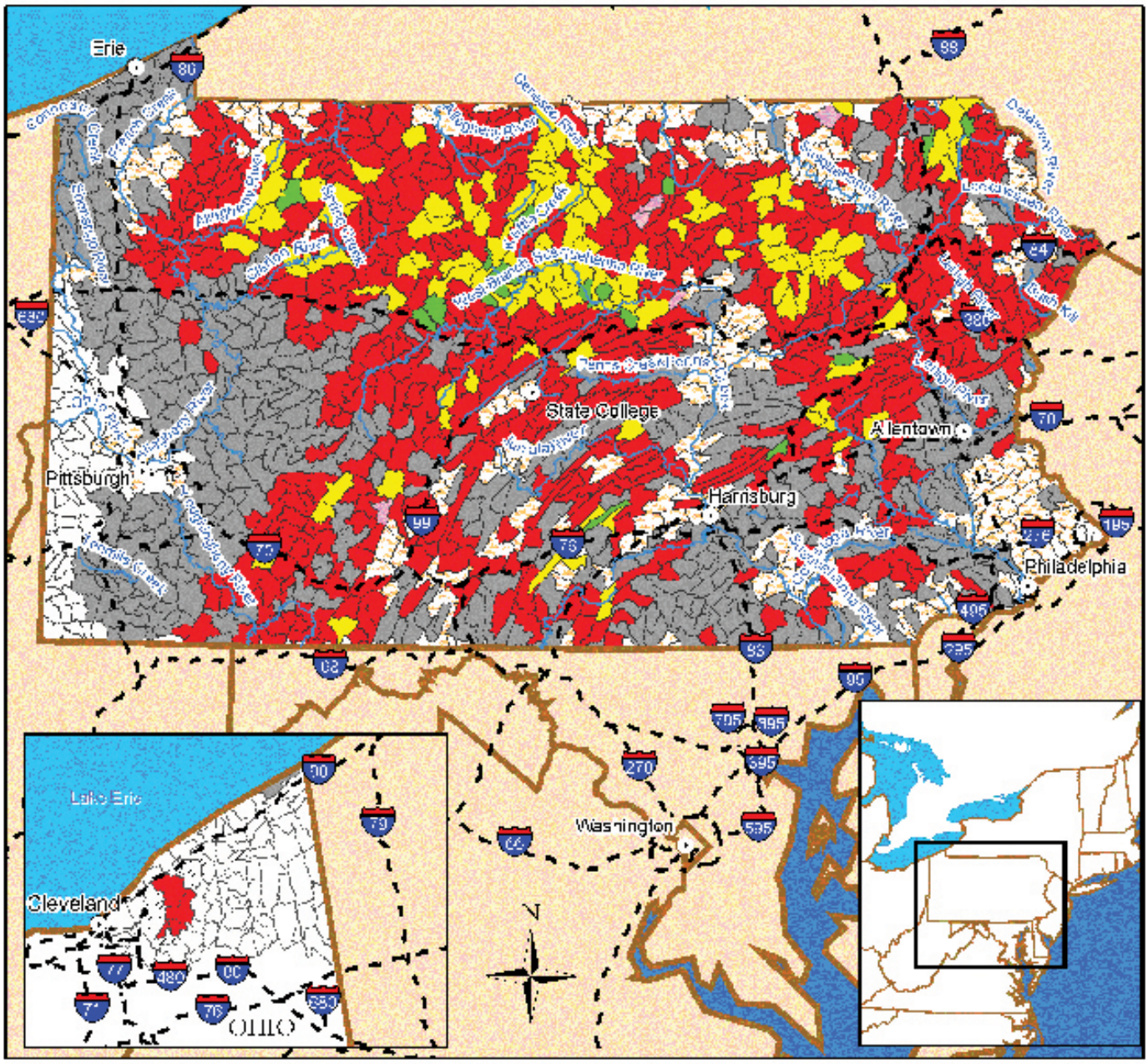
LEGEND
Poor Land Management
- High Impact (158)
- Historically High Impact (7)
- Medium Impact (374)
- Historically Medium Impact (3)
- Low Impact (101)
- Interstate
- Lake
- Cities

Abandoned Mine Drainage Impacts to Brook Trout in Pennsyvania and Ohio by Subwatershed



LEGEND
Abandoned Mine Drainage
- High Impact (135)
- Medium Impact (36)
- Low Impact (6)
- Interstate
- Lake
- Cities

Pennsylvania & Ohio Brook Trout Population Status by Subwatershed



Legend

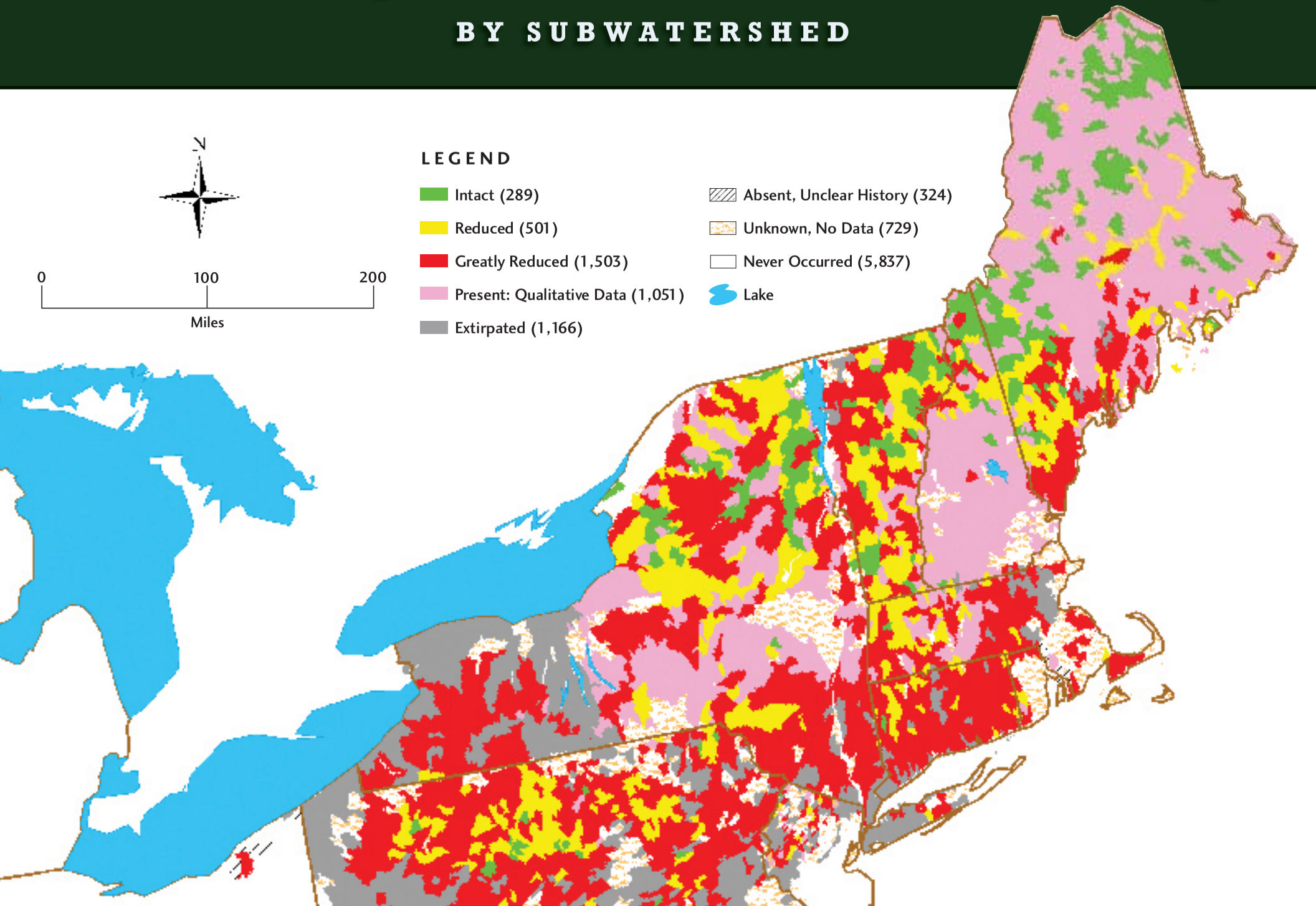
- Intact (16)
- Reduced (118)
- Greatly Reduced (507)
- Qualitative Presence (5)
- Extirpated (449)
- Unknown, No Data (218)
- Never Occurred (72)
- Rivers
- Lake
- Interstate
- Cities

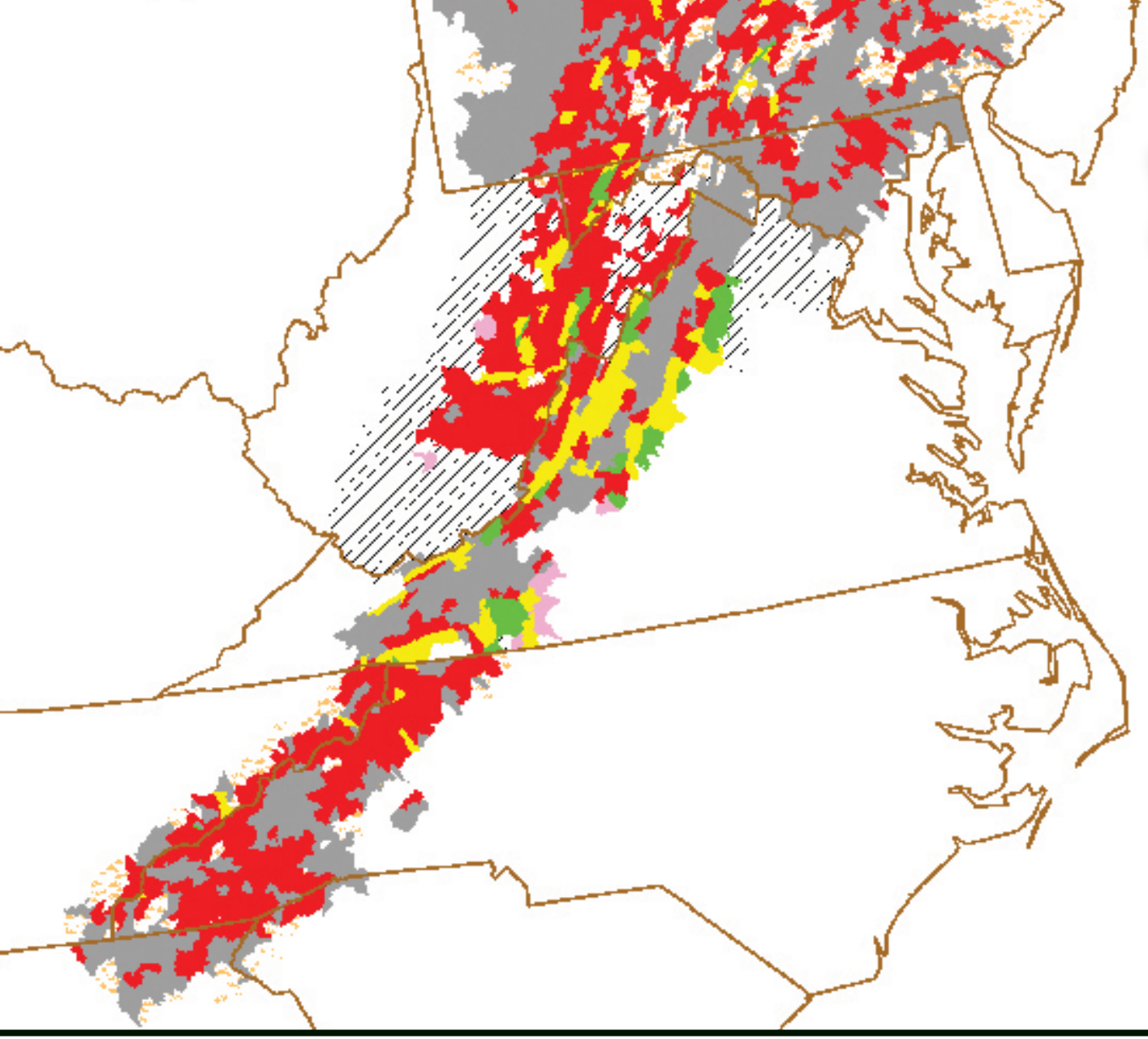
0 25 50
Miles

Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006*. Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

Brook Trout Population Status in the Eastern U.S. Range

BY SUBWATERSHED





Strong wild brook trout populations demonstrate that a stream or river ecosystem is healthy and that water quality is excellent. A decline in brook trout populations can serve as an early warning that the health of an entire system is at risk.

Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited. For more information, go to **www.brookie.org**.

New Jersey:

Brook trout survive in less than half of their original range in New Jersey, although reduced populations remain in the New Jersey Highlands and the Delaware Water Gap. Urbanization and a variety of environmental impacts associated with industry and roads have played a major role in the loss of brook trout populations. Further assessment data is needed in a third of the state.

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Intact (>90% habitat occupied)	1	<1%
Reduced (50-90% habitat occupied)	14	6%
Greatly Reduced (<50% occupied)	44	18%
Present, Qualitative Data Only	19	9%
Extirpated	94	38%
Absent, Unclear History	0	0%
Unknown, No Data	76	30%
Total	248	100%

Population Status: Brook trout survive in less than half of their original range in New Jersey. Less than 1% of subwatersheds remain intact, and 6% are reduced. Brook trout populations are greatly reduced in another 18% of the state's subwatersheds. Brook trout are present in another 9% of subwatersheds, but no quantitative data is available. These areas where brook trout persist total less than the number of subwatersheds (38%) where brook trout have been extirpated. Population status is unknown for 30% of the historical brook trout range in New Jersey.

While the New Jersey Highlands are home to most of the healthier brook trout subwatersheds, populations also exist in tributaries to the Delaware River within the Delaware Water Gap National Recreation Area.

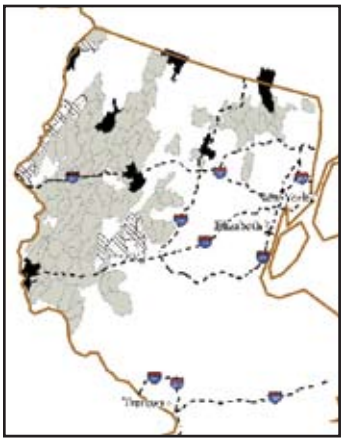
Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
Sedimentation (Roads)	114	66%
Urbanization	111	65%
Dam Inundation/Fragmentation	100	58%
High Water Temperature	96	56%
Stream Fragmentation (Roads)	95	55%
1 or more Non-Native Fish	65	38%

Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

Threats: New Jersey is the most densely populated state in the country. Its industrial legacy has left a heavy footprint on brook trout habitat, with the greatest impacts in the most populated and urbanized regions of the state. State fisheries experts listed sedimentation from roads and urbanization as the top two most widely distributed impacts to native brook trout subwatersheds. A dense road network across much of the state contributes to declines in water quality from sedimentation, warmer water, and non-point source pollutants. In addition, regional experts identified fragmentation by dams--many built more than a century ago for mills and local power--as the third greatest impact across the state. Dams physically dissect a stream and isolate fish populations, and they also increase water temperatures by slowing down water and exposing it to the sun. Road culverts can exert similar ecological impacts by preventing fish from moving past these barriers. Poorly designed culverts may also contribute to sediment pollution.

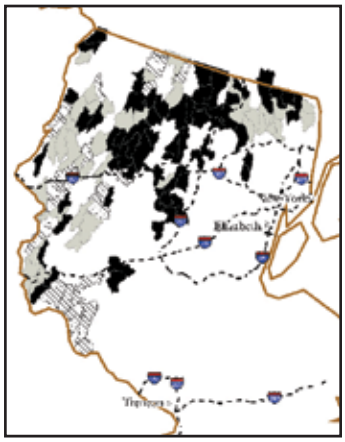
Considering that New Jersey is the most densely populated state in the United States, the presence of brook trout in 59 subwatersheds is encouraging, yet it is tempered by the documentation that more than a third of the historical subwatersheds have lost their native trout.

Sedimentation (Road) Impacts to Brook Trout in New Jersey by Subwatershed



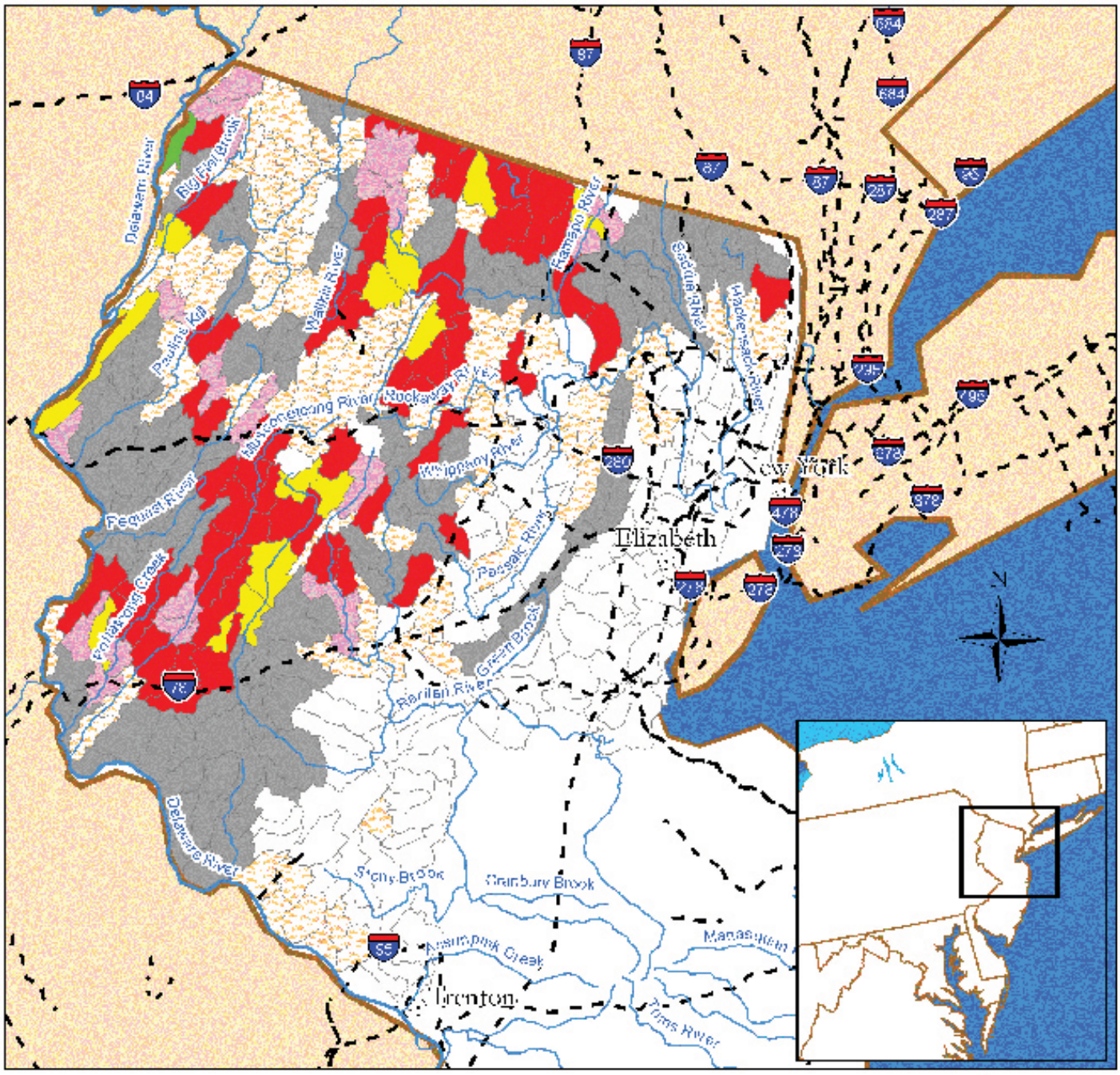
LEGEND
Sedimentation (Roads)
- High Impact (8)
- Medium Impact (106)
- Low Impact (11)
- Interstate
- Cities

Dam Inundation/Fragmentation Impacts to Brook Trout in New Jersey by Subwatershed



LEGEND
Inundation/Fragmentation (Dams)
- High Impact (58)
- Medium Impact (42)
- Low Impact (24)
- Interstate
- Cities

New Jersey Brook Trout Population Status by Subwatershed



Legend

- Intact (1)
- Reduced (14)
- Greatly Reduced (44)
- Qualitative Presence (19)
- Extirpated (94)
- Unknown, No Data (76)
- Never Occurred (122)
- Rivers
- Interstate
- Cities

0 10 20
Miles

Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

New York:

In New York, 5% of watersheds that historically contained brook trout in streams and rivers remain intact, located primarily in portions of the Adirondacks and the Tug Hill Plateau. Western and south central New York have suffered the greatest losses of brook trout. Data gaps remain in the central part of the state from Albany to Syracuse. While many lakes and ponds still contain brook trout, losses have been substantial due to competition with non-native fish and acid rain.

Brook Trout Classifications	Number of Watersheds	Percentage of Watersheds
Intact (>90% habitat occupied)	25	5%
Reduced (50-90% habitat occupied)	63	11%
Greatly Reduced (<50% occupied)	149	27%
Present, Qualitative Data Only	106	19%
Extirpated	129	23%
Absent, Unclear History	0	0%
Unknown, No Data	89	16%
Total	561	100%

Population Status: New York's intact watersheds occur mostly in the Adirondack Park and along the Tug Hill Plateau. The Catskill Mountains support a block of reduced watersheds. The Finger Lakes, Southern Tier and Western New York have suffered the greatest losses, where brook trout live in small, fragmented populations in headwater streams. A large portion of central New York stretching from Albany to Syracuse and south to the Catskills lacks brook trout information. Although New York once boasted vast and famed lake fisheries for brook trout, only two of the 136 watersheds that historically supported lake populations remain intact today.

New York is the only state where subwatersheds are not delineated, and therefore this analysis was conducted on a watershed basis. Data was collected and analyzed separately for streams and rivers and for lakes and ponds.

Threats: High water temperature was listed as the top disturbance to stream populations of brook trout. High water temperatures are a common symptom of various land uses that remove streamside vegetation, particularly poor land management associated with agriculture (ranked fourth). Degraded riparian (streamside) habitat also contributes to increased water temperatures. In addition, regional experts noted the resurgence of beavers--now thriving without natural predators along waterways altered by forestry--as a source of warmer water.

Non-native fish (specifically brown trout) were identified as the second largest stream disturbance. While non-native fish can out-compete brook trout, they are also more tolerant of warmer, more polluted waters that formerly supported brook trout.

The most widespread disturbance to New York's lake and pond populations is non-native fish--specifically smallmouth bass, largemouth bass, and other warm-water fish such as yellow perch and golden shiners. Acid deposition has a severe but regionalized impact on lakes, eliminating or reducing aquatic life in 23 Adirondack watersheds.

Many approaches exist to protect and restore New York's lake populations of brook trout. These include restricting illegal fish introductions into brook trout waters, increasing current monitoring programs, reducing acid deposition, liming acidified ponds and reintroducing native brook trout. Stream populations can benefit from building more partnerships among landowners, agencies and non-profit organizations to restore streamside trees and improve habitat for New York's state fish.

Disturbances (High or Medium)	Number of Watersheds	Percentage of Watersheds
High Water Temperature	282	60%
1 or More Non-Native Fish	245	52%
Brown Trout	218	46%
Poor Land Management	215	46%
Beavers	197	42%
Riparian Habitat	190	40%

Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each watershed.

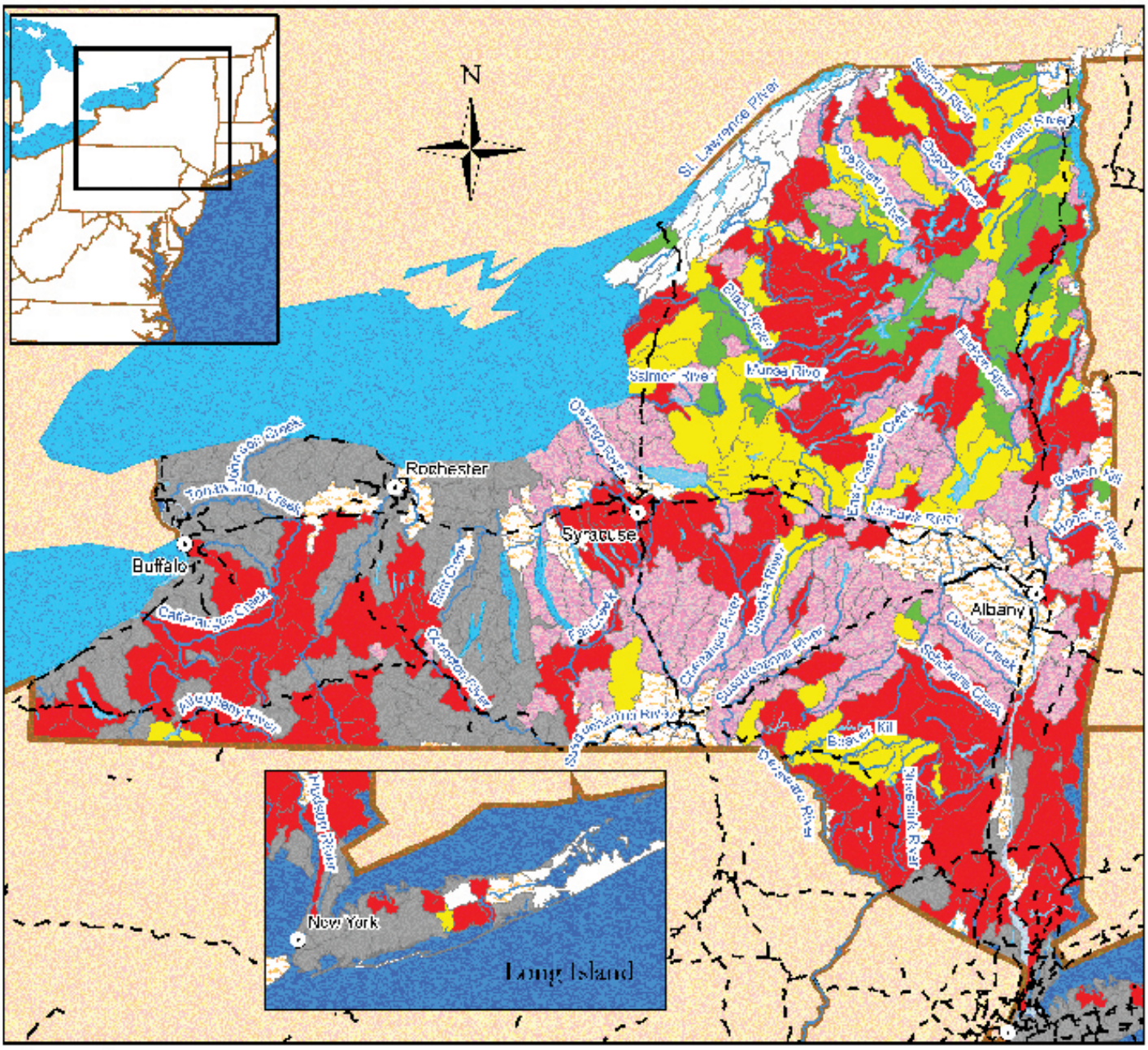
Acid Deposition Impacts to Brook Trout in New York by Watershed

LEGEND
Acid Deposition
- High Impact (20)
- Medium Impact (2)
- Low Impact (1)
- Interstate
- Lake
- Cities

High Water Temperature Impacts to Brook Trout in New York by Watershed

LEGEND
High Water Temperatures
- High Impact (164)
- Medium Impact (118)
- Low Impact (31)
- Interstate
- Lake
- Cities

New York Brook Trout Population Status by Watershed



Legend

- Intact (25)
- Reduced (63)
- Greatly Reduced (149)
- Qualitative Presence (106)
- Extirpated (129)
- Unknown, No Data (89)
- Never Occurred (36)
- Rivers
- Lake
- Interstate
- Cities

Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

0 25 50
Miles

USGS

Connecticut & Rhode Island:

While brook trout are still present within most Connecticut and Rhode Island subwatersheds, remaining brook trout populations are small and fragmented. Only one subwatershed remains intact for brook trout in these states. Fairly healthy subwatersheds are scattered within the Housatonic, Connecticut, Thames and Wood River drainages. Extirpated areas are concentrated in the southwest and near Hartford.

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Intact (>90% habitat occupied)	1	<1%
Reduced (50-90% habitat occupied)	19	10%
Greatly Reduced (<50% occupied)	134	69%
Present, Qualitative Data Only	3	2%
Extirpated	29	15%
Absent, Unclear History	1	<1%
Unknown, No Data	6	3%
Total	193	100%

Population Status: Brook trout remain distributed across much of Connecticut and Rhode Island, although in relatively depleted numbers. In Connecticut, brook trout currently occupy 80% of historical subwatersheds, but the vast majority of these support populations that are greatly reduced. Roughly 10% of the state's subwatersheds support reduced populations, and only one intact subwatershed remains. For the most part, Connecticut's brook trout populations are small and fragmented. These populations are located in the uppermost headwaters of stream systems and have disappeared from the larger river segments they once inhabited due to declines in water quality, increased water temperature, and displacement by non-native fish.

Rhode Island data is only partially available, and further data collection is needed to document the condition of its only native trout. The Wood River contains the healthiest known wild brook trout populations in the state.

Threats: Regional experts noted that nearly every subwatershed in Connecticut suffers from increased water temperatures. High water temperature is a symptom of a variety of human activities that alter streamside vegetation and change the pathways that water takes as it flows across the land and into streams. Urbanization, roads and dam fragmentation represent physical disturbances to brook trout habitat that lead to increased water temperature and decreased water quality.

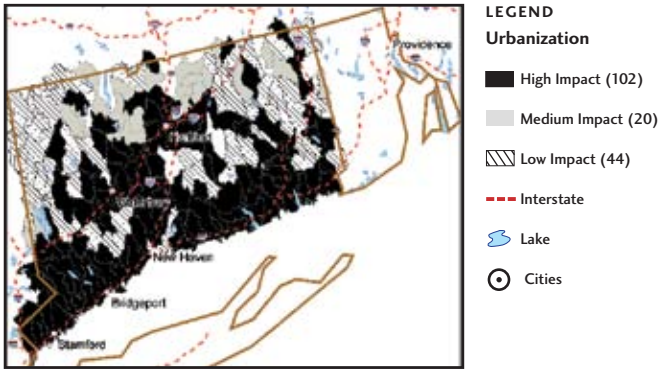
Like much of southern New England, past land uses have left a heavy footprint on Connecticut's landscape. Regional experts identified historical clearing of forests as a profound disturbance that continues to impact streams and water quality today. Urbanization impacts reflect the state's industrial past and current population and development issues. In addition, experts identified dams--many built more than a century ago--as a disturbance to brook trout habitat in almost half of the state's subwatersheds. No impact data was available for Rhode Island.

Water quality has improved across New England following the decline of historical agriculture, the enforcement of the Clean Water Act and the regrowth of forests. By protecting streams from poorly designed development, removing dangerous or nonfunctional dams and improving stormwater management, policy makers and resource managers can improve water quality and help rebuild intact brook trout populations over time.

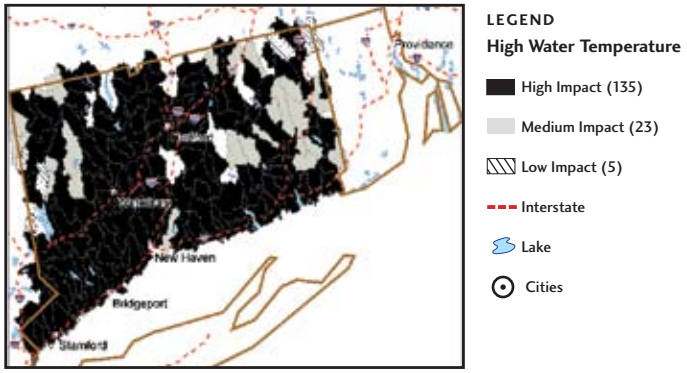
Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
High Water Temperature	165	94%
Historical Forestry	139	79%
Urbanization	122	69%
Road Sediment	122	69%
Dam Fragmentation	85	48%

Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

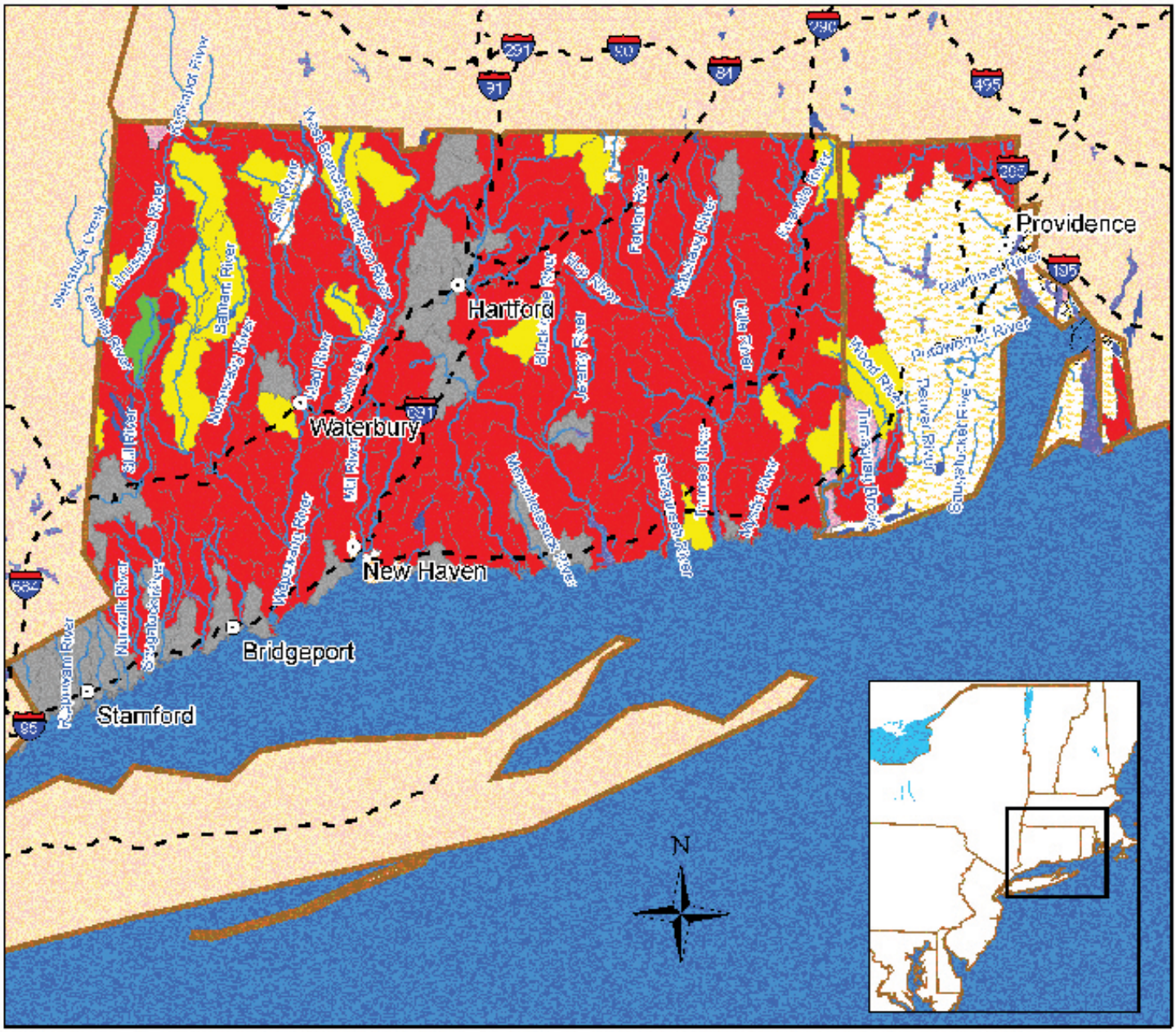
Urbanization Impacts to Brook Trout in Connecticut by Subwatershed



High Water Temperature Impacts to Brook Trout in Connecticut by Subwatershed



Connecticut & Rhode Island Brook Trout Population Status by Subwatershed



Legend

- Rivers
- Intact (1)
- Reduced (19)
- Greatly Reduced (134)
- Present, Qualitative Data (3)
- Extirpated (29)
- Absent, Unclear History (1)
- Unknown, No Data (6)
- Lake
- Interstate
- Cities

0 12.5 25
Miles

Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

Massachusetts: **Western Massachusetts possesses the state's best remaining brook trout habitat, with some comparatively strong brook trout populations in the western Taconics and in parts of the Connecticut River watershed. Coastal "salter" brook trout survive in several subwatersheds along shores including Cape Cod and Martha's Vineyard. Brook trout have vanished from the greater Boston area. Data gaps exist in the central part of the state, while large portions of Eastern Massachusetts lack any population data.**

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Intact (>90% habitat occupied)	1	<1%
Reduced (50-90% habitat occupied)	29	10%
Greatly Reduced (<50% occupied)	80	28%
Present, Qualitative Data Only	34	12%
Extirpated	20	7%
Absent, Unclear History	4	1%
Unknown, No Data	119	42%
Total	287	100%

Population Status: Less than 11% of the subwatersheds in Massachusetts support intact or reduced brook trout populations. These relatively healthy populations are located primarily in the Berkshire and Taconic mountains in the western part of the state, and within portions of the Hoosic, Deerfield and Westfield subwatersheds and several tributaries to the Connecticut River. In 28% of subwatersheds, brook trout are greatly reduced, occupying only isolated headwater stream sections. The sprawling Boston area has lost the greatest amount of brook trout habitat in the state.

Very little data is available for the eastern portion of the state south of Boston to Cape Cod. In addition, 12% of Massachusetts subwatersheds - largely in the central part of the state- have only qualitative data to document the presence of brook trout.

Threats: Massachusetts rivers and streams are heavily burdened by dams and roads. Regional experts identified dam fragmentation as a high or medium disturbance in 65% of all subwatersheds where brook trout status is known. Dams inundate habitat and increase water temperatures by slowing down flowing water and exposing it to the sun.

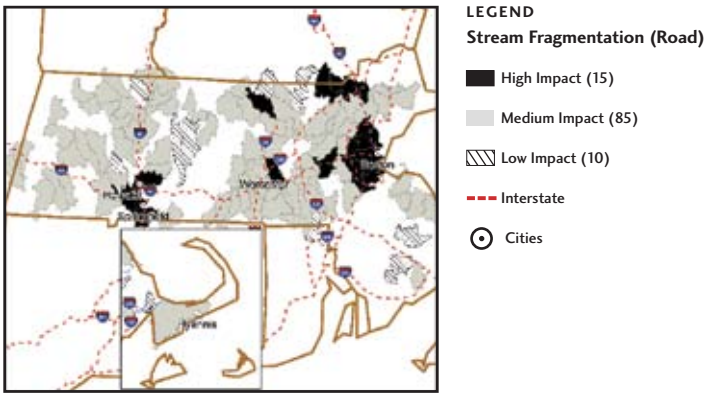
Dams and culverts often form barriers to fish movement, effectively cutting streams into biological fragments. Small, isolated populations of brook trout without connection to a larger population run the risk of vanishing over time as they succumb to natural flood and drought cycles. Because these fragmented populations are isolated from one another, if a population disappears, it cannot be reestablished by other fish from downstream. Removing or breaching unnecessary dams can restore a biological connection between isolated populations, reduce summer water temperatures and re-establish lost stream habitat.

Regional experts ranked stream fragmentation and sedimentation from roads as the second and third most common disturbances to brook trout habitat. In addition, streamside (riparian) and instream habitat degradation were listed as factors in over 50% of the state's brook trout subwatersheds where data is available. Instream habitat losses often result from gravel mining, flood control manipulation and loss of trees.

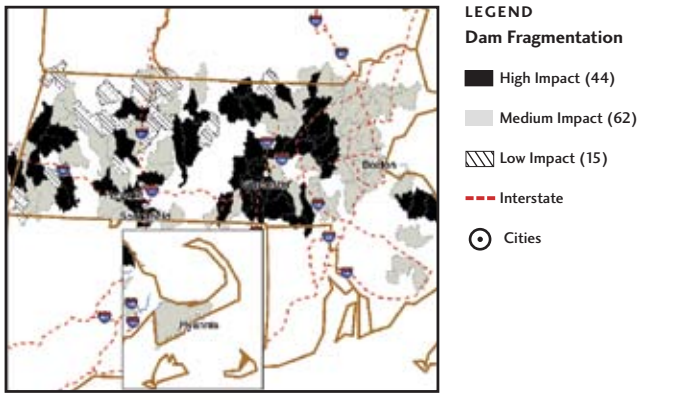
Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
Dam Inundation/Fragmentation	106	65%
Stream Fragmentation (Roads)	100	61%
Sedimentation (Roads)	96	59%
Riparian Habitat	93	57%
Instream Habitat	91	56%

Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

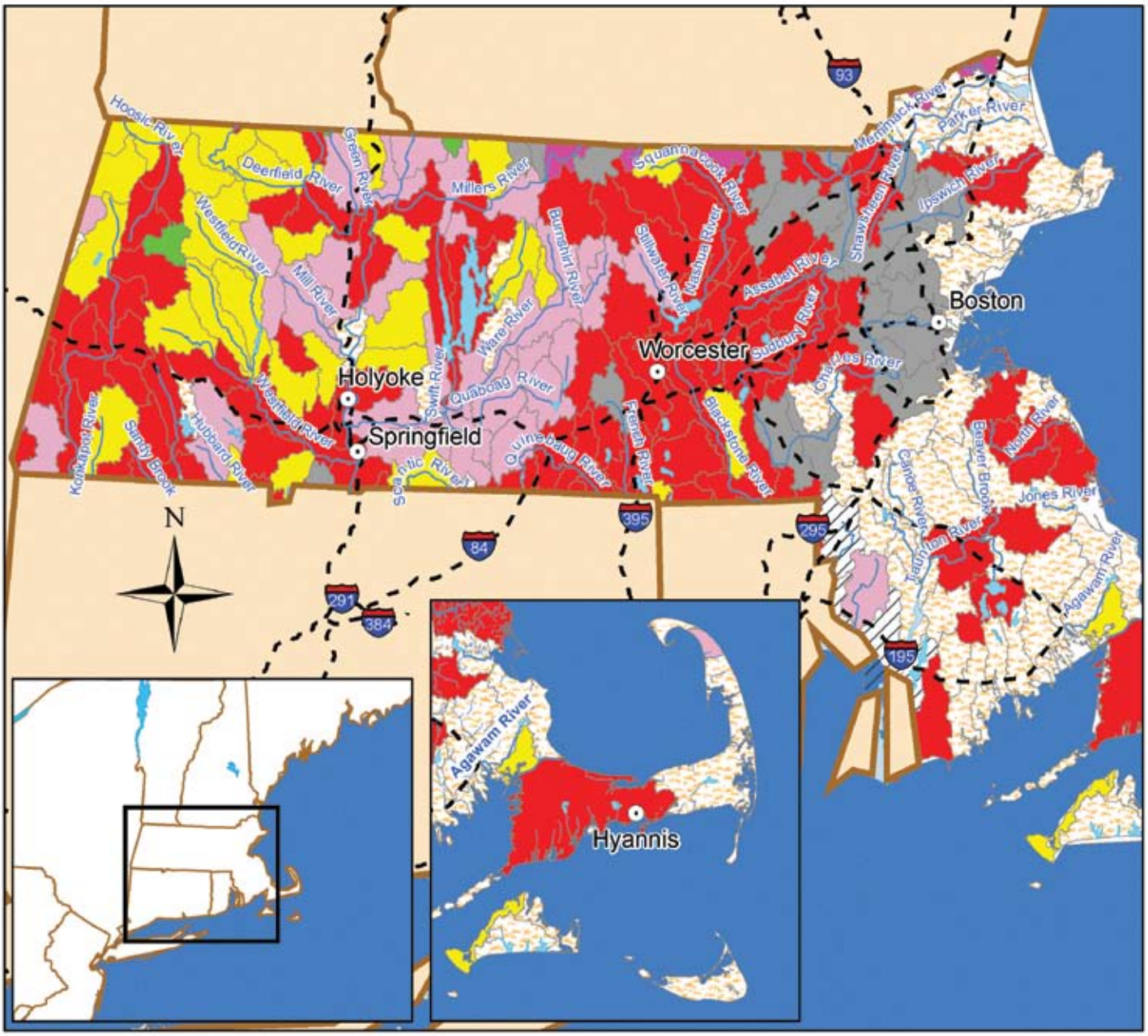
Stream Fragmentation (Road) Impacts to Brook Trout in Massachusetts by Subwatershed



Dam Fragmentation Impacts to Brook Trout in Massachusetts by Subwatershed



Massachusetts Brook Trout Population Status by Subwatershed



Legend

- Rivers
- Lake
- Interstate
- Intact (1)
- Reduced (29)
- Greatly Reduced (80)
- Qualitative Presence (34)
- Extirpated (20)
- Absent, Unclear History (4)
- Unknown, No Data (119)
- Never Occurred (19)
- Cities

0 15 30
Miles

Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

TROUT UNLIMITED

USGS science for a changing world

Vermont:

Vermont boasts some of the largest concentrations of intact subwatersheds outside of Maine for wild, self-reproducing populations of brook trout. Most of these subwatersheds are located in the headwaters of the Batten Kill, White and East Branches of the Nulhegan and Passumpsic Rivers. While sedimentation and high water temperatures from roads and poor land management have degraded aquatic habitat in over half of the state, non-native fish have displaced brook trout from many of Vermont's streams and lakes.

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Intact (>90% habitat occupied)	33	14%
Reduced (50-90% habitat occupied)	64	27%
Greatly Reduced (<50% occupied)	86	36%
Present, Qualitative Data Only	20	8%
Extirpated	6	3%
Absent, Unclear History	0	0%
Unknown, No Data	31	13%
Total	240	100%

Population Status: Vermont's wild brook trout status is among the best in the East. Nearly 14% of the state supports intact habitat, and another 27% of the subwatersheds are reduced. These intact and reduced subwatersheds are centered in the Batten Kill and White River headwater regions, in several tributaries to Otter Creek, within and adjacent to the Green Mountain National Forest and within much of the sparsely populated Northeast Kingdom. The Green Mountain National Forest protects portions of five intact and 18 reduced subwatersheds. The remainder of Vermont's strong brook trout habitat is located on private land.

Over 35% of brook trout habitat is greatly reduced, concentrated in lower elevation areas on the west side of the state and within the White and Black River watersheds. Extirpated areas are concentrated in the lower reaches of the Winooski and Missiquoi rivers. Brook trout population data is lacking for 21% of the state, mostly located east of Rutland and along the Lake Champlain and New Hampshire borders.

Of the 45 subwatersheds that historically supported lake and pond populations of brook trout, only 2% of these subwatersheds remain intact, 31% are greatly reduced, 31% are extirpated, and in 29% status is unknown.

Threats: The impacts to brook trout in Vermont's streams relate to poor land management as well as to historical timbering and roadbuilding. Six of the top seven disturbances listed by regional experts relate specifically to increased sedimentation and water temperature. Loss of riparian (streamside) habitat and poor land management associated with agriculture are direct causes of higher water temperatures.

Often, a combination of several disturbances determines brook trout's ability to thrive or persist. Replanting trees and restricting livestock from sensitive streamside areas are examples of best management practices that may be used to reverse some of these impacts. Numerous state and federal agencies currently provide incentives to protect or restore streamside vegetation.

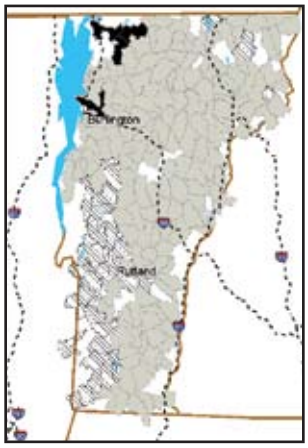
Non-native fish represent an additional threat to wild brook trout in Vermont. Following clearcutting in the 19th century, non-native fish were introduced to degraded waters where brook trout could no longer survive. These non-native fish are more tolerant of high water temperatures and competing species. As stream habitat has recovered, these non-native fish have spread into areas of high water quality where they frequently out-compete wild brook trout.

Regional experts documented that Vermont's lake populations of brook trout have suffered primarily from introductions of smallmouth bass and warmwater fish such as sunfish and yellow perch.

Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
Sedimentation (Roads)	166	79%
Historical Forestry	163	78%
Riparian Habitat	121	58%
Poor Land Management	121	58%
High Water Temperature	116	56%
1 or More Non-Native Fish	106	51%

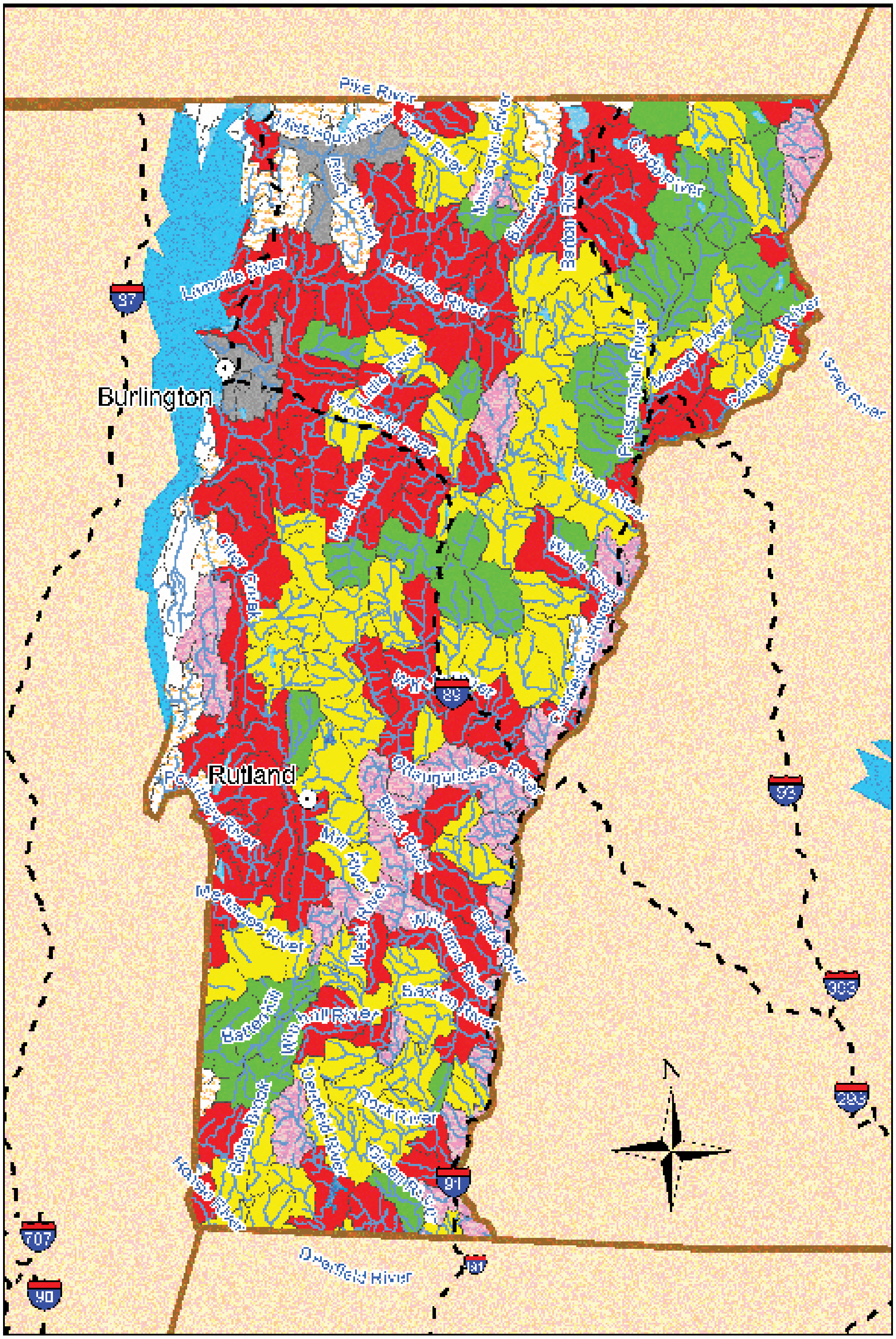
Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

Road Sediment Impacts to Brook Trout in Vermont by Subwatershed



Riparian Habitat Impacts to Brook Trout in Vermont by Subwatershed

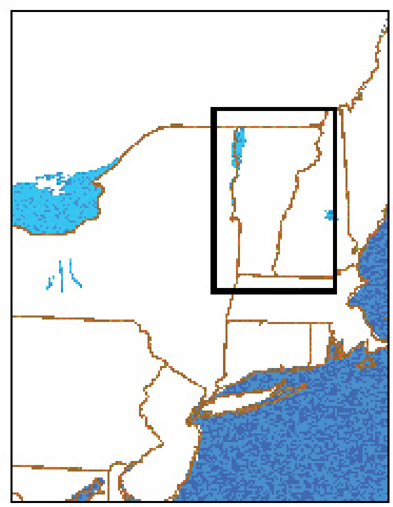
Vermont Brook Trout Population Status by Subwatershed



Legend

- Intact (33)
- Reduced (64)
- Greatly Reduced (86)
- Qualitative Presence (20)
- Extirpated (6)
- Unknown (31)
- Never Occurred (27)
- Lake
- Interstate
- Cities
- Rivers

0 15 30
Miles



Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

New Hampshire: **The majority of New Hampshire lacks quantitative brook trout population data for streams, and brook trout status is unknown in the vicinity of Concord and Manchester. Much of northern New Hampshire maintains intact brook trout habitat, including portions of the White Mountains. Only 1% of the state's lake subwatersheds are known to be intact, while 90% of subwatersheds have no data on lake populations of brook trout.**

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Intact (>90% habitat occupied)	21	7%
Reduced (50-90% habitat occupied)	13	5%
Greatly Reduced (<50% occupied)	13	5%
Present, Qualitative Data Only	195	70%
Extirpated	0	0%
Absent, Unclear History	0	0%
Unknown, No Data	37	13%
Total	279	100%

Population Status: In New Hampshire, 7% of subwatersheds are known to support intact, self-reproducing populations of brook trout. These subwatersheds (including the Upper Connecticut River system and the Magalloway, Dead Diamond and Swift Diamond Rivers) represent most of the intact brook trout habitat remaining outside of Maine. Portions of the White Mountain National Forest also support intact subwatersheds, although other areas are reduced or only quantitative data is available. Throughout the majority of the state (70% of subwatersheds), brook trout are known to be present, but insufficient scientific documentation prevents experts from classifying the status of the populations.

New Hampshire boasts over 279 subwatersheds that historically held lake populations of brook trout. For the majority of these subwatersheds (88%), brook trout population status is unknown. Only 1% of subwatersheds are documented as intact - where more than 90% of historical lake and pond habitat is currently occupied by wild, self-reproducing brook trout.

Threats: Like most of New England, New Hampshire suffers from a legacy of intensive timber cutting. Deforestation, associated sedimentation and channelization for log drives degraded stream habitat and depleted many brook trout populations. Regional biologists ranked road sedimentation as the number one threat to brook trout in New Hampshire. Road construction and poorly maintained roads can increase sedimentation and impair water quality. Non-native fish, particularly rainbow trout, were ranked as the second and third most widespread disturbances to brook trout statewide. Smallmouth bass pose a specific threat to lake and large river populations of native brook trout in this state.

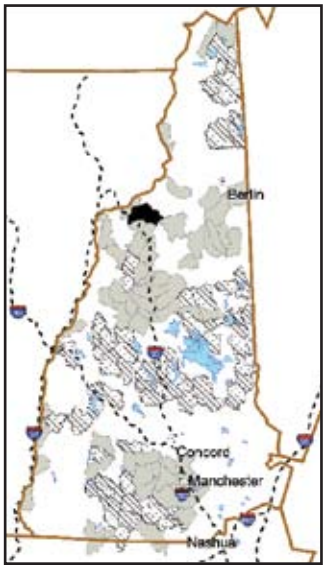
Acid deposition impacts are highest in the southern portion of the White Mountain National Forest and west of Concord and Manchester. In addition, poorly designed road culverts and dams fragment brook trout habitat and restrict fish movement.

State agencies have been working closely with fish habitat biologists to ensure that best design practices minimize the impact of road culverts on brook trout. In addition, habitat restoration work is ongoing in impacted areas to restore vegetation and instream habitat damaged by historical logging and log drives.

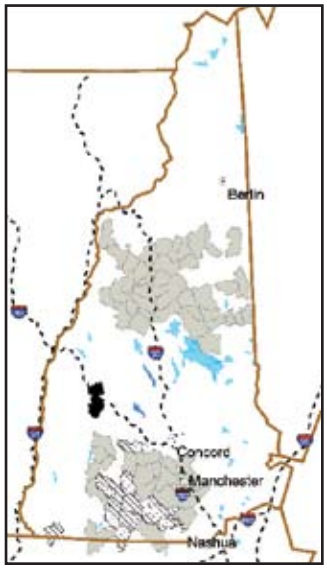
Disturbances (High, Medium or Low)	Number of Subwatersheds	Percentage of Subwatersheds
Sedimentation (Roads)	108	45%
1 or more Non-native Fish	95	39%
Rainbow Trout	74	30%
Acid Deposition	69	28%
Stream Fragmentation (Roads)	66	27%
Dam Indundation/Fragmentation	57	24%

Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

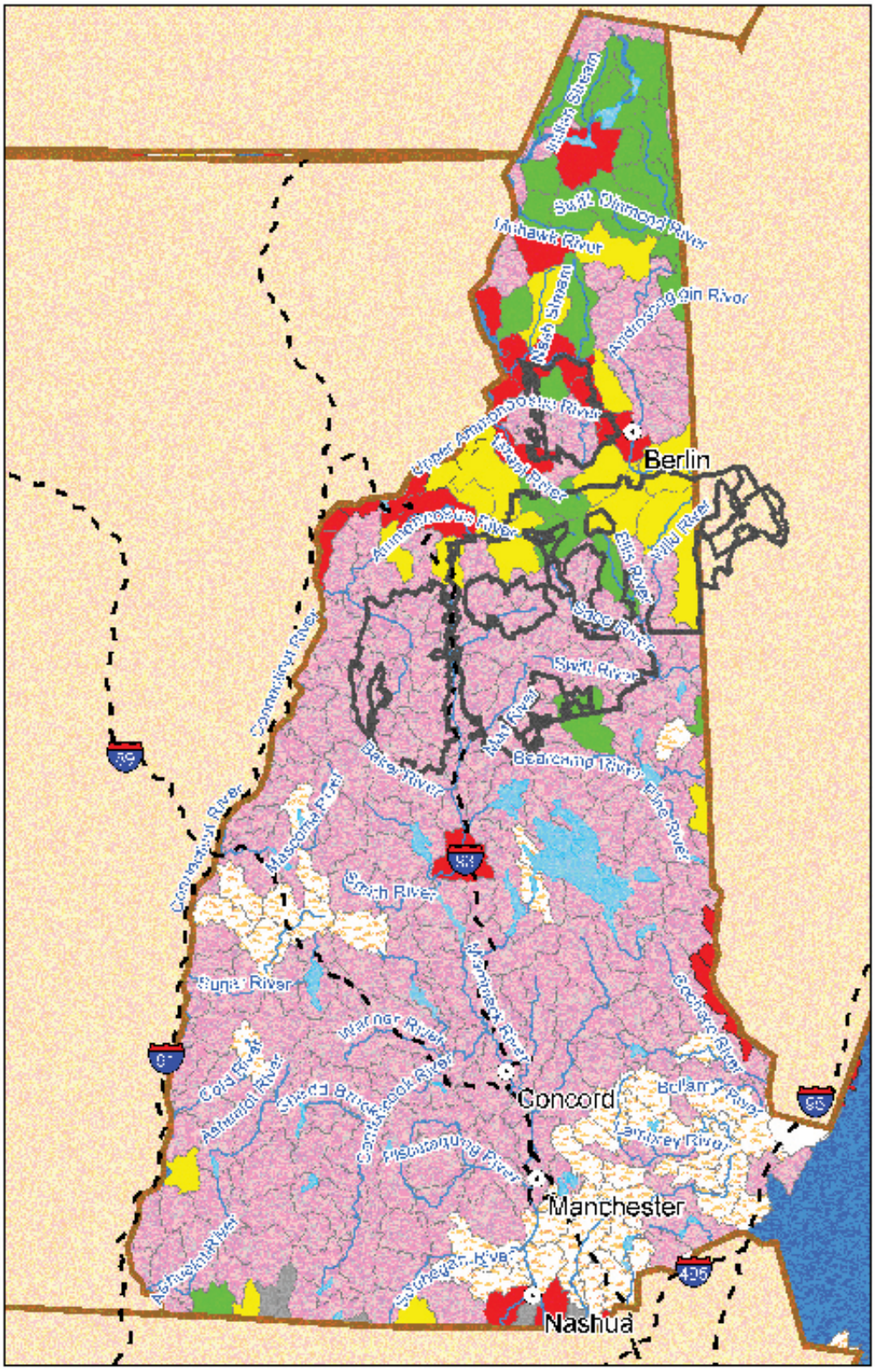
Road Sediment Impacts to Brook Trout in New Hampshire by Subwatershed



Acid Deposition Impacts to Brook Trout in New Hampshire by Subwatershed



New Hampshire Brook Trout Population Status by Subwatershed



Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

Maine Rivers & Streams:

Maine is the last true stronghold for brook trout in the eastern United States, with as many intact subwatersheds as all other states in the eastern range combined. Over 60% of Maine lacks stream population data for brook trout, although the majority is presumed to be intact. Southern Maine has experienced the greatest reduction in populations, mainly from dams, poor land management and fragmentation of stream habitat by roads and culverts. Sedimentation from certain forestry practices and poorly maintained roads impact brook trout populations in most of the northern half of the state.

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Intact (>90% habitat occupied)	147	14%
Reduced (50-90% habitat occupied)	76	7%
Greatly Reduced (<50% occupied)	88	8%
Present, Qualitative Data Only	658	64%
Extirpated	5	<1%
Absent, Unclear History	0	0%
Unknown, No Data	61	6%
Total	1035	100%

Population Status: Maine boasts more than twice the number of intact subwatersheds for brook trout populations as the other 16 states in the eastern range combined, yet almost 65% of the state has no quantitative data on brook trout status. Greatly reduced and extirpated subwatersheds are concentrated in the lower Kennebec and Androscoggin drainages, and in the Portland area south to the New Hampshire border.

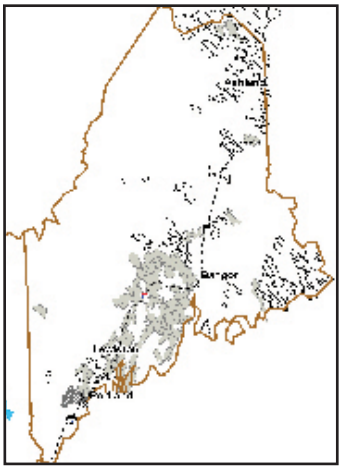
Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
Beavers	117	12%
Dam Inundation/Fragmentation	105	11%
Poor Land Management	86	9%
Forestry	82	8%
Stream Fragmentation (Roads)	73	7%

Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

Threats: Generally, Maine's disturbances are relatively less severe than those in the rest of the eastern United States. Southern and coastal areas of Maine increasingly are experiencing urbanization pressures and associated water temperature and sedimentation impacts. Brook trout habitat between Portland and Bangor has been degraded by poor land management and dams. Poor land management practices also impact Down East and northern potato country. Regional experts noted that sedimentation and culvert fragmentation associated with forestry roads exert widespread but less severe impacts north and east of Bangor. Threats from non-native fish appear to be less common than in many other states, with impacts focused in the St. John's, Kennebec, Rapid and Penobscot River drainages.

While Maine's brook trout resources are superior to any other state in the eastern range, stream assessment and monitoring is needed to gauge the extent and status of brook trout populations and to benchmark conditions as Maine undergoes imminent land ownership changes. Excellent water quality, a high percentage of forest cover, and rivers unaltered by dams and development have allowed Maine's native brook trout to thrive in many subwatersheds. However, increasing residential development (particularly along the coast and in southern Maine) and the illegal introduction of non-native fish pose a threat to the best remaining brook trout habitat in the eastern United States.

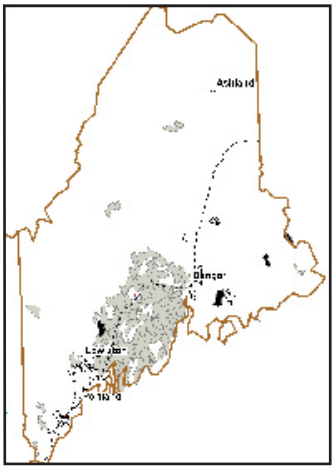
Poor Land Management Impacts to Brook Trout in Maine Streams & Rivers by Subwatershed



LEGEND
Poor Land Management

- Medium Impact (86)
- Historical Medium Impact (3)
- Low Impact (97)
- Lake
- Interstate
- Major Towns

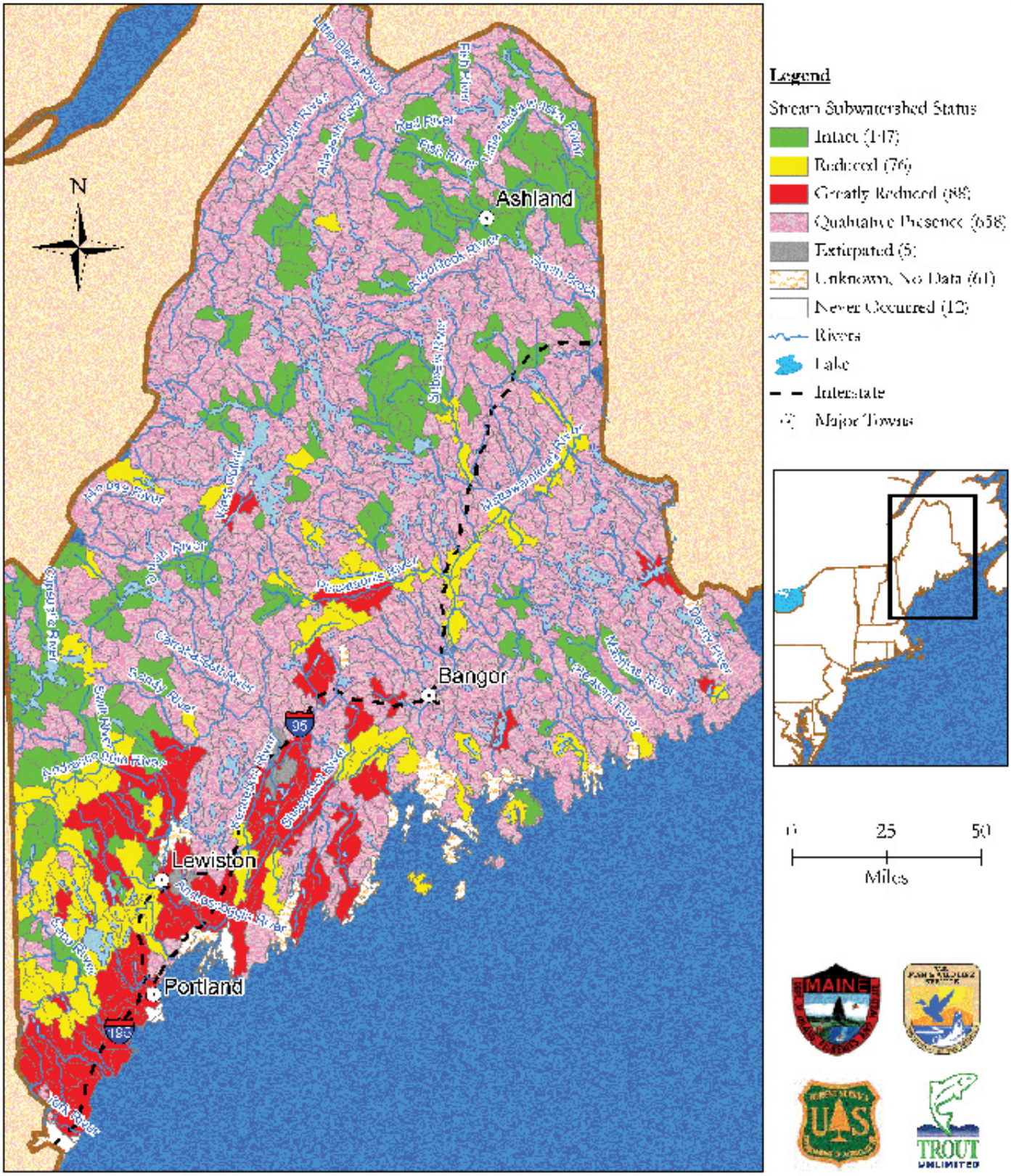
Dam Fragmentation/Inundation Impacts to Brook Trout in Maine Streams & Rivers by Subwatershed



LEGEND
Dam Fragmentation

- High Impact (4)
- Medium Impact (101)
- Low Impact (9)
- Lake
- Interstate
- Major Towns

Maine Stream and River Brook Trout Population Status by Subwatershed



Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

Maine Lakes & Ponds: With 185 intact subwatersheds and many other healthy wild brook trout lakes and ponds, Maine represents the last stronghold for lake and pond brook trout populations. However, these fish populations are extremely vulnerable to introductions of non-native fish. Over 30% of Maine's subwatersheds are greatly reduced, primarily from smallmouth bass and other non-native fish.

Brook Trout Classifications	Number of Subwatersheds	Percentage of Subwatersheds
Intact (>90% habitat occupied)	185	21%
Reduced (50-90% habitat occupied)	35	4%
Greatly Reduced (<50% occupied)	323	37%
Present, Qualitative Data	89	10%
Extirpated	7	1%
Absent, Unclear History	0	0%
Unknown, No Data	235	27%
Total	874	100%

Population Status: Maine is the only state with extensive intact populations of wild, self-reproducing brook trout in lakes and ponds, including some lakes over 5,000 acres in size. Maine's lake and pond brook trout resources are the jewel of the eastern range: lake populations are intact in 185 subwatersheds (18% of the historical range), in comparison to only six intact subwatersheds among the 16 other states. Although brook trout historically thrived in most of Maine's ponds and lakes, over 30% of lake subwatersheds are greatly reduced. Data is not available for another 22% of the state's subwatersheds. Less than 1% of Maine's lake subwatersheds are extirpated.

Disturbances (High or Medium)	Number of Subwatersheds	Percentage of Subwatersheds
1 or More Non-Native Fish	222	25%
Smallmouth Bass	126	14%
Other Cool/Warmwater Fish (Perch, Sunfish, Muskellunge)	121	14%
Largemouth Bass	109	13%
Dissolved Oxygen	43	5%

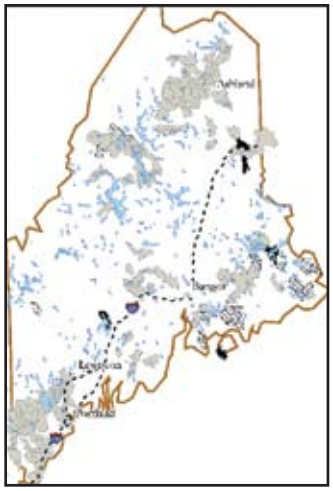
Threats information based on professional opinion of regional experts. Figures do not add to 100% because zero, one, or multiple disturbances may occur in each subwatershed.

Threats: Non-native fish are the dominant threat to Maine's lake and pond populations of brook trout. Many of these fish are illegally introduced by sportsmen who want to catch species of fish other than brook trout. The results are disasterous, as these fish outcompete brook trout within several years. Approximately 25% of Maine's lake subwatersheds that have brook trout data are known to suffer from impacts from non-native fish. Regional experts identified smallmouth bass, largemouth bass, and other cool/warm water fish such as yellow perch, sunfish and muskellunge as the most common introduced species limiting brook trout populations.

Habitat degradation plays only a minimal role in the overall status of Maine's brook trout lakes and ponds. Regional experts identified dissolved oxygen as an impact in less than 5% of Maine's subwatersheds. Dissolved oxygen levels typically are related to pollution of waters due to septic, agriculture and stormwater runoff pollution.

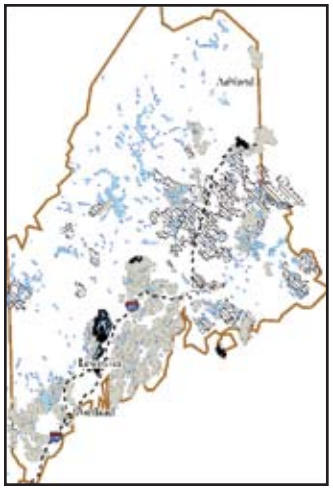
Maine is the only state in the eastern range with large lakes and large populations of self-reproducing brook trout, as well as hundreds of smaller lakes and ponds with self-reproducing brook trout populations. The deliberate spread of non-native fish threatens to eliminate these vulnerable brook trout lakes and ponds. Increased awareness and a more effective means of community self-policing to discourage people from intoducing non-native fish will prevent Maine's brook trout from suffering the same fate as other lake populations in the eastern United States.

Other Coolwater/Warmwater Fish Impacts to Brook Trout in Maine Lakes & Ponds by Subwatershed



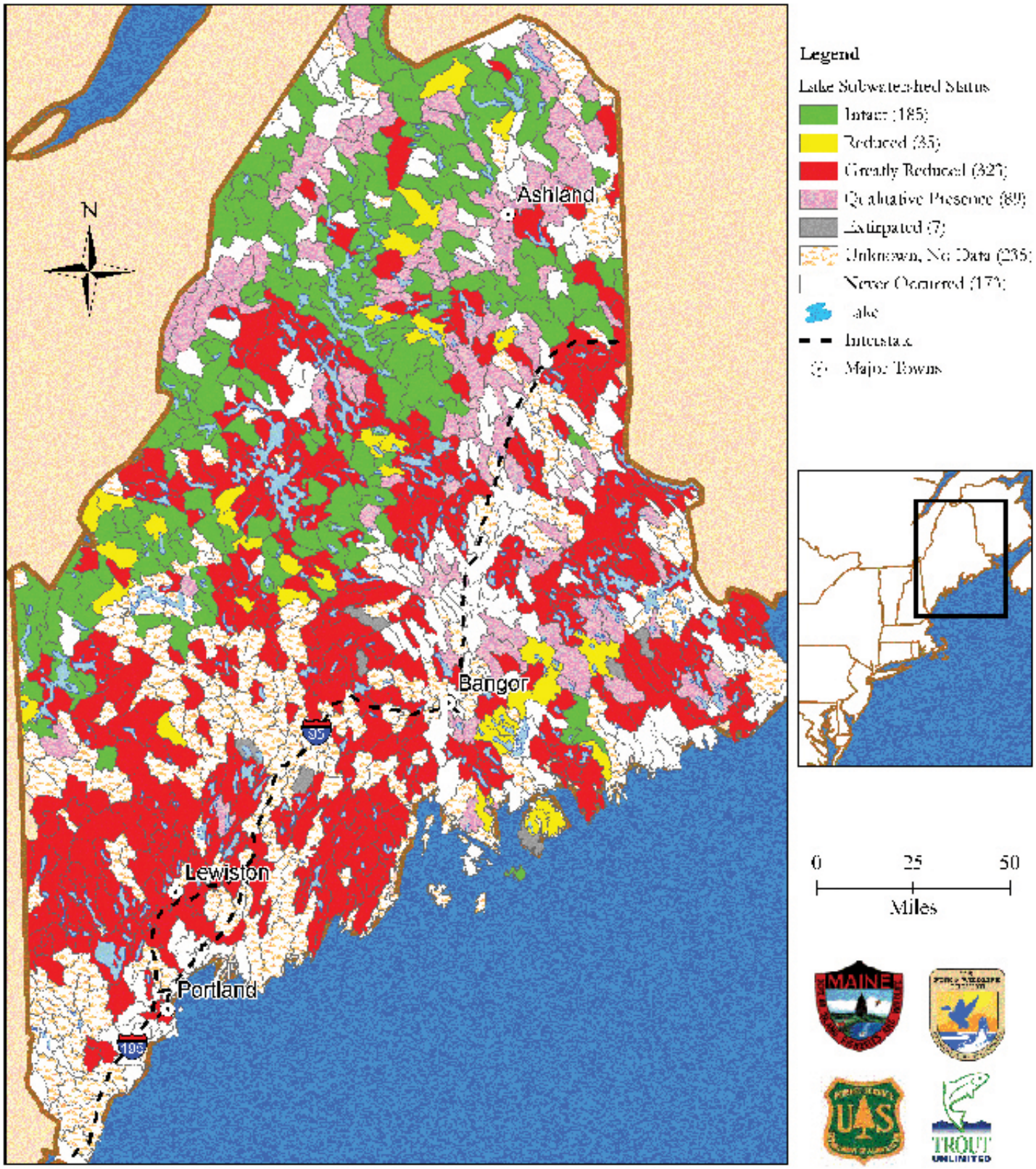
LEGEND
Perch, Sunfish, Muskellunge
- High Imapact (6)
- Medium Impact (115)
- Low Impact (18)
- Lake
- Interstate
- Major Towns

Smallmouth Bass Impacts to Brook Trout in Maine Lakes & Ponds by Subwatershed



LEGEND
Smallmouth Bass
- High Impact (11)
- Medium Impact (115)
- Low Impact (80)
- Lake
- Interstate
- Major Towns

Maine Lake and Pond Brook Trout Population Status by Subwatershed



Map data derived from state and federal data and compiled in EBTJV assessment results titled, *Distribution, status, and perturbations to brook trout within the eastern United States, 2006.* Authored by Mark Hudy, US Forest Service; Teresa Thieling, James Madison University; Nathaniel Gillespie, Trout Unlimited; Eric Smith, Virginia Tech. Map created on 2/24/06 by Nathaniel Gillespie, Trout Unlimited.

This report is a product of the Eastern Brook Trout Joint Venture, which is a cooperative effort to develop and implement a conservation strategy for brook trout in the East. The following organizations have participated significantly in the EBTJV and the work that produced this report:

Federal Agencies:

U.S. Geological Survey

U.S. Fish and Wildlife Service

National Park Service

U.S. Forest Service

National Resources Conservation Service

Office of Surface Mining

State Agency Participants:

Maryland Department of Natural Resources

Virginia Department of Game and Inland Fisheries

North Carolina Wildlife Resources Commission

Tennessee Wildlife Resources Agency

South Carolina Department of Natural Resources

Georgia Department of Natural Resources

Maine Department of Inland Fisheries and Wildlife

New Hampshire Fish and Game Department

Vermont Department of Fish and Wildlife

Massachusetts Department of Fisheries, Wildlife and Environmental Law Enforcement

Rhode Island Department of Environmental Management

Connecticut Department of Environmental Protection

New York Department of Environmental Conservation

New Jersey Division of Fish and Wildlife

Pennsylvania Fish and Boat Commission

West Virginia Division of Natural Resources

Ohio Department of Natural Resources

University Participants:

Virginia Tech, College of Natural Resources

James Madison University, Department of Biology

Conservation Organizations:

Association of Fish and Wildlife Agencies

Trout Unlimited

Izaak Walton League

Trust for Public Land

The Nature Conservancy

Conservation Management Institute, Virginia Tech

Much of TU's work collecting data and information for this report was funded by a grant from the National Fish and Wildlife Foundation. The writing and publication of this report was funded by a multi-state conservation grant from the US Fish and Wildlife Service, administered by the Association of Fish and Wildlife Agencies.

Special Acknowledgements: The authors of this report would like to especially thank Mark Hudy (U.S. Forest Service/James Madison University) and Teresa Thieling (James Madison University) for their drive and effort in completing an assessment of such daunting scale. Many thanks go out to the individual state and federal biologists and others among the EBTJV partners that provided input and edits.

The maps and data in this publication are based on "Distribution, Status, and Perturbations to Brook Trout within the Eastern United States," a technical report by the Joint Venture's assessment team that will be published later in 2006.

Trout Unlimited
1300 North 17th Street, Suite 500
Arlington, VA 22209-3801
www.tu.org