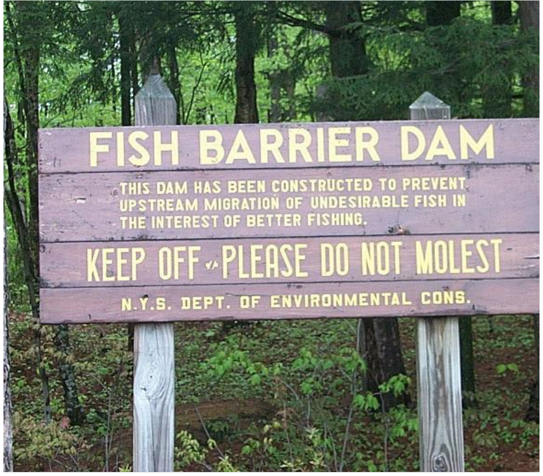

NEW YORK STATE | Department of Environmental Conservation

Historical Perspectives on Brook Trout Management

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Introduction

The modern era of brook trout pond management in New York grew out of scientific research carried out after the second world war. New York State's *Management of Wild and Hybrid Brook Trout in New York Lakes, Ponds and Coastal Streams* plan was informed by this research (Keller 1979). This report summarizes the most important lessons learned from implementing aspects of the plan associated with ponded waters in the Adirondacks. Its purpose is to preserve those lessons learned in writing and to inform the development of a modern plan for managing Adirondack brook trout ponds.

Pre-1979 Management Plan

In New York State brook trout are an important native species from conservation, angling and economic perspectives. Brook trout populations in ponded waters are an extremely rare and valuable resource, occurring in large numbers only in the Adirondack Mountains of New York and in Maine. Brook trout were proclaimed as the New York State Fish by legislative act in 1975. They were once widely distributed in the state, and nearly ubiquitous in the Adirondacks (Demong 2001). However, anthropogenic effects have caused a dramatic decline in the number of New York brook trout populations in lakes and ponds. In the 19^{th} century, these effects resulted from changing land use practices, primarily extensive logging, and the introduction of a suite of incompatible and detrimental fish species (see incompatible and detrimental fish section). In the 20^{th} century, new anthropogenic environmental factors, like acid precipitation, negatively affected brook trout populations while introductions of incompatible and detrimental fishes continued to reduce the presence of brook trout on the landscape.

In response to these losses, management strategies were developed to protect or restore a subset of the populations once present in New York (Keller 1979). To accomplish this goal, Adirondack ponds and lakes were stocked with a domesticated strain of brook trout. These hatchery reared brook trout had been stocked in Adirondack waters since at least 1872 and were gradually domesticated. Their phenotypic expression was influenced by the artificial selection from generations of captive breeding. By the mid-twentieth century, decreased growth rates in the wild, shorter life span, smaller size, and poor survival of domestic brook trout in the wild were all becoming apparent. Beginning in the late 1940's, a limited number of wild strains of brook trout native to New York were stocked for specific purposes, but most waters were still stocked with the domestic strain. By the 1970's, Cornell University demonstrated the advantages of wild x domestic hybrids over domestic brook trout.

In addition to stocking, dams were built in the 1930s at Bay Pond and Follensby Jr. Pond to control introduced yellow perch, a species that is incompatible with brook trout (Flick and Webster 1992). These dams were used experimentally for a few years to lower water levels in the spring to destroy Yellow Perch eggs. This method of control was not effective, and the practice of controlling water levels to manage Yellow Perch populations ended. Lake reclamations using piscicides to eliminate incompatible and detrimental fish began in the 1950s and were often done in conjunction with fish barrier construction to prevent re-introduction. Lake liming to counter acidification was begun in 1959.

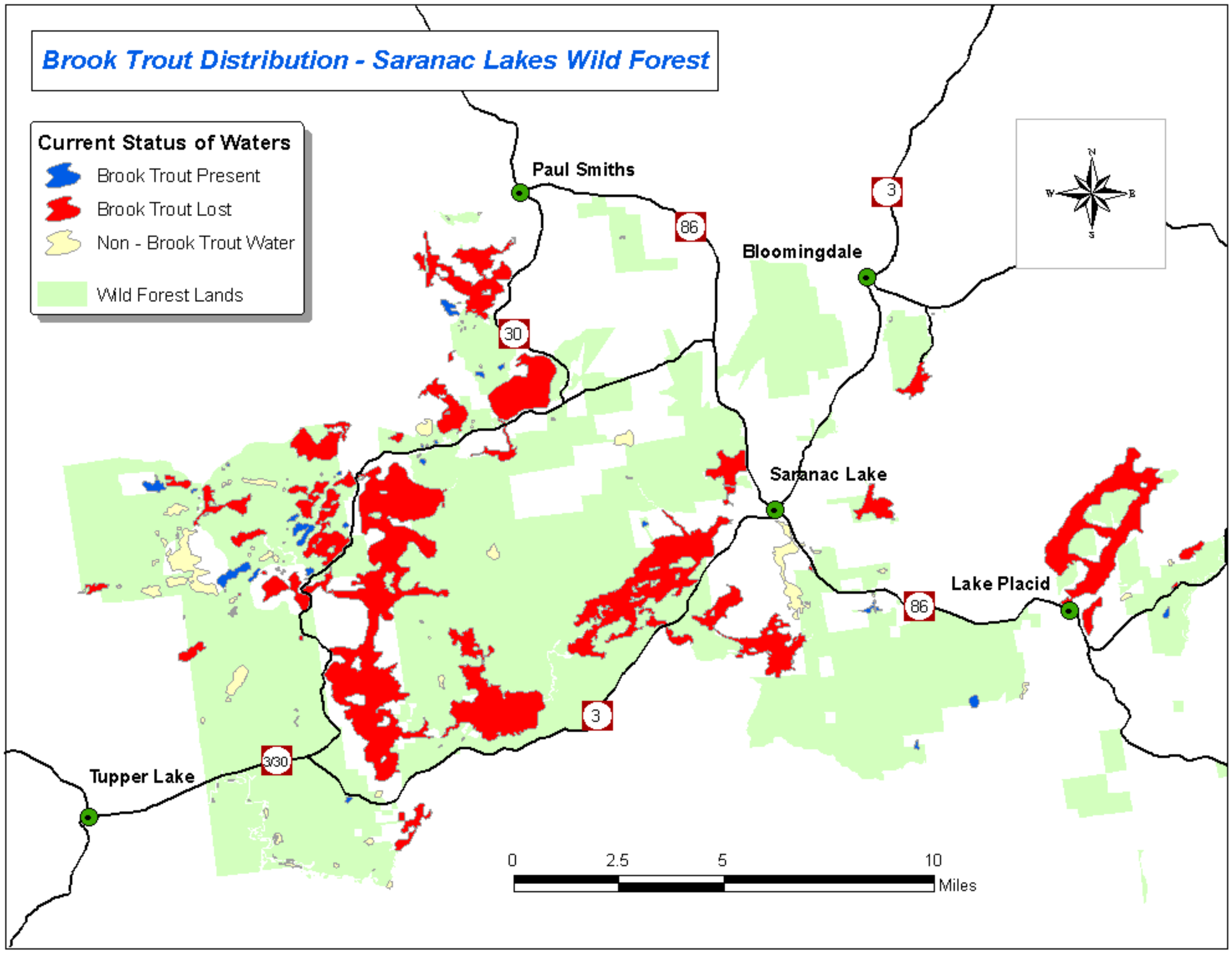

Figure 1: Historic (red) and current (blue) distribution of brook trout in the Saranac Lakes Wild Forest showing a 97% reduction in populated area.

1979 Brook Trout Management Plan to Present

The poor performance of domestic brook trout post stocking and the research being conducted on wild and hybrid brook trout strains, primarily by New York State Department of Environmental Conservation (DEC) and Dr. Dwight Webster and William Flick of Cornell University, led to the adoption of the 1979 DEC Brook Trout Plan (Keller 1979). The 1979 plan defined ten wild brook trout strains originating from natal waters with no history of stocking as "heritage" brook trout and set forth the following three objectives:

1. To provide approximately 125,000 user-days of brook trout angling opportunity for New York heritage and Canadian wild x domestic hybrid strains in selected lakes and ponds by 1992
2. To provide an additional 40,000 user-days of angling opportunity for Canadian wild strains of brook trout in the Finger Lakes, Lake Ontario, Lake Champlain and in several Long Island coastal streams by 1992
3. To preserve for perpetuity in natural waters, those New York heritage strains of brook trout native to Balsam Lake, Dix Pond, Honnedaga Lake, Horn Lake, Little Tupper Lake, Nate Pond, Stink Pond, Tamarack Pond, Tunis Lake and both Windfall Ponds, and other important strains as they become identified.

Objective 1 was likely met. While the number of user days of brook trout fishing opportunity was not directly measured, a 2007 Angler Survey reported that 21% of anglers (175,241) preferred to fish Back Country Adirondack Ponds (Connelly and Brown, 2009). The objective would have been met if 2/3^{rds} of these anglers fished an Adirondack Pond a single day on an annual basis.

Objective 2 was never pursued except for some limited stocking of brook trout into Lake Ontario in 1980 and 1981.

Objective 3 was largely met. Of the 10 heritage strains identified in the 1979 Brook Trout Plan, 6 (Dix Pond, Honnedaga Lake, Horn Lake, Little Tupper Lake, Nate Pond and Windfall Pond strains) are confirmed still on the landscape. The Tamarack Pond strain no longer exists. Balsam Lake, Stink Pond, and Tunis Lake strains exist on private land but have not been confirmed due to a lack of sampling. Of the 3 strains used by DEC, 26 ponds have Horn Lake strain (7 ponds are natural spawning adequate (NSA)), 28 ponds have Little Tupper Strain (4 ponds are NSA), and 15 ponds have Windfall strain (6 ponds are NSA). All 3 strains meet the policy to establish 3 heritage waters per strain established in the plan. Due to hatchery capacity and other constraints, less emphasis was placed on the other 7 strains and this outcome was not achieved.

The 1979 Plan emphasized the shift from domestic stocks to hybrid stocks, wild x domestic hybrids, as well as heritage strains where they can remain genetically isolated. Canadian brook trout strains (Temiscamie and Assinica strains) were imported from the James Bay region of Quebec to New York waters by Cornell University staff. These strains and their hybrids were extensively tested (Webster and Flick 1981). The Canadian strains provided a brood source with a size potential exceeding that of New York strains (Keller 1979). Their hybrids, particularly the Temiscamie x Domestic (Temiscamie hybrid), clearly demonstrated advantages in survival, yield, longevity, growth, maximum size, and natural reproduction when compared to the domestic strain. The development of acid-resistant brook trout was also explored but was ultimately unsuccessful. Based on its superior performance, the Temiscamie hybrid strain was chosen for propagation and is still in use today. It continues to be produced by crossing the Temiscamie strain, maintained in privately held Adirondack ponds, with domestic strain maintained at DEC hatcheries. The hybrid provides an excellent fish for stocking in most Adirondack brook trout waters. It should be noted that cooperation from private landowners has been significant in the management of wild and hybrid brook trout strains in New York.

While extensive use of the Temiscamie hybrid strain has continued, management of wild brook trout in New York has been ongoing. The 1979 plan called for heritage strains to be stocked into Adirondack ponds that are genetically isolated waters from other brook trout by natural or man-made barriers. DEC has been producing and stocking three heritage strains: Little Tupper, Windfall and Horn Lake. The management practices of liming and reclamation are ongoing and have facilitated the restoration of brook trout through stocking in many waters. Most of our notable brook trout angling waters have either been reclaimed or limed, which points to the success of these efforts.

The Adirondack Lakes Survey of the 1980s provided invaluable physical, chemical, and biological information for over 1,400 ponded Adirondack waters with many of these waters being remote. The information from the Adirondack Lake Survey Corporation (ALSC) survey is still commonly used and seen as a valuable resource. While stringent limits on aviation and other motorized transportation have limited resurveys of the most remote waters, DEC has completed hundreds of surveys on brook trout waters as part of ongoing management and to update fish community and water chemistry information.

Recent genetic research has led to an improved understanding of conservation genetics as it pertains to brook trout and the use of different brook trout strains has been explored by DEC. Significant recent changes in the acid/base water chemistry of some Adirondack waters, resulting from the Clean Air Act, have allowed for the restoration of brook trout into many waters previously fishless.

Summary of Lessons Learned 1979 to Present

Water chemistry

- When evaluating low pH waters for the restoration of brook trout it is helpful to use a suite of "advanced chemistry" metrics, such as base cation surplus (BCS), ration of Base Cations to Strong Organic Ions (BC/RCOOs), and level of inorganic monomeric or "toxic" aluminum (IMAL). These metrics give a more complete picture of a pond's chemical characteristics and better predict the likelihood of brook trout survival.
- The presence of silica, which is closely correlated with groundwater, can help identify waters where brook trout populations can be self-sustaining. Areas of upwelling groundwater are critical habitat for successful brook trout spawning and as summertime thermal refuge.
- Trophic status index, based on the Secchi depth, chlorophyl A, or total phosphorous is likely a better indicator of productivity than conductivity as previously presumed.

Liming

- Liming has been effective at creating stocked brook trout fisheries but has not produced many NSA fisheries.
- Recent trends have indicated that the impacts of acid rain are less severe and adding lime may not be required as often in the future.
- The amount of lime needed to develop quality brook trout waters is less than originally calculated.

Incompatible and detrimental fish species

- The removal and exclusion incompatible and detrimental fish species vastly improves the quality of brook trout fishing in ponds.
- Incompatible fish species include yellow perch, black crappie, largemouth bass, walleye, smallmouth bass, northern pike, and pickerels.
- Detrimental fish species include brown bullhead, white sucker, longnose sucker, pumpkinseed/redbreast sunfish, rock bass, golden shiner, creek chub/fallfish, fathead minnow, rainbow smelt, and alewife.
- An intensive electrofishing program can greatly enhance brook trout populations by removing black bass to suppress the population. However, the steep opportunity cost of this labor-intensive approach precludes broad application.
- Despite continued outreach, many anglers are either unaware or do not believe that baitfish introductions pose a threat to wild brook trout populations.

Pond reclamation

- Pond reclamation, using the registered piscicide rotenone, remains the most effective strategy to rid ponds of incompatible and/or detrimental species.
- Only a very small subset of Adirondack waters are possible candidates for reclamation, either because preventing the reinvasion of invasives is not possible or because associated wetlands cannot be effectively treated.
- Studies have shown that any negative impacts of a pond reclamation are minor and short-term (Demong 2001).
- Reclaimed waters generally remain viable brook trout ponds for 30 years or more.
- The length of time a brook trout fishery remains free of incompatible or detrimental fish post-reclamation, appears to be only somewhat affected by the ease of access.
- Reclaimed waters are an important subset of fishable ponded wild brook trout populations, accounting for almost half of such waters.
- Reclamations are expensive, time-consuming, and challenging to plan and carry out.

Fish passage barriers

- Fish passage barriers are a successful tool in protecting Adirondack ponded brook trout from upstream movement of incompatible and detrimental fish species.
- The cost of maintaining functional barriers is trivial compared to the expense of a reclamation.

Strains

- Post-stocking performance of New York Heritage Strains or the Temiscamie hybrid strain is vastly superior to that of domestic strain brook trout in Adirondack ponds.
- Windfall hybrid brook trout may provide an alternative hatchery product if access to Temiscamie strain trout in private waters is lost.
- There is a strong indication that the Temiscamie strain used in New York is a naturalized population consisting of both Lake Albanel and native New York ancestry.

Stocking

- Aviation support is critical for brook trout stocking; 285 out of 317 stocked ponds require aviation to stock them.

Fish culture

- Biosecurity measures, including regular fish health inspections of feral broodstock and scrupulous attention to hatchery sanitation, is a prerequisite for successfully raising wild and hybrid brook trout.

Wild broodstock

- The ideal wild broodstock water has a low risk of invasion by incompatible or detrimental fish species and easy access for egg takes and other broodstock maintenance tasks.

Angler use/preferences

- Collection of angler use and preference data from Adirondack brook trout pond anglers has been challenging in many regards; much of what we know about brook trout anglers and their experiences has been obtained through direct personal communication and not via formal surveys.
- Except for the online survey conducted in 2022 (NYSDEC 2022), DEC has very limited data on angler use and preferences.
- A slight majority of respondents to a brook trout survey perceived the impacts of baitfish introductions to be either no problem or a minor problem.

Genetics

- The genetic structure of wild brook trout populations is largely intact. The long-term genetic influence of stocked domestic brook trout is far less prevalent than previously assumed.
- Most wild brook trout populations in New York State have very low levels of admixture with stocked domestic strains.
- Higher levels of admixture are mostly seen in or near ponds that continue to be stocked with Temiscamie-hybrid brook trout on a regular basis.

Water Chemistry

Adirondack lakes and ponds have experienced dramatic changes in water chemistry in the past, and Adirondack water chemistry is now again in a period of rapid, and dramatic change. Such changes can profoundly affect brook trout populations. These chemical changes and our understanding of their effects has greatly increased since the early 1990s, leading to the successful restoration of many brook trout populations since 1995. These chemical processes are ongoing and our understanding of them will continue to evolve.

Partners

Continually updating our knowledge of the chemistry of Adirondack waters and adapting to changing conditions is crucial for the management of brook trout fisheries. Engaging with our partners (from institutions like ALSC, USGS, Cornell and Syracuse Universities), who are doing ongoing work on the chemistry of Adirondack waters, is important for our continued understanding of this changing environment.

Geological and climate influences

The Adirondack Mountains of New York are unique in both geology and climate, and these factors ultimately drive the chemical and physical characteristics of the ponded waters that hold important brook trout fisheries. The Adirondacks can be characterized as a large, forested region with thin acidic soils, that receives a relatively large amount of precipitation. Adirondack lakes were categorized in the ALSC Analysis Report (Baker 1990) largely by the degree of interaction between this incoming precipitation and soils. This has profound effects on the water chemistry and hydrology of lakes and ponds and therefore brook trout populations. The best-known chemical metric used for characterizing Adirondack ponds is pH, but there are many other important chemical metrics that may or may not be linked to acid/base chemistry. The values for these chemical metrics can change quickly on both a local and regional scale and can have far reaching consequences; as an example, elevated levels of mercury in yellow perch (if consumed) can pose a risk to human health. Elevated mercury levels have been shown to be associated with low pH waters (Brown, et al. 2010).

Acid recovery metrics

A variety of water chemistry metrics are currently being used by DEC to help manage brook trout fisheries. Air equilibrated pH or AEQ pH (hydrogen ion concentration) and acid neutralizing capacity (ANC) have been used as the primary measures of acidity for decades. AEQ pH is used rather than lab pH, as a sample purged of excess CO_2 better represents the actual “geochemical” pH which is more useful for evaluating trends in pH. The lab pH is less reproducible and more likely to express diurnal variation. ANC is a measurement of buffering capacity, or the resistance to change when an acid is added to a sample. AEQ pH and ANC remain useful and valuable measures in Adirondack waters. Many Adirondack waters are little effected by acidity, but, in a substantial subset of waters, acid/base chemistry is extremely important. The effect of highly acidic water on the biota of Adirondack lakes and ponds is evident not only in fish, but in macroinvertebrates, plankton, diatoms, and plants.

When evaluating low pH waters for the restoration of brook trout, it is helpful to use a suite of “advanced chemistry” metrics. These metrics give a more complete picture of a pond’s chemical characteristics and better predict the likelihood of brook trout survival. Decreases in air pollutants (primarily sulfur and nitrogen compounds) following the NYS Acid Deposition Control Act (1984), the Federal Clean Air Act Amendments (1990), and the Clean Air Interstate Rule (2005) have allowed a subset of Adirondack waters to recover from acidity to a degree that has allowed the restoration of brook trout populations.

In 1995, DEC began the process of re-establishing brook trout populations to 40 waters (1060 acres) recovering from acidity. In “A New Lake Classification Model for Adirondack Waters” (Dukett, et al. 2015), ALSC proposed a framework for the use of advanced chemical metrics to better characterize the water chemistry of recovering Adirondack waters and the possible outcomes of brook trout stocking. Working with this classification system for several years has allowed DEC and ALSC to better refine the thresholds of some metrics used to determine if brook trout stocking success is likely. The base cation surplus (BCS) developed by USGS (Lawrence, et al. 2007) and the ratio of Base Cations to Strong Organic anions (BC/RCOOs) give a deeper understanding regarding the ability of waters to sustain a brook trout population. The BCS is a more useful tool for the evaluation of recovery from acidification in the presence of increasing dissolved organic carbon (DOC) than ANC alone, and the BC/RCOOs helps to quantify the strength of “naturally acidic conditions” found in some Adirondack waters.

The level of inorganic monomeric or “toxic” aluminum (IMAL) is also pivotal in assessing the level of recovery from acidity in affected Adirondack waters, as IMAL has a direct effect on fish survival. However, our understanding of how fish respond to varying levels of IMAL for differing amounts of exposure is evolving. The episodic nature of acidic inputs to Adirondack waters is undeniable and must be accounted for. Recent research (Baldigo, et al. 2019), furthers our knowledge of the toxic effects of various IMAL levels on caged brook trout in streams. Both the duration and the severity of toxic aluminum levels are important in determining brook trout survival in streams. The duration of the high IMAL spikes in lakes is also variable and their duration is likely also important for lacustrine brook trout. The ability for trout to avoid these spikes has been documented (Van Offelen H.K. 1994) as brook trout have been shown to avoid lethally acidic shallow water by moving to greater depths during acidic episodes. Use of these advanced metric thresholds described in Dukett, et al., 2015 has streamlined the identification of waters where brook trout survival, growth and restoration may be possible and experimental stockings with the best potential for success should be initiated.

Groundwater indicators and spawning

Not all Adirondack water chemistry metrics are related to acidity. Brook trout have been described as an obligate groundwater spawning species in both stream and lake environments (Webster and Eiriksdottir 1976). In the 1980s, the Adirondack Lakes Survey Corporation (ALSC) collected detailed chemical, biological and physical information on 1469 lakes in the Adirondack ecological zone. Relationships between habitat characteristics and the reproductive status of brook trout populations were explored (Schofield 1993) using the information from the Adirondack Lakes Survey. That analysis found a relationship between the levels of silica and sodium (indicators of groundwater input) and brook trout reproductive status.

A recently developed strategy by DEC that utilizes silica concentrations (groundwater signature) greater than 2.0 mg/L to prioritize waters for wild population evaluation has proved successful. Timely cessation of stocking and/or fin clipping of stocked fish have proven to be effective approaches enabling the differentiation between fish of stocked versus wild origin. Preliminary results seem to show that, while fish community composition and other factors are obviously very crucial, silica values can help identify waters where brook trout populations can be self-sustaining. To date, six new NSA waters, which were historically stocked annually, were identified using this water chemistry-based prioritization.

Interactions with changing acid-base chemistry

Conductivity measurements are also changing as some lakes recover from acidity. While the acid/base chemistry of many lakes are improving, the ions associated with acidity are coming out of the water, driving conductivity values down. This phenomenon may also partially be driving the increases in DOC (Driscoll, et al. 2016). The morpho-edaphic index or MEI (which can be used to help calculate fish stocking rates) uses conductivity as a surrogate for productivity. As ponds become less acidic, one might assume that conductivity would also increase. However, the opposite appears to be true. Conductivity appears to be decreasing as pH increases. This may be simply driven by the fact that conductivity, and even buffering capacity, in some low pH waters are driven by a different set of ions than is the case in waters with higher pH. Notable decreases in the sulfate deposition and the depletion of calcium are likely driving this phenomenon in acid impacted waters. Trophic status index, based on the Secchi depth, chlorophyl A, or total phosphorous is likely a better indicator of productivity. This recent finding of declining conductivity in Adirondack brook trout ponds brings into question the utility of the MEI for calculating stocking rates in the future.

Liming

The addition of lime to waters impacted by acid rain dates to 1959 and is intended to neutralize acidified waters for the purpose of restoring or protecting fish communities. The most active period for liming Adirondack waters occurred in the 1970's and 80's prior to the 1990 Final Generic Environmental Impact Statement (FGEIS) on the New York State Department of Environmental Conservation Program of Liming Selected Acidified Waters (NYSDEC 1990). Over 110 waters have been limed in the Adirondacks with many of them limed multiple times. However, ALSC research, and data of waters surveyed between 1984-87 focused the liming program so that a realistic number of waters could be effectively managed. Waters selected for the Liming Program must meet a specific set of criteria which allows for the greatest opportunity for success while also protecting sensitive ecosystems. Thirty-two waters were originally identified along with an additional eighteen waters listed as potential candidates. Waters have been added and removed from the Liming Program as we gain more knowledge about individual waters. There are currently thirty-nine waters in the Liming Program. The average number of times a water was limed is 3.2 times. The average number of years between liming is 23 years. Only two waters that have been limed support a wild population of brook trout. The last liming occurred in 2020.

The 1990 Liming FGEIS states that water chemistry should be maintained above pH 6.0 and an Acid Neutralizing Capacity (ANC) of 25µeq/L f to protect brook trout from exposure to toxic water quality. Since 1990, research has provided valuable insight into the water chemistry required for brook trout survival. It has been well documented that brook trout can survive and grow in conditions below pH 6.0 and ANC 25 µeq/L. This finding has led to the realization that quality brook trout waters can be maintained using less frequent liming events. Aside from the research on water quality necessary for brook trout survival, it has been noted that conditions for brook trout are generally improving naturally across the Adirondacks.

Hydrated lime was originally used to treat Adirondack waters, however research as well as availability, led to the use of pulverized agriculture lime. The standard application rate of one ton of lime per surface acre of water is used to treat ponds. Anywhere from one to eighty tons of lime have been used in past treatments. Transporting these large amounts of lime to remote waters has presented a suite of challenges. Helicopters are most often used to sling-load pallets of bagged lime to the lake or pond during the winter where it is spread by hand. Other methods of getting lime to the desired water include snowmobile or even draft horses.

Spreading the lime on the ice allows it to disperse in the spring when the ice melts. Poor ice conditions have recently made it impossible to move lime to the treatment water. Helicopter loads range between 1,000-1,500 pounds of lime per flight. Distances from a safe loading zone may be up to 15 miles from the water to be treated and a 30-acre pond may require up to 60 flights to transport the material necessary for liming. Many of these waters are in designated Wilderness Areas, so approval to use aircraft (or any motorized equipment) in or over a Wilderness Area is required.

Thermal impacts and browning

The thermal impacts from climate change will likely pose an increasing threat to brook trout fisheries, but decreased acid deposition, beginning in the 1990s, may provide some respite. As waters recover from acid deposition, increasing dissolved organic carbon (DOC) will reduce water clarity; this is referred to as browning (Monteith, et al. 2007). Browning may provide larger thermal refuge areas in stratified waters. In the future, DOC may become the main determinant of thermocline depth, rather than temperature (Warren, et al. 2016). In a warming climate, the reference value of DEC standard dissolved oxygen/temperature profiles may increase. Warming has been shown to directly affect brook trout physiology and reproduction as well as survival (Robinson, et al. 2010). On the other hand, browning may result in decreased concentrations of dissolved oxygen in areas of thermal refuge. This effect could squeeze brook trout between surface waters that are intolerably warm and deeper waters that are thermally suitable but are intolerably deficient in oxygen (Personal Communication, Dr. Peter McIntyre).

Controlling Incompatible and Detrimental Fish Species

A persistent cause of the decline of brook trout populations in Adirondack ponds has been the introduction of incompatible and detrimental fish species.

- **Incompatible fishes** are fish species whose presence precludes a population of naturally reproducing or stocked brook trout in a pond. A healthy brook trout population cannot coexist with incompatible fish species. These species are incompatible: yellow perch, black crappie, largemouth bass, walleye, smallmouth bass, northern pike, and pickerels.
- **Detrimental fishes** are fish species whose presence impairs a population of naturally reproducing or stocked brook trout in a pond. The impacts of detrimental species depend on their abundance and pond characteristics. These species are detrimental: brown bullhead, white sucker, longnose sucker, pumpkinseed/redbreast sunfish, rock bass, golden shiner, creek chub/fallfish, fathead minnow, rainbow smelt, and alewife.

Ponded brook trout were originally found alone or in very simple fish communities. The above listed species cause the decline and, very often, the elimination of brook trout populations. The (illegal) use of live bait by anglers has been a primary vector for unwanted introductions of incompatible and detrimental fishes. Outreach regarding the harmful effects of baitfish on wild brook trout ponds has taken place since the mid-1900s. However, survey feedback suggests that many anglers do not know that baitfish are harmful to wild brook trout populations or do not believe they pose a threat (NYSDEC 2022).

Pond reclamation and brook trout

Brook trout are unable to compete effectively with incompatible species and, depending on circumstances, with detrimental species. Thus, chemical reclamation with the botanical piscicide rotenone is the only safe, effective, and legal tool to remove these undesirable species and restore native fisheries to these waters. Ponds that have been reclaimed account for 52% (36 of 69 waters) of ponds currently managed for heritage strain brook trout.

Fish management, which includes pond reclamation, is allowable in all land classes under the State Land Master Plan for the Adirondacks, but only a very small subset of Adirondack waters are candidates for reclamation. Most waters are not reclaimed because the reinvasion of incompatible and detrimental fishes cannot be prevented or because associated wetlands cannot be effectively treated. Therefore, most historic Adirondack brook trout fisheries have been irretrievably lost due to introduced incompatible and detrimental fish species.

New York was one of the first states to widely adopt pond reclamation as a technique to restore native fish communities. Many New York reclamations were performed between 1950 and 1969, including a very large project undertaken primarily to eradicate yellow perch from many waters in the Saint Regis Canoe area. This area remains largely free of yellow perch and provides tremendous benefits to conservation, tourism and angling to the present day.

The reclamation program in New York is ongoing, and a total of 234 reclamations have been performed to date. About 42% of the waters reclaimed between 1950 and 1999, and 93% of the waters reclaimed after 1999 continue to support either stocked or self-sustaining brook trout fisheries. The length of time a brook trout fishery remains free of incompatible or detrimental fish post-reclamation, appears to be only somewhat affected by the ease of access. Waters with easy, mildly difficult, or difficult access all had brook trout fisheries that persisted for more than 30 years on average.

Recent survey data suggests that with continued removal of incompatible and detrimental species, more waters could become NSA for brook trout which are self-sustaining populations. Reclaimed waters currently account for 21 of the 45 currently identified NSA brook trout waters.

Adirondack fish passage barriers

In the 1950's and 60's, as the DEC started reclamation efforts, fish barriers were installed to stop incompatible and detrimental fishes from moving upstream into brook trout ponds. Many of the barriers created were rock filled crib dams. Costs to build these barriers were lower than other types of dams due to the availability of materials and use of unskilled labor. During this time, materials were typically brought to work sites by hand or with horses due to the remoteness of the ponds.

In the 1970's, DEC helicopters were used for moving equipment into remote areas for dam construction. Sheet pile dams were used where soils were highly permeable. Concrete dams are rare and only used at sites adjacent to roadways. Many of the barriers that were built or rebuilt in the 1980's and 1990's are drop inlet or perched culvert designs.

The average life span of barriers that have been built by the DEC is 38 years. There are currently 18 barriers protecting brook trout waters in the Adirondacks (Table 1). The average age of these barriers is 27 years. The oldest barrier being used today is a concrete barrier on Fish Hatchery Pond to protect Otter Lake in the town of Caroga. The barrier was originally built in the 1920s and was repaired in 1959.

Table 1. Adirondack Fish Barrier Locations

Water	Pond Number	County	Town	Date Reclaimed	Condition	Year Built	Fish Status
Black Pond	SLC-P256	Franklin	Brighton	9/8/1997	Good	Rebuilt in 1997	ST, GS, CC
Bubb Lake	ONT-P748	Herkimer	Webb	1994	-	1999	ST-Lil Tup, BB
Clear Pond	UH-P594	Hamilton	Indian Lake	10/30/2007	Good	Rebuilt in 2006	St-monoculture-Horn Lake
Clear Pond	SLC-P91	St. Lawrence	Parishville	1988	-	1988	ST, BB, GS
Ledge Pond	CH-P155	Franklin	Santa Clara	10/19/2009	Good	2007	ST-WF, CMM, RWF
Little Fish Pond	SLC-P147	Franklin	Santa Clara	8/12/1954	Good	Rebuilt in 2016	ST, LT, CS, BB, WS, PKS, CC
Little Green Pond	CH-P192	Franklin	Santa Clara	8/19/2003	Good	Rebuilt in 1992	ST-HL. BB, WS, RWF, RS, PKS, BG, GS
Long Pond	SLC-P257	Franklin	Brighton	9/3/1997	Fair	Rebuilt in 1997	ST-WF, CC
Lost Pond	ONT-P878	Hamilton	Arietta	8/26/1965	Fair	Rebuilt in 1993	ST, BB, CC, NRD
Lower Sargent Pond	SL-P294	Hamilton	Arietta	10/22/2013	Good	Rebuilt in 1992	ST
Mountain Pond	CH-P156	Franklin	Santa Clara	10/22/1991	Good	Rebuilt in 1990	ST, BB
North Twin Lake	SL-P267	St. Lawrence	Fine	1996	-	1998	ST, KOK, BB, WS
Otter Lake	M-P729	Fulton	Caroga	8/25/1959	Fair	Rebuilt in 1959	ST, BB
Palmer Pond	UH-P368	Warren	Chester	8/15/1989	Good		ST, BT, RT, GS, FHM
West Pine Pond	CH-P173	Franklin	Altamont	8/18/1975	Good	Rebuilt in 2022	St, LT, KOK, GS, NRD, FHM
Whey Pond	CH-P180	Franklin	Santa Clara	10/19/1989	Good	1955	ST, BT, RT, GS, BB

Adirondack Fish Barriers Fish Abbreviations: **BB**-Brown Bullhead, **BT**-Brown Trout, **CC**-Creek Chub, **CMM**-Central Mud Minnow, **CS**-Common Shiner, **FHM**-Fathead Minnow, **GS**-Golden Shiner, **KOK**-Kokanee, **LT**-Lake Trout, **NRD**-Northern Redbelly Dace, **PKS**-Pumpkinseed, **RS**- Rainbow Smelt, **RT**-Rainbow Trout, **RWF**-Round Whitefish, **ST**-Brook Trout, **ST-Horn**-Horn Lake strain Brook Trout, **ST-Lil Tup**-Little Tupper strain Brook Trout, **ST-WF**-Windfall strain Brook Trout, **WS**-White Sucker

Wild/NSA Brook Trout Populations

There are 45 ponds that are currently considered wild or NSA[1] by the DEC. Of those ponds, 17 contain heritage strain brook trout (Figure 2), including 4 Little Tupper strain ponds, 6 Windfall strain ponds, and 7 Horn Lake strain ponds. The other 28 ponds support other heritage strains not actively propagated by DEC or self-sustaining populations of Temiscamie-hybrids.

Dix Pond, Honnedaga Lake and Nate Pond heritage strains remain NSA in their natal waters. The Dix Pond strain is considered particularly secure due to the large watershed upstream of Dix Pond that supports brook trout. The Honnedaga Lake strain made a comeback after Honnedaga Lake was recolonized by brook trout from its tributary streams. The Tamarack Pond heritage strain no longer exists.

Six ponds formerly stocked with Temiscamie hybrids are now NSA. Stocking was experimentally halted when water chemistry data indicated ample groundwater for spawning. Additional waters capable of supporting NSA populations need to be identified.

Reproduction in NSA populations varies from pond to pond. In some cases, reproduction is so high that growth is impacted and brook trout stunt. Productivity is best in brook trout monoculture ponds.

Fish Propagation

Strain considerations

Heritage strains

NYSDEC has established heritage strains of brook trout in about 69 waters.[2] Restoration has focused on waters recovering from acidity, limed waters, and reclaimed waters. DEC has propagated and stocked the following heritage strains where the potential to establish a self-sustaining heritage population was deemed high:

- Little Tupper
- Windfall
- Horn Lake

The Adirondack origins of these strains are described in detail by Keller (1979). Subsequent genetic analyses have confirmed their status as distinctive endemic strains (Bruce, Daniel, et al. 2019). Their current distribution is depicted in figure 2. At least 3 self-sustaining populations of each of these strains have been established, partially meeting the 1979 plan objective of establishing at least three self-sustaining populations of each heritage strain (10 in total).

The 1979 plan did not consider watersheds in deciding where to stock heritage strains. While this was considered later, it proved impractical to consistently follow. The management objectives for waters in which the stocked heritage strain failed to establish a self-sustaining population were reconsidered on the basis of recreational fishing potential. In some cases, brook trout stocking was terminated. However, depending on the specific ecological and recreational potential of the pond, maintenance stocking of either a heritage strain or a hybrid strain was a common outcome.

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[1] In this paragraph, Wild (in contrast to NSA) means that spawning is inadequate to sustain a high quality fishery.
[2] The 69 waters include both stocked and NSA populations.

Heritage Strain Brook Trout Waters

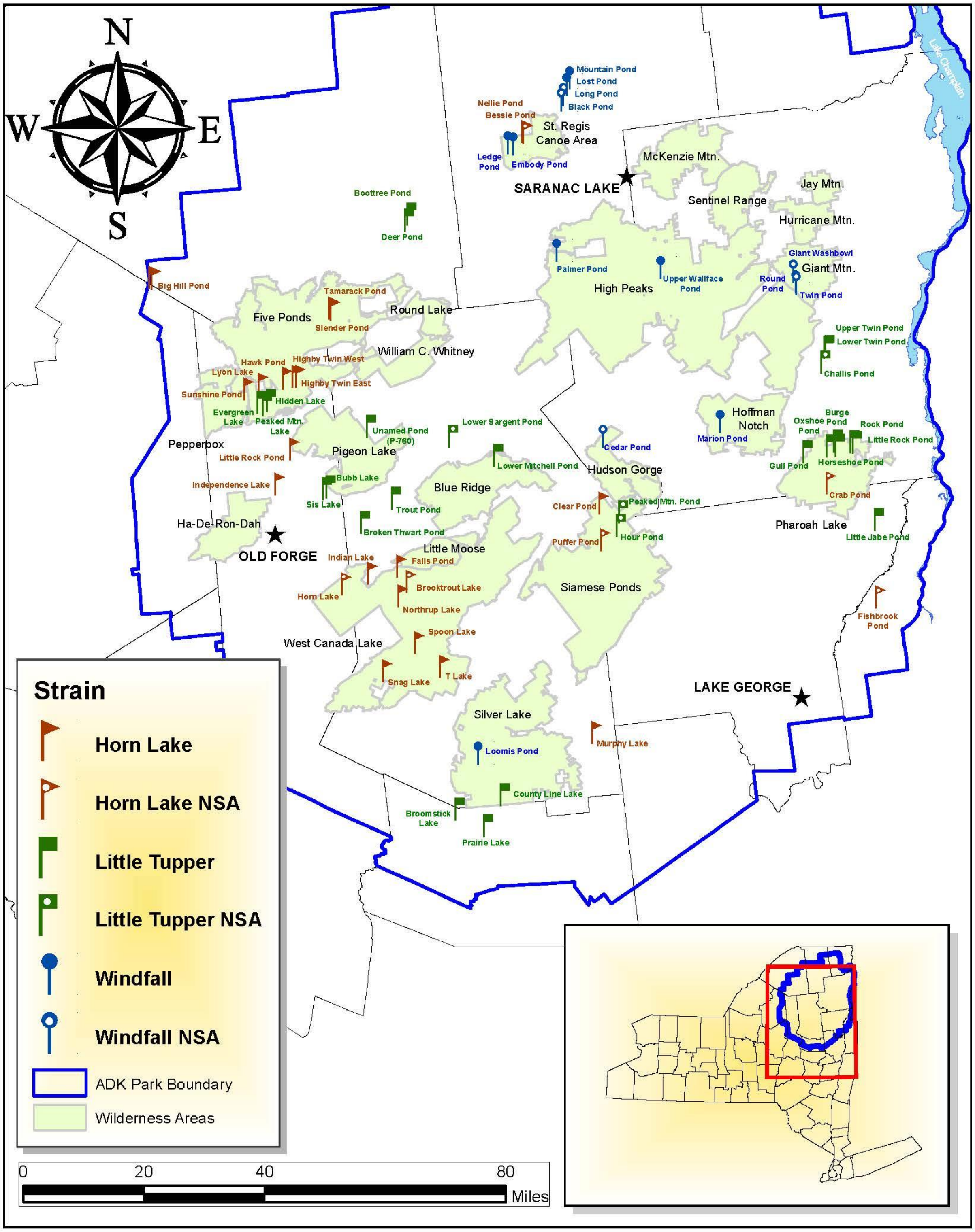

Figure 2. Heritage Strain Brook Trout Waters on public lands as of 2023.

Hybrid strains

Among the most important findings that informed the 1979 plan was strong evidence for the relative advantages of wild-domestic hybrid strains over domestic strains for brook trout pond management (Webster and Flick 1981). While these strains are more difficult and more costly to produce than domestic brook trout, their superior post-stocking survival rates and growth characteristics provide a much greater return to the angler for the investment. The result of a long collaborative research project between DEC and Cornell University was the adoption the Temiscamie hybrid brook trout (Temiscamie (Canadian wild strain) X Rome (DEC domestic strain)) as the primary hatchery product for sustaining put-grow-and-take brook trout fisheries in Adirondack ponds. This hybrid was preferred to other experimental hybrids because it was considered more tolerant of acidified waters (Keller 1979).

DEC never established an NSA population of pure Temiscamie strain brook trout in a public water in New York. In addition to the Rome strain brook trout (Ehlinger 1964), annual production of Temiscamie hybrids therefore depends on access to pure Temiscamie strain brook trout from privately held waters. Concern for the future availability of Temiscamie strain gametes from Brandon Enterprises in 2012 led to the consideration of alternative wild-domestic hybrids. The decision was made to conduct a preliminary evaluation of a Windfall X Rome hybrid because of the potential to implement a cooperative agreement with a private landowner securing long term access to a Windfall population that would be large enough to support DEC propagation needs, easily accessible by road, and at minimal risk from unauthorized introduction of incompatible species. The Windfall hybrids were stocked in 19 ponds in the St. Regis Canoe Area in Franklin County and a few ponds in the Massawepie Conservation Easement in St. Lawrence County. Surveys to evaluate the Windfall hybrids were conducted on a subset of these waters. The tentative conclusion was that there was no evidence that Windfall hybrids would produce an inferior fishery relative to Temiscamie hybrids (Fieroh 2017). However, that conclusion should not be considered definitive given the constraints on the scope and methodology of the evaluation. Further evaluation was not pursued due to the continued availability of Temiscamie hybrids from Brandon Enterprises since 2012.

Perhaps the ambiguity of functional distinctions between the Temiscamie and Windfall hybrids is to be expected given their apparent ancestry. In 2017, a study comparing microsatellite DNA between the Temiscamie broodstock at Brandon Enterprises and fish collected from Lake Albanel[3] in 2000 concluded that the Temiscamie strain currently propagated by Brandon is a naturalized population consisting of both Lake Albanel and native New York ancestry (S. Bruce 2017)." Given the continued success in sustaining productive put-grow-and-take fisheries with Brandon-sourced hybrids, this recent revelation was not viewed as a serious problem.

[3] Original source of Temiscamie strain brook trout (Webster and Flick 1981).

Impacts of DEC producing Temiscamie hybrid eggs

The procurement of Temiscamie hybrid eggs from a private facility continues to be a favorable arrangement. DEC purchases 410,000 eyed Temiscamie hybrid eggs each year at a reasonable price. Conducting this program in-house would require three year classes of enough domestic broodstock females to supply roughly 680,000 green eggs (700 to 800 females). Heritage and hybrid brook trout are reared at lower densities than other species (1.5 lbs./cu ft. vs 2.5 lbs./cu ft.). If brook trout broodstock for a hybrid program were located at the Chateaugay Hatchery, they would occupy three outdoor concrete rearing ponds, displacing roughly 100,000 domestic brown and/or rainbow trout held at the hatchery over the summer, and 40,000 to 50,000 held over the winter and available for spring stocking. Incubator space would be diverted from other species – the hybrid brook trout would take up six of the eight stacks of incubators at the hatchery (approximately 500,000 eggs). DEC would also need to develop a productive Temiscamie broodstock water from which we could collect milt from 600-700 mature males. Collecting milt from enough mature males would take three weeks, further complicating and extending egg care. Current broodstock waters could not support such an effort.

Broodstock

Stocking, as a tool to reestablish or maintain brook trout populations in Adirondack ponds, depends on practical access to broodstock populations that can reliably produce enough fertilized eggs to meet the management need. Since the 1979 plan, the broodstock for the hybrid and wild brook trout strains propagated by DEC has been maintained as follows:

- Temiscamie Hybrids – The Temiscamie broodstock is maintained by Brandon Enterprises in a natural pond on the hatchery premises. The domestic Rome strain broodstock is maintained in captivity by DEC and domestic eggs are provided to Brandon Enterprises for rearing to broodstock sizes for egg takes. Temiscamie hybrid eggs are produced by Brandon Enterprises and provided to the DEC for a fee.
- Little Tupper Strain – Broodstock maintained by DEC in multiple natural ponds on public land.
- Windfall Strain - Broodstock maintained by DEC in multiple natural ponds on public land.
- Horn Lake Strain - Broodstock maintained by DEC in multiple natural ponds on public land. Fingerlings are raised at the Warrensburg County Fish Hatchery.

Maintaining multiple populations of the above-named strains provides a hedge against the loss of the strain if a pond is compromised. However, remote ponds that are difficult to access have little practical value as broodstock sources. DEC does make use of NYS Police helicopter aviation to complete some egg takes on remote ponds. However, reliance on aviation complicates egg take planning, adds expense, and adds a greater risk of scheduling conflicts or weather-related postponements. Proximity to a road maximizes the efficiency and predictability of egg take operations The ideal broodstock water combines maximum long-term security of the brook trout population with ease of access for egg takes.

Stocking

Stocking is an important tool for managing Adirondack brook trout ponds. DEC relies on stocking for two major purposes:

- Restoration of self-sustaining brook trout populations in reclaimed ponds,ponds that have been limed or have naturally recovered from acidification, and are reproductively isolated
- Enhancing recreational fishing opportunities in ponds lacking adequate natural reproduction or in waters with unknown reproductive status

Stocking rates

Stocking rates are initially based on the Morpho-Edaphic Index (MEI)[4]. Current stocking rates for fall fingerling brook trout in Adirondack ponds range from 7-93 fingerlings/acre with a mean of 39 fingerlings/acre. Sixty percent of these waters have stocking policies of 25-45 fingerlings/acre. Rates are commonly adjusted based on the abundance of competing species, fishing pressure, contribution of natural brook trout reproduction and brook trout growth rates observed in fisheries surveys (Engstrom-Heg 1979). In practice, stocking rates have historically been adjusted by DEC biologists in response to growth rate information ranging from gillnet surveys to informal reporting by avid anglers. Realized stocking rates are frequently less than calculated MEI values.

The MEI favors shallow water, and often calculates unsuitably high stocking rates for these lakes and ponds, particularly considering that shallower waters may have limited suitable summertime oxy-thermal habitat for brook trout. Typically, high stocking rates (>50 fingerlings/acre) occur in small waters (<10 acres). A largely adopted policy of stocking a minimum of 150 fish per water likely contributes to this trend and should be reconsidered. Low stocking rates (<20/acre) have traditionally been used in large and/or remote waters. Specific rationales for rate adjustments are documented in the Justification field in the DEC Stocking Book database.

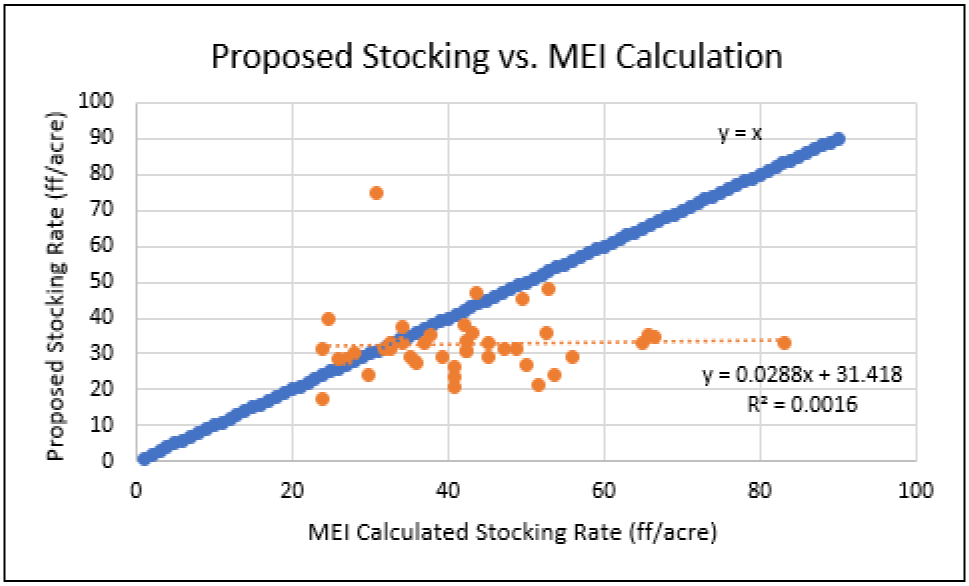

Figure 3. Relationship between brook trout stocking rates adjusted in response to observed growth and initial stocking rates calculated from MEI.

Size at stocking

The preferred stocking strategy for brook trout ponds is to stock fall fingerlings. At this size, the fish are still small enough to be air stocked in remote ponds, and they tend to survive better than smaller spring fingerlings. In a paired stocking study conducted on eleven ponds from 1995-1999, Temiscamie hybrid brook trout stocked as fall fingerlings recruited to the Swedish experimental gillnets at 1.5 times the rate of spring fingerlings (Miller 2000). Subsequently, spring fingerlings have been stocked when surplus fish are available.

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[4] An estimate of fertility and potential fisheries yield (Ryder, et al. 1974)

Method of stocking

Brook trout ponds are stocked either by truck, helicopter, or fixed wing aircraft. Non-motorized transport of fingerling brook trout to remote ponds is impractical. From an operational perspective, truck stocking is preferable because it is far less expensive to conduct and much easier to coordinate. Stocking from aircraft is costly and entails coordination with New York State Police Aviation or private contractors. Small aircraft are also inherently limited in the weight of fish and water that can be transported during a flight. Despite use of GPS and other precautions, air stocking entails a higher risk of a consequential stocking error than truck stocking. Finally, use of aircraft within the Adirondack Park is also subject to review for compliance with DEC policy CP-17. This includes annual submission of a *Conceptual Use Plan for Administrative Access by Motor Vehicle or Aircraft into Wilderness, Primitive and Canoe Areas*.

While truck stocking is strongly preferred whenever possible, few brook trout ponds in the Adirondacks can be stocked by this method. In 2023, only 32 ponds could be stocked using a truck. Aviation support was needed to stock the remaining 285 ponds receiving stocked brook trout.

Stocking portfolio reassessment

Given the challenges associated with stocking Adirondack Ponds, the management of naturally reproducing brook trout populations is preferable to intensive management with stocked brook trout for practical and ecological reasons. For this reason, it is important to periodically check the extent of natural reproduction in stocked ponds as part of post-stocking evaluation. DEC has accomplished these checks by either suspending stocking or by marking/fin clipping stocked brook trout so that they can be distinguished from naturally spawned trout. Where adequate natural spawning (NSA status) can be documented (generally 70% of brook trout caught are unmarked), stocking is terminated.

Rearing

Biosecurity measures

Wild and hybrid brook trout are more susceptible to common pathogens in fish culture and disease problems plagued the early implementation of the 1979 plan. Consistent production of fall fingerlings was only achieved after a series of hatchery disinfections and more stringent biosecurity measures supervised by DEC fish pathologist John Schachte (Miller 2000). From this experience, DEC learned that biosecurity measures, including regular fish health inspections of feral broodstock and scrupulous attention to hatchery sanitation, is a prerequisite for success. Both heritage and hybrid brook trout are kept indoors or in covered raceways to reduce the chance of the introduction of pathogens.

Early life stage care

The early life stages of brook trout (from hatching to fry) are more fragile and must be treated with extra care relative to other species of trout. During the period of late-January to mid-February, brook trout tend to remain on the bottoms of raceways longer, making the cleaning of raceways more difficult and significantly more time consuming.

Maintaining multiple strains of heritage fish concerns

There are no substantial morphological differences among heritage brook trout stains, and so when rearing multiple strains of heritage fish in one facility, precautions need to be taken to prevent the inadvertent mixing of strains. This special care must be taken during the rearing of all life stages, fish transfers, and fish stocking. Genetic analysis conducted on samples collected in 2005 showed no evidence of genetic mixing in heritage broodstock (M. Hare 2010).

Angler Use/Preferences

Collection of angler use and preference data from Adirondack brook trout pond anglers has been challenging in many regards; much of what we know about brook trout anglers and their experiences has been obtained through direct personal communication rather than formal surveys. Many of the ponded waters managed for brook trout are relatively remote, can be reached from multiple access points, and cover a wide geographic area, making informative angler surveys logistically difficult. Furthermore, many brook trout anglers hold their favorite waters in high regard and are often hesitant to share information on their angling experiences. Communication with brook trout anglers, typically via telephone or in-person office visits, has allowed biologists and managers to maintain a broad understanding of angler use and preferences.

Although not necessarily specific to Adirondack ponded waters, brook trout fishing remains popular in New York state. The 2017 Statewide Angler Survey found that brook trout are in the top 7 statewide for species that anglers prefer to fish for. The proportion of anglers that prefer to fish for brook trout was markedly higher in the Adirondacks. The most comprehensive survey of Adirondack brook trout pond angler-use since the previous management plan was developed occurred in 1992 when angler effort was measured at 24 Region 6 ponds using a combination of ground and aerial counts during the months of May, June and September. The survey found an average of 6 angler trips per pond acre per year (Gordon, 1993). However, results were highly variable and likely influenced by pond accessibility, management intensity and status of the fishery. At 9 of the study waters, anglers were also surveyed via in-person interview or catch reporting card. Anglers reported catching 1.9 trout and harvesting 1.3 trout per trip on average. Very few anglers reported harvesting a full limit, which at that time was 10 fish. The author of the study proposed additional surveys to better understand angler use but advised that a minimum sample size of 73 waters (65 remote, 8 accessible) be used to generate reliable angler use estimates. No additional surveys of this type have been conducted since, likely a product of the logistical difficulties mentioned above.

The 2007 Statewide Angler Survey specifically asked recipients to indicate which type(s) of waters they prefer to fish, with “Back country Adirondack Ponds” as an option (Connelly and Brown, New York State Angler Survey 2007, Report 1: Angler Effort and Expenditures 2009). At that time an estimated 21% (175,241) of licensed anglers statewide preferred to fish in these back country ponds. A large proportion of these anglers resided in Regions 5, 6 and 7; however, at least some anglers from out-of-state and each region of New York indicated a preference for angling in this type of water. (Connelly and Brown, New York State Angler Survey 2007, Report 2: Angler Characteristics, Preferences, Satisfaction and Opinion on Management Topics 2009)The 2007 survey also sought to better understand angler preferences for different types of fishing opportunities.

Survey responses were analyzed using a clustering approach that grouped anglers into 5 distinct groups based on their fishing location preferences. The largest group of respondents (38.9%) preferred “new experiences” such as going to new places or getting away from the usual places, while the second largest group (20.1%) preferred fishing for wild fish in uncrowded and unspoiled areas. With hundreds of ponds and lakes to choose from, the majority of which are located within Forest Preserve, fishing on Adirondack brook trout ponds is likely attractive to many of the anglers that compose these two groups.

To aid in the development of this report, a 14 question online brook trout angler survey was distributed via email to NYS licensed anglers on July 15, 2022. The survey resulted in 1,902 validated responses from anglers who reported they fished for brook trout in Adirondack or Catskill ponds (NYSDEC 2022). Survey results suggested that anglers who fish brook trout ponds are generally older in comparison to the statewide average of all licensed anglers. A large majority of brook trout pond anglers live in Regions 5 & 6 and immediately adjacent areas; however; there were respondents from other areas of the state and additional states as well. The majority of anglers (82%) reported fishing 1 to 5 ponds annually with May, June and September being the most popular times to fish. Fifty-eight percent of anglers said they fish with bait (including wabbler-worm) while 30% said they prefer to fly fish. Harvest rates of brook trout remain high, with 70% of anglers sometimes or always keeping a fish if they catch one, with 30% of respondents saying they never keep fish. Forty-nine percent of anglers said that when fishing brook trout ponds they are seeking to catch fish of “any size” while the remaining anglers said they are looking to catch “some large fish” or “trophy” fish.

A follow up survey was sent via email to the anglers who preferred to catch some large, or trophy fish to better understand those size preferences. The results suggested that a 16” fish is considered large with an 18” or larger fish constituting a “trophy”. Surprisingly, 54% of the survey respondents perceived the impact of baitfish introductions on brook trout ponds as “no problem” or a “minor problem”. A follow up survey was sent to these individuals to learn why they do not perceive baitfish introductions as a problem and determine which relevant publications and outreach materials they had seen on this topic. Out of 113 responses, the most common were that brook trout grow better when then can consume baitfish so they can’t be harmful or anglers simply were not aware that baitfish introductions can negatively impact brook trout populations in ponds. More than half of the respondents to the baitfish follow up survey said they had seen the list of baitfish prohibited waters in the fishing regulations and the same was true for the baitfish prohibition signs at ponds and trailheads. Less than 30% of the respondents had seen information regarding baitfish introductions on the DEC website or in brochures and printed fliers, while 22% said they had not seen any materials on this topic at all.

Brook trout ponds and lakes in the Adirondacks continue to provide a unique, geographically widespread fishery that is attractive to a variety of anglers employing a diverse range of fishing effort, angling tactics and harvest preferences.

History of Regulations

Until 2022, brook trout regulations in ponded waters were part of “trout” regulations that applied to both lakes and streams. In general, few brook trout ponds have an individual brook trout or trout special regulation. Most brook trout ponds were and still are regulated by statewide regulations.

Trout regulations have slowly become more restrictive through time. In 1912, the statewide trout regulation was May 1-August 31, Minimum Length 6 inches, with a “size of catch” of not to exceed 10 pounds of trout in 1 day. In 1954, special trout regulations were implemented in the Adirondacks and adjoining counties: April 10-September 12, Minimum Length-6”, with a daily limit of 10. After several Adirondack area regulation changes, a statewide trout regulation was implemented in 1963: April 1-September 30, Minimum Length-any size, Daily Limit 10. This regulation remained in place until 1996 except between 1977-1981 during the Evaluation of Trout Regulations in Streams 1977-1980 study (Engstrom-Heg and Hulbert 1982). During this time, the daily limit for salmonids (brook, brown, rainbow and lake trout, landlocked salmon, and splake) was 5 plus 5 more brook trout; therefore, 10 brook trout could still be harvested. Brook trout minimum size limit remained at any size.

In 1996, statewide trout regulations changed to April 1-October 15, Minimum Length-any size, Daily Limit-5 to spread out harvest among more anglers. DEC Regions 5 and 7 implemented county-wide special regulations that allowed for an additional (bonus) 5 brook trout shorter than 8” to be harvested. The county-wide “bonus” brook trout regulations were eliminated in 2010 to simplify regulations. At that time, statewide regulations applied to most brook trout waters in both Regions 5 and 6.

In 2015, Region 6 implemented the 5 trout with no more than 2 longer than 12” trout regulation to be consistent with DEC Regions 7, 8 and 9 in central and western New York. The intent was to distribute larger wild trout and stocked 2-year-olds more evenly. However, waters with baitfish prohibited regulations were exempted from this county-wide regulation. Since virtually all brook trout ponds have baitfish prohibited regulations, the effective regulation on most public ponded brook trout waters in Region 6 did not change.

In 2022, statewide brook trout regulations in ponds were separated from brown trout, rainbow trout and splake in recognition that brook trout in ponds are managed differently than other trout species. Brook trout are managed to achieve self-sustaining populations where possible and put-grow-take fisheries if not possible. To protect wild brook trout during their spawning season and protect brook trout during the vulnerable ice fishing season, the April 1-October 15, Minimum Length-none, Daily Limit-5 regulation was retained for brook trout statewide. Brown trout, rainbow trout and splake are generally not managed for wild populations, so their season was extended to all year because there was no need to protect them during the spawning season.

Generally, other regulations impacting brook trout in ponds are ice fishing regulations and baitfish prohibited regulations. Regulations prohibiting fishing through the ice in waters inhabited by trout were in place at least as far back as 1912. Those regulations remained in effect until 2022 when ice fishing was permitted unless specifically prohibited in New York, except for Essex, Franklin, Fulton, Hamilton, Herkimer, Lewis, St. Lawrence, Warren and Washington Counties where ice fishing is prohibited in waters inhabited by trout unless specifically permitted. Since most brook trout waters fall within these counties, ice fishing regulations for brook trout did not change for almost all brook trout waters and remain in place due to the vulnerability of brook trout to ice fishing.

Brook trout are vulnerable to baitfish or other incompatible and detrimental fish species introductions that can severely decrease or eliminate brook trout populations in ponds. Starting in 1951, use of minnows or other species of fish were prohibited “in lakes and ponds and their tributaries in waters where brook trout were the predominate species and were not infested with yellow perch or lakes, ponds and their tributaries where the conservation department eradicated yellow perch by chemical treatments and were restocked with brook trout.” These regulations tie directly back to pond reclamation efforts that began at the same time (see Pond reclamation and Brook Trout section). The Department has been required to provide lists of waters where the use of fish as bait is prohibited since 1951. The number of waters where the use of fish as bait is prohibited has expanded since 1951; including large state-owned land areas.

Research

Contributions of the Adirondack Fishery Research Program

Cornell University's Adirondack Fishery Research Program was initiated in 1950 by Dr. Dwight Webster (Josephson and Webster 2016). Since then, in collaboration with both DEC and private landowners, it has been a prolific contributor to the knowledge base of brook trout pond management. Some findings have proved broadly applicable to DEC fisheries management in the Adirondacks while the applicability of others has been thus far limited to private landowners.

The most important lessons DEC has learned from Cornell's research include the following:

- The removal and exclusion of competing invasive fishes, particularly yellow perch, vastly improves the quality of brook trout fishing in ponds. Flick and Webster (1992) reported that post-reclamation standing crops of brook trout ranged from 5 to 16 pounds/acre on a sample of 7 waters; all produced less than 1 pound/acre pre-reclamation.
- An intensive electrofishing program to reduce unwanted black bass can greatly enhance brook trout populations (Weidel, Josephson and Kraft 2007). However, the steep opportunity cost of this labor-intensive approach precludes its broader application by DEC.
- Temiscamie-hybrid brook trout are well suited for providing brook trout fishing opportunity in Adirondack ponds that lack robust populations of endemic brook trout due to the following characteristics (Webster and Flick 1981) (Keller 1979):
    - Better survival and growth in ponds compared to domestic strains
    - Late maturity delays the loss of fish through pond outlets due to spawning migrations
    - Tolerant of acidified waters
- Areas of upwelling groundwater are critical habitat for successful brook trout spawning and as summertime thermal refuge (Webster and Eiriksdottir 1976)
- Recognition of the origin and role of acid precipitation in the destruction of brook trout ponds and development of lime application as a mitigation technique has enabled DEC to restore stocked brook trout fisheries in ponds where they were extirpated. Direct application of lime to ponds has been adopted as a management strategy by DEC (NYSDEC 1999). The Adirondack Fishery Research Program has also investigated the restoration potential of aerial applications of lime to the watershed of a pond (New York State Energy and Research Development Authority 2018). However, due to the steep cost of aviation and flight restrictions associated with many land management units, landscape scale application of this liming strategy is impractical.

Advances in understanding brook trout genetics

The 1979 brook trout plan was greatly influenced by the prevailing contemporary view that indiscriminate historic stocking practices had largely homogenized the genetic composition of the original stocks. Consequently, the conservation and propagation of "heritage" brook trout strains from the short list of ponds believed to have no history of stocking was emphasized in the plan. Over last decade however, the assumption that the genetic integrity of wild brook populations has been irredeemably adulterated by past stocking has been examined in research published by investigators at Cornell University and other academic institutions. Recent findings include:

- Most wild brook trout populations in New York State have very low levels of admixture with stocked domestic strains. Instead, patterns of genetic variability coincide with drainage basins as would be expected to occur naturally (Bruce, Daniel, et al. 2019) (Beer, et al. 2019);
- High levels of admixture are mostly seen in or near ponds that continue to be stocked with Temiscamie-hybrid brook trout on a regular basis (Bruce, Daniel, et al. 2019) (Bruce, Kutsumi, et al. 2020) (Létourneau, et al. 2018);

- The number of years elapsed since stocking is the best predictor of domestic genetic membership (Létourneau, et al. 2018);
- Admixed populations are not without value. There is evidence of natural selection for and against specific genes of domestic origin (Lamaze, et al. 2012). Selection models suggest that the genetic composition of some admixed populations is likely to revert to the pre-stocking condition (Létourneau, et al. 2018);
- The level of genetic introgression from stocked brook trout may be influenced by several environmental factors including:
    - temperature (Létourneau, et al. 2018) (Marie, Bernatchez and Garant 2012)
    - pH (Bruce, Kutsumi, et al. 2020) (Marie, Bernatchez and Garant 2012)
    - dissolved oxygen, lake size and depth (Marie, Bernatchez and Garant 2012)
    - ratio of watershed area to lake area (Bruce, Kutsumi, et al. 2020)

Interpretation of these findings is complicated by differences in the genetic markers used to draw inferences. Lamaze et al. (2012) and Létourneau et al. (2018) used single nucleotide polymorphisms (SNP) while the other researchers used microsatellites which are non-coding and therefore selectively neutral.

The best available evidence today suggests that native brook trout genetic diversity is not confined to a handful of heritage strains in remote ponds surrounded by a sea of stocking-induced genotypic homogeneity. Instead, populations homogenized by stocking are the exception rather than the rule. Therefore, by default, the conservation value of any wild brook trout must be considered equal to the heritage strains defined in the 1979 plan.

Conclusion

Since 1979, tremendous advances have been made in the applied sciences and management techniques relevant to managing Adirondack brook trout ponds. The information catalogued in this report confirms that much has been learned, and that the knowledge acquired should be directed towards a structured approach for improved management. Furthermore, because the management needs of Adirondack brook trout ponds are sufficiently distinct and unique compared to other brook trout fisheries, the authors of this report recommend that the Bureau of Fisheries develop a new, stand-alone, plan that will serve as a roadmap to guide future management actions for the perpetuation of this valuable and iconic resource.

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