

White River Wild Trout Evaluations 2017

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Summary

The evaluation of wild salmonid populations has been a standard part of District fisheries investigations in Vermont since MacMartin's (1962) *Statewide Stream Survey by Watersheds*. These surveys included several White River tributaries and provided a baseline of wild trout abundance and distribution throughout Vermont. In 2017, Kirn compared wild brook trout (*Salvelinus fontinalis*) populations from 150 of MacMartin's sites to current populations and found abundant natural reproduction with significantly higher young-of-year brook abundance and multiple age-classes of trout including the contribution of older, larger fish (Kirn 2017). In 2018, the Vermont Fish and Wildlife Department (VFWD) updated the *Vermont Management Plan for Brook, Brown, and Rainbow Trout* to reflect current research, management strategies and department initiatives.

This report serves to assess wild trout population trends for recreational fishing within the White River Basin throughout roughly the last 40 years. VFWD has conducted regular surveys of 8 important White River spawning tributaries. In addition, 34 additional tributaries were surveyed by VFWD staff within the White River Basin in 2017. Overall, wild trout populations are relatively stable with evidence of widespread, successful natural reproduction. While it is often difficult to attribute annual variation in trout populations to any one factor, general observations, population metrics and potential environmental concerns are discussed. Water temperature data was also collected along several tributary and mainstem locations to assess potential impacts of warm summer water temperatures on salmonid populations.

Introduction

The White River is Vermont's fourth largest watershed flowing through 5 counties and encompassing 710 mi² including 50,000 acres of Green Mountain Forest. The 56-mile mainstem

has 5 major tributaries and represents the longest reach of un-dammed river of any Connecticut River tributary. Fisheries evaluations within the White River basin have been conducted by the VFWD since 1936 when the West Branch of the White River was designated as a “Test Water” requiring all anglers to report daily catch information (Lord 1946). Several angler surveys have been conducted along the mainstem of the White River between 1971 and 2017 (Ladago 2018) and routine population surveys along some White River tributaries have occurred regularly since the 1950s (Claussen 1999).

Wild (naturally reproducing) rainbow trout (*Oncorhynchus mykiss*) are abundant throughout the White River basin and provide a variety of angling opportunities. In 1962, MacMartin stated: “rainbows have found this to be an ideal watershed and over the years have been continually increasing their range as well as their abundance. Reproduction by rainbows in this watershed is highly successful.” While not native to Vermont, rainbow trout were widely stocked during the early 1900s and now exist as wild, self-sustaining “naturalized” populations (VFWD 2018). Sterile triploid rainbow trout are still stocked annually into mainstem reaches between Stockbridge and Hartford to help supplement recreational fisheries while avoiding genetic introgression or further expanding the range of rainbow trout (Ladago 2018, VFWD 2018).

Wild brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) populations also occur within the White River Basin. Wild brook trout are commonly found in cold, headwater tributaries where water temperatures remain below 68°F and wild brown trout occur primarily in lower tributary reaches and likely migrate seasonally throughout the mainstem. Tributaries providing fish passage upstream of the mainstem generally offer excellent spawning and nursery habitat for wild trout in addition to valuable refuge from elevated water temperatures (Claussen 1971). Brook trout are stocked annually in the First Branch and brown trout within the Third Branch to provide additional angling opportunity.

Anadromous (sea-run) Atlantic salmon (*Salmo salar*) were once abundant throughout the mainstem of the Connecticut river and tributaries, including the White River. Following the construction of the first Connecticut River Dam at Turner Falls, MA in 1798, anadromous fish populations rapidly declined and Atlantic salmon soon became extirpated from the basin. The stocking of fry hatched from eggs taken from Penobscot River Atlantic salmon was initiated in the 1860s, however, this program resulted in low returns and early restoration efforts were abandoned. By the mid-1900s smolt stocking of Canadian origin Atlantic salmon occurred with the first adult salmon returning from smolt releases in 1974. In 1987, efforts shifted from stocking hatchery raised smolts within the Connecticut River Basin to again stocking fry but within assessed areas containing suitable habitat. By 1994, stocked fry were entirely of Connecticut River origin (hatched from returning brood) to limit introductions of genetic material from outside the basin. Throughout the Atlantic salmon stocking program, studies showed that shifts in salmon marine prey species abundance and distribution, changes to predator

assemblages, and declining habitat conditions in addition to impacts from climate change limited program success. (CRASC 2017).

Atlantic salmon fry stocking within the White River drainage was initiated by the U.S. Fish and Wildlife Service (USFWS) in 1971 and evaluated by USFWS and the Vermont Fish and Wildlife Department (VFWD) beginning in 1987 (McMenemy 1993). Initial evaluations by Claussen showed that the survival of stocked fry was less than projected in many White River tributaries (Claussen, Claussen 1991, Claussen 1992b, Claussen 1994, Claussen 1997, Claussen 1998). In 2012, Massachusetts and New Hampshire decided they would no longer participate in stocking due to poor salmon returns within the Connecticut River Basin. Vermont then abandoned fry stocking efforts with the final stocking occurring in 2013 after the White River National Fish Hatchery, which produced approximately 65% of the fry for the program and the Roxbury Fish Culture Station were severely damaged during Tropical Storm (TS) Irene (Kirn 2013).

The state of Connecticut continues to operate a “Salmon Legacy Program” to maintain Connecticut river salmon genetics and provide brood stock. In 2017, a total of 20 sea-run adult Atlantic salmon returned to the Connecticut River basin. (Figure 1) (CRASC 2017). Atlantic Salmon have not been observed in the White River basin by VFWD staff since 2013.

During TS Irene, flows within the mainstem White River in West Harford peaked at 90,100 cfs on August 29, 2011 (Figure 2) causing severe damage to roads, bridges and other infrastructure throughout the basin. Furthermore, stream channels were significantly altered by the event and the subsequent human response, which included the removal of coarse materials and/or large natural wood along roughly 143,050 linear feet of instream habitat (Kirn 2012). The Third Branch, Tweed River, Hancock Branch, West Branch (Photo 1) and Stony Brook were among the streams most impacted by instream post-flood channel work (Table 1).



Photo 1 – An example of the type of conditions characterized as “major impact”. This photo was taken along the West Branch of the White River (Rochester) following TS Irene.

In 2017, mainstem flows peaked to 20,900 cfs on July 2nd causing damage in some areas particularly in lower watershed tributaries near Hartford, VT (Photo 2). Given that all 2017 sampling within the White River Basin occurred after July 2nd, this event may have influenced population estimates, particularly for young-of-the-year (Age -0) trout.



Photo 2 – Flood damage that occurred on July 2, 2017 along Podunk Brook in W. Hartford.

The goal of this study was to monitor the status and trends of wild trout populations within the White River Basin. We estimated wild trout abundance annually at a series of index stations and opportunistically at additional sites during years when resources permitted and/or information needs required doing so. This report reviews data collected to date to identify and characterize long-term trends, annual variability, species distributions and potential recreational angling opportunities along surveyed tributaries.

Methods

Trout Population Surveys:

Trout population surveys were conducted using single or multiple pass electrofishing with a 250/500-volt DC stream-side generator or a HallTech HT-200 backpack electrofisher. Captured brook, brown, and rainbow trout were measured to the nearest millimeter (total length), weighed to the nearest gram, and released. All other fish species were identified and released.

Trout population metrics are presented as minimum estimates for single run surveys (i.e., total number of fish captured), or calculated using the maximum weighted likelihood method developed by Carle and Strub (1978) for multiple run surveys. Stocked trout were distinguished by the presence of a fin clip or from physical appearance (fin condition, scale loss) and were not included in population estimates. 2017 population surveys for 8 of the 42 tributaries have occurred regularly throughout the last 30 years and trends among four population metrics are presented here: (1) the total number of trout per mile, (2) the total number of young-of-year (yoy) trout, (3) total trout biomass (pounds per acre), and (4) large (≥ 6 inches) trout abundance. Temporal trends in total trout abundance over the last 40 years were evaluated with linear regression, trend lines and R^2 values with p-values shown where significant trends were detected.

Population estimates from 34 other tributaries within the White River Basin sampled in 2017 were also made, within five separate age/size classes: young-of-year (yoy); <6.0 inches; 6.0-9.9 inches; 10.0-11.9 inches; and 12+ inches. Population estimates are presented as number of trout per mile and kilometer and pounds of trout per acre for each age/size category and total trout for each trout species present. The population estimates were standardized to represent number per mile and pounds per acre for each age class and summed for the total trout population within each station.

Water Temperature Monitoring:

Onset Hoboware Pro v2 water temperature loggers were deployed along the mainstem and in 10 tributaries to the White River in 2017. Temperatures were recorded on the hour, 24 hours a day from June through September. Temperature loggers placed in the lower Third Branch and Lilliesville Brook were either lost or dewatered preventing any analysis. As the 2017 summer represented a relatively cool year, temperature data collected in 2001 and 2002 (relatively warm years) were included for reference where available for the same locations (Table 2).

Additional 2017 White River tributary wild trout sampling and assessment:

Streams containing high quality recreational fisheries, which are typically found in surface waters that exhibit clean and cool conditions with abundant wild self-sustaining salmonid populations supporting multiple age classes were identified as “very good”, candidates for classification as B(1) waters for recreational fishing per guidance supporting reclassification under the Vermont Water Quality Standards (unpublished guidance memo, dated January 18, 2018 – Appendix II). These waters support multiple age classes of trout totaling a minimum of 1,000 trout per mile (all species/ages/sizes), and/or 200 per mile \geq 6 inches (total length) and/or 20lbs/acre obtained from a minimum of two surveys within the last 20 years. Wild trout populations in all streams surveyed within the last 20 years (Including surveys by the U.S. Forest Service) were assessed to determine whether metrics for class B(1) waters were met.

It should be recognized that wild trout populations vary widely from year to year and therefore an individual population may sometimes go below or greatly exceed these values (1,000 per mile, and/or 200 per mile \geq 6 inches (total length) and/or 20lbs/acre) in any given year, which is why multiple years of data are necessary to make a recommendation for B(1) fishing use classification. Additionally, while electrofishing surveys only provide insight on trout abundance within the surveyed reach, the upstream and downstream extent of the stream classification should be based upon consistent or improving water quality, physical habitat quality and land use conditions. The reach should include all upstream habitats which are deemed essential to sustain water quality and physical habitat requirements necessary to support wild salmonid populations at a very good level. Other waters that have not been surveyed may also support similar wild trout densities and may be identified in the future.

Results

Alder Meadow Brook

This upper mainstem tributary is dominated by wild brook and rainbow trout with brown trout occasionally observed (Figure 3 and 4). Trout populations have been sampled annually since 1992 and meet criteria for B(1) (very good) waters for recreational fishing (Table 3). Overall, A significant increase ($R^2 = 0.25$, p-value < 0.05) in the total number of trout per mile has been observed since 1992 (Figure 5). In 2017, water temperatures remained below 65°F throughout the summer (June – October) and in 2001 temperatures exceeded 68 °F on three days (Table 2).

Tweed River

A routinely sampled site (elevation 800 ft) located 3.2 miles upstream of the confluence of the mainstem of the White River contains populations of wild brook, brown, and rainbow trout (Figure 6 and 7) and meets criteria for B(1) waters for recreational fishing (Table 3). In 2010, a change in land ownership prevented further access to the site limiting analysis from 1980

to 2009. No trend in the total number of trout per mile was observed during this time period ($R^2 = 0.00$) (Figure 8). Following TS Irene, roughly 15,050 ft of major habitat impact occurred (Table X). Two additional upstream sites were sampled in 2017 and showed similar species composition with total trout populations exceeding 1,000 trout per mile (Appendix I).

Stony Brook

Two locations along Stony Brook have been sampled routinely since 1983 and contain almost exclusively wild rainbow trout with wild brook trout also being observed on occasion (Figure 9, 10, 12 and 13). Both stations meet criteria for B(1) waters for recreational fishing (Table 3) and have not shown a significant change in populations status through time ($R^2 = 0.02$ & 0.03 ; Figure 11 and 14). Major impact occurred along roughly 11,300 ft following TS Irene (Table 1).

Locust Creek

Locust Creek has been sampled roughly 5 miles upstream from the mouth annually since 1983, meets criteria for B(1) waters for recreational fishing and contains all three species of wild trout, with rainbow trout being the most abundant (Figure 15 and 16). No significant trend was observed for total trout numbers since 1983 (Figure 17). One station upstream of the annual station was surveyed in 2017; it also showed very good trout populations (Appendix I). Following TS Irene, major impacts occurred along roughly 10,000 ft of the stream (Table 1). Summer water temperatures within Locust Creek were elevated compared to surrounding tributaries and in 2002 temperatures exceeded 80°F on 14 days (Table 2).

Lilliesville Brook

Lilliesville Brook has been sampled regularly since 1983 and contains wild brook trout and rainbow trout populations, with brown trout being occasionally observed (Figure 18 and 19). Roughly 5,000 ft of major impact occurred following TS Irene, including work within the regularly sampled station located 1 mile upstream from the confluence with the White River, however, this site still meets criteria for B(1) waters for recreational fishing (Table 3). No significant change in the total trout numbers ($R^2 = 0.05$) was observed throughout the sampling period (Figure 20).

Bethel Gilead Brook

This tributary to the Third Branch of the White River has been sampled regularly at a station located 1.8 miles above the mouth. It contains primarily wild rainbow trout and brook trout with some wild brown trout (Figure 21 and 22). Total trout abundance in this stream is relatively low compared to other tributaries, however, no significant trend was found ($R^2 = 0.02$) (Figure 23). Bethel Gilead represents the only regularly sampled stream that did not meet criteria for B(1) waters for recreational fishing (Table 3). Temperature data collected in 2002 showed the second highest number of days above 65°F of any sampling location, including 3 days when water temperatures exceeded 80°F (Table 2).

Broad Brook

Broad Brook is a productive lower mainstem tributary that supports high wild rainbow trout abundance, with some wild brook trout and brown trout (Figure 24,25,27 and 28). Two sites have been sampled annually since 1984 and both meet criteria for B(1) waters for recreational fishing (Table 3). The upper site (elevation 820 ft) showed a significantly increasing trend in total trout numbers ($R^2 = 0.20$, p -value < 0.05) (Figure 26) and no significant trend was found for the lower site ($R^2 = 0.04$) (elevation 489 ft) (Figure 29). In 2017, water temperatures at the lower Broad Brook site remained below 72°F and reached 68°F on only 5 days (Table 2).

Mill Brook

Mill brook enters the White River in West Hartford roughly 8 miles above the confluence with the Connecticut River and contains wild rainbow trout and brook trout (Figure 30, 31, 33, and 34). Two sites have been evaluated since 1993; however only limited sampling occurred between 2001 and 2013 (2 of 12 years sampled). Trout populations at both the upper (elevation 600ft) and lower (elevation 470 ft) did not change significantly though time ($R^2 = 0.07$ and 0.01) (Figure 32 and 35) and the total number of trout and biomass of trout observed in 2017 was the lowest documented since 1994, however, both sites still meet criteria for B(1) waters for recreational fishing (Table 3). Water temperatures in 2017 remained relatively cool with no days reaching 72°F and only 6 days with temperatures above 68°F (Table 2).

Additional 2017 White River tributary wild trout sampling and assessment

Population metrics for the 34 tributaries sampled in 2017 within the White River Basin are presented in the Appendix and 33 waters within the Whiter River basin were identified as meeting criteria for “very good” or class B(1) waters for recreational fishing (Table 3).

Discussion

Populations of wild trout sampled in eight regularly surveyed streams within the White River Basin showed stable (6 streams) or positive (2 streams – Alder Meadow and Broad Brook) trends in total wild trout populations throughout the last 38 years. While most streams showed some inter-annual variability especially among young-of-year trout, no significantly negative trend in total trout numbers was found. Considering three major flood events within the last decade (2007, 2011, and 2017), subsequent in-stream impacts (Photo 1,2 & 4 – 9), and overall effects from climate change throughout the last 40 years, the resilience of wild trout populations within the White River Basin is encouraging.

Natural reproduction of wild trout, inferred from the presence of young-of-year trout, is widespread throughout the basin and the recruitment to age 1+ is common. While Claussen (1999) observed some reduction in wild rainbow trout populations within the upper mainstem and lower spawning tributaries between the 1970s and 2000s, populations appear to remain stable nearly 20 years later. While trout exceeding 12 inches in length are rarely encountered during stream surveys, larger wild trout have been documented in creel surveys since 1972

(Claussen 1987, Claussen 1993, Kirn 2003, Ladago 2018) and are regularly reported by anglers indicating recruitment of larger trout to the White River.

Alder Meadow Brook

This headwater brook contains mostly young-of-year rainbow trout and brook trout of larger size classes (Figure 3 and 4). While Route 100 cuts through floodplains and crosses the brook at several locations, heavily forested headwaters (U.S. National Forest) in addition to good instream habitat (Photo 3) support abundant wild trout populations. The large proportion of young-of-year rainbow trout indicates seasonal use by adult rainbow trout that migrate to this area in spring to spawn and move downstream as flows decline. The high density of brook trout ≥ 6 " indicates suitable conditions for trout year-round (Figure 4). In 2017, this location was the only place monitored in the watershed where water temperatures remained below 65°F through the summer. The total number of trout observed from this site since 1992 showed the strongest positive trend of any annually monitored site ($R^2 = 0.25$) and the weight of trout regularly exceeded 20 lbs per acre (Figure 5). Prior to annual sampling, Claussen observed very good trout populations (2,061 trout per mile and 53 lbs per acre) at this site as far back as 1974 (Claussen 1974).



Photo 3 – Example of good instream habitat characteristic of the historic sampling location in Alder Meadow Brook

Tweed River

During a previous evaluation of wild rainbow trout populations in the Tweed River, Claussen (1999) noted declines in rainbow trout biomass between 1971 and 1998. Covington (2001) attributed some of these declines to a change in habitat and sample station length but also observed an increase in young-of-year production. This trend is consistent with observations

through 2009 as the number of young-of-year rainbow trout remained above 805 trout/mile from 2005-2009 and the number of trout ≥ 6 " did not change significantly and remained below pre-2000 numbers (Figure 7). While access to the historic sampling location (Elevation 800ft) was no longer available after 2009, both upstream sites surveyed in 2017 contained over 1,000 trout per mile and one large 18.6" brown trout was caught at the upper site (elevation 1000ft).

Stony Brook

In Stony Brook, heavily forested headwaters provide cold water and good habitat capable of supporting abundant wild trout. While limited sampling occurred between 1989 and 2012, wild trout populations regularly exceeded 2,000 trout per mile and were dominated by young-of-year rainbow trout (Figure 9). Major impact occurred along 11,300 ft of stream (Photo 4), which may help explain the decline in trout numbers from 2013 to 2015, however, populations improved by 2016 (Figure 11). The lower elevation (910ft) station contained the highest average total number of trout per mile of any of the 8 tributaries sampled and the upper site (elevation 1090ft) contained good numbers of trout ≥ 6 " indicating healthy populations.



Photo 4 – Major impact to Stony Brook following TS Irene.

Locust Creek

A series of stream channel modifications has occurred throughout Locust Creek including within the historically sampled site following TS Irene (Photo 5) and again more recently in 2017 (Photo 6). This stream supports good numbers of primarily rainbow trout including some

larger than 6". The relatively low number of young-of-year trout in 2017 (Figure 15) may have been a result of a slight change in the station section as in-stream work was actively occurring within the lower historic reach preventing sampling (Photo 6). Elevated water temperatures during summer are a concern in Locust Creek as 80°F was exceeded during several days in 2002 and although the 2017 season was relatively cool, 75°F was still exceeded, which is above the thermal range preferred by trout.



Photo 5 – Major instream impact to Locust Creek within the historic sampling reach following TS Irene.



Photo 6 – Before (Left) and after (Right) stream bank alteration work along Locust Creek along the historic sampling reach in 2017.

Lilliesville Brook

This tributary serves as a spawning and nursery habitat for primarily rainbow trout, consisting of largely two age classes (young-of-year and yearling trout) (Figure 18 and 19). Following a major flood event in 2007, wild trout numbers were reduced to a 24-year low and

while populations were quick to rebound, TS Irene in 2011 caused a delay in recovery. In 2017, the population was the highest observed since 2009 (Figure 20).



Photo 7 – Impact to Liliiesville Brook within the historic site following TS Irene in 2011.

Bethel Gilead Brook

Bethel Gilead Brook was severely damaged from flooding in 2007 and 2011 including within the historic survey reach (Photo 8). Restoration efforts by the U.S. Fish and Wildlife helped to stabilize the stream channel but provided little benefit to instream fish habitat as the gradual slope and widened river channel likely limited restoration potential. Trout populations found within this reach in 2017 were relatively low (in weight and numbers) (Figure 23) and Bethel Gilead was the only stream of the eight regularly sampled White River tributaries that did not meet criteria for reclassification as a B(1) water. Since 2001, trout biomass has remained below 10lbs/acre. A substantial *Didymo* bloom was also observed in 2017 along the sampled reach (Photo 10).



Photo 8– Work that occurred following TS Irene along the historic sampling reach.



Photo 9 – An example of some of the major impact observed within Bethel Gilead following TS Irene.



Photo 10 - Didymo bloom observed in Bethel Gilead Brook in 2017 within the historic sampling reach.

Broad Brook

Broad Brook represents a major spawning tributary in the Lower White River Basin. Trout populations within Broad Brook are represented primarily by rainbow trout with some brook trout and occasionally brown trout also being observed. Since 1984, total trout numbers have remained stable at the lower site (elevation 489ft) and increased significantly (p -value <0.05) at the upper site (elevation 820ft) indicating good habitat and cool water (confirmed by temperatures below 72°F in 2017) (Figure 26). The lower trout numbers observed in 2017 may have been partly attributed to the July 2017 flood.

Mill Brook

Mill Brook is a productive wild trout stream represented by rainbow trout and brook trout and is the lowest major trout spawning tributary in the White River. Following a 1973 flood, a culvert impassible to fish was installed under Pomfret Road just above the mouth. To address this issue, baffles were installed within the culvert in 1995 and 2012 to provide aquatic organism passage. Following the first baffle failure during TS Irene, the second baffle treatment failed in 2013 preventing further upstream fish passage (Photo 11) (Figure 35). Abundant trout populations remained at the upper site (elevation 600ft) following TS Irene (2013-2016) (Figure 31 and 32), but declined in 2017, which may be attributed partly to the July 2017 flood which changed some habitat characteristics within the sampling reach (e.g., a previous scour pool was filled with sediment). The low numbers in 2017 at the lower site was likely a combination of limited upstream passage and impacts from the July flood. Restoring aquatic organism passage to Mill Brook should remain a priority to improve local wild trout populations within this stream and lower White River mainstem.




Photo 11– Mill Brook baffles used to replace the original 1995 baffles, following TS Irene. These baffles failed in 2013

Conclusions

Wild trout populations have remained stable and, in some cases, improved throughout roughly the last 38 years within the White River Basin despite multiple flood events, major in stream impacts and overall effects from climate change. To maintain robust wild trout populations into the future, it is imperative to focus attention on protecting and restoring instream and riparian habitat, removing impassable culverts and dams, and preventing the spread of aquatic invasive species and fish pathogens.

Recommendations

- Continue to monitor wild trout populations within the White River watershed.
- Work with partners (i.e., White River Partnership, Trout Unlimited, U.S. Forest Service, U.S. Fish and Wildlife, Connecticut River Conservancy) to remove barriers, and improve habitat.
- Work with the Vermont Department of Environmental Conservation to reclassify and protect waters meeting “very good” (B(1)) criteria for recreational fishing and remain involved with the tactical basin planning process.
- Work with partner organizations to help highlight and promote recreational angling opportunities for wild trout populations with the White River Basin.
- Engage in outreach to private landowners to identify, maintain and enhance riparian areas, aquatic organism passage, and angler access.
- Engage in outreach to help limit the spread of aquatic invasive species and pathogens.
- Continue to participate in the regulatory review process to protect aquatic habitat.

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Literature Cited

- Carle, F.L. and M.R.Strub. 1978.A new method for estimating population size from removal data. *Biometrics* 34:621-630
- Carline, R.F. and B.J McCullough. 2003. Effects of floods on brook trout populations in the Monongahela National Forest, West Virginia. *Transactions of the American Fisheries Society* 132:1014-1020.
- Claussen, J. 1974. Alder Meadow Brook Job Progress Report. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-12-R-8. Montpelier.
- Claussen, J. 1987. White River Creel and Angler Use Survey. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-12-R-20. Montpelier
- Claussen, J. 1991. Atlantic Salmon Stocking Evaluations. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-12-R-24. Montpelier.
- Claussen, J. 1992b. Atlantic Salmon Stocking Evaluations. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-12-R-25. Montpelier.
- Claussen, J. 1993. White River Creel and Angler Use Survey. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-12-R-26. Montpelier.
- Claussen, J. 1994. White River/Ompompanoosuc River. Atlantic Salmon Restoration. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-12-R-27. Montpelier.
- Claussen, J. 1997. White River/Ompompanoosuc River. Atlantic Salmon Restoration. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-12-R-30. Montpelier.
- Claussen, J. 1998. White River/Ompompanoosuc River. Atlantic Salmon Restoration. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-12-R-31. Montpelier.
- Claussen, J. 1999. Statewide Inventory of Rainbow Trout Populations. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-36-R-1. Montpelier.
- Kirn, R. 2003. White River Trout Evaluations 2001. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-36-R-5. Montpelier.
- Kirn, R. 2012. Impacts to Stream Habitat and Wild Trout Populations in Vermont Following TS Irene. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-36-R-14. Montpelier.
- Kirn, R. 2013. White River / Ompompanoosuc River / Waits River Atlantic Salmon Fry Stocking Evaluation. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-34-R-15. Montpelier.

- Kirn, R. 2017. Evaluation of Wild Brook Trout Populations in Vermont Streams. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration. Annual Progress Report, F-36-R-19. Montpelier
- Ladago, B. 2018. 2017 White River Angler Survey. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration. Annual Progress Report, F-36-R-20, Study No V. Montpelier
- Lord, R. F. 1945. The Vermont Test-Water Study 1935 to 1945 Inclusive. Vermont Fish and Game Service. Fisheries Bulletin No 2. Montpelier.
- Snedecor, G.W. and Cochran W.G. *Statistical Methods*. Iowa State University Press. 1980.
- Sprankle, K. 2017. Connecticut River Basin Anadromous Fish Restoration: Coordination and Technical Assistance Annual Progress Report. U.S. Fish and Wildlife Service. F-100-R-34. Sunderland, MA.
- Platts, W.S. and R.L. Nelson. 1988. Fluctuations in trout populations and their implications for land-use evaluations. *North American Journal of Fisheries Management* 8 :333-345.
- MacMartin, J.M. 1962. Statewide stream survey by watersheds. Vermont Fish and Game Department. Federal Aid in Fish Restoration, Final Report. Montpelier.
- McMenemy, J. 1993. Atlantic Salmon Stocking, Evaluation and Habitat Survey in Tributaries of the Connecticut River. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-12-R. Montpelier.
- Warren, D.R., A.G. Ernst and B.P. Baldigo. 2009. Influence of spring floods on year-class strength of fall- and spring-spawning salmonids in Catskill Mountain streams. 2009. *Transactions of the American Fisheries Society* 138:200-210

Figures and Tables

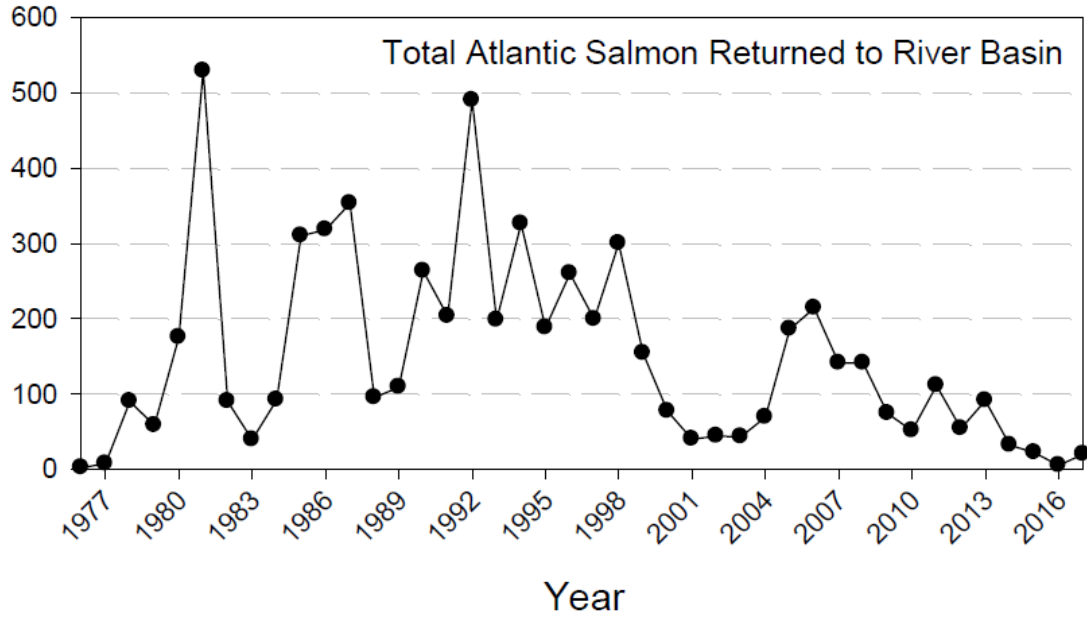


Figure 1. The total number of Atlantic Salmon returned to the Connecticut River Basin (at Holyoke Dam) between 1976 and 2017. Figure from Sprankle (2017).

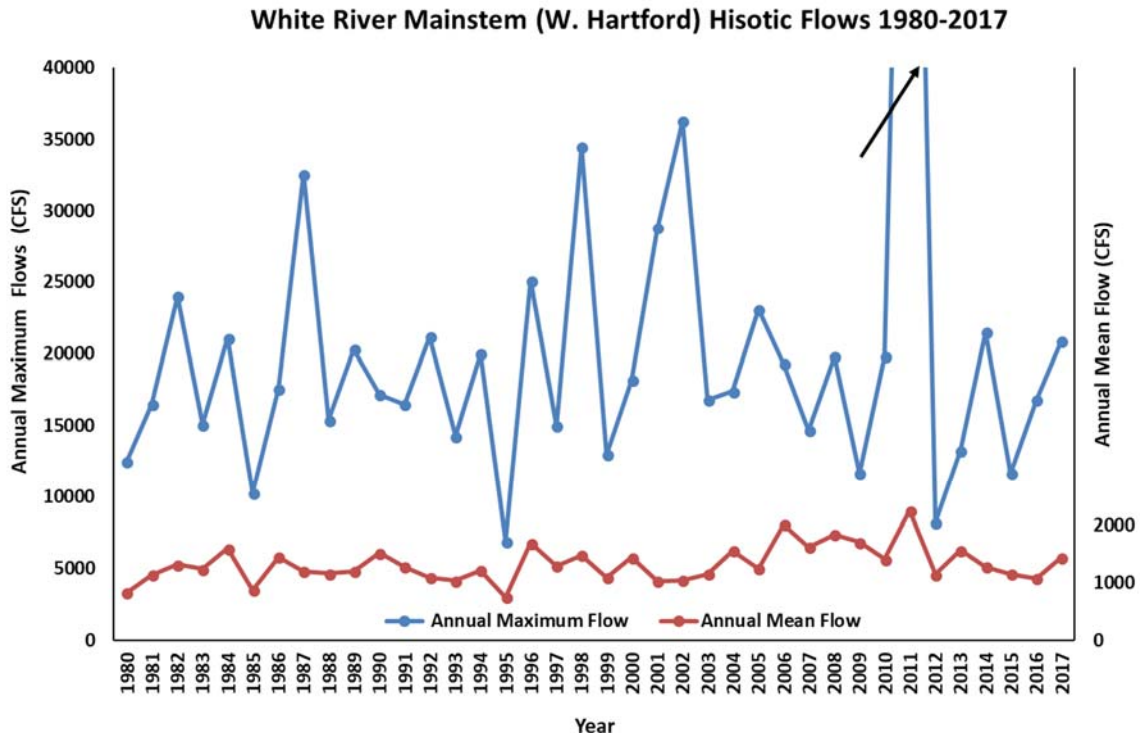


Figure 2. USGS gauge data showing the Annual mean and maximum flows measured along the Mainstem of the White River in W. Hartford

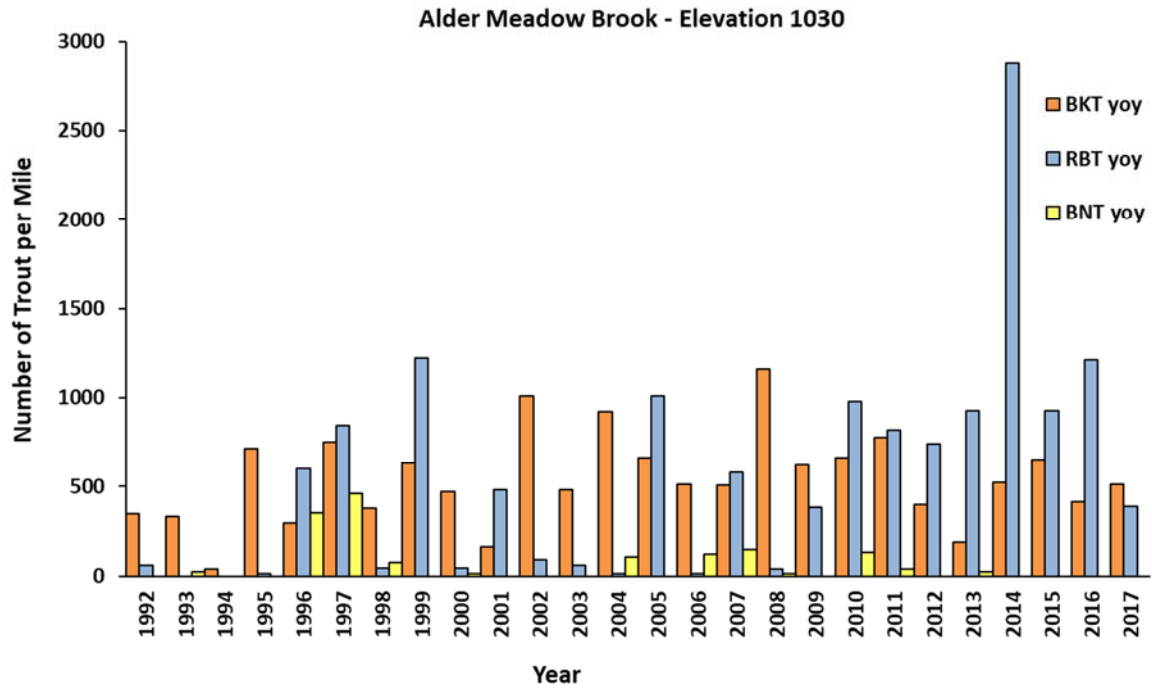


Figure 3 – The number of wild young-of-year trout (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Alder Meadow Brook annually since 1992

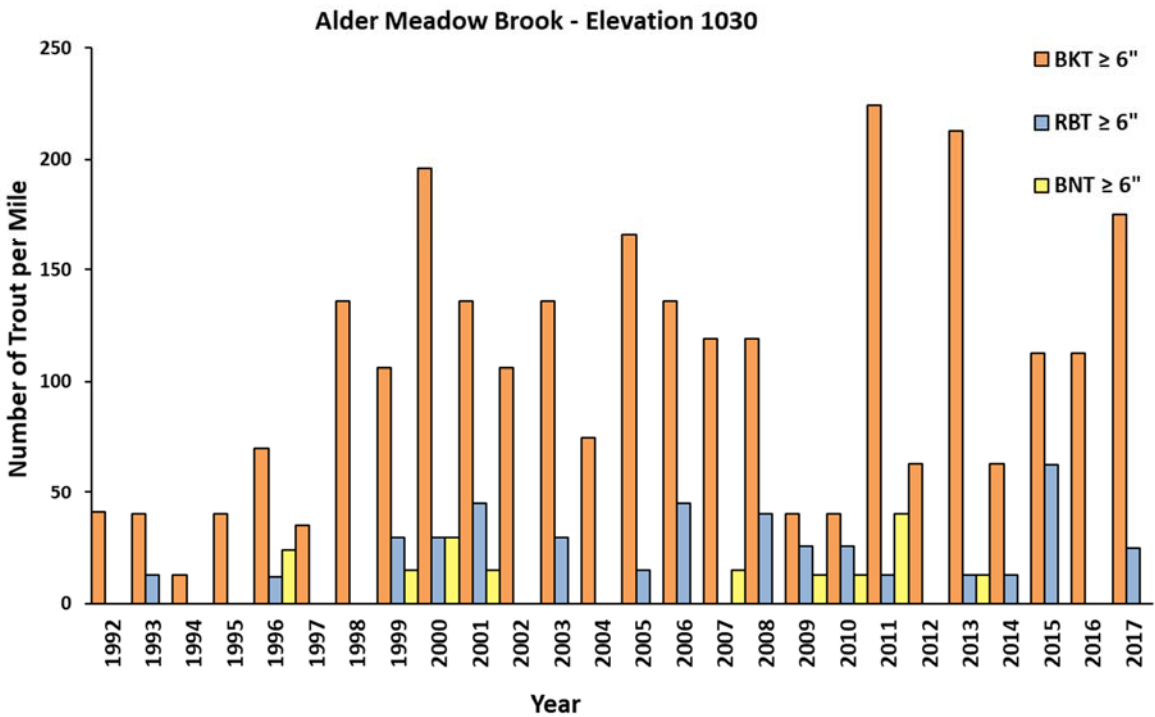


Figure 4 – The number of wild trout $\geq 6"$ (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Alder Meadow Brook annually since 1992.

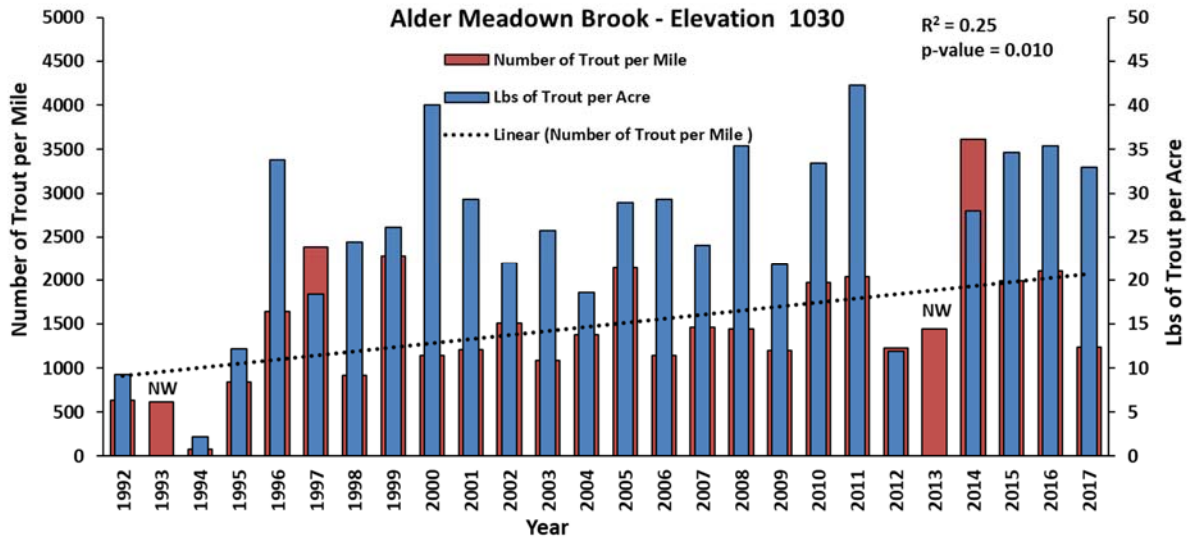


Figure 5 – Wild trout populations metrics (total trout per mile and total pounds of trout per acre) in Alder Meadow Brook since 1992

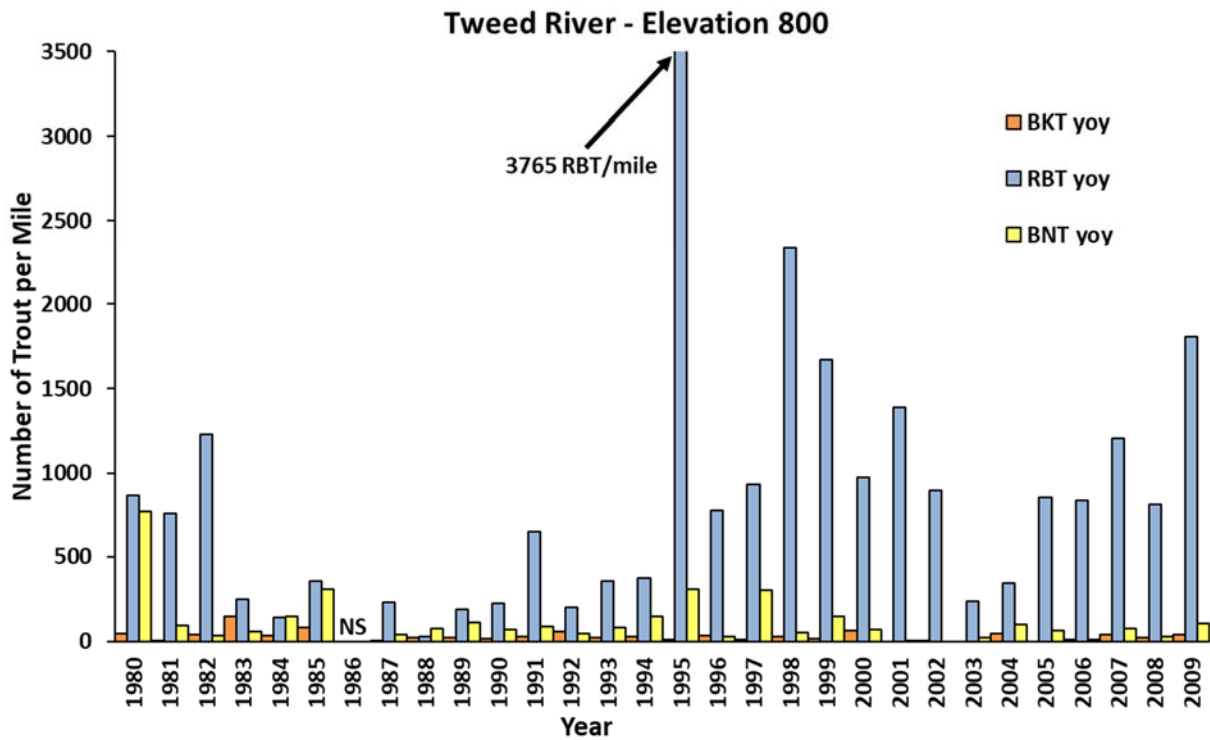


Figure 6 – The number of wild young-of-year trout (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in the Tweed River annually between 1980 and 2009.

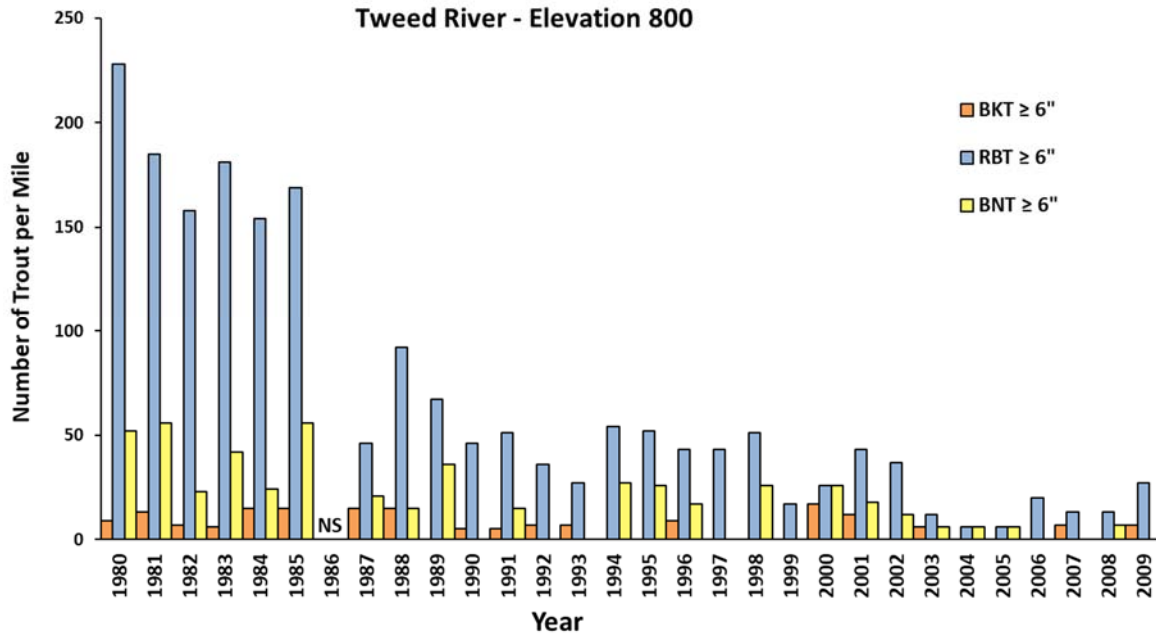


Figure 7 – The number of wild trout $\geq 6''$ (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in the Tweed River annually between 1980 and 2009.

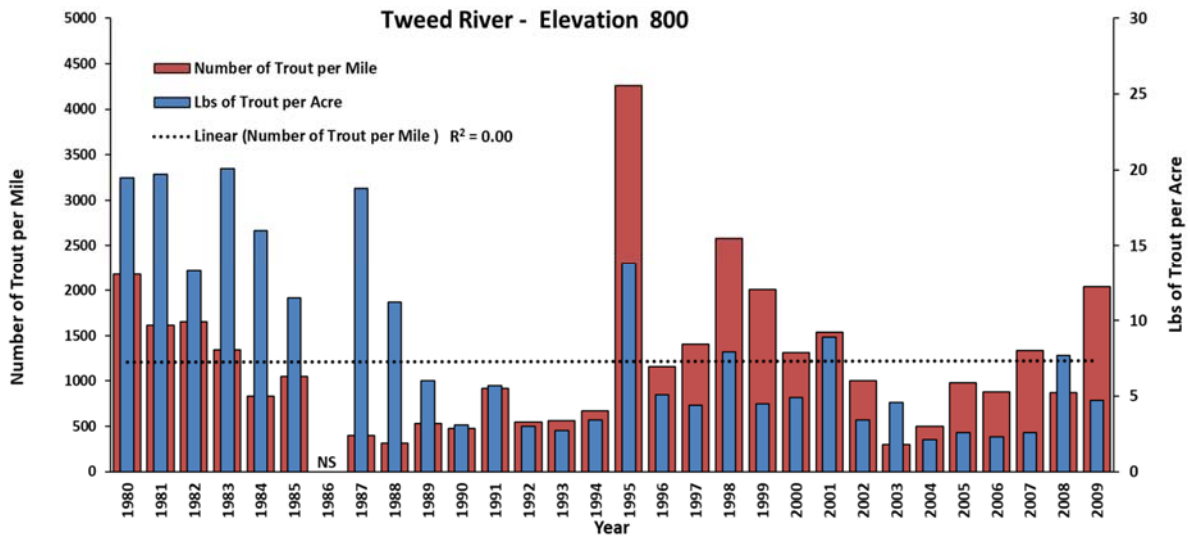


Figure 8 – Wild trout populations metrics (total trout per mile and total pounds of trout per acre) in the Tweed River between 1980 and 2009.

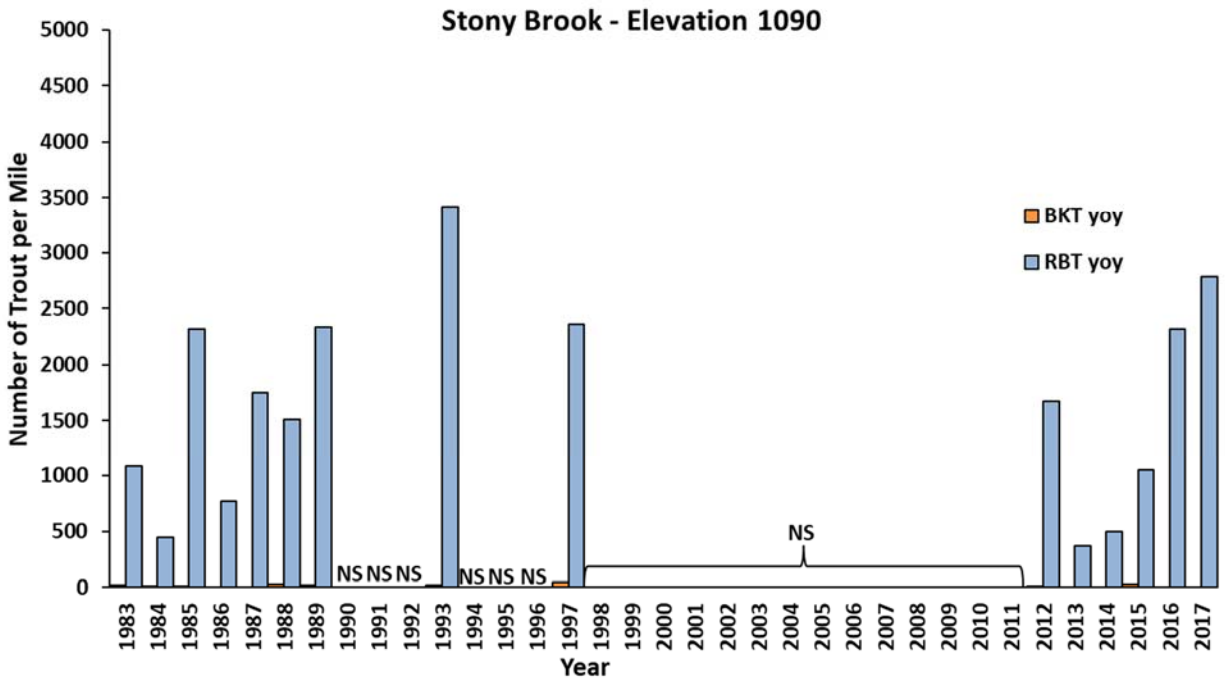


Figure 9 – The number of wild young-of-year trout (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Stony Brook (elevation 1090ft) since 1983.

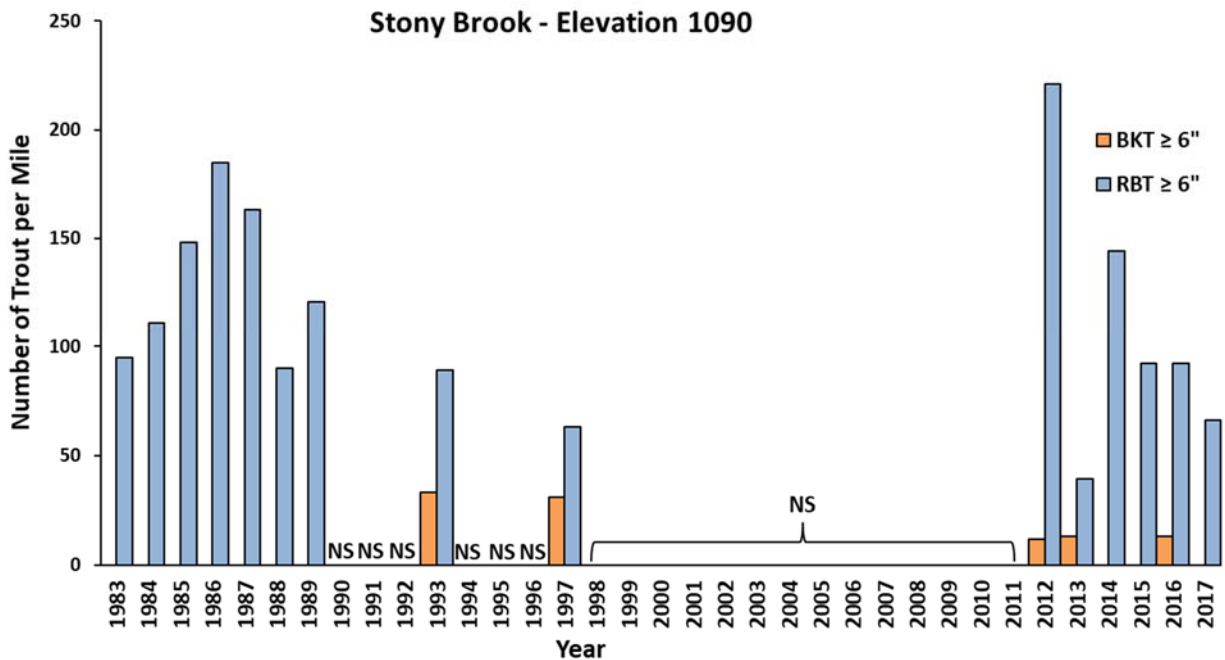


Figure 10 – The number of wild trout $\geq 6''$ (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Stony Brook (elevation 1090ft) since 1983.

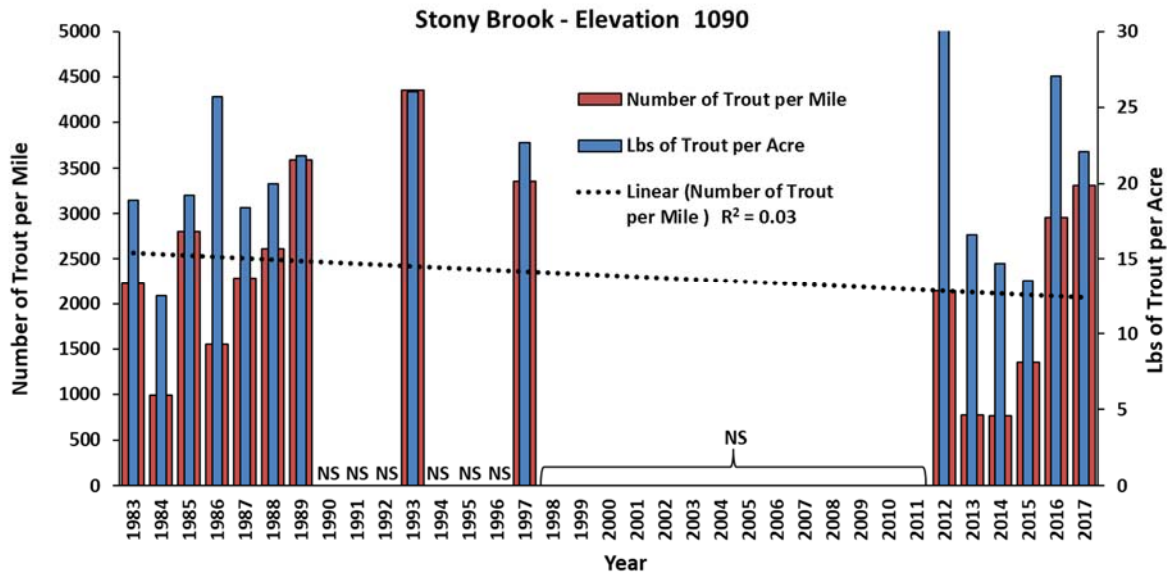


Figure 11– Wild trout populations metrics (total trout per mile and total pounds of trout per acre) in Stony Brook (elevation 1090ft) since 1983.

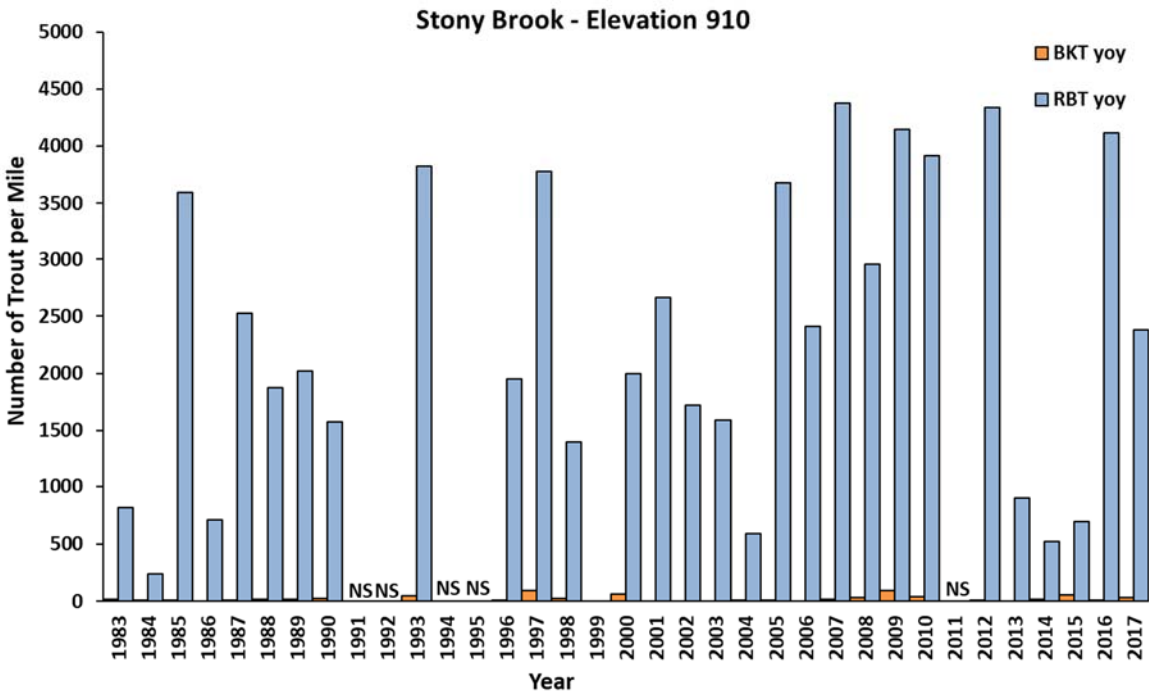


Figure 12 – The number of wild young-of-year trout (BKT = brook trout, RBT = rainbow trout) in Stony Brook (elevation 910ft) since 1983.

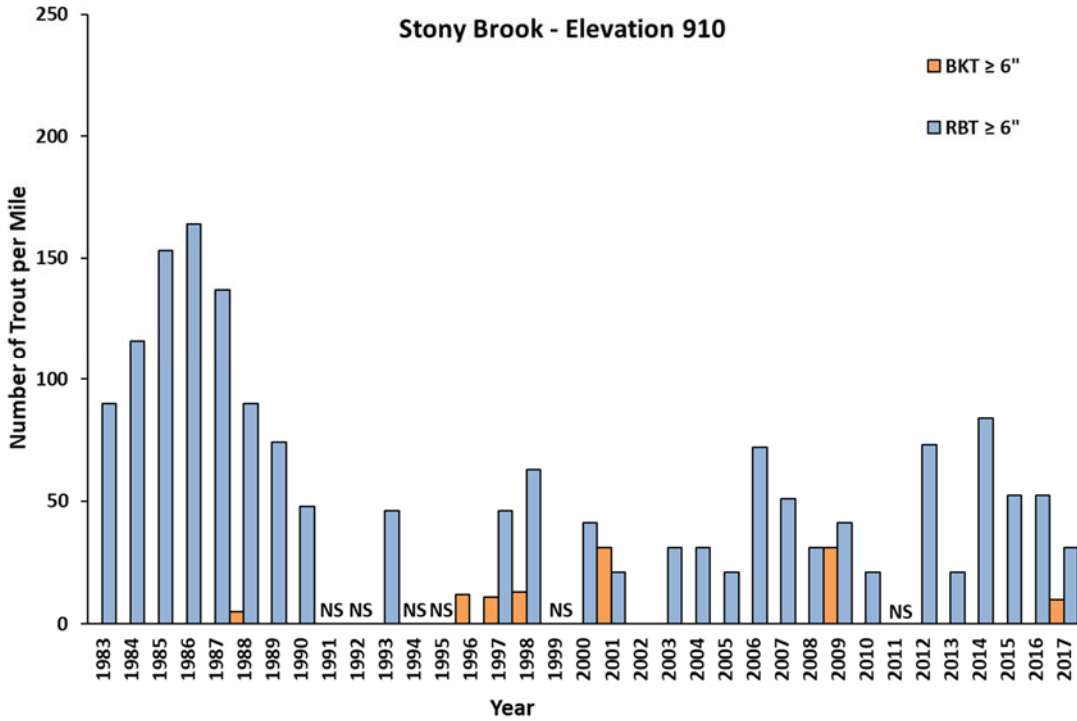


Figure 13 – The number of wild trout ≥6" (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Stony Brook (elevation 1090ft) since 1983.

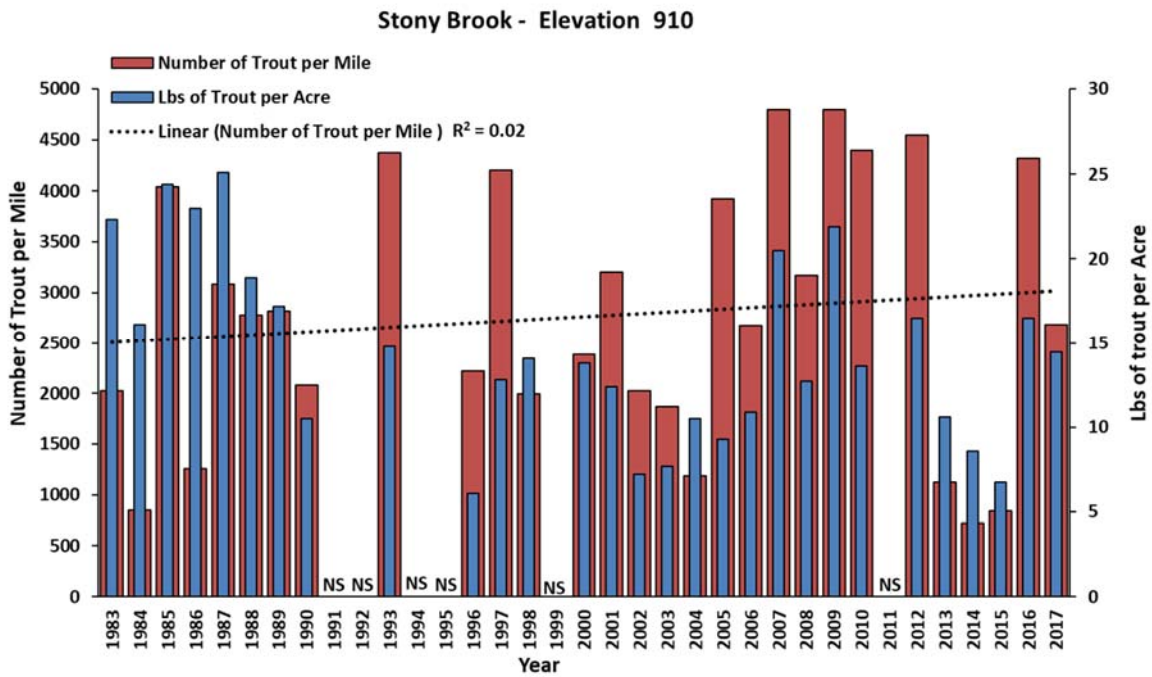


Figure 14 – Wild trout populations metrics (total trout per mile and total pounds of trout per acre) in Stony Brook (elevation 910ft) since 1983.

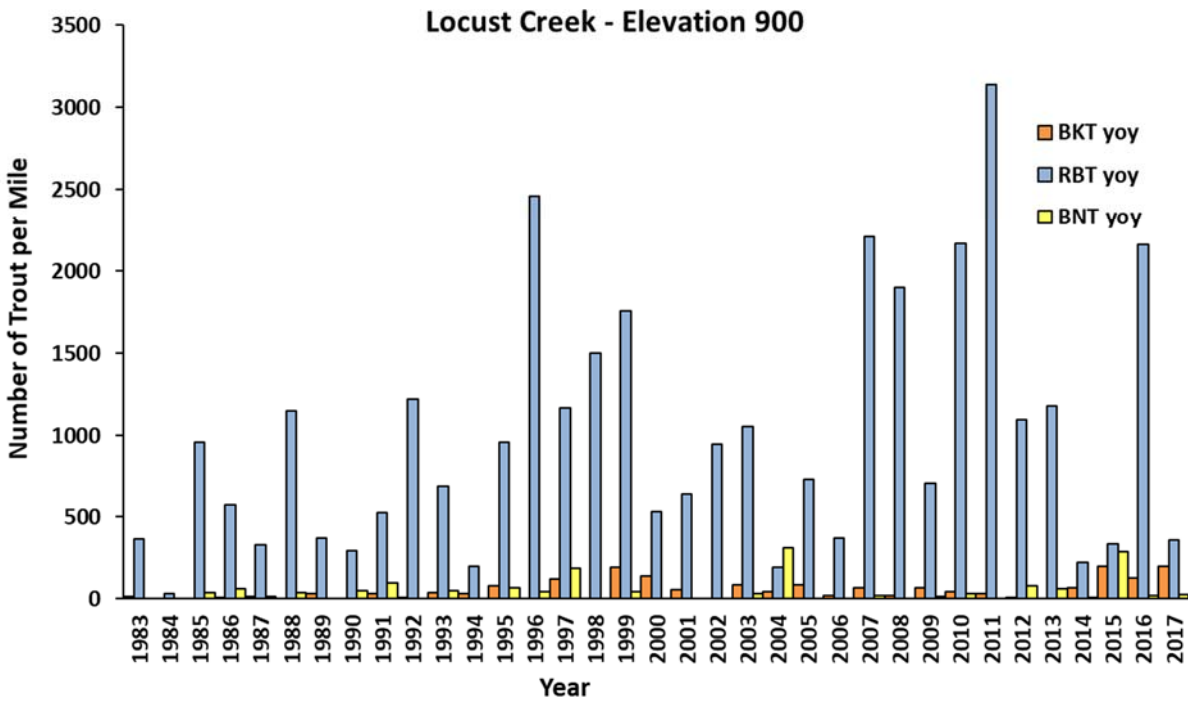


Figure 15– The number of wild young-of-year trout (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Locust Creek since 1983.

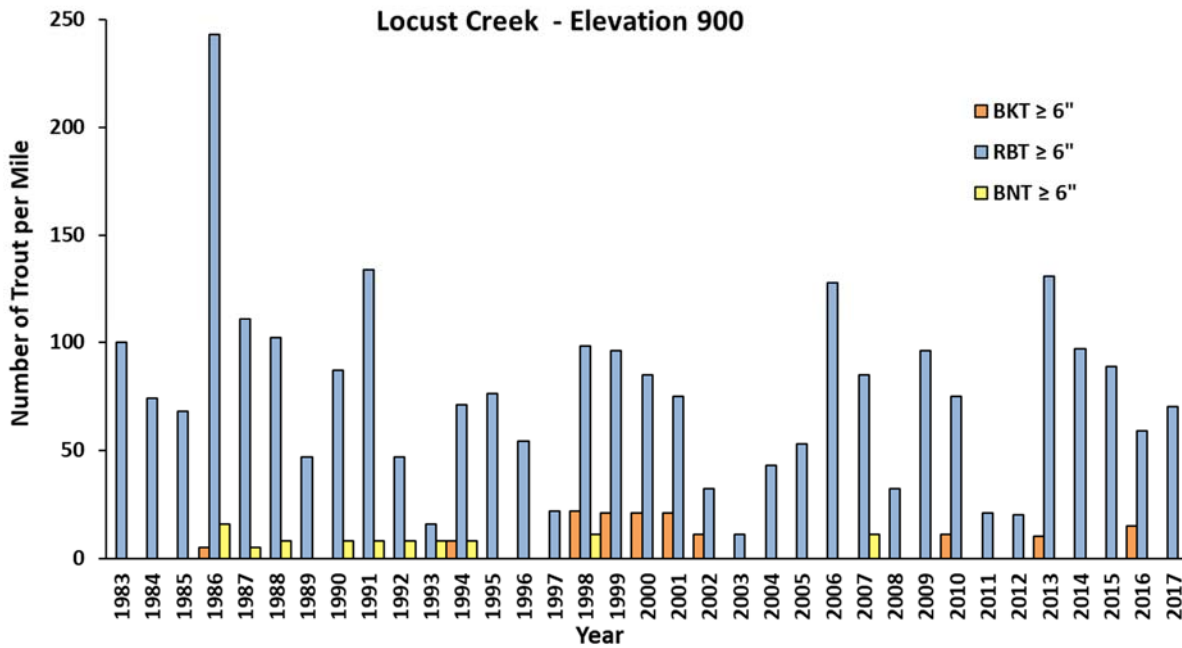


Figure 16 – The number of wild trout ≥ 6 " (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Locust Creek since 1983.

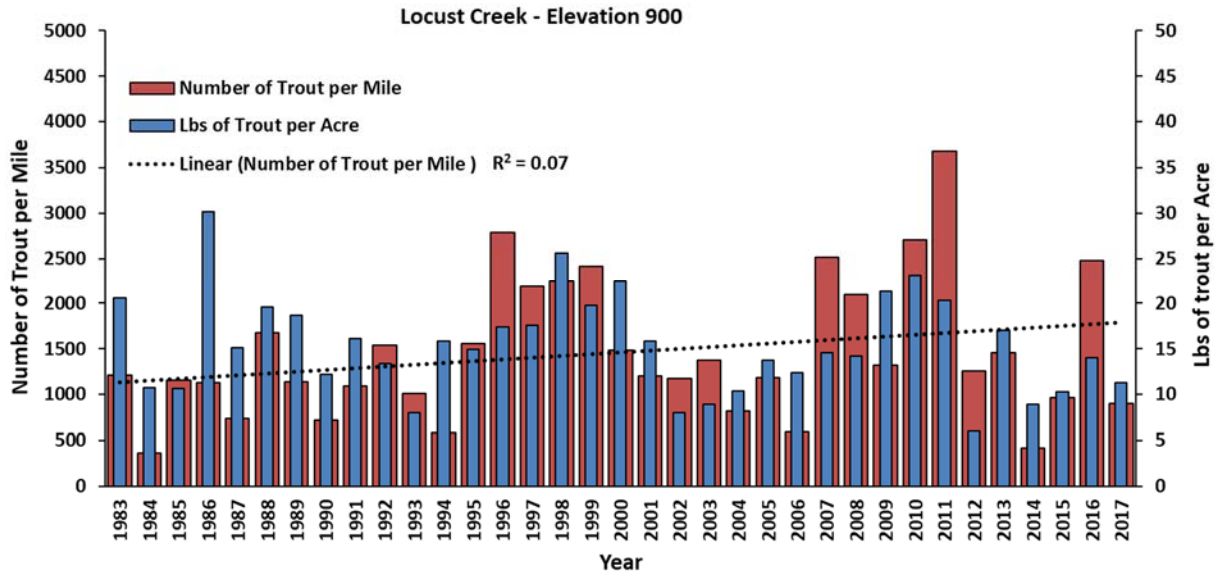


Figure 17 – Wild trout populations metrics (total trout per mile and total pounds of trout per acre) in Locust Creek since 1983.

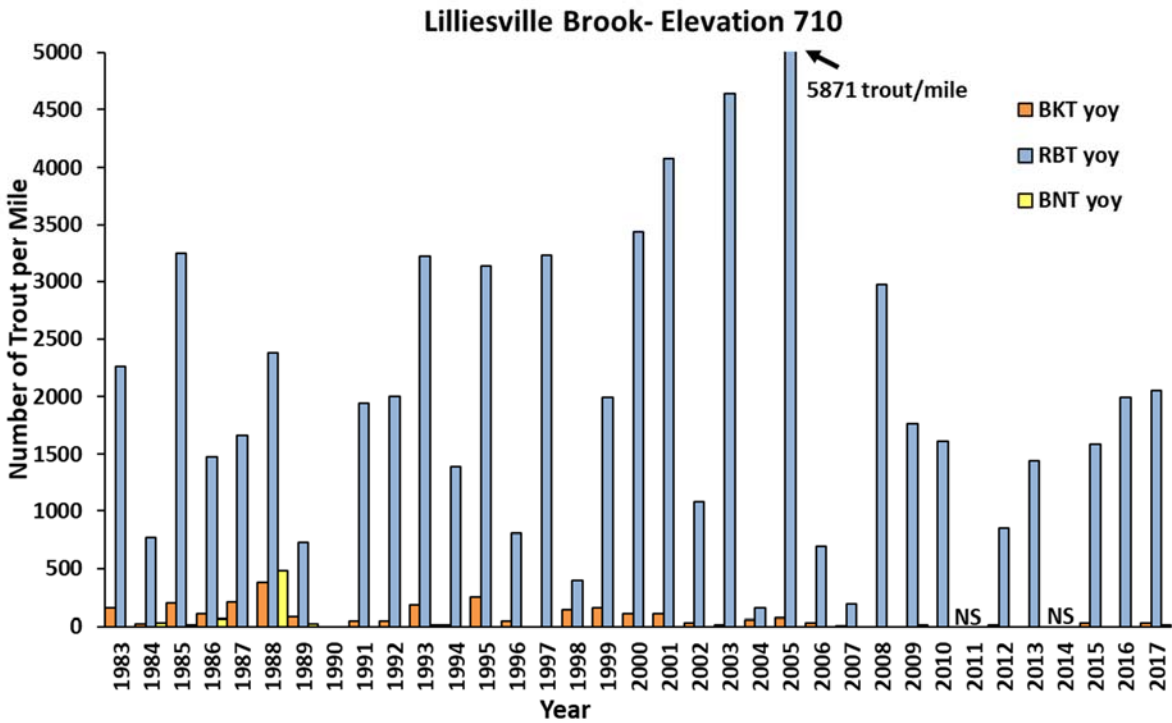


Figure 18 – The number of wild young-of-year trout (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Lilliesville Brook since 1983.

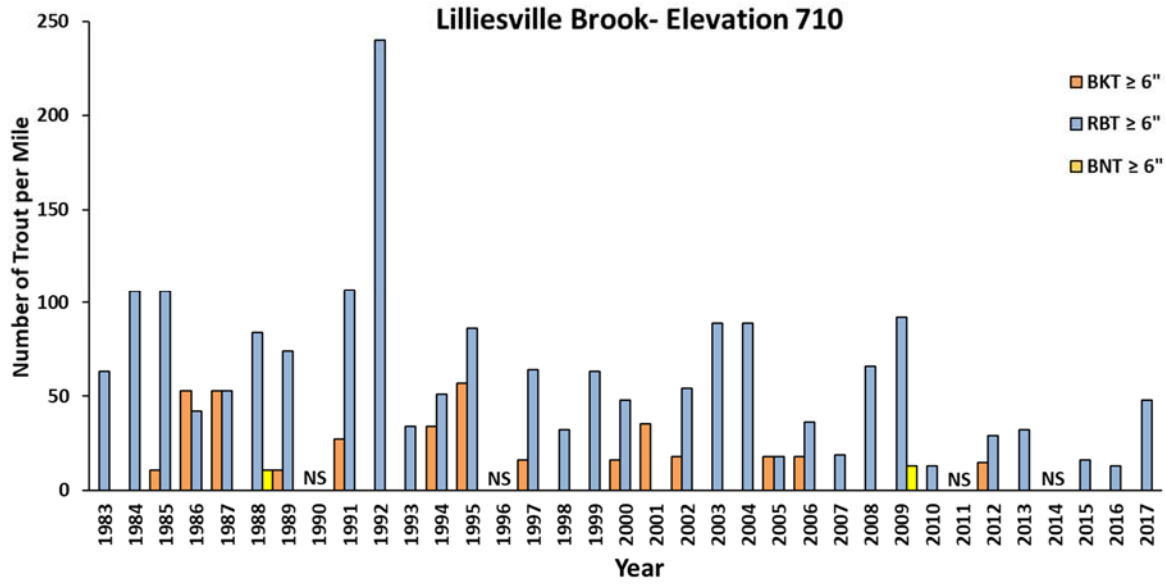


Figure 19– The number of wild trout $\geq 6"$ (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Lilliesville Brook since 1983.

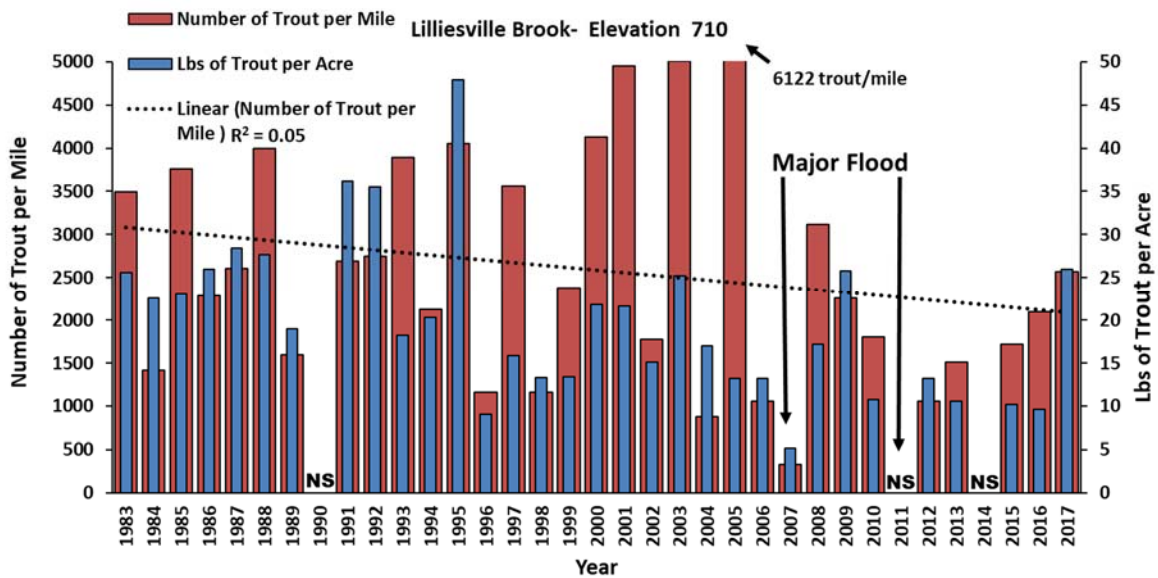


Figure 20 – Wild trout populations metrics (total trout per mile and total pounds of trout per acre) in Lilliesville Brook since 1983.

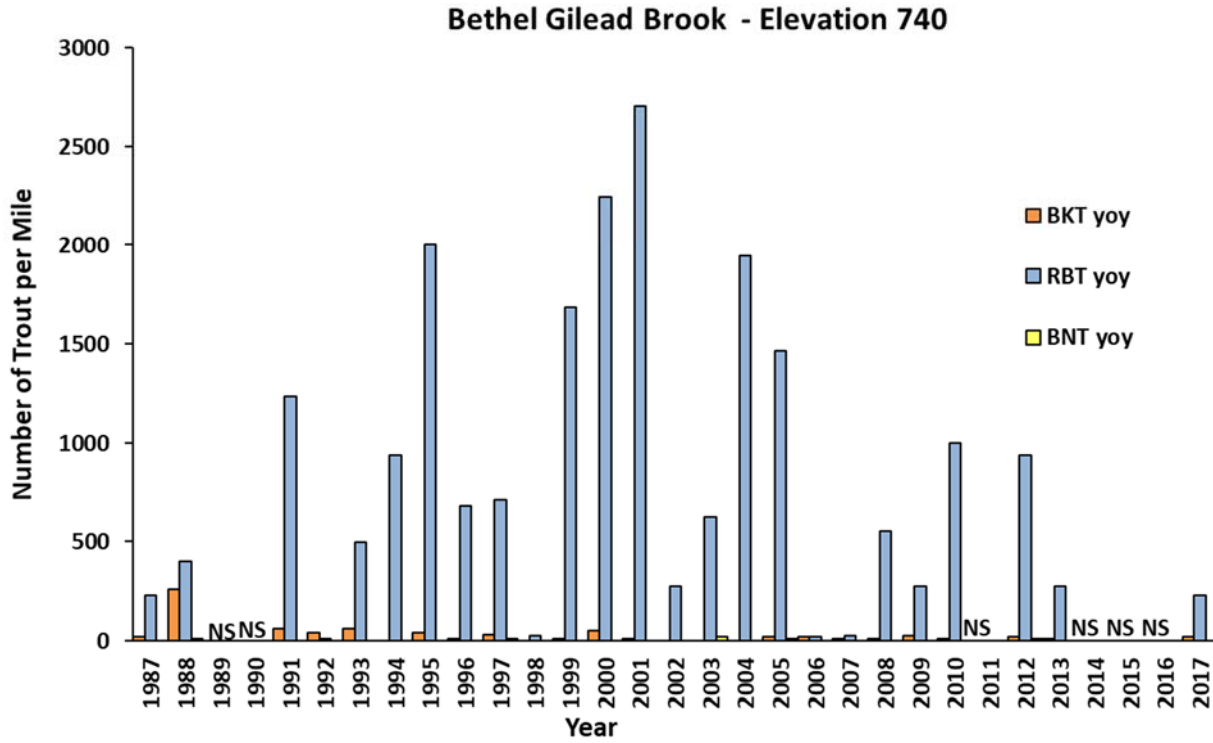


Figure 21– The number of wild young-of-year trout (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Bethel Gilead Brook since 1987.

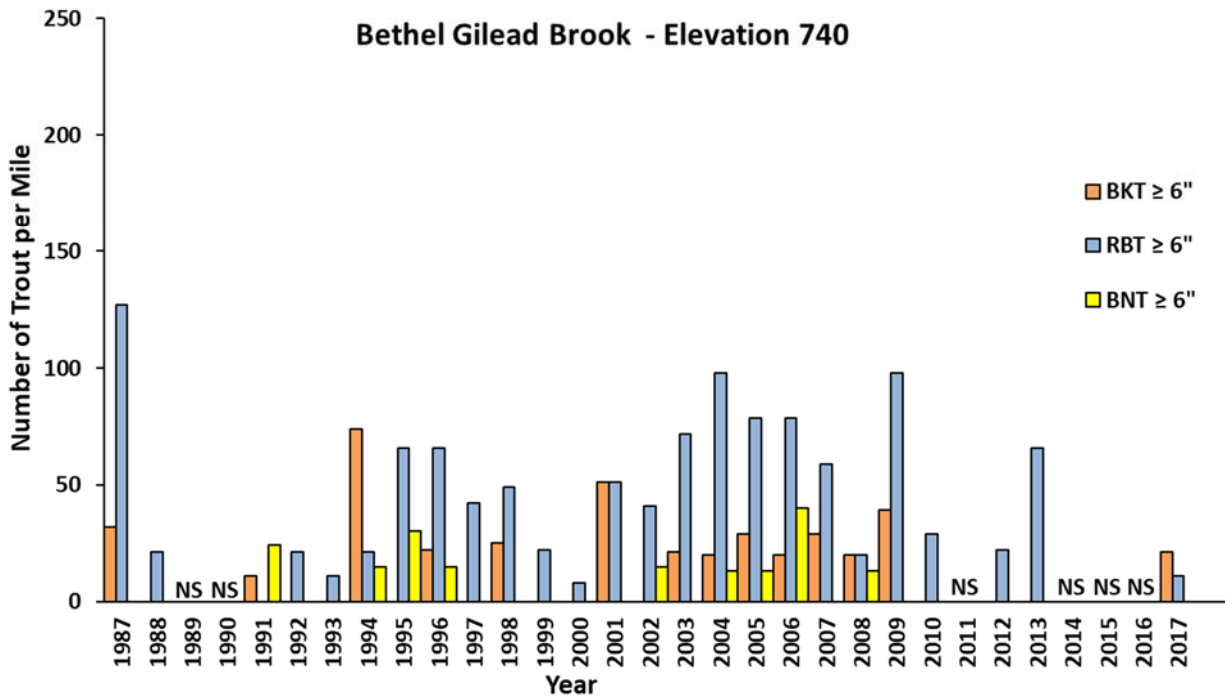


Figure 22– The number of wild trout $\geq 6"$ (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Bethel Gilead Brook since 1987.

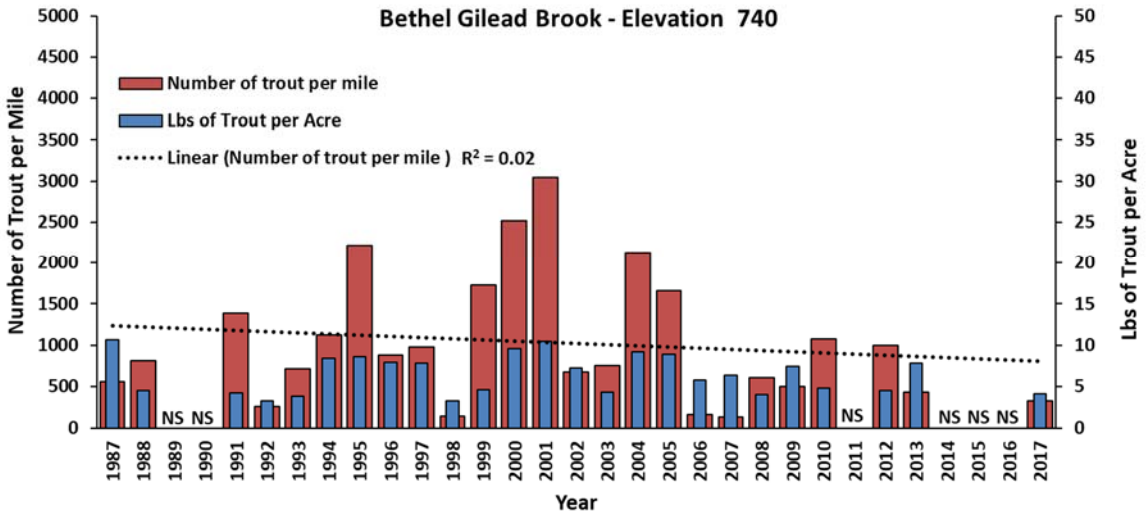


Figure 23 – Wild trout populations metrics (total trout per mile and total pounds of trout per acre) in Bethel Gilead Brook since 1987.

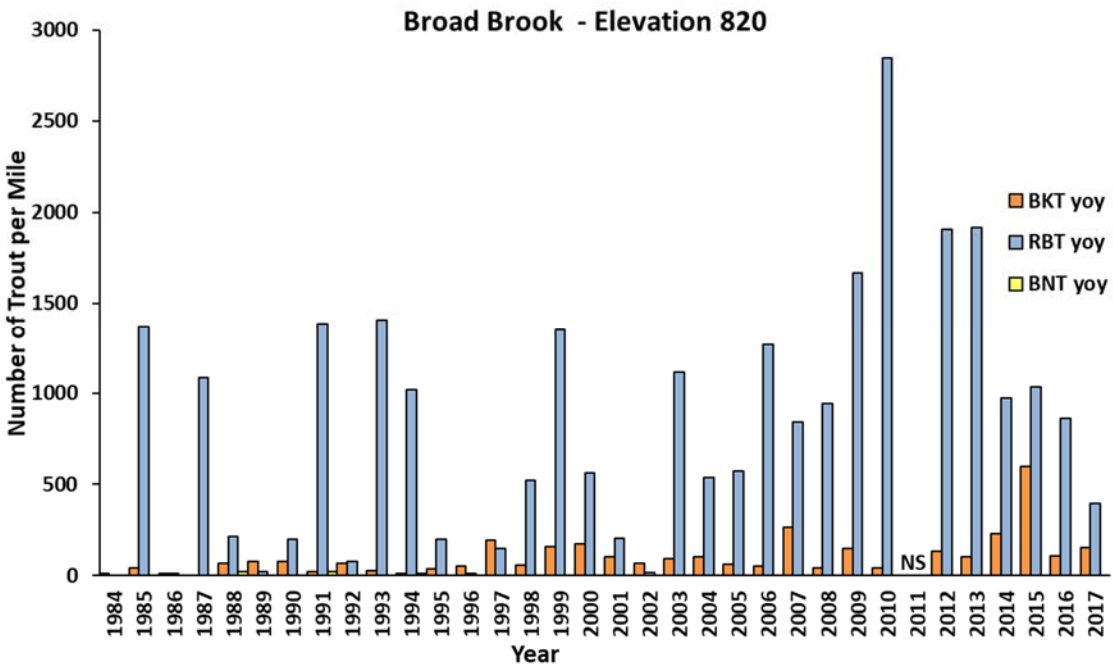


Figure 24 – The number of wild young-of-year trout (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Broad Brook (elevation 820ft) since 1984.

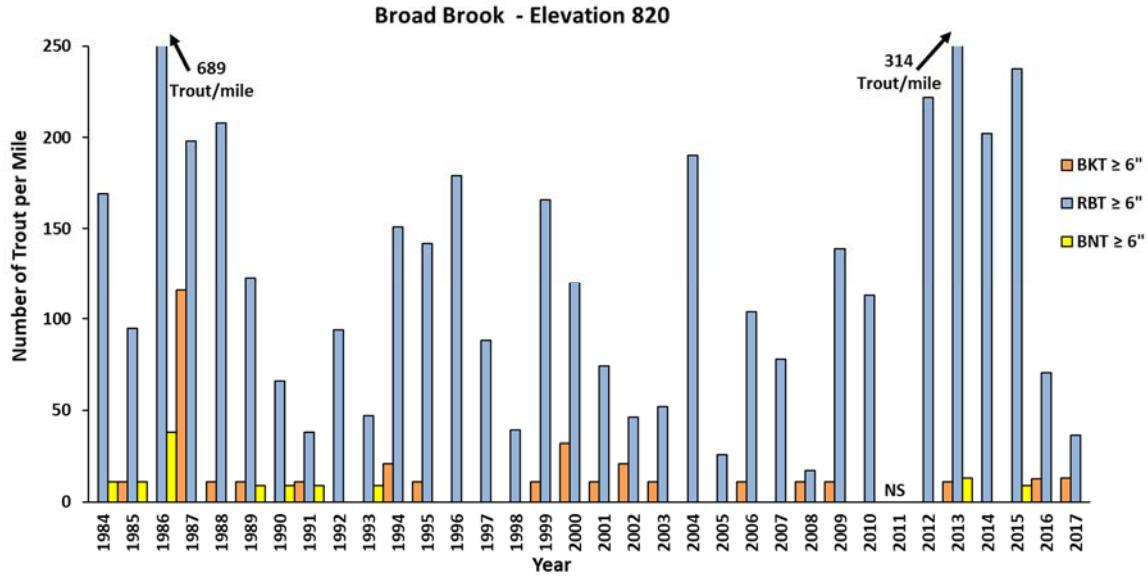


Figure 25– The number of wild trout $\geq 6''$ (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Broad Brook (elevation 820ft) since 1984.

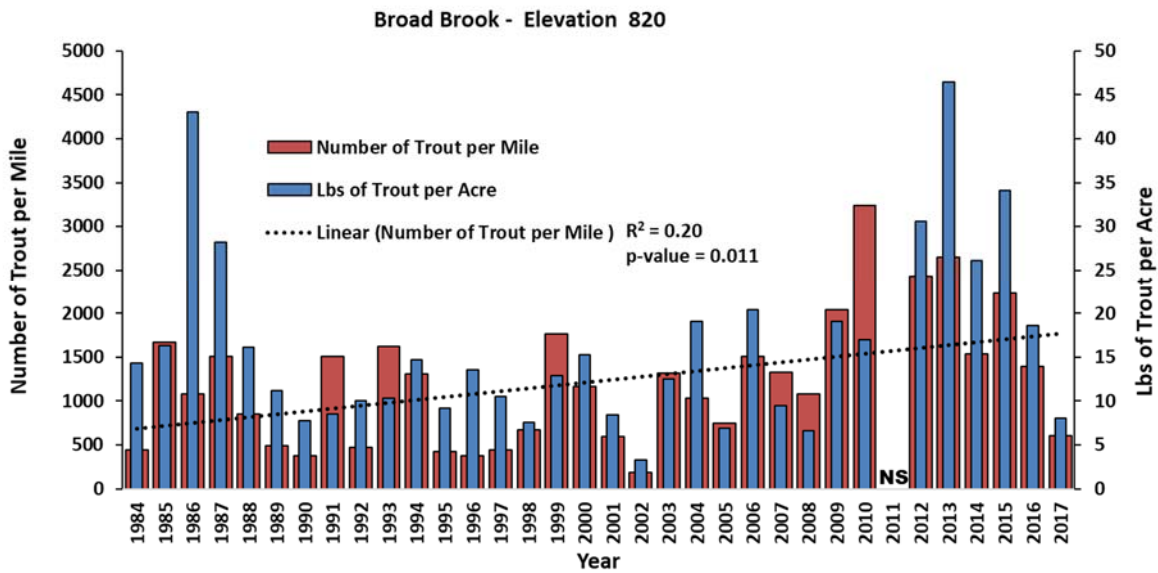


Figure 26 – Wild trout populations metrics (total trout per mile and total pounds of trout per acre) in Broad Brook (elevation 820ft) since 1984.

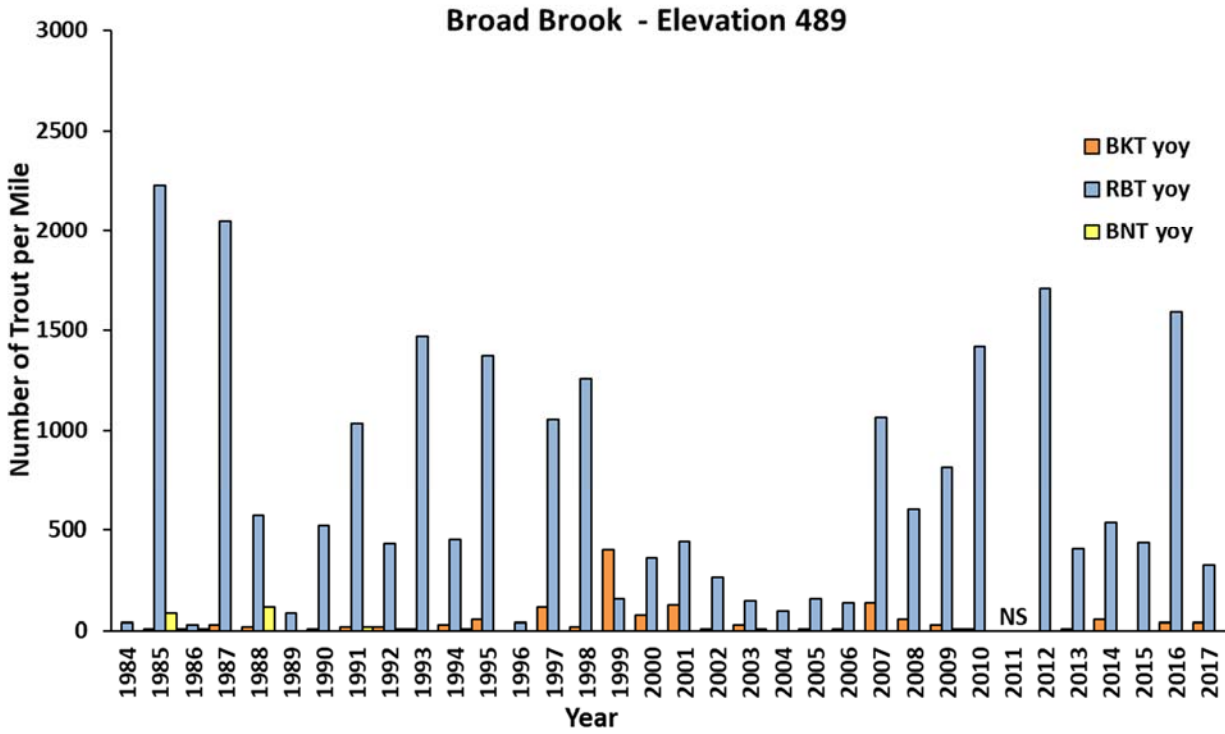


Figure 27– The number of wild young-of-year trout (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Broad Brook (elevation 489ft) since 1984.

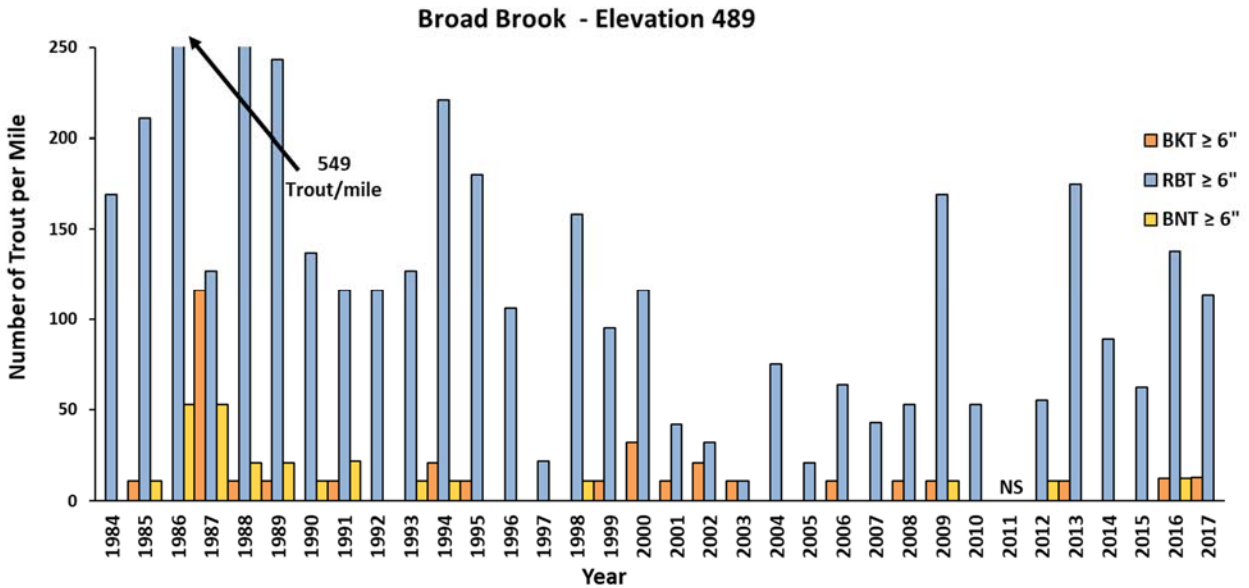


Figure 28– The number of wild trout $\geq 6"$ (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Broad Brook (elevation 489ft) since 1984.

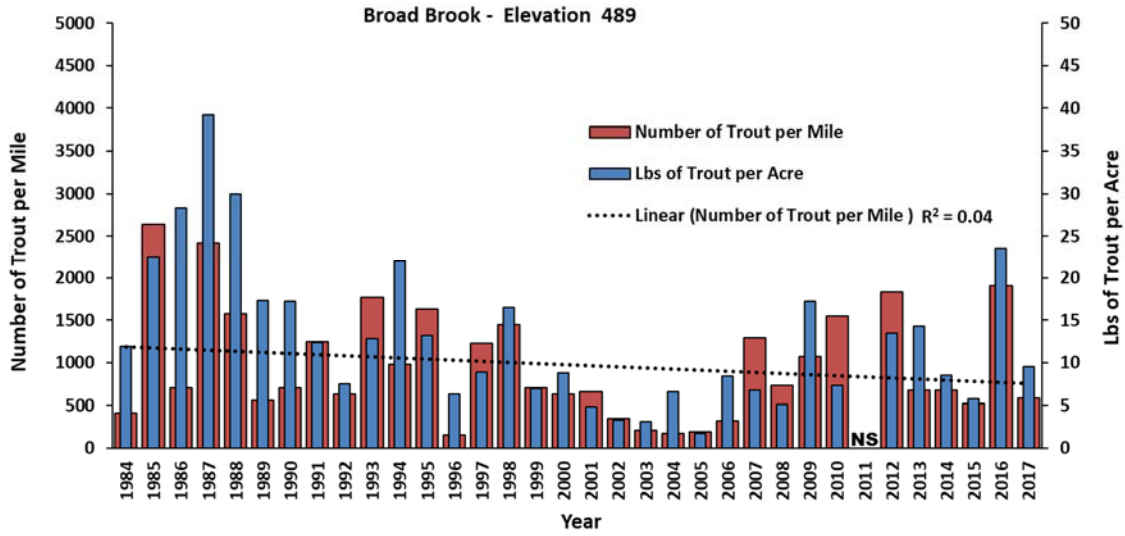


Figure 29 – Wild trout populations metrics (total trout per mile and total pounds of trout per acre) in Broad Brook (elevation 489ft) since 1984.

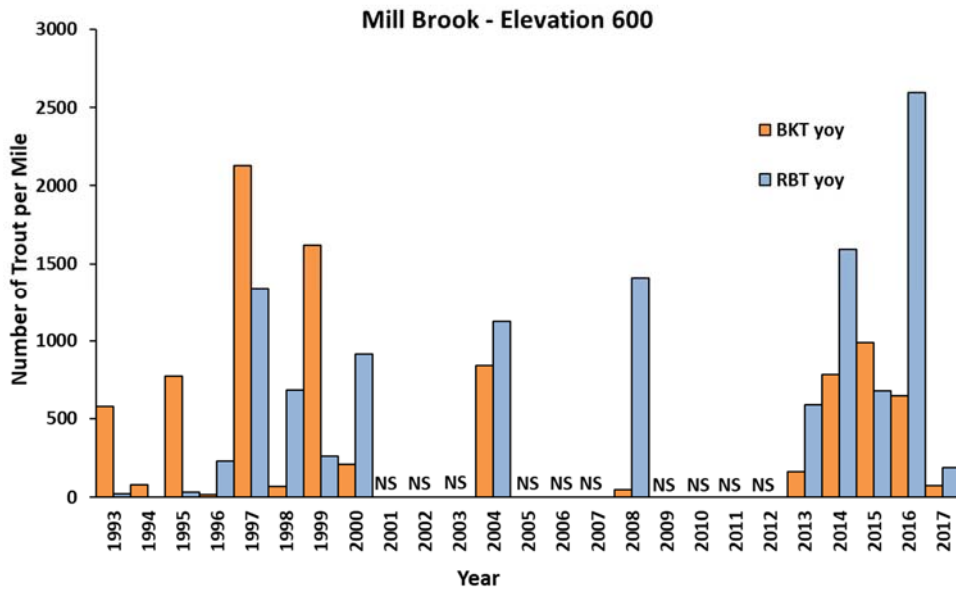


Figure 30 – The number of wild young-of-year trout (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Mill Brook (elevation 600ft) since 1993.

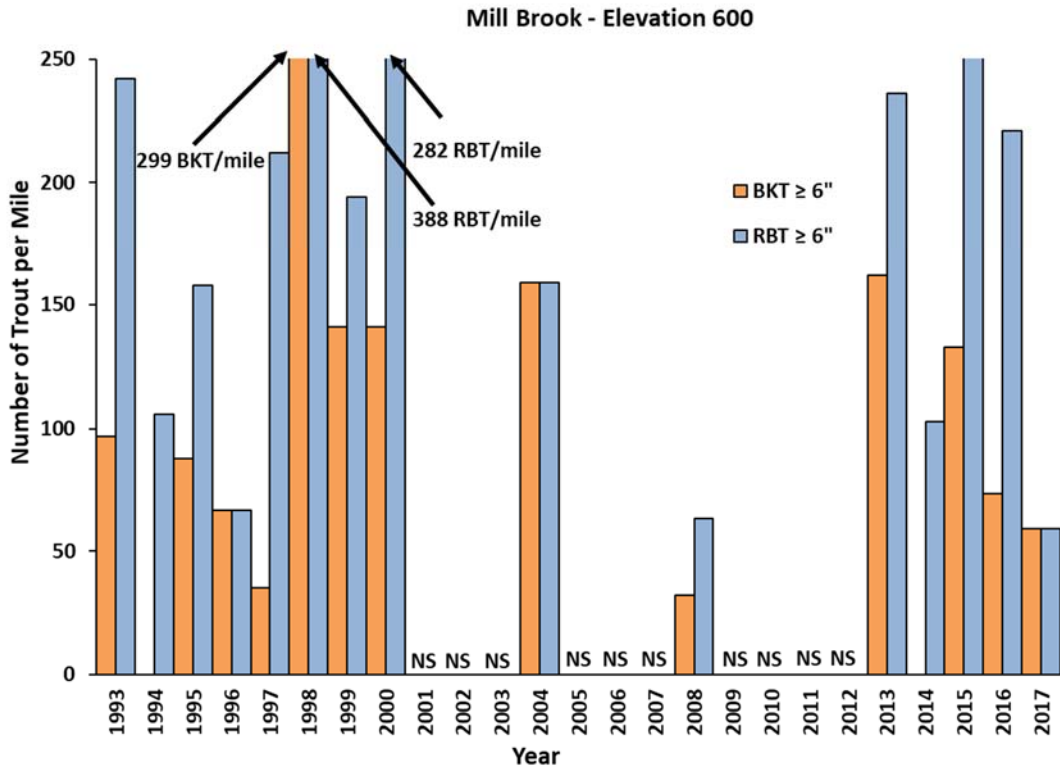


Figure 31– The number of wild trout ≥6" (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Mill Brook (elevation 820ft) since 1993.

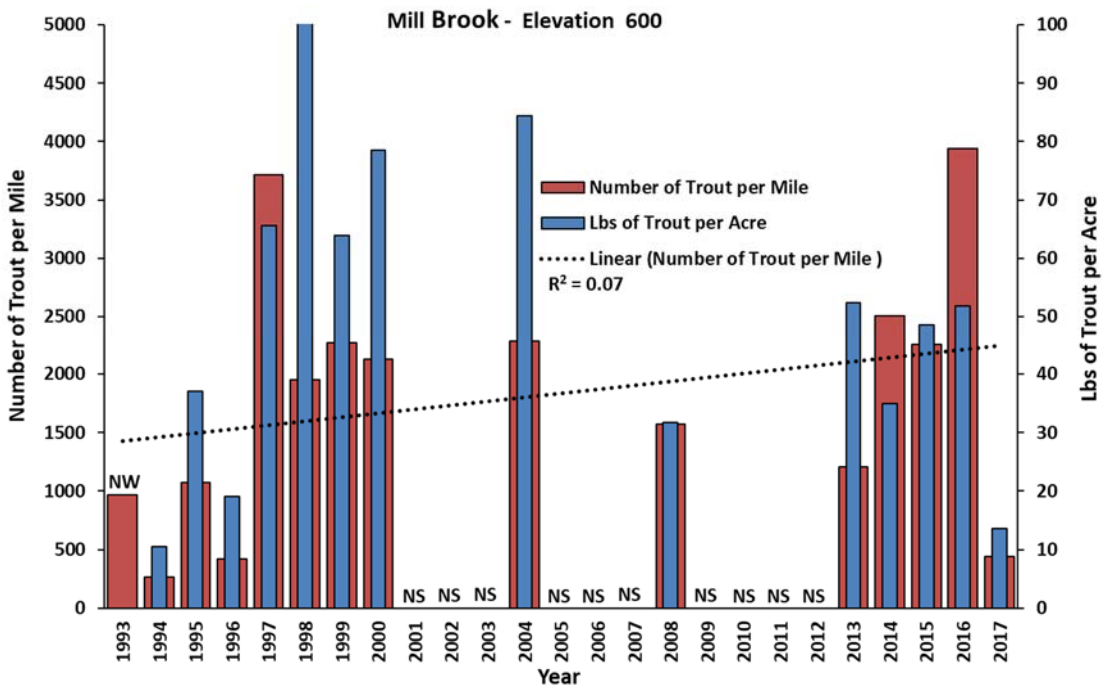


Figure 32 – Wild trout populations metrics (total trout per mile and total pounds of trout per acre) in Mill Brook (elevation 600ft) since 1993.

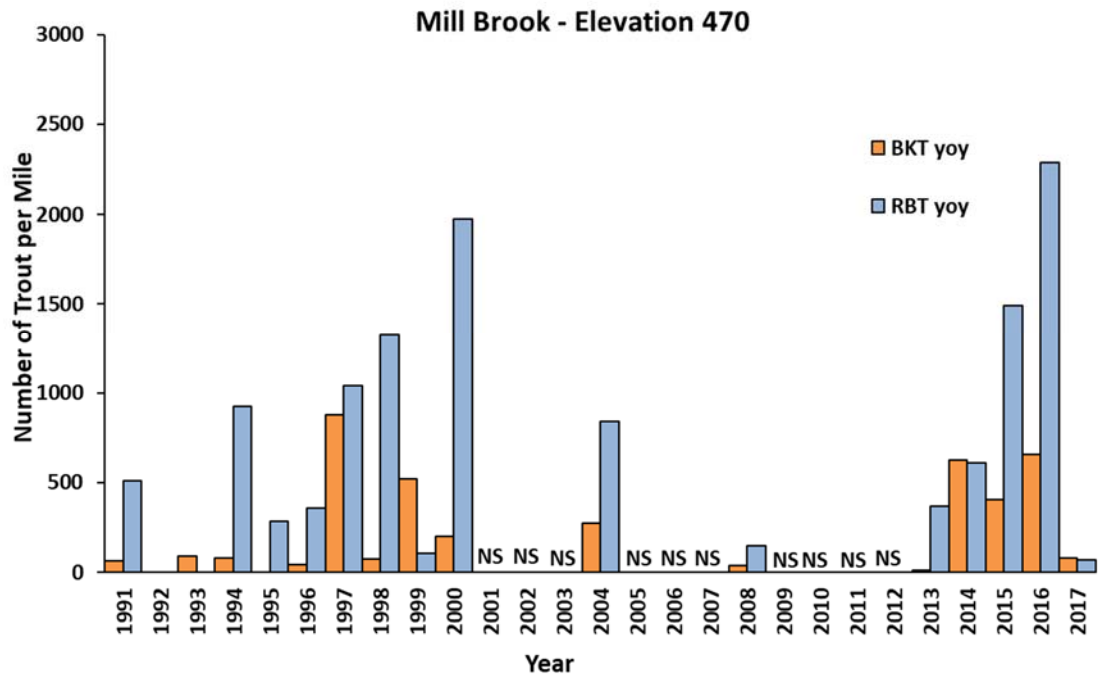


Figure 33 – The number of wild young-of-year trout (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Mill Brook (elevation 470ft) since 1993.

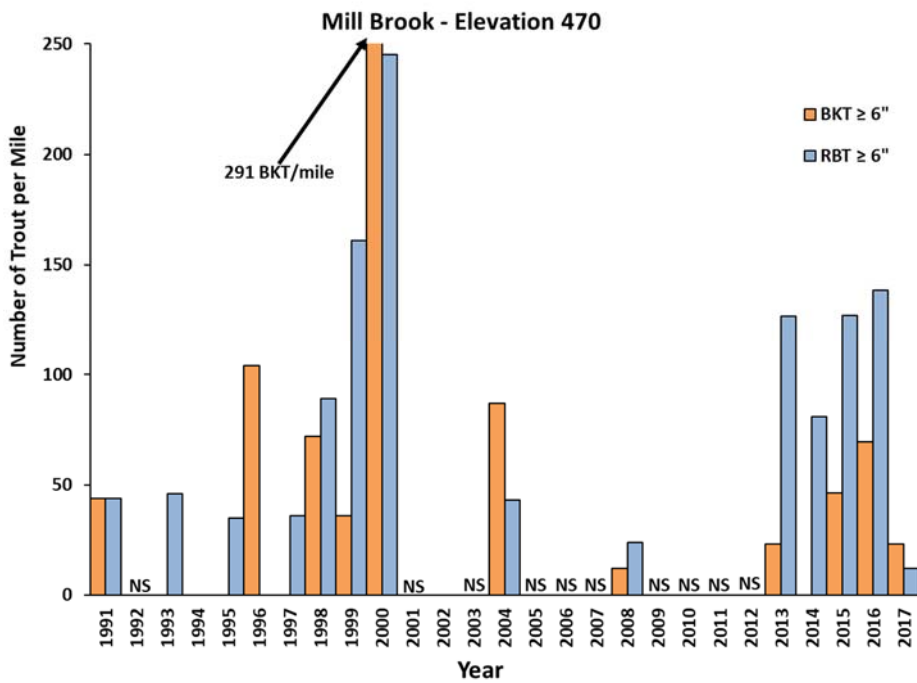


Figure 34– The number of wild trout ≥6" (BKT = brook trout, RBT = rainbow trout, BNT = brown trout) in Mill Brook (elevation 820ft) since 1993.

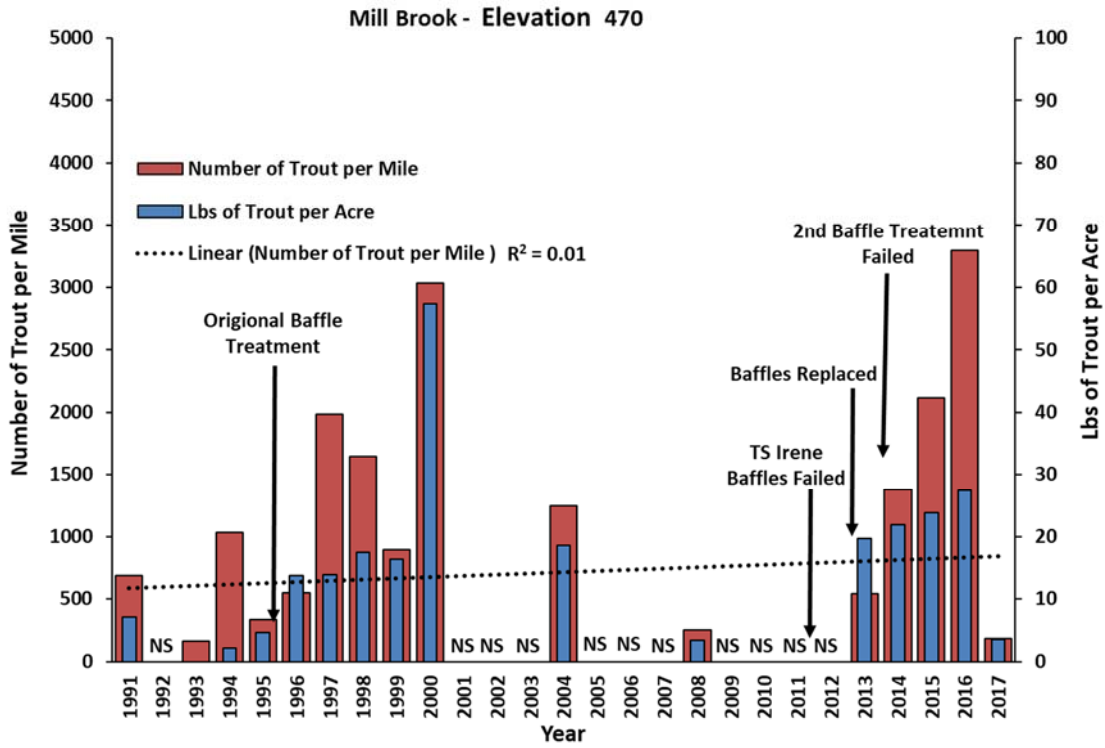


Figure 35 – Wild trout populations metrics (total trout per mile and total pounds of trout per acre) in Mill Brook (elevation 470ft) since 1993.

Table 1. The estimated length(ft) of instream habitat impacts from post-flood channel alterations identified in a partial assessment of Vermont watersheds (Kirn 2012)

Watershed	Subwatershed	Major impact (feet)	Minor impact (feet)
White River	Mainstem	12550	0
	Alder Meadow Brook	4000	10650
	Broad Brook	1340	0
	First Branch	200	0
	Hancock Branch	12800	0
	Lilliesville Brook	5000	1600
	Locust Creek	10000	0
	Stony Brook	11300	0
	Third Branch	54110	2020
	Tweed River	15050	0
	West Branch	11300	0
	Marshs Brook	1500	0
	Nason Brook	1700	0
	Clark Brook	500	0
	unnamed tributary	1700	
	<i>watershed total</i>	143050	14270

Table 2- Water temperature data (°F) between June and October from the White River Basin. Elevation (Above mean sea level (MSL)), number of days each temperature (65,68,72,75 and 80) was reached or exceeded, the overall maximum temperature (Max Temp F) and the overall maximum of a 7-day rolling average of daily maximum temperatures (7DaymaxAVG F).

Stream	Town	Year	Elevation (feet MSL)	Latitude	Longitude	Days >65	Days >68	Days >72	Days >75	Days >80	Max Temp	7-Day max AVG
Alder Meadow Brook	Granville	2001	1030	43.9995	-72.8533	22	3	0	0	0	69.4	66.5
Alder Meadow Brook	Granville	2002	1030	43.9995	-72.8533	12	0	0	0	0	67.8	65.0
Alder Meadow Brook	Granville	2017	1030	43.9995	-72.8533	0	0	0	0	0	64.2	62.0
Mainstem	Rochester	2001	830	43.8847	-72.8126	89	76	38	19	7	80.8	78.6
Mainstem	Rochester	2017	830	43.8847	-72.8126	71	37	1	0	0	72.6	70.8
West Branch	Rochester	2017	910	43.8492	-72.8373	64	35	3	0	0	74.1	70.0
Tweed River	Stockbridge	2017	800	43.7723	-72.7606	47	15	0	0	0	70.0	67.7
Mainstem	Stockbridge	2001	750	43.7908	-72.7642	51	25	6	0	0	75.0	71.3
Mainstem	Stockbridge	2017	750	43.7908	-72.7642	78	55	15	2	0	75.9	73.2
Stony Brook	Gaysville	2017	720	43.7605	-72.7070	82	57	14	0	0	73.8	72.1
Locust Creek	Bethel	2002	550	43.8108	-72.6501	97	78	49	26	14	82.7	81.4
Locust Creek	Bethel	2017	550	43.8108	-72.6501	89	66	23	2	0	75.9	73.0
Mainstem	Bethel	2017	550	43.8150	-72.6372	88	67	28	4	0	76.7	74.0
Upper First Branch	Tunbridge	2017	625	43.9309	-72.4658	77	56	17	3	0	77.1	73.1
Lower First Branch	S. Tunbridge	2017	498	43.8549	-72.5033	80	49	8	0	0	73.9	71.1
Lower Second Branch	S. Royalton	2017	535	43.8305	-72.5716	74	43	3	0	0	72.7	70.6
Upper Third Branch	Braintree	2017	750	43.9658	-72.7424	20	1	0	0	0	68.1	66.7
Bethel Gilead Brook	Bethel	2002	580	43.8641	-72.6405	102	83	47	30	3	81.2	79.5
Broad Brook	Sharon	2017	489	43.7793	-72.4866	42	5	0	0	0	69.1	67.9
Mainstem	Sharon	2017	360	43.7408	-72.4400	87	65	31	2	0	76.2	73.8
Mill Brook	Hartford	2017	470	43.7190	-72.4362	50	6	0	0	0	70.0	67.9

Table 3 – Waters that qualify for reclassification as B(1) waters for recreational fishing in the White River basin including stream name, trout species present, and downstream location.

Stream Name	Elevation (ft.)	Town	Latitude	Longitude	Species Present		
					Brook	Brown	Rainbow
Alder Meadow Brook	1030	Granville	44.000331	-72.853231	X	X	X
Ayers Brook	831	Randolph	44.018446	-72.657953	X		X
Bicknell Brook	820	Tunbridge	43.945836	-72.448703	X		
Brandon Brook	1020	Rochester	43.857868	-72.87379	X		X
Broad Brook	820	S. Royalton	43.770536	-72.527408	X	X	X
Chittenden Brook	1940	Chittenden	43.822877	-72.920075	X		
Clark Brook	1360	Granville	43.995900	-72.877870	X		
Deer Hollow Brook	1640	Granville	44.02492	-72.861475	X		
Dickerman Brook	880	Tunbridge	43.938489	-72.480217	X		
Dimick Brook	710	W. Hartford	43.694164	-72.434436	X		
Elmers Brook	445	S. Royalton	43.77899	-72.46895	X		
Farnsworth Brook	1020	Braintree	43.999633	-72.663959	X		
Fay Brook	830	Sharon	43.812414	-72.448117	X		
Flint Brook	990	Roxbury	44.068361	-72.747661	X		
Guernsey Brook	940	Roxbury	43.786214	-72.801857	X		X
Hart Hollow Brook	1020	Chelsea	44.012567	-72.439131	X		
Jail Brook	1050	Chelsea	43.992725	-72.436325	X		
Jenkins Brook	1200	Chelsea	43.960769	-72.417344	X		
Joe Smith Brook	1490	Chittenden	43.84027	-72.898349	X		X
Lilliesville Brook	700	Bethel	43.800700	-72.684000	X	X	X
Locust Creek	900	Barnard	43.755819	-72.636819	X	X	X
Michigan Branch	1040	Pittsfield	43.777140	-72.844460	X		X
Mill Brook	470	W. Hartford	43.718981	-72.436175	X		X
Patterson Brook	1240	Granville	43.993917	-72.867004	X		
Podunk Brook	680	W. Hartford	43.716908	-72.405097	X		
Riford Brook	960	Braintree	43.948803	-72.735989	X		X
Robbins Branch	1280	Hancock	43.926729	-72.921416	X		X
S. Washington Creek	1137	Chelsea	44.014364	-72.430419	X		
Stony Brook	910	Stockbridge	43.732278	-72.722072	X		X
Tweed River	800	Pittsfield	43.769914	-72.805872	X	X	X
Unnamed Trib. to S. Wash. Ck.	1140	Chelsea	44.015083	-72.428806	X		
Unnamed Trib. to the Mainstem	1450	Rochester	43.879987	-72.780572	X		
West Branch White River	940	Rochester	43.85032	-72.85724	X		X
White River	740	Stockbridge	43.788971	-72.763347		X	X