Status of Brook Trout and Coldwater Habitat

Great Brook Watershed

2018

White Mountain National Forest

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Written by:

Mark Prout, Fisheries Biologist

Summary of Findings to Date:

- Average summer stream temperatures of Great Brook and Beaver Brook within the White Mountain National Forest were indicative of "true" coldwater streams (<18 C) and did not approach "lethal" averages (21 C) for eastern brook trout, between 2012 and 2018.

- Despite ranking as true coldwater streams, average 30-day summer stream temperatures varied 2.4 C (15.4 – 17.8) at Beaver Brook and 2.1 C (15.8 – 17.9) at Great Brook during the sampling years. Given this year-to-year variation without any detectable trend, the ability to detect a trend would either take many years of sampling or a very substantive change in either air temperature or riparian forest condition.

- Despite differences in slope, substrate, drainage area size, all brook trout sampling sites varied similarly across the three years of sampling. Both biomass and densities of adult brook trout were highest in 2016, declined by nearly 50% in 2017, and remained within +/- 20% in 2018 of 2017 estimates.

- Young-of-the-year (YOY) brook trout declined each year from 2016 to 2018 at all sites. Low YOY densities observed in 2018 at all five sample reaches, as well as at other monitoring sites in the WMNF, suggest that the October, 2017 storm event may have caused high egg mortality shortly after spawning occurred. YOY density at GRT10 in 2018 was the lowest estimate in 15 years of monitoring.

- Comparing data collected in this effort to historical data in the watershed suggests that brook trout populations ranged from "high" in 2016 to "average" abundance by the end of 2018. Summer stream temperature data suggest that thermal conditions never reached stressful levels for brook trout in any of the years of sampling. While average stream temperatures were considerably lower in 2017 and nearly identical in 2016 and 2018, temperature is not likely a large factor in controlling the shifts in abundance observed

- Although flow data was not measured at fish sampling sites, very low flows were observed in the summer of 2016, a high flow event occurred in July of 2017, and a higher flow event occurred in October of 2017. These events may have strongly influenced fish habitat and fish abundance over the three years.

- Trends in both brook trout metrics and stream temperatures suggest that annual "weather" patterns may strongly influence these parameters watershed-wide. Future monitoring of these fish metrics in Beaver Brook after timber harvesting operations are initiated (Albany South Project Decision, 2018), should consider these broader "influences". Therefore, continued monitoring at the long-term sites in Great Brook (GRT10) and Willard Brook (WIL10) would be beneficial for historical comparisons. In addition, no forest harvesting is scheduled within the Willard Brook sub-watershed during the time that the Albany South Project will be implemented, therefore providing a "control" that can highlight potential "weather" effects on brook trout and its' habitat.

Introduction:

In response to public concerns regarding the potential effects of forest management to streams in the Great Brook watershed in the Albany South Project Area of the White Mountain National Forest, a collaborative monitoring effort was initiated in 2016. At this time, the Kezar Lake Watershed Association (KLWA) had already begun collecting data in the watershed for their Climate Change Observatory and the WMNF had already had a history of monitoring brook trout in Great Brook. KLWA had contracted the services of Stantech Consulting Services (SCS) to provide fisheries expertise about the watershed. Together, in 2016, staff of the WMNF and SCS identified 5 stream reaches that would document brook trout population numbers downstream of future potential timber harvesting activities associated with the Albany South project. In 2018, an official decision was made by the WMNF to proceed with several timber sales in the watershed. Data presented here serves two purposes: 1) baseline data for comparison to data collected during/after timber harvesting occurs in the Great Brook and Beaver Brook drainages; and 2) provide baseline data for detecting long term trends associated with climate change.

Selection of Sampling Sites and Reaches:

Each monitoring site is described below and locations are shown in Figure 1.

BEA10: This site was located on Beaver Brook just above the Forest Service property boundary to allow monitoring of Forest Service timber sale operations within the Beaver Brook watershed. Since harvesting will be widespread throughout the Beaver Brook drainage, this site is the priority for monitoring impacts associated with timber harvesting. In addition to harvesting, road reconstruction and stream crossings will be needed for transporting logs out of the watershed. The brook is a meandering, low gradient reach dominated by a gravel substrate. Pools are more common in this reach than in other reaches due to lateral scour along meander beds and the gravel substrate.

GRT10: This site was monitored because of the long term data collected there on brook trout beginning in 1994. Although there are gaps in the data series, it provides the longest running data set on brook trout in the WMNF. The site is considerably different than other sites in that it located just above a ledge falls and just below a large cascade plunge pool. It also is dominated by large angular rock and round boulders due to the presence of bedrock near the surface in the area. For this reason it is considered a highly stable reach despite its inclusion of a large meander pool, boulder pocket water, and a small side channel along the main riffle. Changes in fish numbers is more likely to be due to changes in flows or temperature, than in habitat structure. While some timber harvest is proposed within the watershed upstream of the site, it is a small proportion of the watershed.

WIL10: This reach is located on Willard Brook, the coldest tributary of Great Brook. This site was added because no timber harvesting will occur within this drainage area, therefore provides information on brook trout which are responding mainly to physical forces not associated with active land management. A snowmobile bridge does cross the brook in the lower end of the station, but erosion

associated with the bridge appears to be insignificant.

GRT05: This site is located on the furthest downstream reach of Great Brook within the WMNF boundary. This site was chosen because warmer stream temperatures associated with climate change would occur here first, within the National Forest. This reach is low gradient with plane bed features and some pools associated with LWD. The streambed is unstable in some areas due to its large gravel substrate.

BEA05: This site is located on Beaver Brook on private land, just upstream of the Hut Road crossing of the brook, and downstream of another culvert on private land. The two culverts are potential fish barriers at some flows. The site may also show first signs of climate change effects on Beaver Brook.

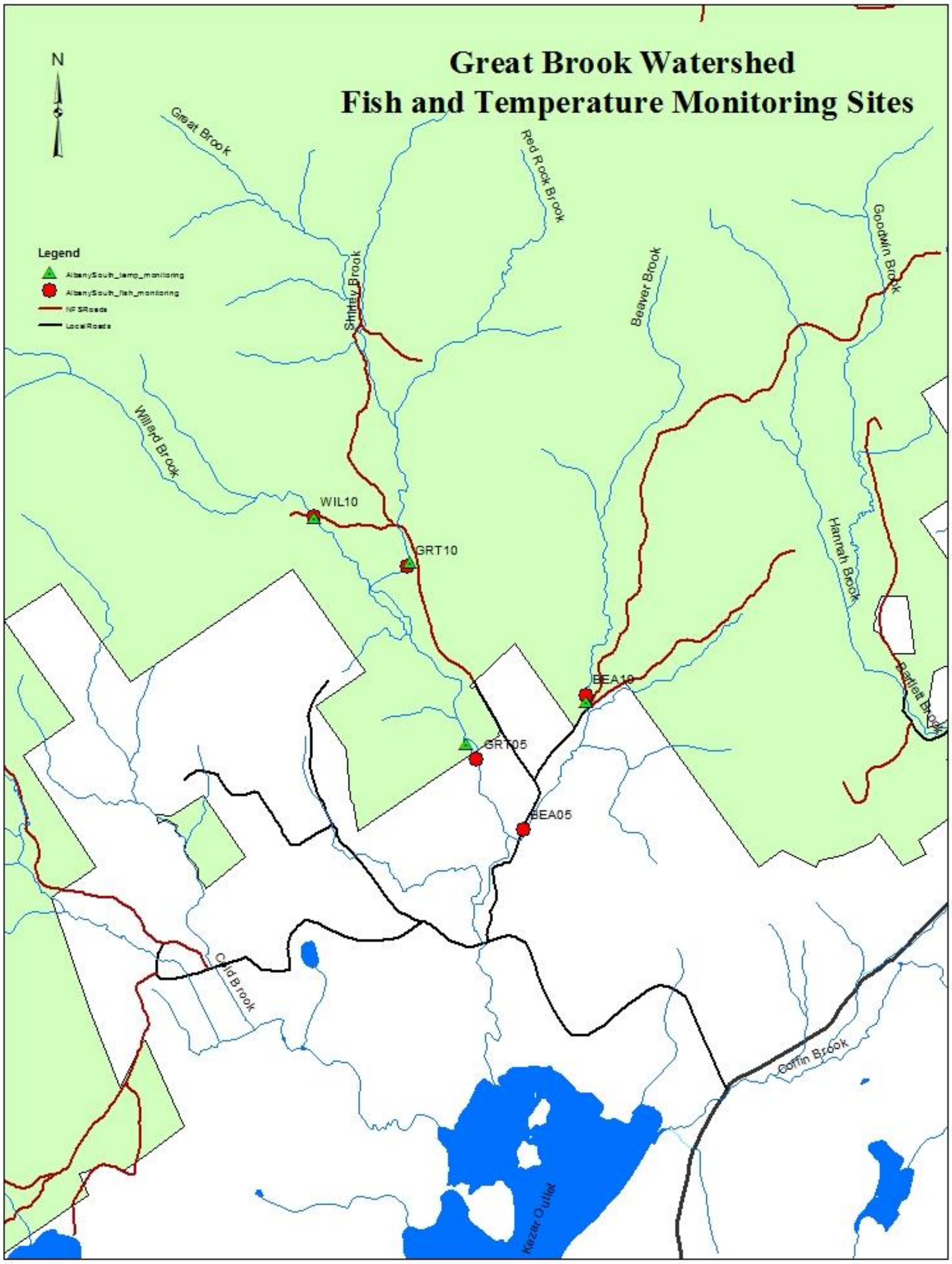


Figure 1. Location of brook trout and stream temperature monitoring sites in the Great Brook watershed.

Stream Temperature Monitoring Methods:

Temperature data was measured hourly during July and August of each summer, using Onset HOBO temperature loggers. Stream temperature data was collected annually at Beaver Brook near the WMNF boundary beginning in 2012. Additionally, air temperature data was collected with a logger placed in the shade of the riparian forest of Beaver Brook, adjacent to the water temperature logger site. Water temperature loggers were also placed at the two fish sampling sites on Great Brook, beginning in 2013 at GRT10 and in 2016 at GRT05. Another was installed in Willard Brook (WIL10) but it was lost during the July storm, therefore data is only available beginning in 2018. Sample locations are shown in Figure 1.

Hourly data at each site was averaged for each 30 day moving average between July 1st and August 30th. This metric was chosen over average July temperature because sometimes the hottest days occurred in early August. The maximum average 30 day water temperature was determined for each site for each year. Based on the scientific literature, true coldwater fish streams have average monthly temperatures less than 18 C. Coolwater streams average between 18 – 21 C monthly. Warmwater streams average over 21 C, and brook trout generally do not inhabit these stream reaches, except for migratory reasons in cooler times of year.

Stream Temperature

Summer water temperature in Beaver Brook averaged approximately 0.5 -1.0 C less than Great Brook over the years 2013-2018 (Table 1). Willard Brook was 0.8 C and 1.4 C cooler than Beaver Brook and Great Brook in 2018. Summer riparian air temperatures averaged between 18 and 20 C, which is cooler than the warmwater stream temperature threshold (21 C), demonstrating the cooling effect of the riparian forest canopy.

Over this sampling period, when no forest harvesting occurred, maximum average 30 day summer stream temperatures varied 2.4 and 2.1 degrees C between years at Beaver Brook and Great Brook, respectively (Figure 2). Maximum average 30 day summer air temperature varied 1.7 C over the same time period. In six year to year change comparisons, average air and water temperatures followed very similar patterns in four of them, but showed poor agreement in two others (2012-2013 and 2014-2015). This suggests that using only the maximum average 30 day air temperature metric to predict water temperature could be misleading in some years. It is not clear why this occurred, but may be due to differing patterns of diurnal fluctuation.

Despite differences between temperature metrics of all three streams, all sites were within the coldwater threshold, except for Great Brook at the WMNF boundary in 2016, when it averaged just over 18 C. While this falls within the coolwater stream range, it was still well below the warmwater threshold and within the tolerable range of the native eastern brook trout. Annual hourly stream and air measurements are shown graphically in Appendix A.

Table 1. Maximum 30 day average air and stream temperatures (C) measured near associated fish sampling sites throughout Great Brook watershed.

Year	Ave Air Temp C (BEA10)	Beaver Brook @WMNF Boundary (BEA10)	Great Brook Long Term Index Site (GRT10)	Great Brook @ WMNF Boundary (GRT05)	Willard Brook @ Snowmobile Crossing (WIL10)
2012	19.6	17.8			
2013	19.9	16.4	16.9		
2014	18.9	15.4	15.8		
2015	19.0	16.9	17.5		
2016	19.3	16.8	17.7	18.4	
2017	18.2	15.6	16.2	16.3	
2018	19.8	17.3	17.9	18.0	16.5

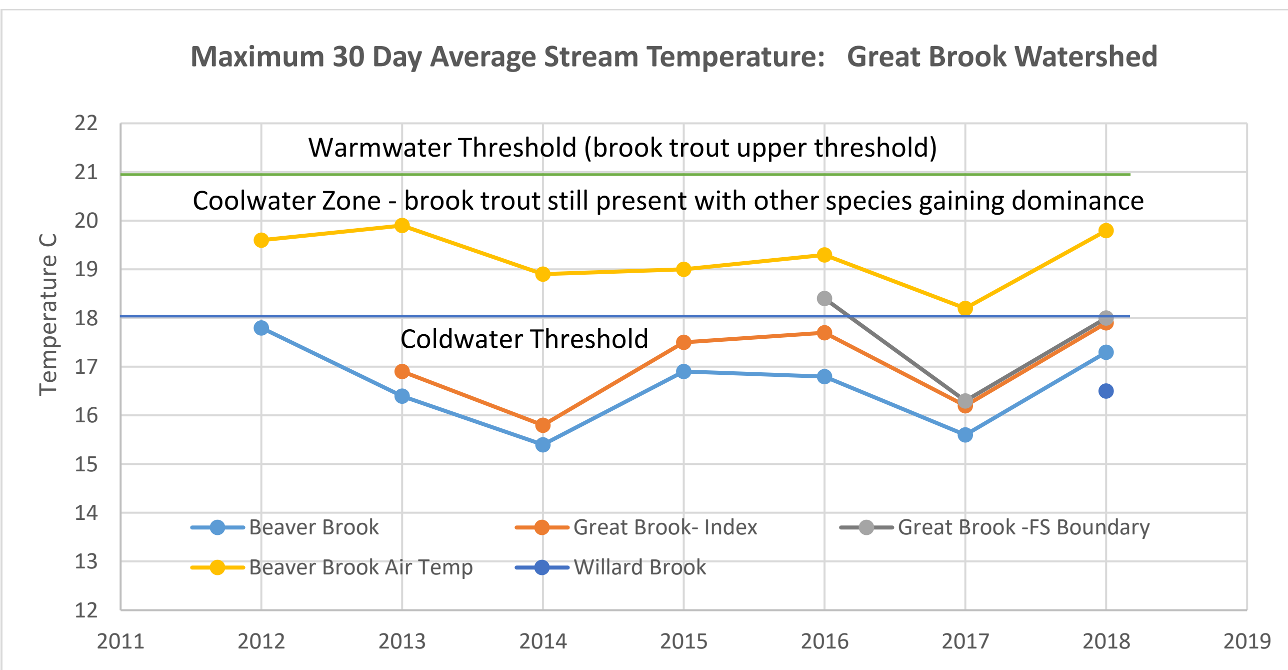


Figure 2. Maximum 30 day average summer stream and air temperature for Great Brook and Beaver Brook sites as compared to thresholds for fish thermal communities.

Brook Trout Population Metric Methods:

Estimate of both brook trout adults and young-of-the-year were made using depletion sampling methods. At each site of at least 100 meters, block nets were installed at the upstream and downstream ends of the station for the purpose of preventing fish migration in and out of the sampling unit. Smith and Root backpack electrofishers were used for the purpose of stunning fish so that they could be collected with nets. At least three passes of each station were conducted on a given sampling date. Fish netted were "removed" from the sample area and enumerated, measured, and weighed. Population estimates were made by entering the number of brook trout collected in each pass into a computer application (MicroFish 3.0) developed for estimating population numbers from capture data. Densities and biomass estimates were also calculated by incorporating lengths and widths of the stream sampling area and fish weights.

Brook Trout Population Metrics:

Estimates of YOY brook trout measured in August represent the numbers of brook trout that originate from the spawning activity in October of the previous year. These fish are generally 45-75 mm (2-3") at sampling time. The numbers of young trout can be determined by the total amount of successful spawning, survival of fertilized eggs over the winter months, availability of food after eggs hatch, sufficient stream flow, and occurrence of large flood events.

Young of the year brook trout were highest at all sites in 2016 (Table 2). Historic data at Great Brook and Willard Brook suggest that these estimates in 2016 were not exceptionally high or low, but more "typical". Interestingly that numbers dropped each year at all sites despite the occurrence of both natural and man-made barriers between all sampling sites. These features are not considered complete barriers but certainly minimize significant "mixing" of fish throughout the watershed. This suggests that "weather" related factors such as winter severity, floods, and droughts tend to control brook trout populations similarly throughout the watershed. Numbers in 2018 represented the lowest values observed historically in the watershed (Figure 3).

Adult brook trout were also more abundant at all sites in 2016 compared to 2017 and 2018 (Table 2). Estimates of both total brook trout biomass and adults per length of stream reflected similar decreases in 2017 from 2016 numbers. Declines in biomass estimates ranged from 32-62% across the five sites and declines in adult trout per mile ranged from 32-61%. Biomass estimates incorporate measures of stream width, measured on the day of sampling. Drastic changes in flow just before fish sampling could add more variability in estimates based on water area sampled. Since measures of fish per mile showed similar changes, it appears that brook trout populations did decline dramatically from 2016 to 2017 throughout the Great Brook watershed. Despite the large declines from 2016, it appears brook trout populations in 2016-2018 ranged from "high" to "average" levels based on comparisons of historical data at Great Brook and Willard Brook over the last two decades (Figure 3).

Table 2. Estimates of young-of-year (YOY) brook trout, all brook trout biomass, and adult brook trout per mile of stream for five sampling stations in the Great Brook watershed. Average = for years 2016-18; Long term average at GRT10 is for years 1994-2000, 2002-2004, 2007-2010, and 2016-18; at WIL10 for years 2002-2004, 2008-2010, and 2016-18.

YOY Brook Trout /100 m2					
Year	**BEA05**	**BEA10**	**GRT05**	**GRT10**	**WIL10**
2016	10.6	13.2	4.3	7.3	12.6
2017	7.2	6.8	0.9	3.9	9.9
2018	3.7	2.6	1.2	2.6	3.4
Average	**7.2**	**7.5**	**2.1**	**4.6**	**8.6**
Long Term Average				**9.3**	**9.1**
Brook Trout Biomass (kg/hect)					
Year	**BEA05**	**BEA10**	**GRT05**	**GRT10**	**WIL10**
2016	24.2	42.1	21.5	20.4	31.3
2017	15.1	16.3	8.1	13.9	19.2
2018	14.6	21.0	4.5	12.5	18.5
Average	**18.0**	**26.5**	**11.4**	**15.6**	**23.0**
Long Term Average				**15.3**	**19.1**
Adult Brook Trout / Mile					
Year	**BEA05**	**BEA10**	**GRT05**	**GRT10**	**WIL10**
2016	815	1050	898	1244	1164
2017	429	528	347	762	791
2018	426	593	189	571	633
Average	**557**	**724**	**478**	**859**	**863**
Long Term Average				**625**	**703**

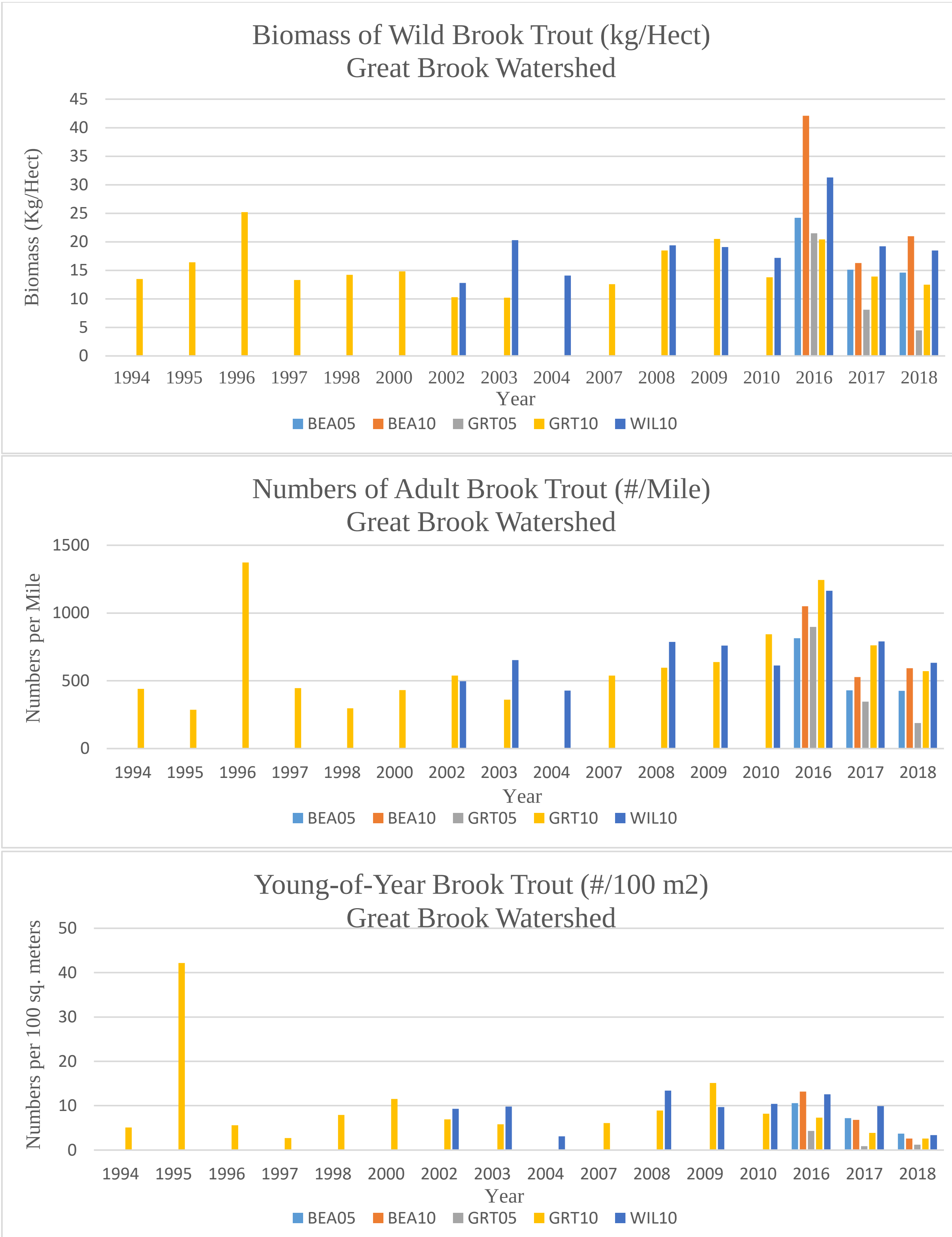
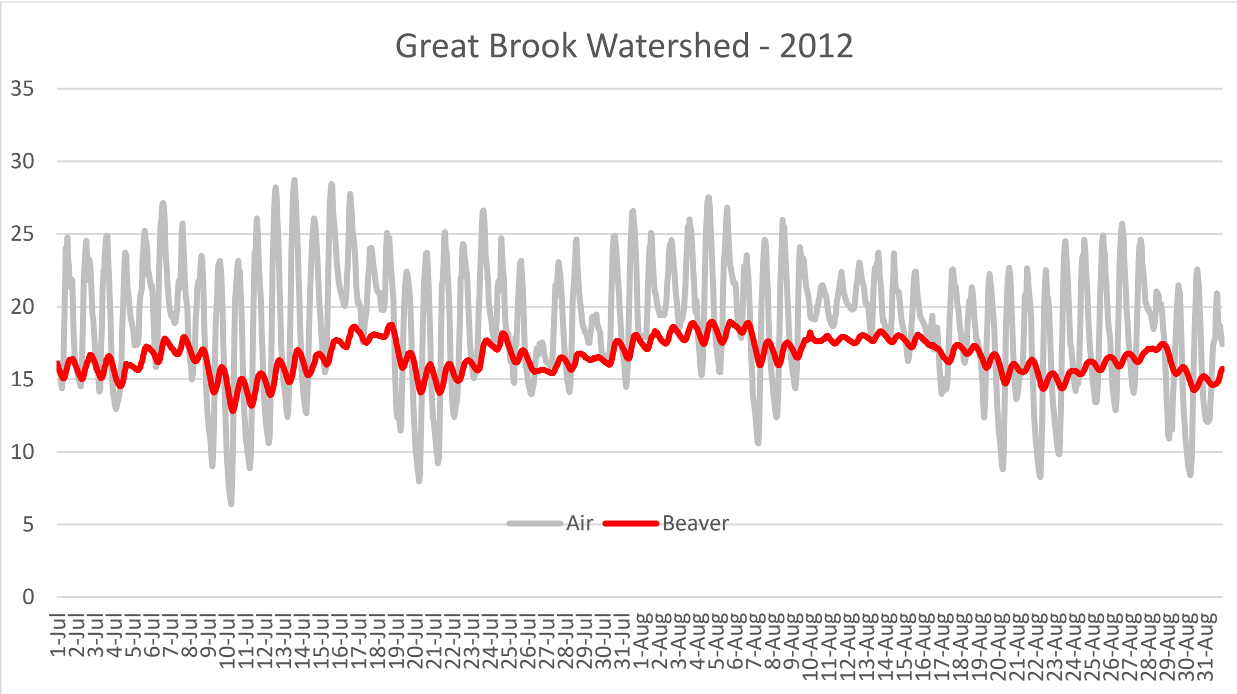
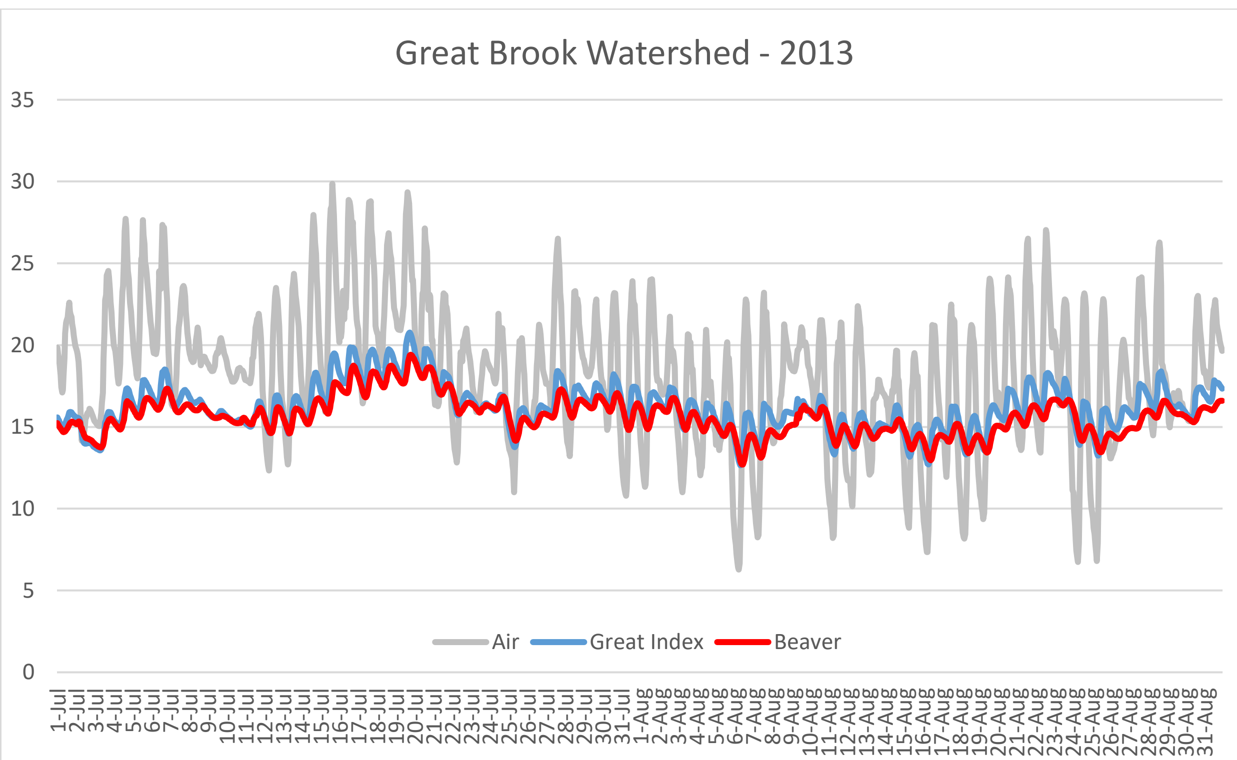
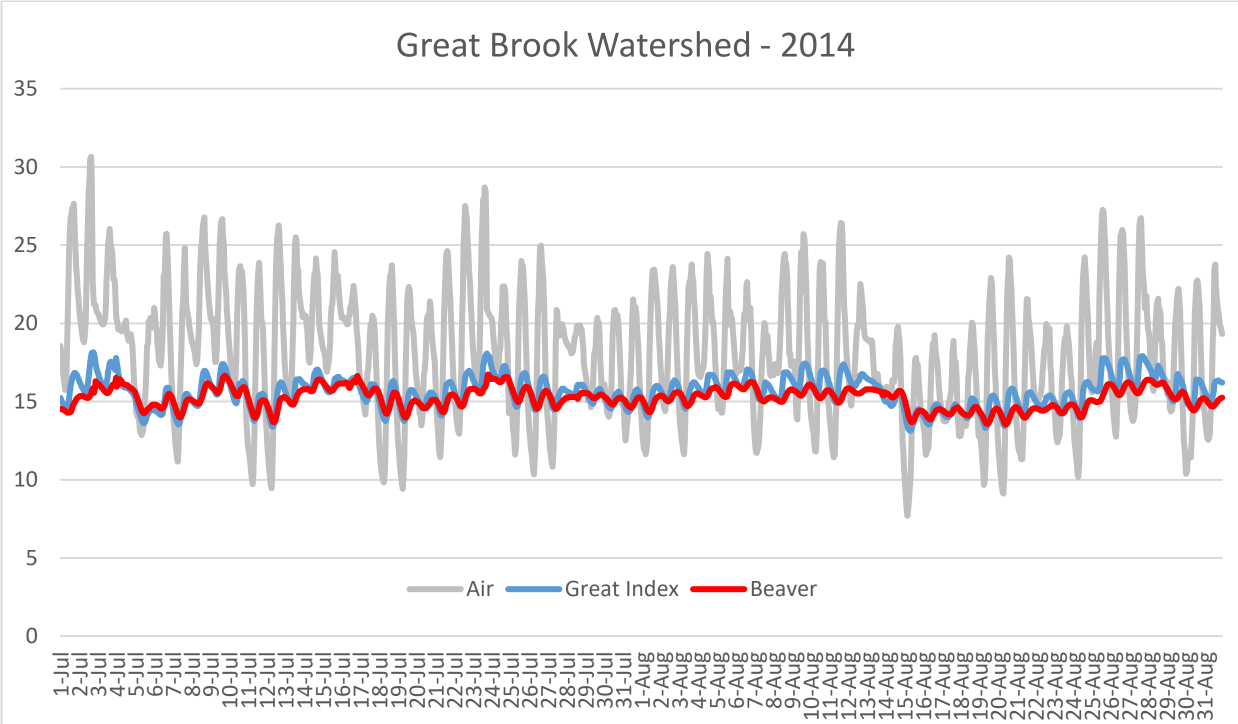


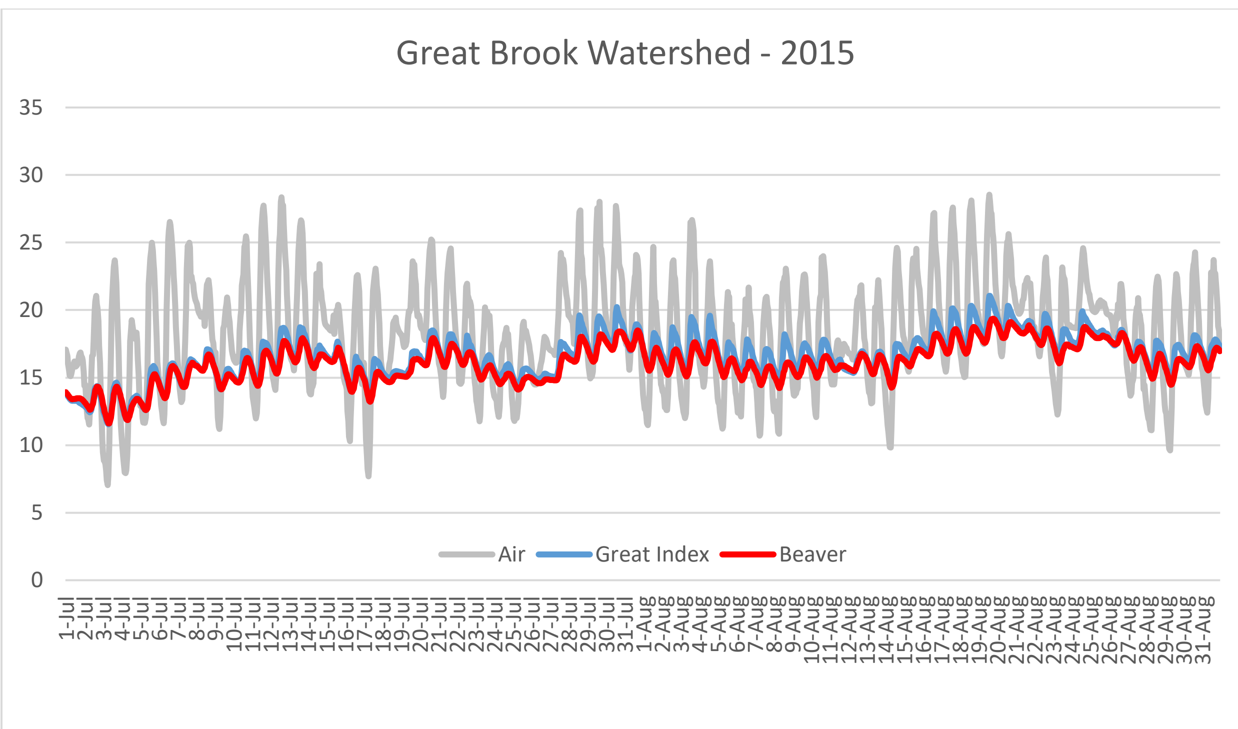
Figure 3. Comparison of YOY brook trout, brook trout biomass, and adult trout/mile at five sites in 2016-2018 with historical data at Great Brook (GRT10) and Willard Brook (WIL10) sampling sites.

Appendix A. Hourly air and stream temperatures measured in July-August in the Great Brook watershed from 2012-2018.






Great Brook Watershed - 2014
35
30
25
20
15
10
5
0
Air
Great Index
Beaver


Great Brook Watershed - 2015
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30
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Air
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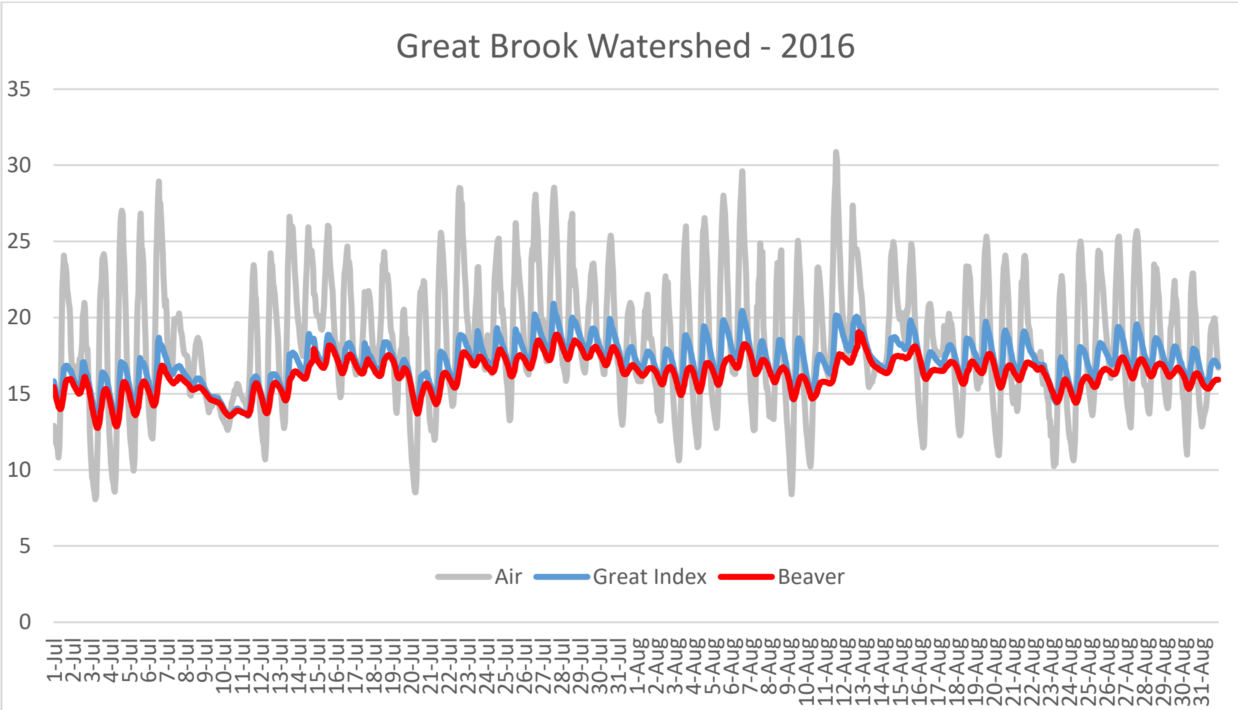
Beaver


Great Brook Watershed - 2016
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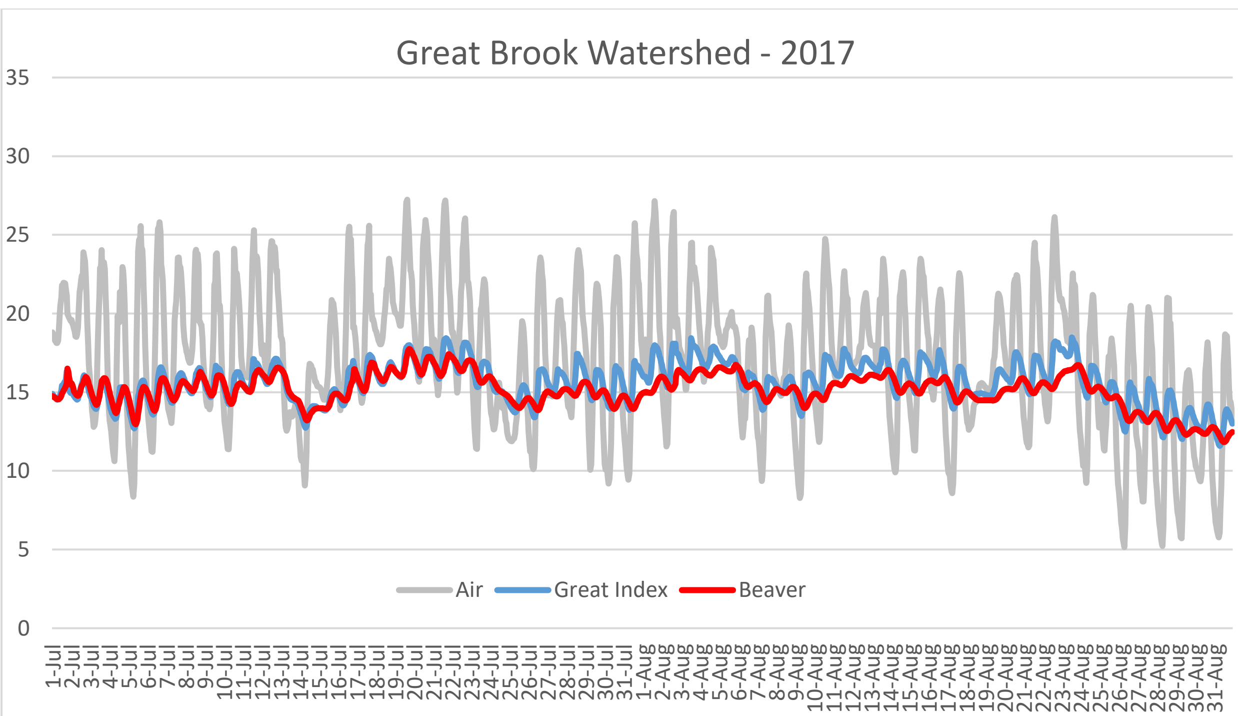
30
25
20
15
10
5
0
Air
Great Index
Beaver
1-Jul
31-Aug


Great Brook Watershed - 2017
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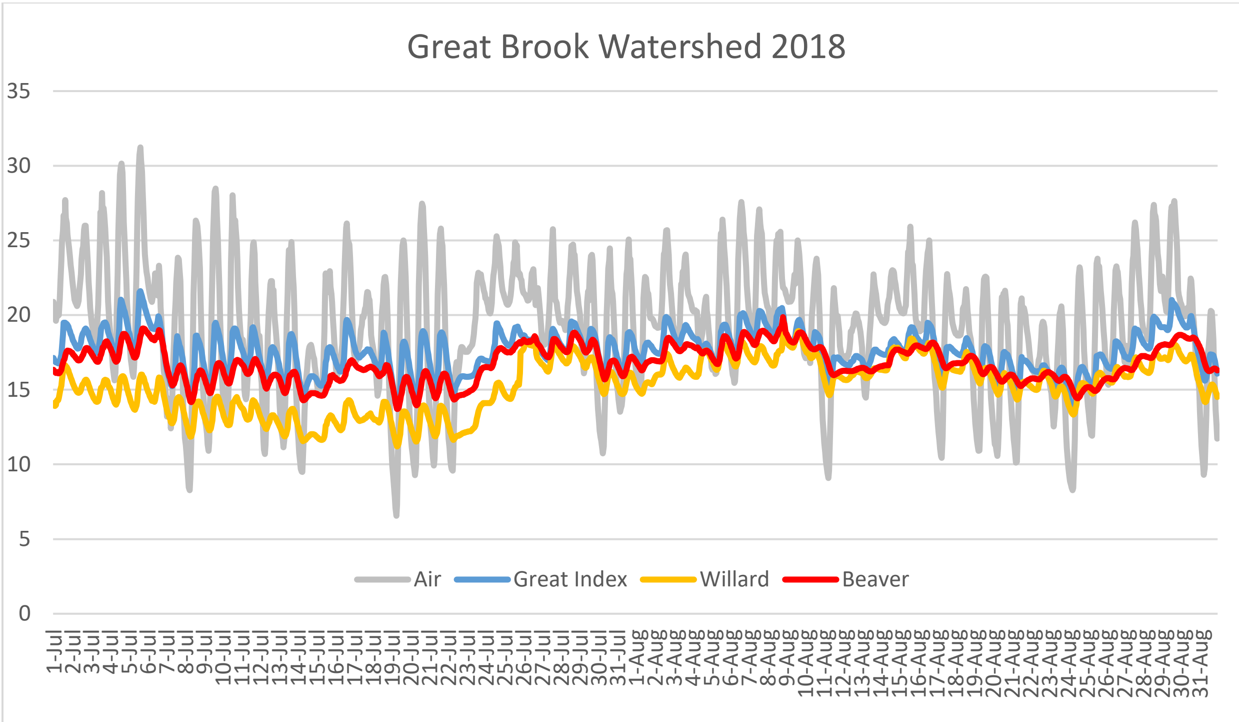
Air
Great Index
Beaver
1-Jul
31-Aug


Great Brook Watershed 2018
35
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Air
Great Index
Willard
Beaver
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