2016–2018 Great Brook Watershed Electrofishing Summary Report

Lovell, Maine

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1.0 INTRODUCTION

In August 2016, 2017, and 2018, five stream reaches in the Great Brook Watershed (GBW) were sampled to monitor the resident brook trout (*Salvelinus fontinalis*) population. The GBW includes the main stem of Great Brook and two tributaries (Beaver Brook and Willard Brook) located within the White Mountain National Forest (WMNF) in western Maine (Figure 1). The GBW has been historically logged but the mountainous and cold-water watershed is now largely undisturbed. This project was a collaborative survey effort between the U.S. Forest Service (USFS), Stantec Consulting Services Inc. (Stantec), and the Kezar Lake Watershed Association (KLWA) to gather baseline data prior to potential future impacts from upstream logging activities and climate change. Specifically, there is a planned Albany South timber harvesting project throughout the GBW in 2020.

This three-year report summarizes the methods, results and conclusions from the 2016-2018 sampling effort and compares current brook trout population estimates at the five stream reaches from 2016 through 2018 to results from previous brook trout monitoring efforts within GBW conducted by the USFS from 1994 through 2010. The previous USFS survey was an effort to monitor habitat restoration in the watershed. The electrofishing methods from 2016 through 2018 were the same as those employed by the USFS from 1994 through 2010. The 2016–2018 survey included two of the USFS sites to provide historic context to the recent brook trout monitoring results.

2.0 METHODS

2.1 SAMPLING SITES

In June 2016, Stantec conducted a reconnaissance site walk with USFS biologists within the GBW to identify four stream sampling sites for the three years of consecutive baseline electrofishing surveys. The fifth sampling site was located in Willard Brook (WIL10), and results from USFS sampling there are included in this report although Stantec never participated in those sampling efforts. The objective of the June 2016 site walk was to identify, flag, and spatially locate sampling sites that had representative habitat for brook trout and that were downstream of the planned Albany South timber harvesting project in the GBW. Identified sampling sites constituted a 300- to 400-foot river reach that had moderate quality representative habitat (i.e., deep pools with natural cover). Of the four sites assessed during the site walk, one of them in Great Brook (GRT 10) had been previously monitored by USFS and the other three are newly established electrofishing sampling sites for sampling baseline brook trout populations in 2016–2018 (Figure 1). The following are the four sites identified in June 2016 and monitored in 2016–2018:

1. Beaver Brook 5 (BEA5) – Located 200 feet upstream from the double barrel culvert under Hut Road, which likely acts as a barrier to brook trout movement during low flows. BEA5 was more influenced from roads and residential development than BEA10 discussed below, and stream substrate consisted of more fines and larger cobbles than BEA10 (Photograph 1, Appendix A).

2. Beaver Brook 10 (BEA10) – Located approximately 200 feet upstream from a USFS road crossing and upstream from the proposed timber harvest crossing. This reach had several deep pools with good cover, relatively high sinuosity, and low gradient (Photograph 2, Appendix A).

3. Great Brook 5 (GRT5) – Located downstream of a wildlife crossing and just upstream of the USFS property boundary. This site has some areas of plan-bed featureless habitat but also contains some pools with moderate amounts of cover from large woody debris (Photograph 3, Appendix A).

4. Great Brook 10 (GRT10) – Previously established USFS monitoring site located just upstream of Dyer's Falls. There is a big pool located at the downstream end of GRT10 and the site has a higher gradient, larger substrate, and not as many pools as GRT5 (Photograph 4, Appendix A).

2.2 ELECTROFISHING

From 2016 through 2018, the one site in Willard Brook (WIL10), two sites in Beaver Brook (BEA5 and BEA10), and two sites in Great Brook (GRT5 and GRT10) were surveyed for brook trout with electrofishing backpacks in early August in accordance with the USFS multi-pass depletion survey protocol. Each year, USFS (only) sampled Willard Brook (WIL10), which is a previously established USFS long-term brook trout monitoring site. Similar to the two sites in Beaver Brook, WIL10 represents a control site from a 2004 and 2005 USFS stream restoration project that included increasing the amount of large woody debris (LWD) in upper Great Brook. As reported by the USFS, the same electrofishing protocol outlined below was followed at WIL10 each of the three years.

The USFS electrofishing sampling protocol was implemented at all five sampling sites in 2016–2018. At each site, an approximate 300-foot (i.e., 100-meter) reach was measured following the stream thalweg (i.e., main concentration of flow) to the upstream end of the site at a natural habitat break (i.e., pool tail or riffle tail). Two block nets with ¼-inch mesh were set at the upstream and downstream ends of the sampling reach to prevent fish from leaving and entering the sampling reach. Depending on the site stream width, one or two biologists operating an electrofishing backpack unit proceeded in an upstream direction with an initial voltage setting of 500V. Temporarily stunned fish were captured by two "netters" accompanying each unit. The fish were temporarily stored in a 5-gallon bucket until the end of the reach, which constituted one pass. Three passes were completed in each sampling reach with the same level of effort and time electrofished. Fish collected during each pass were temporarily held in separate mesh bins placed in flowing water downstream of the sampling reaches. A 50% depletion rate threshold was set between passes to increase the accuracy of the estimate of brook trout in each sampling site.

All the fish captured were enumerated by species after each pass and measured in millimeters (mm) and weighed in grams (g). Salmonids measuring less than 75 mm were considered to be young-of-year (YOY) (Photographs 5 and 6), and brook trout greater than 75 mm were classified as adults. After processing the fish, they were released throughout the site in which they were captured. Before removing the block nets, the aquatic habitat units in each site (e.g., pool/riffle/runs) were tallied and their depth, length, and widths were measured. Fish and habitat data were recorded on a data form, and USFS staff entered the data and developed a spreadsheet estimating four density metrics for brook trout: 1) brook trout biomass; 2) brook trout YOY per 100m^2; 3) adult brook trout per 100 m^2; and 4) brook trout adults per stream mile.

The fish density population estimates are based on the output of a modeling program called Micro Fish, which factors in the depletion rates of fish captured between each of the three passes to estimate the total fish population in each sampling site.

3.0 FISH SURVEY RESULTS

The electrofishing survey results are summarized below by each of the four brook trout density metrics in each of the three years of sampling (i.e., 2016, 2017 and 2018). Appendix A includes photographs of the sampling sites and the salmonid species observed.

3.1 2016 RESULTS

Four different fish species were caught in the GBW: brook trout, landlocked salmon (*Salmo salar*), longnosed dace (*Rhinichthys cataractae*), and slimy sculpin (*Cottus cognatus*). The dominant fish species caught was brook trout, and a total of 583 brook trout were captured across all 5 sites. Other observed aquatic biota in the GBW included crayfish (*Orconectes sp.*) and northern two-lined salamanders (*Eurycea bislineata*). It was noteworthy that a single yearling landlocked salmon was captured and released in GRT5, which is upstream from the "first impediment" (a series of bedrock cascades located in lower Great Brook, just downstream from the confluence with Beaver Brook; Figure 1). During the one-day spawning survey in November 2014, all of the observed landlocked salmon redds were located downstream of the first impediment.

Biomass

Biomass, calculated in kilograms per hectare (Kg/Hect), is a fish density metric that factors in the observed weight of all the brook trout within a unit area sampled (i.e., width and length of the sampling reach). In 2016, the upper Beaver Brook site (BEA10) had the highest estimated biomass (42.1 Kg/Hect) (Figure 2). The second highest estimated biomass in 2016 was slightly above 30 Kg/Hect at WIL10. The 2016 biomass in the lower Beaver Brook site (BEA5), 24.2 Kg/Hect, was comparable to the biomass estimated in Great Brook (GRT5 – 21.02 Kg/Hect, GRT10 – 20.4 Kg/Hect). The average annual biomass estimate at GRT10 is 15.3 Kg/Hect based on 12 years of previous biomass estimates. Based on the 6 years of biomass estimates at WIL10, the average annual biomass is 17.2 Kg/Hect. Both 2016 biomass estimates in GRT10 and WIL10 exceeded previous averages. The 2016 biomass in WIL10 represents the highest estimate ever recorded at that site and the 2016 biomass at GRT10 represents the third highest estimate recorded at GRT10. The 2016 biomass at BEA10 (in the first year of monitoring) exceeded the maximum biomass estimates at GRT10 or WIL10 (Figure 2).

Young-of-Year per 100m^2

The density (fish per 100 m^2 of stream area sampled) of YOY provides a metric for evaluating natural reproduction and potential recruitment of juvenile brook trout into the adult population. Brook trout YOY emerged from their eggs and redds in the spring (Photograph 6, Appendix A). The three sampling sites in the smaller tributaries (BEA5, BEA10, and WIL10) had the highest YOY densities: 10.6, 13.2, and 13.8 YOY/100m^2, respectively (Figure 3). These estimates well exceeded the YOY densities recorded in the

main stem of Great Brook (GRT5 – 4.3 YOY/100m^2 and GRT10 – 7.3 YOY/100m^2). The YOY density estimate at GRT10 was less than the 12-year average (10.5 YOY/100m^2), but there were 5 other years in which the YOY density was less than the 2016 estimate at GRT10 (Figure 3). The 2016 YOY estimate at WIL10 (13.8 YOY/100m^2) exceeded the 6-year YOY average of 9.3 YOY/100m^2 and represents the highest YOY density estimate ever recorded at WIL10 (Figure 3).

Adults per 100m^2

The density (fish per 100 m^2 stream area sampled) of adult brook trout provides a metric for evaluating the breeding population of brook trout. Similar to the biomass and YOY density metrics, the highest estimated adult brook trout density in 2016 in the GBW was observed at BEA10 (30.6 adults/100m^2) and WIL10 (26.3 adults/100m^2) (Figure 4). These adult density estimates were well above the 2016 adult densities at BEA5 (16.6 adults/100m^2), GRT5 (13.1 adults/100m^2) and GRT10 (14.9 adults/100m^2). The 2016 adult brook trout density at GRT10 was the second highest value observed at that site and over two times as high as the 12-year average of 6.2 adults/100m^2. The 2016 adult density estimate at WIL10 was over two times as high as the 6-year average of 9.6 adults/100m^2.

Adults Per Mile

Adult brook trout per mile provides a density estimate of the spawning population that is based on linear stream mile as opposed to stream area. The width of the stream sampling reach does not factor to this density metric. This explains why the 2016 estimates for this metric in the Great Brook sampling sites (i.e., GRT5 and GRT10) are higher compared to the sampling sites in the smaller and narrower tributaries (i.e., BEA5, BEA10 and WIL10) (Figure 5). The highest 2016 adult brook trout per mile estimate was recorded in GRT10 (1,244 fish/mile), followed by WIL10 (1,164 fish/mile), BEA10 (1,050 fish/mile), GRT5 (898 fish/mile), and lastly BEA5 (815 fish/mile). The 2016 adult per mile estimate at GRT10 is the second highest value recorded at that site and doubled the 12-year average of 566 fish/mile. The 2016 adult per mile estimate at WIL10 was the highest ever recorded at that sampling site and almost doubled the 6-year average of 623 fish/mile.

3.2 2017 RESULTS

Two different fish species were caught in the GBW in 2017: brook trout and slimy sculpin. The dominant fish species caught was brook trout and a total of 342 brook trout were captured in 2017 across all 5 sites, which was well below the 583 caught in 2016 in the same 5 sites. Other observed aquatic biota in the GBW included crayfish and northern two-lined salamanders. It is noteworthy that no yearling landlocked salmon were observed 2017, while a single salmon was captured and released in 2016 in GRT5.

Biomass

In 2017, WIL10 had the highest estimated biomass (19.2 Kg/Hect) (Figure 2). The second highest estimated biomass in 2017 was slightly above 16 Kg/Hect at BEA10, which was comparable to the biomass at BEA05 (15.1 Kg/Hect) and GRT10 (13.9 Kg/Hect). The 2017 biomass at GRT05 (i.e., 8.1 Kg/Hect) was the lowest observed in the watershed. The average annual biomass estimate at GRT10 is 15.7 Kg/Hect based on 13 years of previous sampling efforts. Based on the 7 years of biomass estimates

at WIL10, the average annual biomass is 19.2 Kg/Hect. Both 2017 biomass estimates at GRT10 and WIL10 were at or just slightly below the historic averages. The 2017 biomass at the downstream most sampling site in the GBW at GRT05 represents the lowest biomass estimate (8.1 Kg/Hect) ever recorded in the watershed. Within Beaver Brook and Great Brook, the 2017 biomass values followed previous observed trends in which sites lower in the watershed have lower biomass estimates within the sampling year. At all five sites, the 2017 biomass estimate was lower than the record highs observed in 2016.

Young-of-Year per 100m^2

Similar to 2016, the 3 sampling sites in the smaller tributaries (BEA5, BEA10, and WIL10) had the highest YOY densities: 7.2, 6.8, and 9.9 YOY/100m^2, respectively. These 2017 estimates well-exceeded the YOY densities recorded in the main stem of Great Brook (GRT5 – 0.9 YOY/100m^2 and GRT10 – 3.9 YOY/100m^2). The 2017 YOY density estimate at GRT10 was considerably less than the 13-year average (10.2 YOY/100m^2) and represents the second lowest YOY density value ever recorded at GRT10 (Figure 3). The 2017 YOY density at GRT5 was even lower at 0.9 YOY/100m^2. The 2017 YOY estimate at WIL10 (9.9 YOY/100m^2) was almost exactly the 7-year YOY average of 9.7 YOY/100m^2 (Figure 3). At all five sites, the 2017 YOY density estimate was lower than what was observed in 2016.

Adults per 100m^2

Similar to the biomass and YOY density metrics, the estimated adult brook trout density in 2017 decreased at all 5 sites by at least 50% compared to the 2016 values (Figure 4). As also observed in 2016, the highest adult brook trout density in 2017 in the GBW was observed at BEA10 (9.8 adults/100m^2) and WIL10 (12.4 adults/100m^2). The 2017 adult brook trout density at GRT10 (7.1 adults/100 m^2) was very close to the 13-year average of 6.9 adults/100m^2. The 2017 adult density estimate at WIL10 (12.4 adults/100 m^2) also just barely exceeded the 7-year average of 12 adults/100m^2.

Adults Per Mile

Similar to 2016, the 2017 estimates for this metric in the Great Brook sampling sites (i.e., GRT5 and GRT10) are relatively higher compared to the other metrics at the sampling sites in the smaller and narrower tributaries (i.e., BEA5, BEA10 and WIL10) (Figure 5). The highest 2016 adult brook trout per mile estimate was recorded in WIL10 (791 fish/mile), closely followed by GRT10 (762 fish/mile), BEA10 (528 fish/mile), BEA5 (429 fish/mile), and lastly GRT5 (347 fish/mile). Similar to the other three metrics, the 2017 adult per mile estimates dropped at each of the five sites by almost 50% of the 2016 fish/mile estimate. The GRT10 2017 estimate exceeded the 13-year average of 618 fish/mile. The 2017 adult per mile estimate at WIL10 also was also above the 7-year average of 700 fish/mile.

3.3 2018 RESULTS

Four different fish species were caught in the GBW: brook trout, landlocked salmon, longnosed dace, and slimy sculpin. The dominant fish species caught was brook trout, and a total of 235 brook trout were captured across all 5 sites. This was the lowest total number of brook trout captured from 2016 through 2018 and over 100 less than total in 2017. It was noteworthy that a single yearling landlocked salmon was captured and released in GRT5, which is upstream from the “first impediment”.

Biomass

Biomass estimates for 2018 decreased from 2016 and 2017 values at each of the five sites, with the exception of BEA10 (Figure 2). The 2018 estimates were similar to the average values at the historic sites (GRT10 and WIL 10) and similar to 2016 results at BEA5 and BEA10, with a significant decline at GRT05 (Figure 2). The 2018 biomass at GRT05 was three to four times lower than what was observed at the other four sites and was the lowest biomass value ever recorded at any site in the watershed since brook trout sampling began in 1994. The biomass at WIL10 in 2018 was 18.5 Kg/Hect compared to a historic 8-year average of 19.2 Kg/Hect and was 12.5 Kg/Hect at GRT10 compared to 14-year average of 15.5 Kg/Hect. Similar to 2016 and 2017 trends, the biomass estimates were highest in the smaller tributaries (i.e., WIL10, BEA05, and BEA10) and lower in the main stem of Great Brook.

Young-of-Year

The 2018 YOY density estimates decreased at four out of the five sites (Figure 3). The only site where it did not decrease was at GRT05, where the 2018 estimate marginally increased from 0.9 fish/100m^2 in 2017 to 1.2 fish/100m^2 in 2018. Each of the last three years, GRT05 (the furthest downstream site in the watershed) has had the lowest YOY density estimate, and highest estimates were recorded in the tributary sites (WIL10, BEA05 and BEA10). BEA05 had the highest YOY 2018 density estimate of 3.7 fish/100m^2. The 2018 YOY at GRT10 (2.6 fish/100m^2) was well below the 15-year historic average of 9.3 fish/100m^2 and represented the lowest observed YOY density observed at this site dating back to 1994. Similarly, the 2018 YOY density estimate at WIL10 (3.4 fish/100m^2) was also well below the 8-year average of 9.7 fish/100m^2, which was the second lowest estimate recorded at that site.

Adults per 100m^2

Compared to 2017 results, adult brook trout density estimates did not see as drastic a decrease as the other metrics. Adult density in 2018 decreased at GRT05, GRT10 and WIL10 but increased at the two Beaver Brook sites (BEA05 and BEA10). The 2018 adult density estimate at GRT05 was considerably lower than the other four sites and was the lowest adult density ever observed in the watershed since sampling began in 1994. However, the 2018 estimates at the historic sites (GRT10 and WIL10) were slightly above historic averages at those two sites. Similar to 2016 and 2017, BEA10 had the highest 2018 adult density estimate, with WIL10 having the second highest value. BEA10 and WIL10 were the highest two sites in the watershed and had the coldest water temperatures.

Adults Per Mile

The 2018 estimate of adult brook trout per mile decreased at four out of five sites with the exception of BEA10, which increased slightly. The biggest decrease in adults per mile was observed at GRT05 where the 2018 estimate was almost 50% lower than the 2017 value. The 2018 adult per mile estimate at GRT05 was the lowest value ever recorded since brook trout sampling began in 1994. Similar to adult density, BEA10 and WIL10 had the two highest 2018 adults per mile estimates. The 2018 estimates of adults per mile at the historic sites (GRT10 and WIL10) were slightly below their historic averages.

4.0 DISCUSSION

The results of three years of brook trout sampling from 2016-2018 included drastic annual fluctuations in the population metrics at the five sampling sites in the GBW (Figures 2-5). Many of the density metrics dropped by 50% or more in 2017 and 2018 compared with 2016 results. Results in 2016 had record high values for the four metrics compared to historic sampling, and 2017 and 2018 results had relatively average values (Figures 2–5).

The seasonal low or high flows with stochastic events (e.g., flooding, scouring, ice damage) seems to have the biggest annual influence on brook trout populations in GBW by affecting egg or YOY survival. The 2016 estimates of metrics incorporating square area of stream sampled (i.e. biomass and adult and YOY per 100m^2) may have been exaggerated by the extreme low flows and water levels observed in New England in August 2016. The nearest U.S. Geological Survey (USGS) stream gage in the Wild River (approximately 10 miles to the north) for the 2 months prior to the early 2016 August had very low flows, which were well below the 52-year median. During low flows, narrower stream channels crowd fish into a smaller area, which reduces the denominator in the density metric calculations while at the same time increases the “catchability” of brook trout as they congregate in deep pools.

Conversely, the water flows and levels were considerably higher at Wild River and GBW in 2017. The USGS gage in the Wild River indicates that flows were consistently above the 52-year median in the 2 months preceding the early August 2-day electrofishing survey, with 4 high flow events approaching or above 1,000 cubic feet per second (cfs) and 1 event exceeding 4,000 cfs around July 4. There was physical evidence observed at GRT10 corroborating these very high recent flows with a distinct line of matted-down ferns observed high along the west river bank. These high flows in the GBW increased the denominator of the per area density metrics and more significantly likely washed brook trout out of their protective habitats and downstream. The high flows observed in 2017 were likely especially detrimental to YOY brook trout, which do not have as strong swimming ability as juveniles and adults and are more vulnerable to high flows. Not surprisingly, the YOY trout/mile was considerably lower at all 5 sites in 2017 and the estimate observed at GRT05 was the lowest ever recorded in the GBW. This trend of lower summer brook trout populations in 2017 was consistently observed at most of the other USFS sampling sites across the White Mountains, with the largest decreases where July storm flows were very high (Mark Prout, Pers. Comm.).

The 2018 metrics were also likely affected by very high flows in late October 2017 after brook trout spawning. Around October 30, there was a major rainstorm in western Maine resulting in flows in the Wild River over 30,000 cfs, which exceeded the 100-year peak flow stage for this gage. This very significant flow event likely occurred after a majority of brook trout fall spawned in the GBW and would have likely scoured brook trout redds and decreased survivability of incubated eggs through the fall and winter. The very low YOY density in 2018 in the five sites within the GBW is likely due to this major flow event, and this trend of lower YOY densities was observed at other sites throughout the White Mountain National Forest that experienced this high October flow event (Mark Prout, Pers. Comm.).

The 2016–2018 sampling also confirmed the importance of the brook trout productivity in the smaller tributaries of Great Brook (i.e., Beaver and Willard Brook). This may be due to 1) the smaller tributaries having higher quality habitat (e.g., more pools, gravel, cover, and habitat complexity) than in Great Brook (especially at BEA10), 2) smaller tributaries having cooler water from more groundwater inputs, or 3) the smaller watersheds associated with these tributaries having less impacts from heavy rain events. The USFS and KLWA monitored water temperature at BEA5 and GRT10 in 2010, 2012, and 2013. The three-year mean of the average July temperature, maximum 7-day average temperature, and instantaneous maximum temperature were all lower/cooler at BEA5 versus GRT10 by -1.2 ^{o}C, -1.5 ^{o}C, and -2.2 ^{o}C, respectively. Cold water is imperative for self-sustaining brook trout populations. Based on USFS monitoring, Willard Brook also has very cold water and had some of the highest estimates of the four-density metrics from 2016-2018 in the GBW. Additionally, Willard Brook and Beaver Brook have smaller watersheds, and brook trout may have been less susceptible to the high flow events observed in July and October 2017.

Overall, the 2016–2018 monitoring results in the GBW for brook trout presented in this summary report and water temperature recorded by USFS and KLWA are encouraging—there is cold water throughout the summer supporting steady brook populations over the last 14 years. In two out of the three years of sampling, there was also evidence of the upper GBW supporting natural recruitment of landlocked salmon in Kezar Lake. The sensitivity of the brook trout to yearly stochastic events emphasizes the importance of collecting multiple years of data as part of a long-term monitoring program that can evaluate landscape changes in the watershed, including the upcoming Albany South timber harvesting project.

FIGURES

2016-18 GREAT BROOK WATERSHED ELECTROFISHING SUMMARY REPORT

Figures
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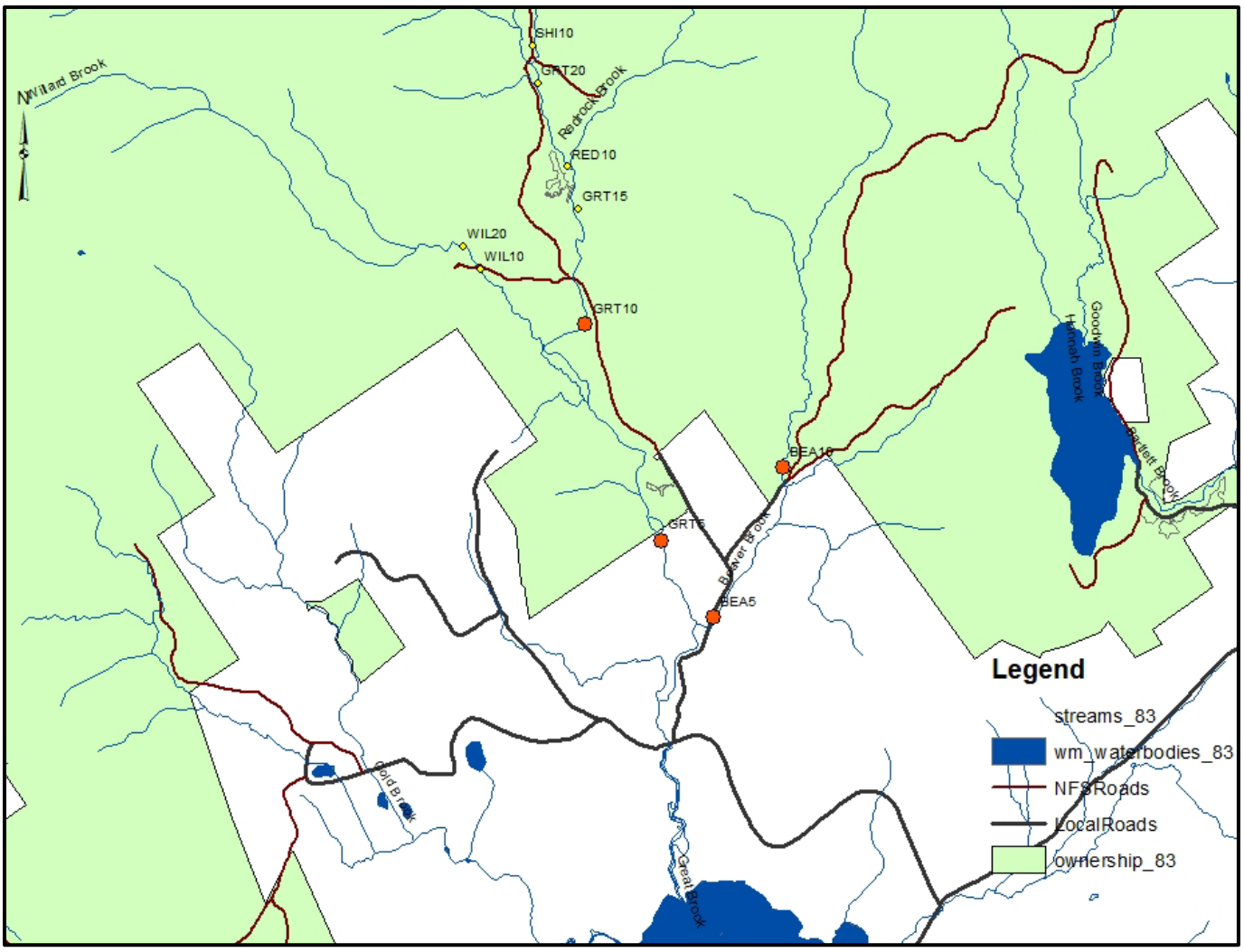

Figure 1. Map of the 2016 electrofishing sampling sites (in red) in Beaver Brook and Great Brook and previously sampled electrofishing sites established by the USFS (in yellow) in Willard Brook and Great Brook. Green shading indicates USFS property (Source: USFS).

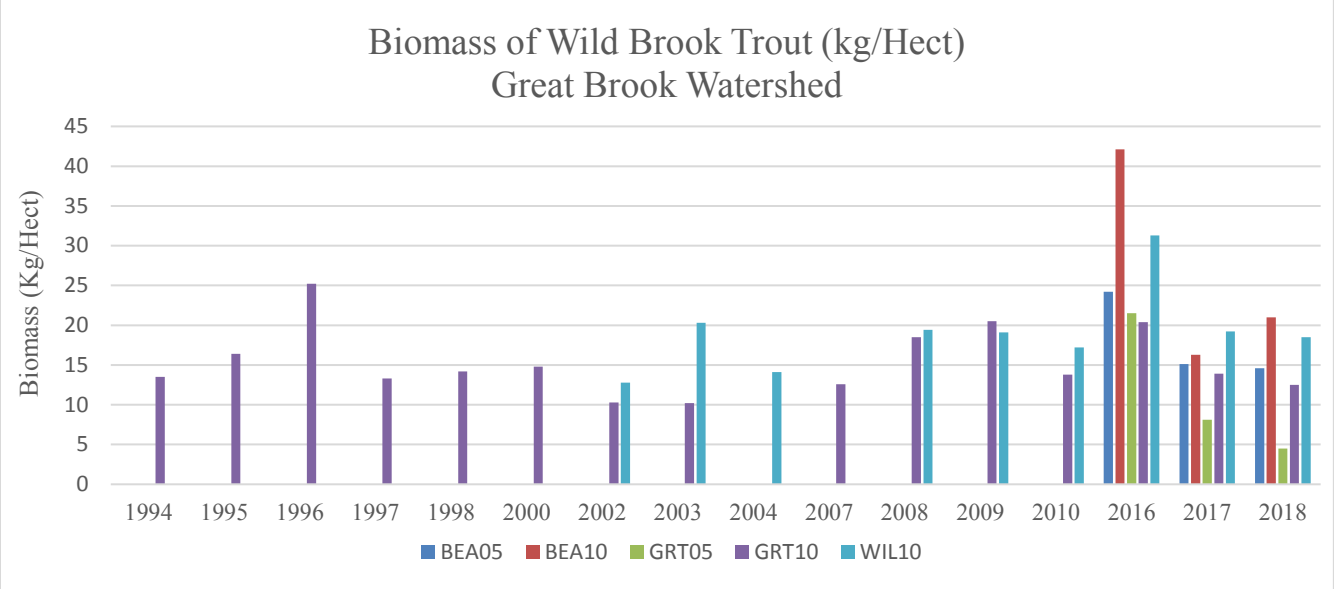

Figure 2. Biomass of wild brook trout in the GBW, 1994–2018 (Source: USFS).

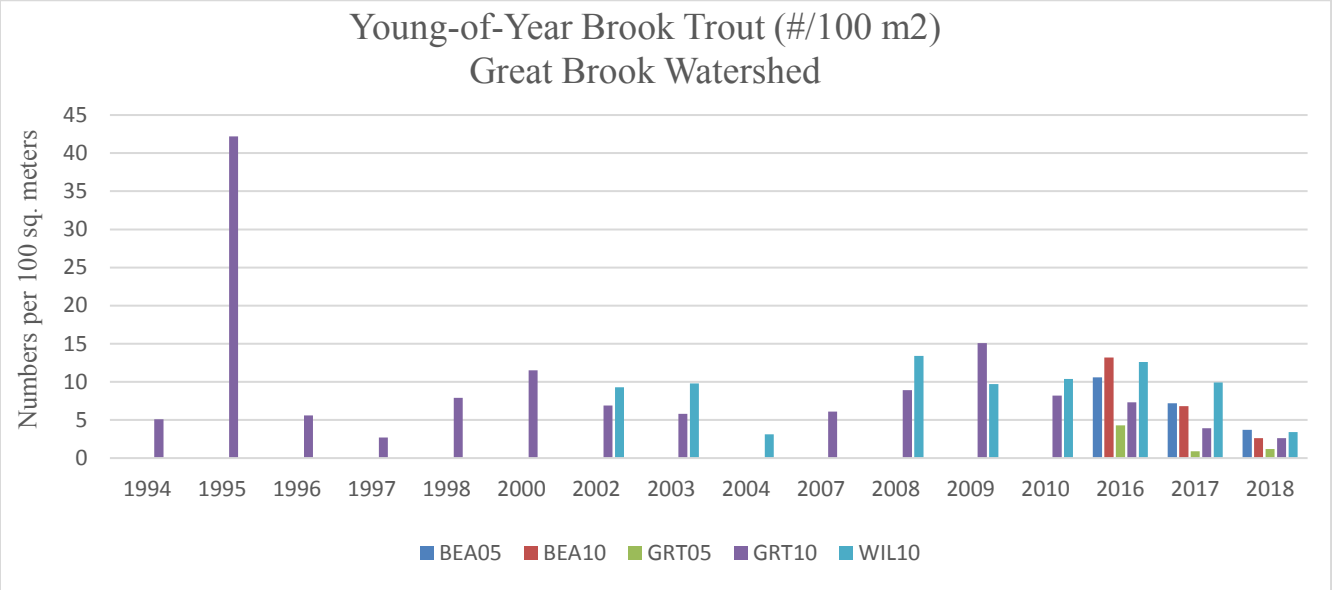

Figure 3. Density of young-of-year brook trout in the GBW, 1994–2018 (Source: USFS).

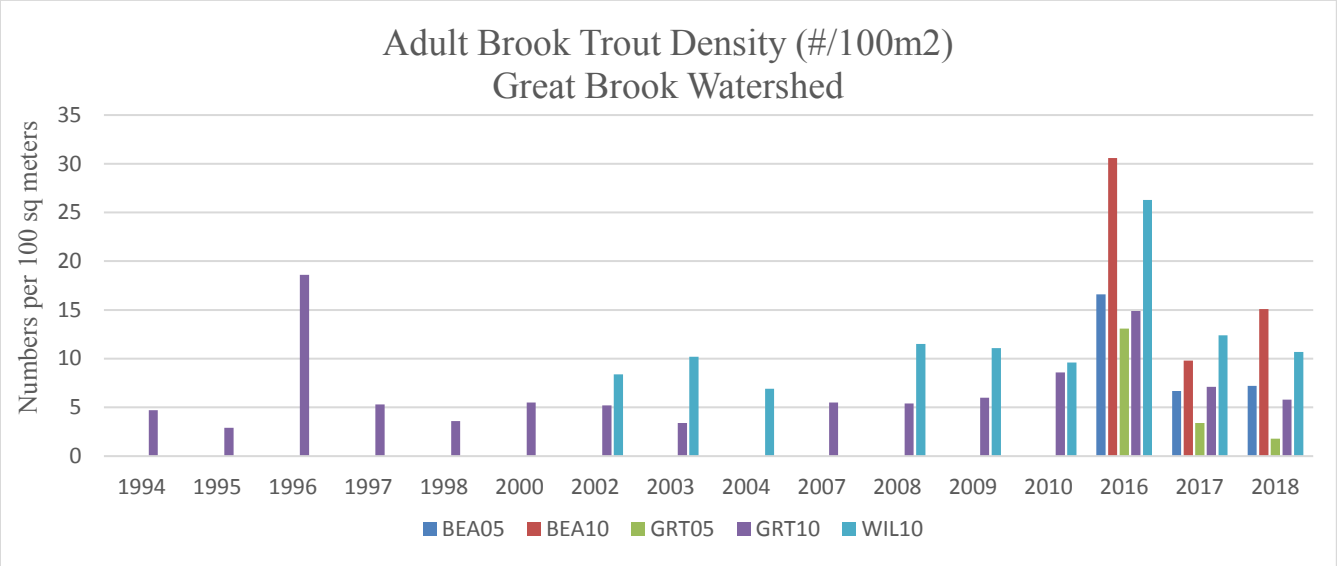

Figure 4. Density of adult brook trout in the GBW, 1994–2018 (Source: USFS).

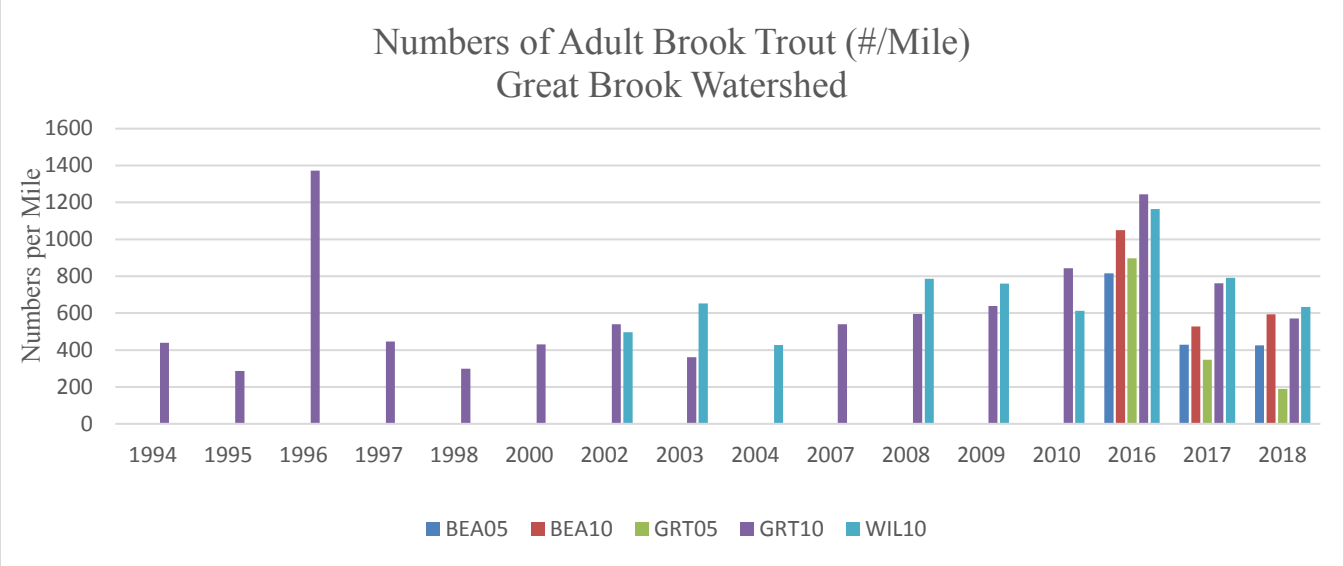

Figure 5. Adult brook trout per linear stream mile in the GBW, 1994–2018 (Source: USFS).

APPENDICES

APPENDIX A PHOTOGRAPHS

Photograph 1. Sampling site BEA5 with fines and boulder substrate (Stantec 6/1/16).

Photograph 2. Downstream end of BEA10 with optimal habitat, including a pool with natural cover and gravel substrate (Stantec 8/8/16).

Photograph 3. Plan-bed stream habitat in GRT5 with water spanning the width of the entire channel in 2017 (Stantec 8/8/17).

Photograph 4. Step-pool boulder habitat dominates site GRT10 (Stantec 8/9/17).

Photograph 5. Landlocked salmon young-of-year observed in GRT5 (Stantec 8/8/18).

Photograph 6. Brook trout young-of-year from 2016 in site GRT10 (Stantec 8/9/16).