Assessment of the Owego Creek Stream Restoration Project, Park Settlement Road Site: A Reevaluation of Stream Habitat and Water Quality.

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Conducted in conjunction with the Leon Chandler Chapter of Trout Unlimited and the Tioga County Soil & Water Conservation District.

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Abstract:

In 2010 and 2011 flooding devastated the East Branch of Owego Creek, killing resident trout populations and destroying in-stream structure and habitat. Utilizing funding from the New York State "Millennium Stream Improvement Fund" Trout Unlimited in conjunction with the Tioga Country Soil & Water Conservation District restored two sections of the East Branch of Owego Creek where serious damaged had occurred. Restoration efforts included the stabilization of banks using the Rosgen Toe Wood Method, creation of deep pool habitat, and the construction of J-hooks. This study focuses on the effects of restoration efforts five years after the completion of the project at the Park Settlement Road Site. The study also intends to serve as a reference point for future research. Cross-sectional surveys, longitudinal surveys, and macrobenthic invertebrate sampling were completed between May and August 2020. Overall the Park Settlement Road Site was found to be fairly healthy, with populations of brown trout, brook trout, and smallmouth bass.

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Introduction

The summer months of 2020 are on track to have some of the hottest land-temperatures since the National Oceanic and Atmospheric Administration began collecting data in 1951 (NOAA, 2020). The unprecedented rate of global climate change observed in the past decade is especially detrimental to riverine ecosystems, partly because limiting factors such as dissolved oxygen and water temperatures are climate dependent (Pletterbauer, 2018). The interplay of climate change and anthropogenic habitat manipulation will further complicate and amplify the mistreatment and mismanagement of our riverine and forest ecosystems (Cadieux, 2020).

Collaborative work between environmental stewards/managers and those who can more regularly access these spaces, such as recreationalists, including anglers, will be an important part of preserving threatened ecosystems. One such instance is in the Southern Tier of New York. In Owego, New York, Trout Unlimited and the Tioga County Soil and Water Conservation District (SWCD) have worked to mitigate damage to stream habitat and structures in the East Branch of Owego Creek.

Figure 1. Shows the location of the restoration site in Owego, New York in the Southern Tier Region of New York (Google Earth, 2020).

Triggered by extreme weather that led to 50-year floods in 2010 and 2011, flooding destroyed in-stream holding structures for fish (three J-hooks) and caused large amounts of bank erosion (SWCD, 2015; Trout Unlimited, 2015; Lenetsky, 2020). The devastation was identified by anglers who frequented the two sections of the East Branch of Owego Creek and noticed a decline in the productive resident trout fishery. In 2015, determining that there was a need for restoration work, Trout Unlimited and the SWCD secured funds through the New York State "Millennium Stream Improvement Fund" for two sites on the

East Branch of Owego Creek: The Park Settlement Road Site and the East Branch Site (SWCD, 2015; Brown, 2020; Jura, 2020).

The Park Settlement Road Site was restored using the Rosgen Toe Wood Method. The method was used to stabilize banks, prevent further erosion, and create habitat for fish. Six-meter-long tree trunks with root balls were installed below low-flow levels along the outer bank of the site. The layer was covered with brush and backfill which was held in place with Coir fabric. An assortment of 3,700

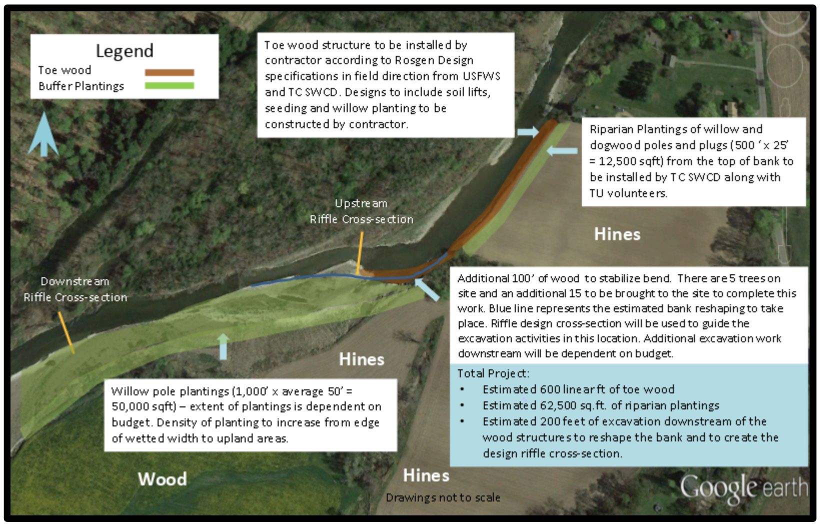

Figure 2. Displays the restoration site at Park Settlement Road as of 2015. Toe wood and buffer plantings are labeled along the ~1000-meter stretch, which is bordered on the left by woodlands and on the right by farmland (Brown, 2013, Figure 1.).

seedlings were planted along 740 feet of the outer stream bank to help secure the bank (SWCD, 2015; Trout Unlimited, 2015; Brown, 2020; Jura, 2020).

Through the Emerson Research Fellowship – guided by Professor Aaron Strong of Hamilton College – and with aid and support from Trout Unlimited and the Tioga County Soil and Water Conservation District, this project intends to collect information and data pertaining to the stream restoration efforts at the Park Settlement Road Site of the Owego Creek Stream Rehabilitation Project. Further, it intends to serve as a reference point, almost five years after completion of the project, for the conditions of the creek in connection to stream habitat, structure, and water quality almost five years after the project was completed.

Methods

Data collection spanned May 1st, 2020, to August 10th, 2020. The Vermont Stream Geomorphic Assessment Rapid Stream Assessment (Kline et al., 2004) protocol was employed to collect cross-sectional data and conduct a rapid habitat assessment. The total study area was defined from the downstream end of the Park Settlement Road bridge to the downstream end of the restoration site. The study area was divided into seven longitudinal reaches of 150-meters, labeled "A" through "G", and was marked with elevation and GPS coordinates. Study reaches "A" and "B" were above the restoration site.

Figure 3. Shows the seven cross-sections, or study reaches, within the defined study area. The study site is 1050 meters in length (Google Earth, 2020).

Study reach "C" included both J-hooks present at the site upstream of the site repaired using the Rosgen Toe Wood Method.

Temperature probes were planted at four locations in even intervals throughout the stream. Cross-sectional data was collected within each reach at 25-meters, 75-meters, and 125-meters with labeled

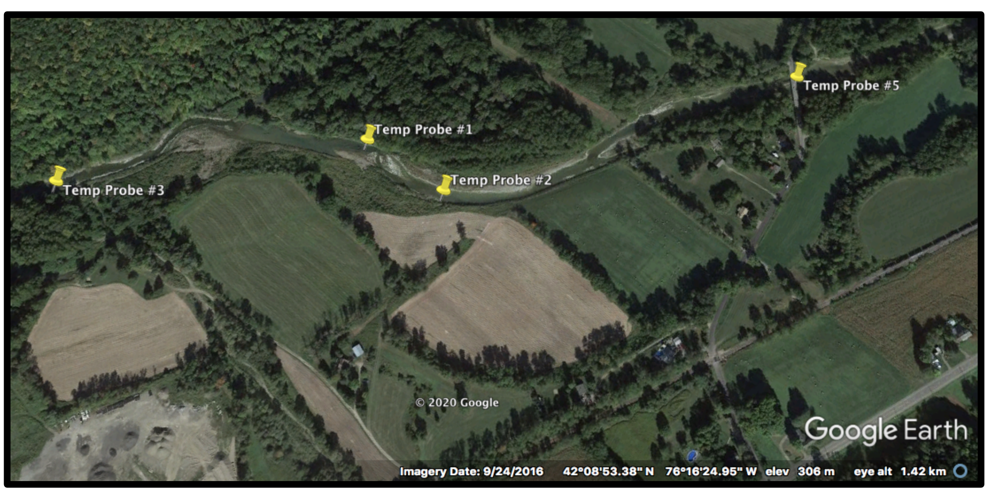

Figure 4. Identifies the locations of the four temperature probes throughout the study area. Temperature probes were located at strategic locations to identify if water temperature was changed by in specific locations by stream structure and pools, runs, and riffles (Google Earth, 2020).

subsections (i.e., A1, A2, and A3, etc.). Latitude-longitude and elevation were taken on each bank as well as the thalweg. The left-bank and right-bank were labeled when looking downstream. Four identification photographs were taken, two at the thalweg looking upstream and downstream, as well as on each bank.

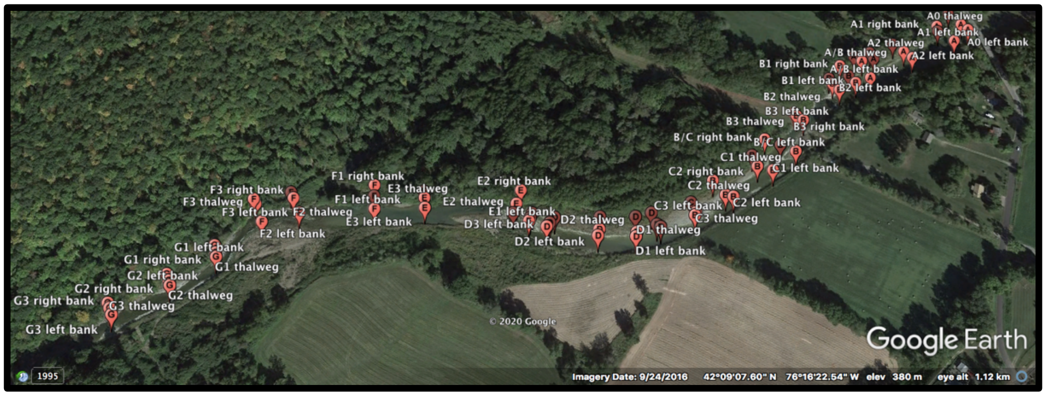

Figure 5. Shows each of the sub sectional GPS measurements taken within each cross-sectional reach. Each measurement had altitude, latitude, and longitude data (Google Earth, 2020).

Bankfull widths and bankfull/water depths were taken at each cross-section. Bankfull and water depths were measured in 10 evenly spaced intervals across the stream from the left-bank.

The Wolman Pebble Count method was used at the same cross-sectional intervals, five pebbles were collected at random in 20 intervals, 10 being the same as in the bankfull and water-depth measurements.

Stream velocity was calculated at each subsection by using a small object and timing its flow over a five-meter interval in the thalweg of each subsection.

Each cross-section was divided longitudinally from 0-50 meters, 50-100 meters, and 100-150 meters for a rapid habitat assessment. Pools, riffles, runs, and large woody debris were counted within longitudinal reach and were sketched and photographed.

Water quality assessments were conducted by sampling macroinvertebrates. Macroinvertebrate sampling and assessment was conducted using the Coldwater Conservation Corps's Advanced Monitoring Protocol (Trout Unlimited, 2014). The 30-meter stream reach was chosen at random from the possible stream reaches. Three 1x1 meter areas were sampled and scoured and macroinvertebrates were collected with kick-nets which were then removed for sorting.

Macroinvertebrates were sorted into taxonomic orders for further identification to the family level. Electroshocking data was incorporated into the data set from the New York State Department of Environmental Conservation Region 7 Fisheries Unit (NYSDEC). Electroshocking data was collected in 2014 and 2016 at the Park Settlement Road Restoration Site before (06/24/2014) and after (08/18/2016) restoration work was completed (NYSDEC, 2020).

Data analysis was conducted using Microsoft Excel. The rapid habitat assessment was completed by summating each of the 10 categories described in the Vermont Stream Geomorphic Assessment Rapid Stream Assessment and then divided by 200. Water quality scores were calculated using the Coldwater Conservation Corps's Advanced Monitoring Protocol*,* 2014 and the Environmental Protections Agency's Index of Biological Integrity (Stribling and Dressing, 2015). The five metrics described in the Index of Biological Integrity Technical Memorandum #4 (p. 10) were the Hilsenhoff Biotic Index (HBI), Total # of Taxa (TotalTax), Total # of EPT Taxa (EPTTax), Percent Individuals as *Cricotopus/ Orthocladius/ Chironomus* of Total Chironomidae (COC2ChiPct), and Total # of Shredders (ShredTax). The Percent Individuals as *Cricotopus/ Orthocladius/ Chironomus* of Total Chironomidae (COC2ChiPct) was

Table 3. Benthic Macroinvertebrate Metrics, Text Description, Category, and Trend with Increasing Stressor Load

Metric Name (abbreviation)	Description	Category	Direction of Change with Increasing Stressors
Total number of taxa (**TotalTax**)	Number of distinct taxa identified in the subsample	Richness	Decrease
Total number of EPT taxa (**EPTTax**)	Number of distinct taxa in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)	Richness	Decrease
Percent individuals as *Cricotopus/ Orthocladius/ Chironomus* of total Chironomidae (**COC2ChiPct**)	Count of individuals in these relatively tolerant genera as percent total Chironomidae individuals in the sample	Composition	Increase
Percent individuals as sensitive EPT (**PSensEPT**)	Of all individuals in the sample, the percentage of individuals in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), except individuals in the families Caenidae, Baetidae, Hydropsychidae, and Hydroptilidae	Composition	Decrease
Number of taxa, as shredders (**ShredTax**)	Number of distinct taxa in the sample that are considered shredders (i.e., they use coarse organic material—primarily leaf litter—for food	Functional feeding group	Decrease
Hilsenhoff Biotic Index (**HBI**)	Composite of total relative sensitivity of all organisms in the sample, calculated as the average tolerance value of all individuals in the sample	Tolerance	Increase

Figure 6. Describes each metric used in calculating the Environmental protection Agency's Index of Biological Integrity Score (Stribling and Dressing, 2015).

excluded. Taxonomic tolerance values used in calculating the Index of Biological Integrity were identified using aggregated data from the Soil & Water Conservation Society of Metro Halifax, 2015, and shredders were identified using the West Virginia Department of Environmental Protection Agency's Guide to Aquatic Macroinvertebrates, n.d.

Results

The mean bankfull width ranged from 12.66-41.80 m, downstream the mean bankfull width decreased throughout the Park Settlement Site. Mean water depth and bankfull depth also decreased

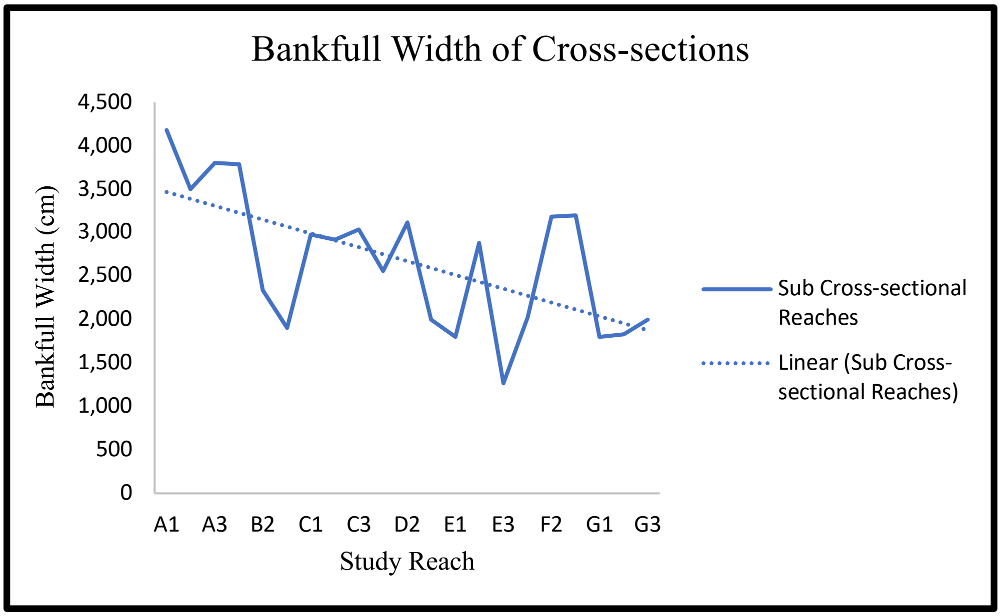

Figure 7. Shows each cross-section (*A1-G3*), related to each bankfull width taken. Upstream study reaches are to the left, while downstream study reaches are to the right.

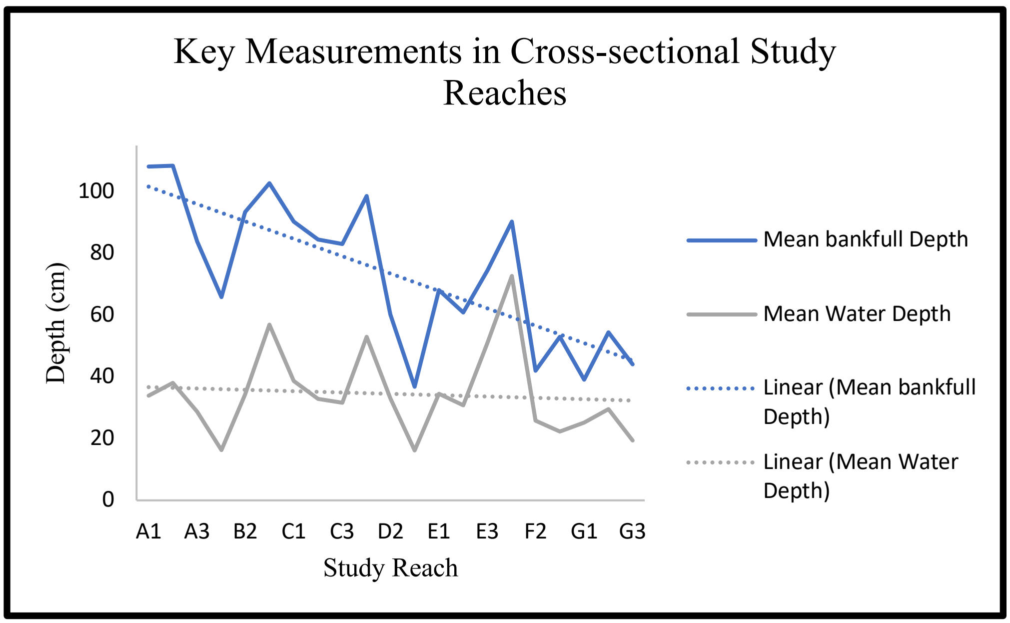

Figure 8. Relates the depth (cm) of each cross-section to its mean bankfull and mean water depth. Mean bankfull depth most noticeably decreases as you move downstream.

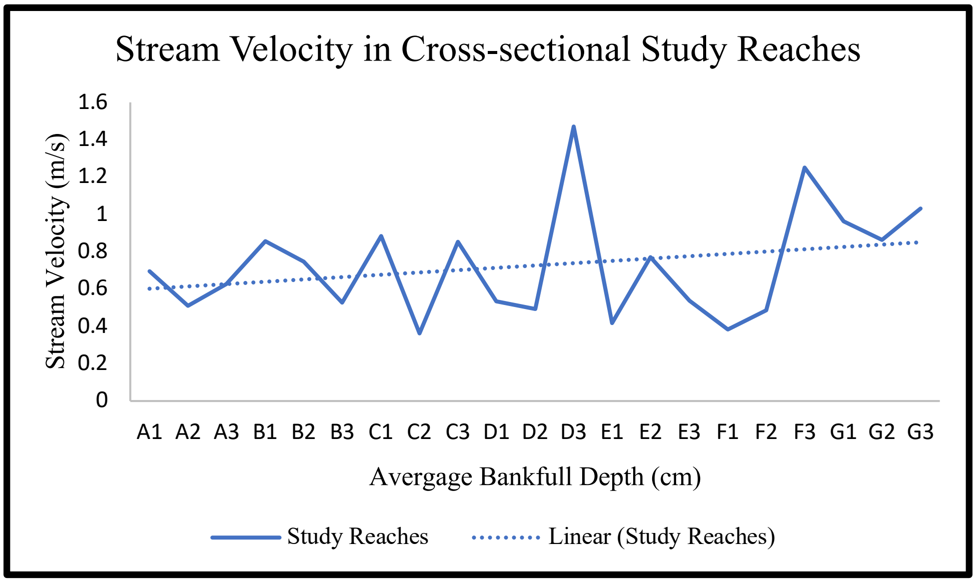

Figure 9. Finds that the decrease in bankfull width, shows in Figure 7, correlates to an increase in water velocity in downstream study sections.

throughout the site. Bankfull width correlated with an increase in stream velocity in downstream study-reaches. The width/depth ratio in each cross-section had a wide range (18.5-75.6) and increased slightly throughout the study site. On average the width/depth ratio was 34.5. Particle distributions remained similar within the study site with no apparent change between the Park Settlement Site and the reaches

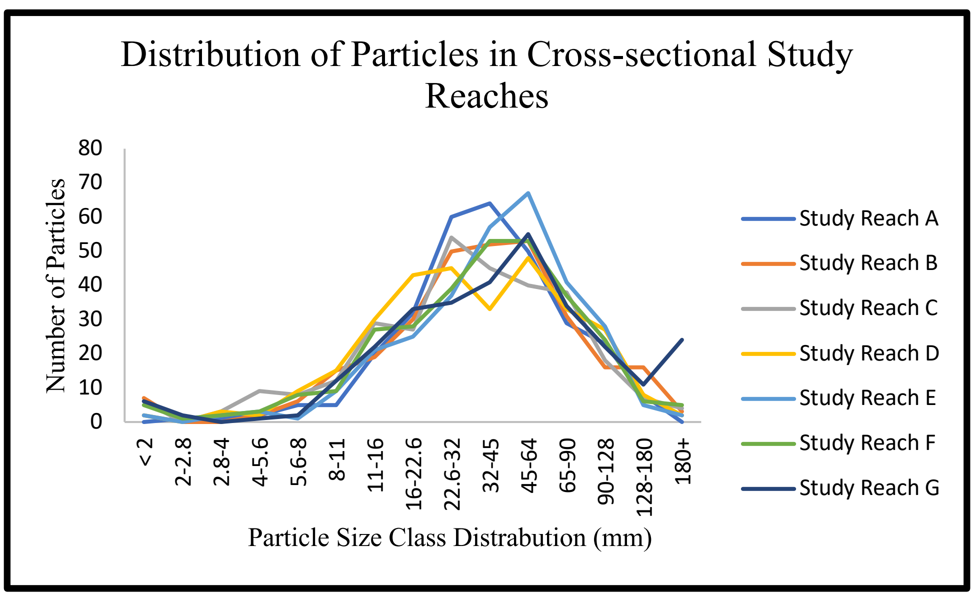

Figure 10. Shows the particle distribution for each of the seven study reaches. Sub cross-sections have been summed, and most cross-sections peak at 45-64mm.

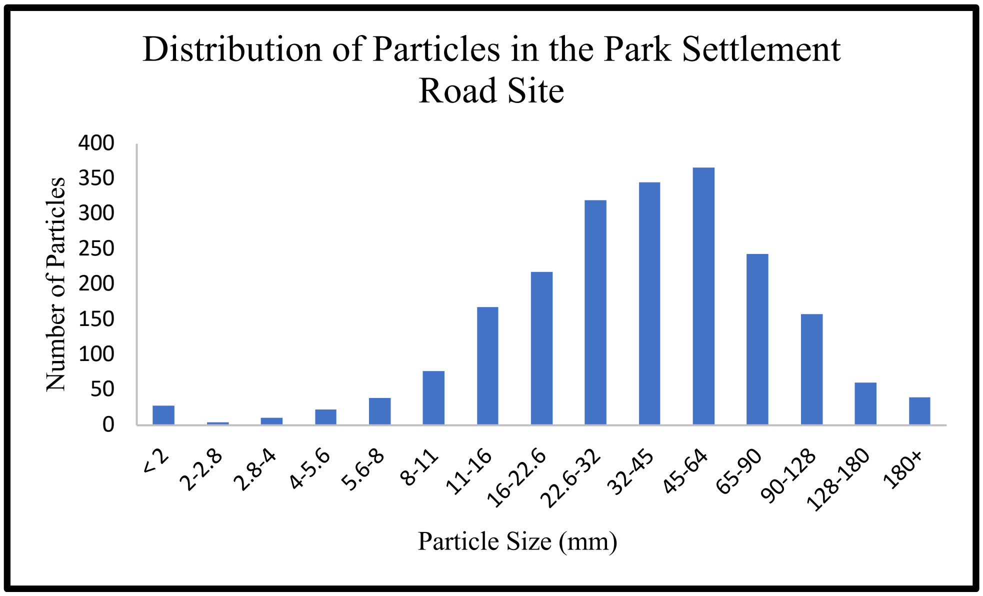

Figure 11. Shows the accumulated particle data for the entire study reach.

directly upstream (study reaches *A*, *B*, and *C*). Coarse gravel was predominant in the study site (45-64 mm). The Park Settlement Road Site was classified as a high gradient Type *C* stream following the Rosgen Classification System for Natural Rivers (Natural Resources Conservation Service, 2007, p. 13). All longitudinal sections fell within the 0.38-0.64 “fair conditions” range shown in Section 6.11 with a mean score of 0.53 (Kline et al., 2004). The morphological diversity of each longitudinal section differed little in runs, riffles, and pools, which all occurred on average ≈ 1 per longitudinal reach.

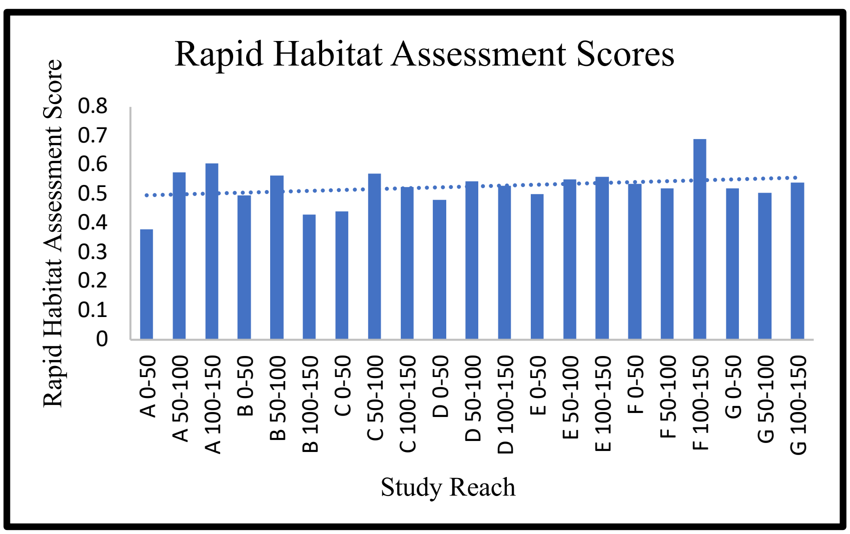

Figure 12. Relates the rapid habitat assessment score with its linear trendline. Scores trended upward towards the downstream section of the study site.

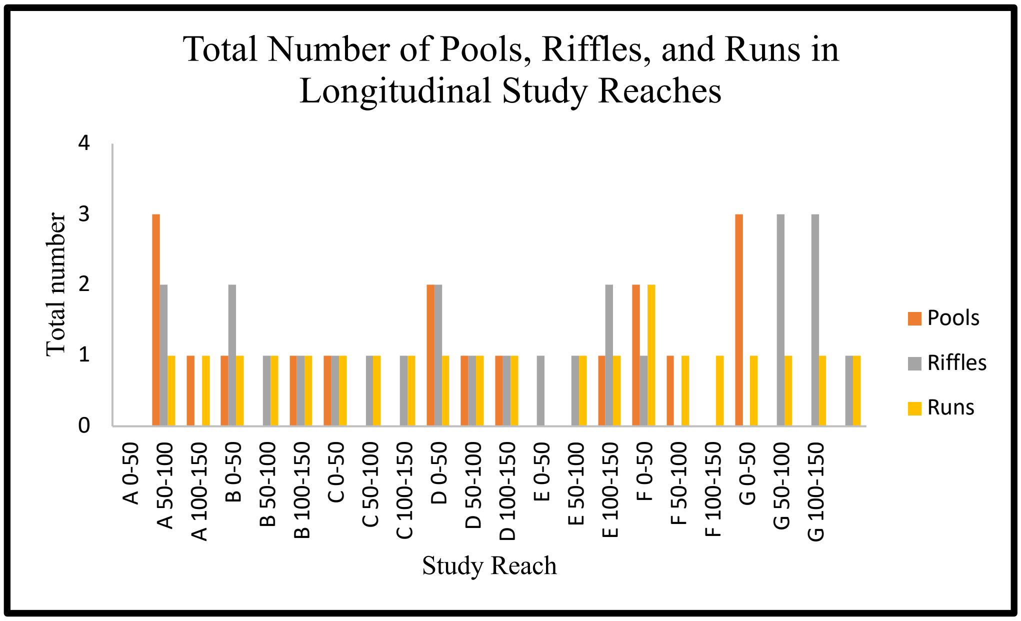

Figure 13. Shows the number of woody debris, pools, runs, and riffles in each longitudinal reach. The spike is due to the use of the toe wood in used to repair the outer bank in the middle of the study site.

Rapid habitat assessment scores increased slightly within the restoration site compared to upstream reaches. The Coldwater Conservation Corps's Advanced Monitoring Protocol water quality score was 39.2, in the "fair" range of 20-40 (p. 15). Using the Environmental Protections Agency's Index of Biological Integrity, the stream received a score of 83.8 indicting the stream to be non-degraded (above the > 65.7 threshold) (p. 11). Electrofishing data showed a 103 fish increase from 05/07/14 to 08/18/2016. Brook trout increased from 0 individuals to 66, and brown trout increased from 1 individual to 14. Dissolved oxygen increased from 8.6 to 11.0 while pH remained at 8.1. Temperature steadily increased throughout the summer from 18 °C to 20.5 °C. Three temperature probes were retrieved for data collection to monitor water temperatures at depths > 1 foot, the fourth captured surface temperature and was 5-8°C warmer due to the direct exposure to sunlight.

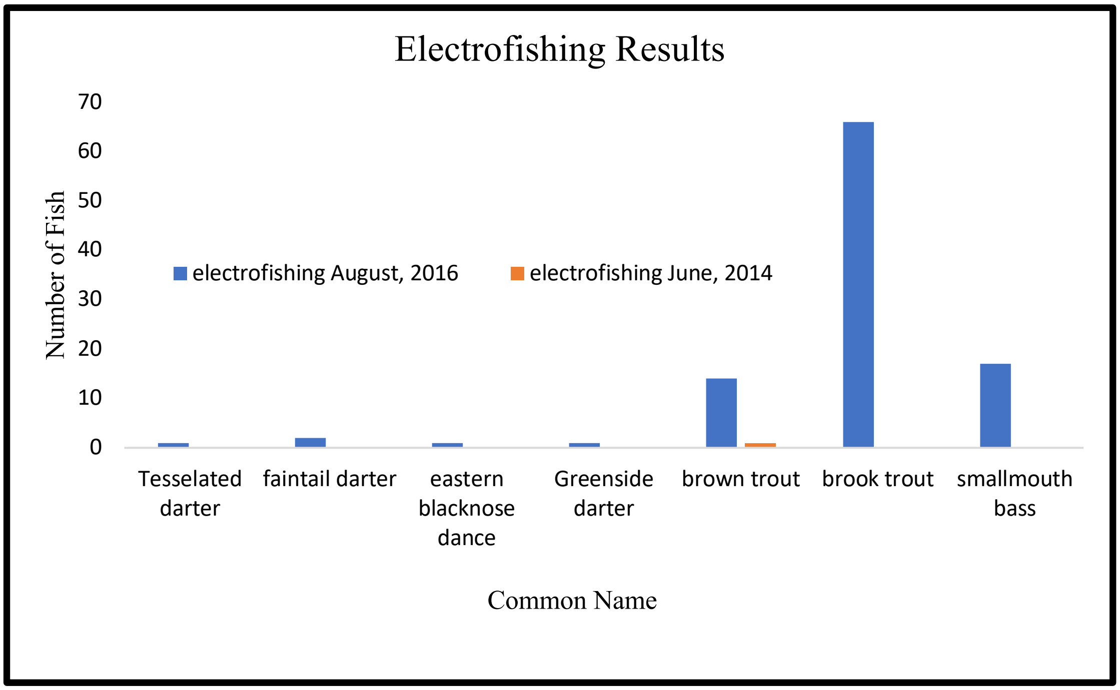

Figure 14. Displays the results from New York State electroshocking conducted in June 2014 (before restoration) and August 2016 (after restoration).

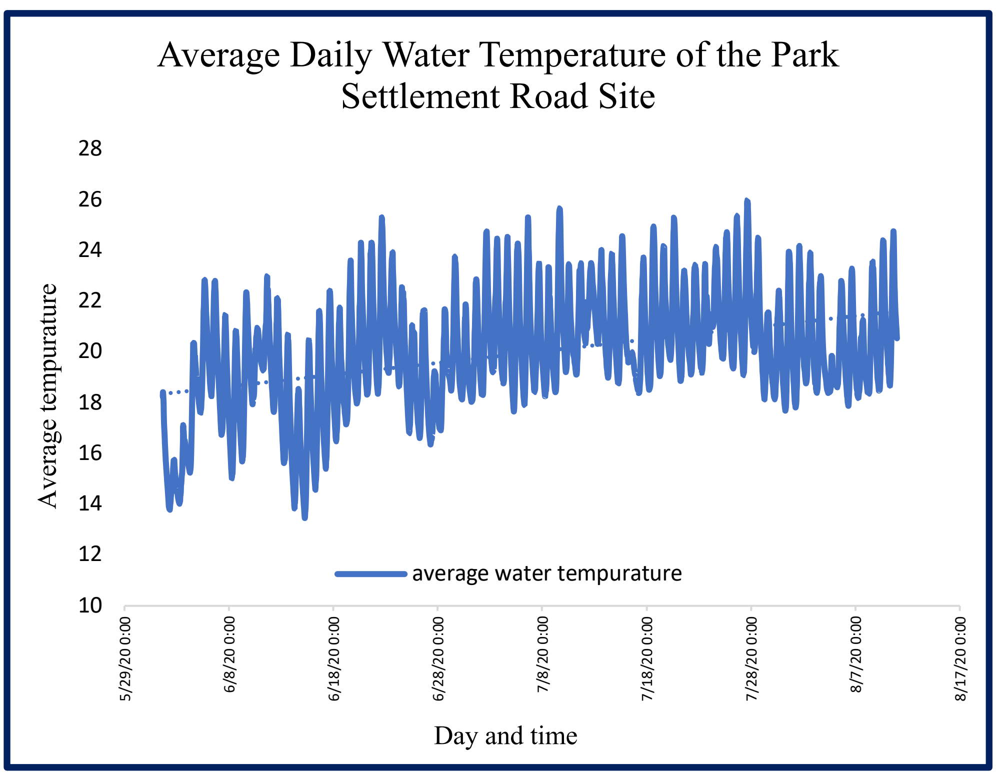

Figure 15. Shows daily average temperature taken at half-hour intervals. Data is averaged from three temperature loggers > 1 foot below surface level. Daily temperature variation is due to day/night temperature changes. An increase was water temperature throughout the summer months.

Discussion

Data indicates that the Park Settlement Site on the East Branch of Owego Creek is a moderately healthy stream and restoration efforts were successful in restoring trout populations.

The width/depth ratio of the creek is very high for a Type C stream (Natural Resources Conservation Service, 2007, p. 13). Although the creek is wide, stream velocity is suitable for trout, falling within the range of .4-.8 m/s range established by Macura et al., 2015. Water depth was below the optimal range for trout in the summer of 2020, falling below the .5-.8 m range determined in the same study. Particle size mean fell within the 45-64 mm class, peaking in the 22.6-64 mm range. Orcutt et al., 1968 and Adams et al., 2008 found the optimal range for trout < 50m cm to be between 15-60 mm and, making particle size in the East Branch of Owego Creek ideal for trout survival and spawning.

Rapid habitat assessment scores for each section predicted the stream to be in "fair condition." Invertebrate sampling also confirmed this predicting the stream to be on the high side of "fair conditions" scoring 39.2. The biological index score from Stribling and Dressing, 2015 was 83.8 ± 12.5 for a 90% CI. This score lies well above the threshold for classifying as a non-degreased stream and further adds confidence to the conclusion that the stream is healthy.

The pH of the creek remained constant throughout restoration from 2014 to 2016 at a pH of 8.1, within the optimal range for most aquatic life (Myers et al., 2018). Water temperatures of 18 °C initially exceeded the optimal range for range for trout survival, 12.4-15.4°C, (Soil Conservation Service, 1986) and moved up into the lethal zone for trout (> 20°C) (Myers et al., 2018). Dissolved oxygen levels increased from 8.6-11.0 mg/L. Levels below 8.0 lead to moderate reproduction impairment while levels ≥ 11 mg/L are optimal for trout survival and reproduction (Carter, 2005).

The strongest data to prove that restoration benefitted the East Branch of Owego Creek is the dramatic increase in fish populations from 2014 to 2016. Overall, every population sampled increased over the two-year period with an overall 106 fish increase. Brook trout populations increased from 0 to 66 individuals, and smallmouth bass and brown trout populations both increased significantly as well.

Conclusion

The Park Settlement Road Restoration Project accomplished its goal, helping to mitigate the effects of flooding on the East Branch of Owego Creek and preserve its resident populations of trout. Although data was not readily available from before restoration in 2015, this study serves to stand as a reference point for the current conditions of the stream as of the summer of 2020, hopefully aiding in future study, rehabilitation, and mitigation efforts.

As the climate continues to change, civilian conservation and science will become an important part in helping to alleviate the multitude of environmental pressures on river and waterways. The Owego Creek

Restoration Project at park Settlement Road should serve as a model for future action as it integrated community input, oversight, and guidance with governmental action that was effective in saving cherished trout populations.

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Data

https://drive.google.com/file/d/1xsEvVXwImP3r_t9UBbJDnkz1TSAqq9lO/view?usp=sharing

- Data: cross-sectional and longitudinal surveys, benthic macroinvertebrates surveys, and pebble count survey.

https://drive.google.com/file/d/1Aq-Uxfhzinu2vtwBtTouR0RRti4_Ti5z/view?usp=sharing

- Data: temperature, June – August 2020.

https://drive.google.com/file/d/1jmSVn_EPHc7Z7LJNpyFTj42X0JHDbrbo/view?usp=sharing

- Data: cumulative pebble count survey.