



Evaluation of Manassas National Battlefield Park Young's Branch Survey Data 2019

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Introduction

Manassas National Battlefield Park (MANA) marks the site of the two Battles of Bull Run in Prince George County, Virginia and features approximately 2,150 acres of grasslands and fields and 2,000 acres of woods. Its most notable hydrologic feature is Bull Run, which runs along the northeast edge of the park. The park contains several other streams, including Young's Branch, which flows from west to east across the park (Thomas et al., 2011) and feeds into Bull Run. Maintaining Young's Branch, as well as the other streams in the park, is a natural and cultural resource issue. MANA strives to preserve the historic character of the site by keeping as much of it as possible as it was during the Civil War and also works to maintain a healthy ecosystem. Tension exists between these two goals regarding matters such as creating vegetative buffers along stream banks, which would help to prevent lateral erosion but could block views that the park wishes to keep clear. The goal of this report is to evaluate existing data on the condition of Young's Branch, which can help inform management and future monitoring.

Existing Data

Surveys of an approximately 550 foot stretch of Young's Branch north of Lee Highway, east of Sudley Road, and south of Law Enforcement were conducted in 2014, 2016, and 2018 (Figure 1). Results of these surveys, including channel profile, bed materials, and cross-sectional dimensions with flow calculations are available in Excel workbooks. This report is largely focused on the implications and usefulness of the data obtained in these surveys with the goal of improving future monitoring and management. Additional data helpful for interpreting the survey results include precipitation records from the National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NCEI) and stream monitoring data from the National Park Service's Inventory and Monitoring program (I&M). I&M has discrete depth, width, velocity, and discharge data for Young's



Branch from 2005 to 2018 and continuous depth measurements from 2013 to 2016 measured at the same point.

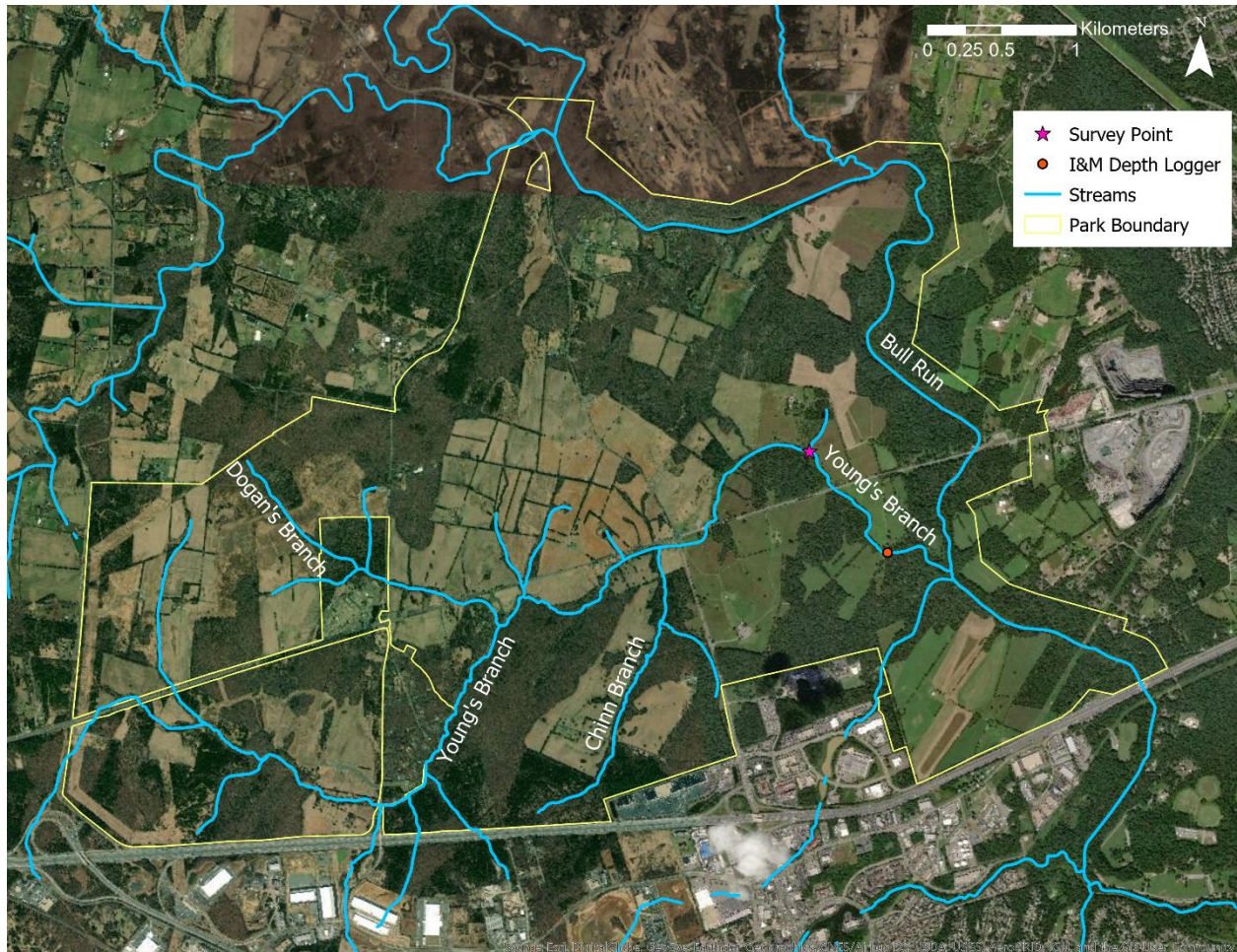


Figure 1: Map of streams in MANA with survey location recorded in 2014.

Inferences

From 2014 to 2018 in the surveyed segment of Young's Branch there was a decreasing trend in pool to pool spacing, glide length, and bankfull depth. The decrease in bankfull depth resulted in a concomitant decrease of other parameters determined by it including bankfull width, cross-sectional area, and calculated discharge, as well as an increase in width to depth ratio (Figures 2-3). The same period saw an increase in pool length and in the slope of riffles and pools as well as the overall channel to a small extent, though some of the apparent change in the size and slope of channel features such as pools and riffles may be due to survey crews identifying features slightly differently from year to year (Figure 4).

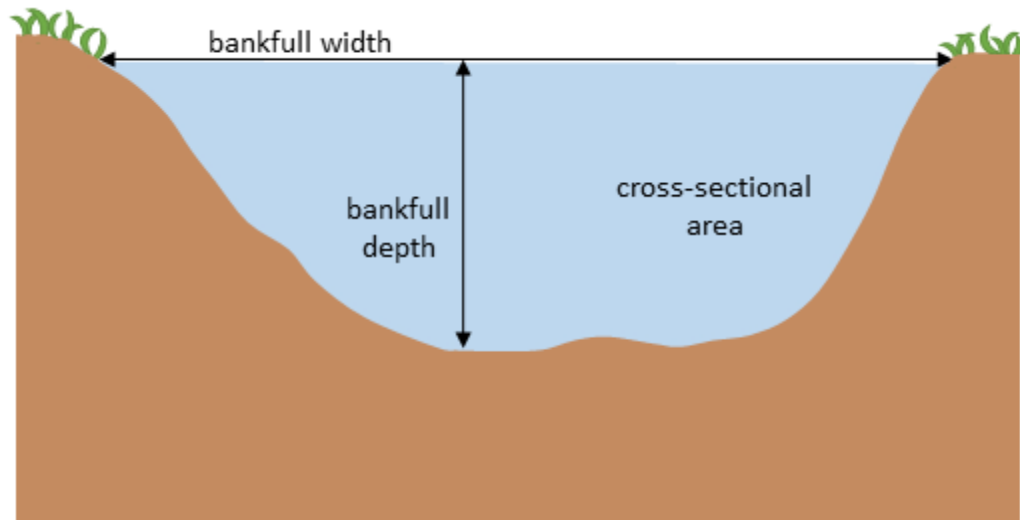
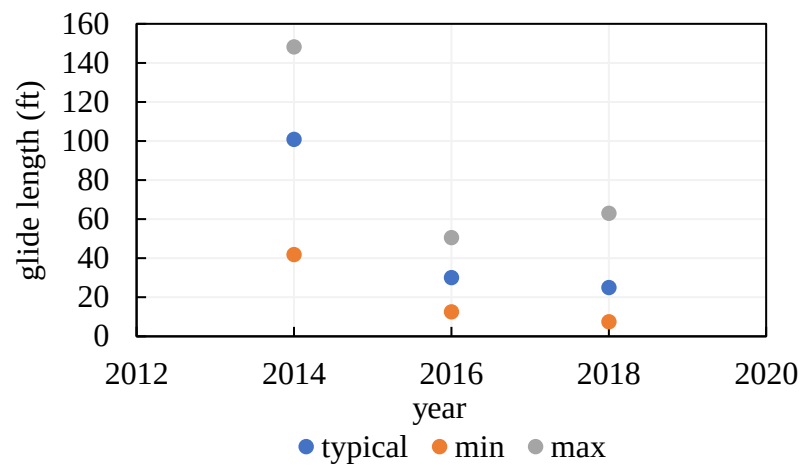


Figure 2: Illustration of some parameters measured during channel surveys. Bankfull depth refers to the depth of water during maximum flow in the channel. This is not necessarily the depth of water at the time of measurement. Other parameters are measured based on channel geometry at bankfull depth.



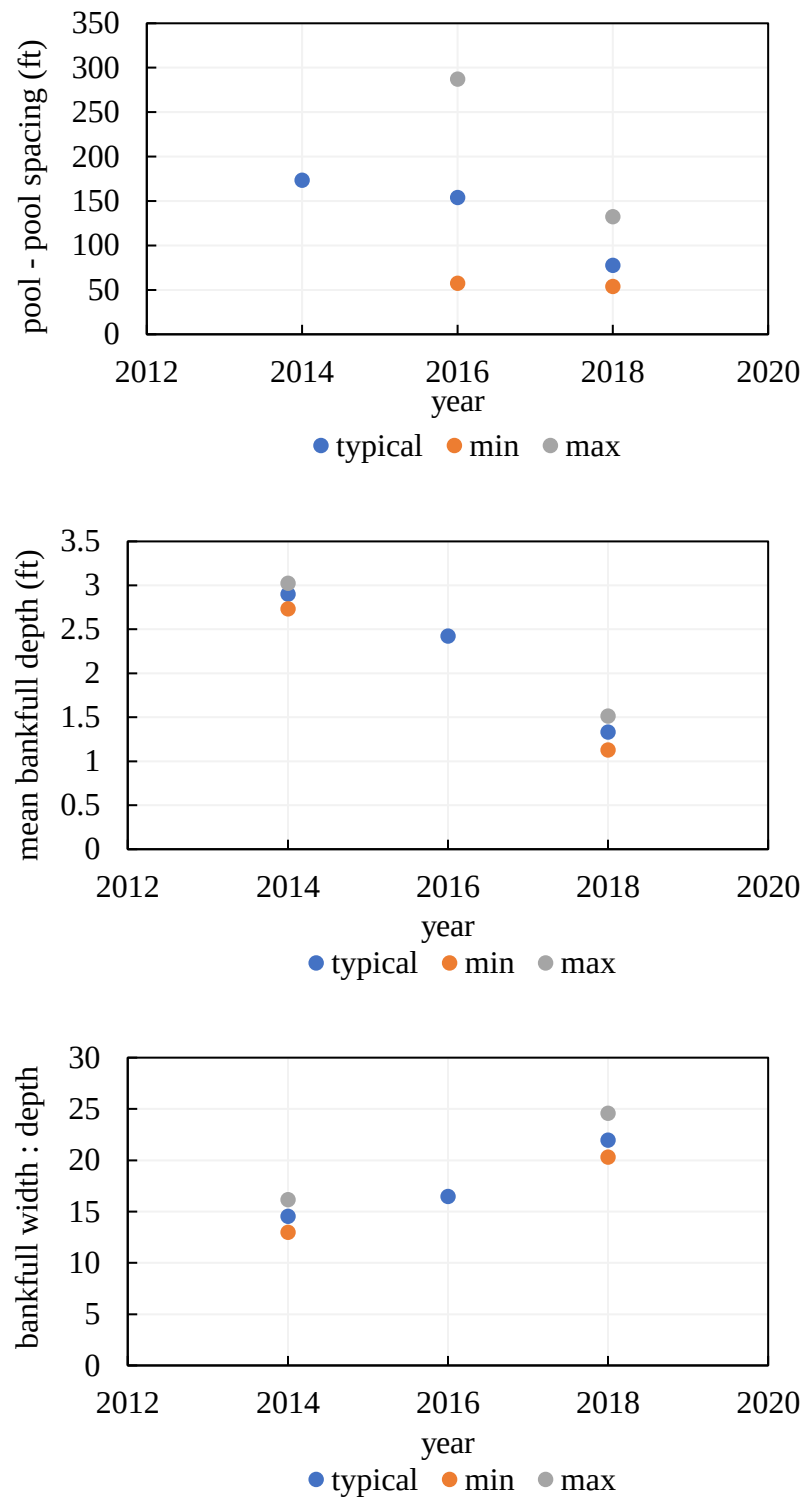


Figure 3: (Top to bottom) glide length, pool to pool spacing, bankfull depth, and bankfull width to depth ratio in Young's Branch as recorded in 2014, 2016, and 2018.

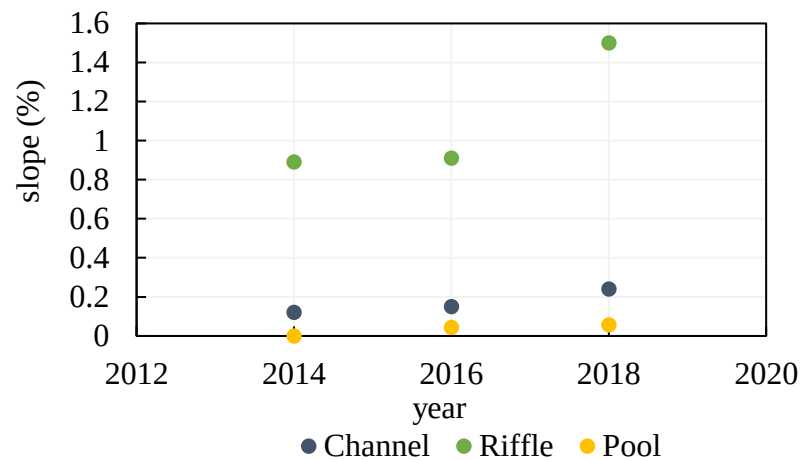
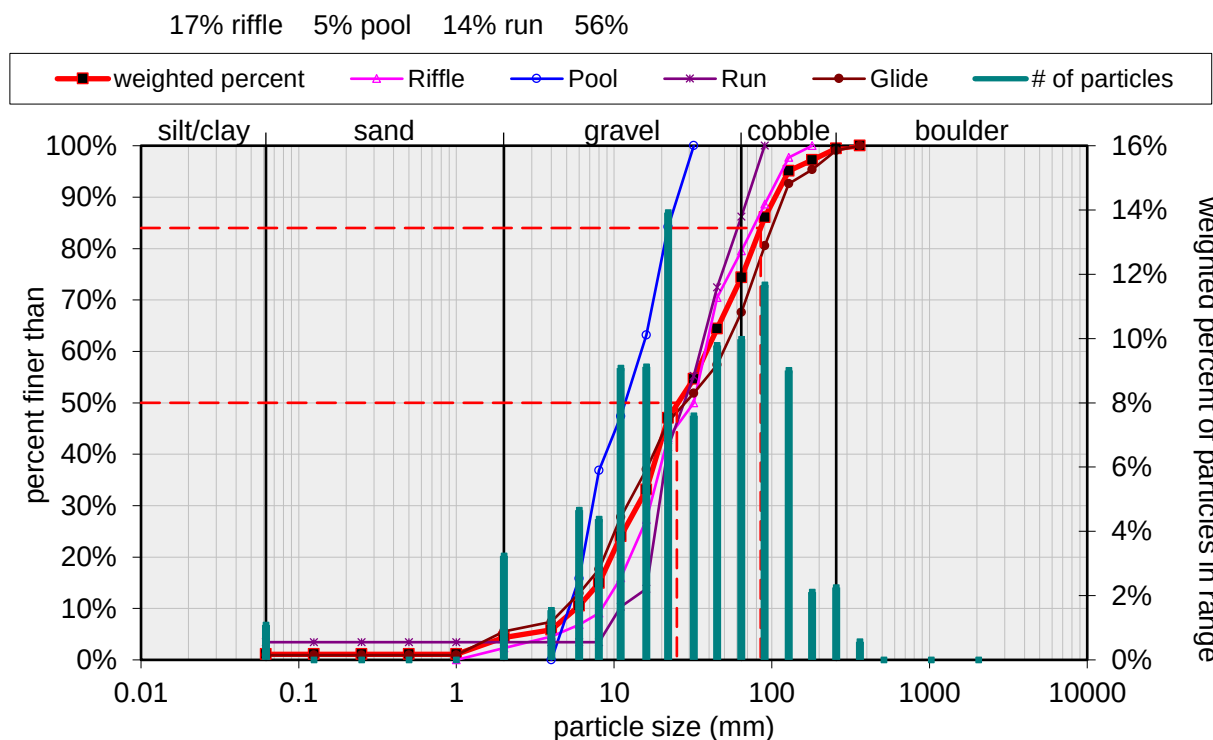


Figure 4: Channel, riffle, and pool slopes calculated for Young's Branch in 2014, 2016, and 2018.

Some aspects did not exhibit a continuous trend in all three survey years. Mean and median grain sizes in the channel increased from 2014 to 2016, then experienced a greater decrease from 2016 to 2018. The distribution of grain sizes became more tightly clustered in 2016 than in 2014 and became more slightly more dispersed in 2018, though not as much as it had been in 2014 (Figure 5).

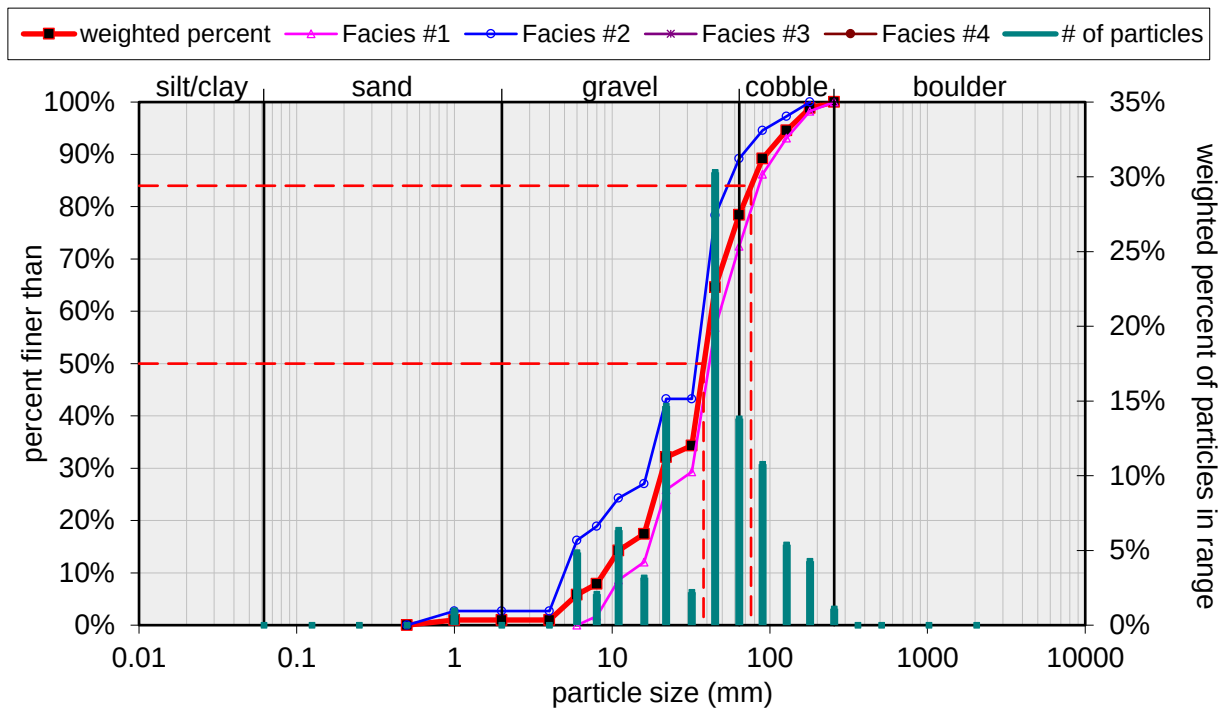
Weighted pebble count by bed features Young's Branch 2014





Weighted pebble count by channel facies Young's Branch 2016

64% facies 1 36% facies 2





Weighted pebble count by bed features Young's Branch 2018

14% riffle 23% pool 29% run

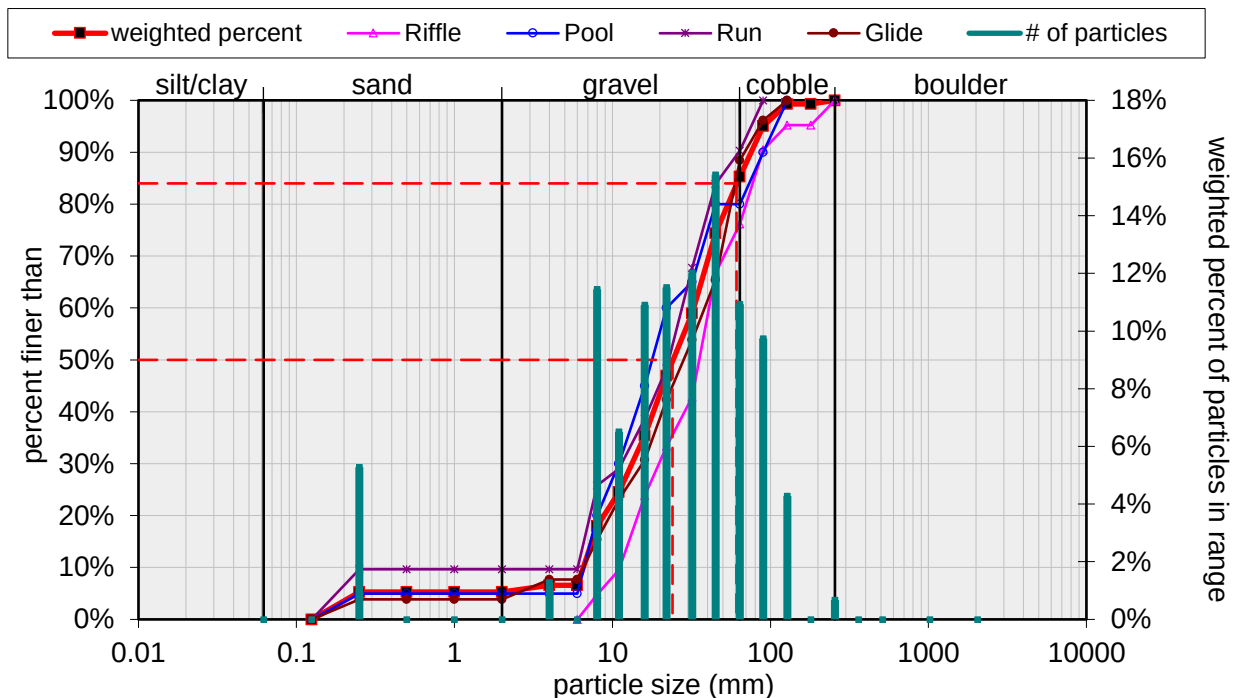


Figure 5: (Top to bottom) Distributions of particle sizes measured in Young's Branch bed material in 2014, 2016, and 2018. The cumulative percent finer lines are organized by the facies, or type of channel area, from which the particles were collected. Since it appears to be the default to present particles from riffle and pool facies first, it is possible that "facies 1" and "facies 2" in 2016 could refer to riffles and pools, respectively.

I&M continuous depth data show shallower base flow in early to mid-2016 than at the same time in 2014 and lower peaks in in mid-2016 than mid-2014 (Figure 6). NCEI records show lower precipitation for most months in 2016 than in 2014 and more precipitation in 2018, which presumably resulted in the lower flows in 2016 (Figure 7). Over long time periods, lower flows tend to lead to finer bed materials, as these would be all that the stream has sufficient energy to transport; however, with coarser material already in place, the reduced flows of 2016 could have caused the increase in average grain sizes by washing away only the fine material and leaving coarser particles behind.

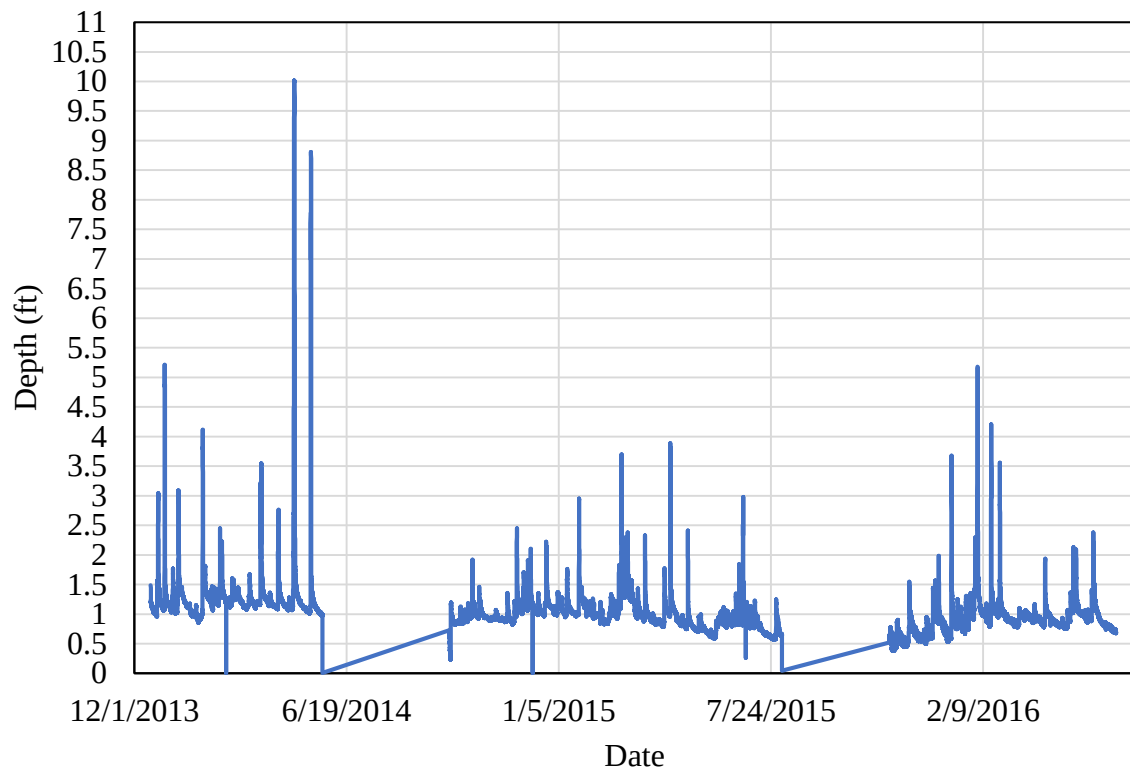
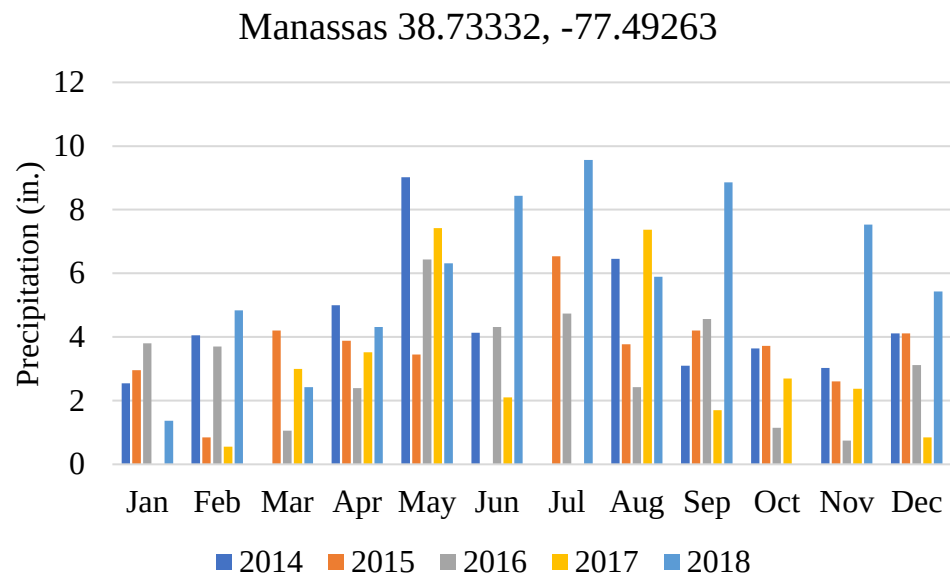


Figure 6: Depth measurements recorded by the I&M continuous logger in Young's Branch from December 2013 to June 2016.



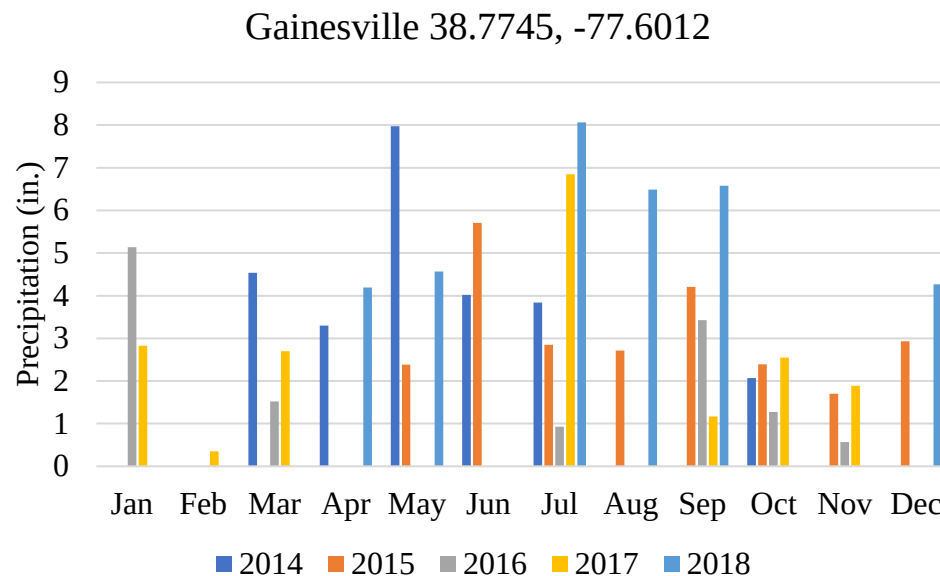


Figure 7: Precipitation recorded near MANA at the Manassas (top) and Gainesville (bottom) weather stations.

Extrapolation from three data points is tenuous at best, but the survey data from 2014, 2016, and 2018 do not appear to give immediate cause for concern. An increase in channel slope is sometimes associated with unstable channel downcutting and bank failures, but there is no trend in channel bed elevation data to suggest that this is occurring, and bankfull width has actually decreased. Additionally, the channel slope is still relatively flat with an overall slope of less than 1%. Nevertheless, the channel should be monitored for headcuts, or sharp drops in bed elevation which propagate upstream, and bank failures. 2018 was the only year in which bankfull and top of bank heights were reported separately, but in that year the bank height to bankfull ratio as measured ranged from 1.3 to 2.8, which often suggests vulnerability to bank failure (Doll et al., 2003, Starr et al., 2015). This can be exacerbated by a lack of trees to stabilize parts of the northern bank, though the prevalence of other vegetation should prove helpful. As another positive factor, the channel appears to have access to a fairly broad floodplain, which is beneficial for its stability.

Data Gaps and Monitoring Priorities

Necessary data to be collected in any study varies depending on its goals, but typical stream evaluation protocols and empty sections of the survey workbooks suggest some gaps to be addressed (Doll et al., 2003, Starr et al., 2015). To start, none of the existing workbooks have complete data on the planform (bird's-eye view) pattern of Young's Branch. This information is important for discerning trends in channel migration and predicting impacts to infrastructure. Unlike most other survey data, it can be obtained retroactively from aerial photographs or lidar from the years in question. Most other potential data gaps cannot be filled after the fact but could be prioritized in future monitoring if such information is desired. The survey workbooks contain a section for particle shape



factor, for which none of the years have any data. Such information is typically used to determine the distance particles have travelled from their source and can also be related to how easily particles are transported in a stream. If there is scientific interest in locating the sources of gravel and cobbles or evaluating their impact on stream bed cohesion or habitat, measuring all three dimensions of particles to calculate a shape factor would be a simple step to add to the next survey. If basic erosion management is the only objective, sieving for particle size without consideration of shape is generally sufficient.

A more prominent gap from a management standpoint is the lack of bankfull elevation for some of the cross sections. Bankfull elevation, or the elevation of the water surface during maximum flow, is necessary for many calculations relating to the discharge and sediment transport capacity of the channel, which is important for anticipating flooding and erosion. I&M have determined discharge rates at Young's Branch on several dates between 2014 and 2018; however, the temporal resolution is not fine enough to establish a reliable trend for the period, particularly with measurements missing for some months. The continuous depth data could be used to calculate discharge in the same way as bankfull elevations from survey data, but while it is extremely high resolution, it ends before 2018. At minimum, bankfull elevation should be recorded in every survey to determine the channel's maximum discharge and sediment transport capacity. Since actual discharge is usually not the maximum and varies quickly based on weather, acquiring enough data to establish a predictive trend would likely require multiple discharge measurements per month. However, given that lower flows are typically less erosive, determining month to month discharge levels is less of a priority than knowing bankfull flows.

Finally, surveys in the park would benefit from more complete and detailed metadata. This is for the benefit of anyone reading the data who did not personally collect it and must be able to understand it based solely on what is recorded. In particular, the survey workbooks tended to be somewhat vague on the location of the surveyed reach and cross sections. Ideally, coordinates should be listed for the up and downstream ends of the reach, or at least at one end with a note as to which end it is, and the location of each cross section should be specified. If measurements are taken in the same place each year based on markers placed in years prior, the locations of the markers should be included so that they can be identified by researchers or managers on maps when they are not in the field. Additionally, the facies from which particles were taken for measurement should be listed by name, for instance "point bar" or "pool", not "facies 1" or "facies 2", as the latter does not convey any information about the source of the particles.

Table 1: Summary of monitoring data gaps

Item	Priority
Bankfull elevations	High
Location and facies metadata	High
Channel pattern	Moderate
Particle shape	Low



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