



**HIGH DEFINITION STREAM SURVEY OF
TALLAPOOSA RIVER FOR THE HORSESHOE BEND
NATIONAL MILITARY PARK, ALABAMA, USA**

Prepared for The U.S. National Park Service
November 28, 2020

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HIGH DEFINITION STREAM SURVEY OF THE TALLAPOOSA RIVER FOR THE HORSESHOE BEND NATIONAL MILITARY PARK, ALABAMA, USA

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Introduction

The Horseshoe Bend National Military Park (HOBE) was established in 1959 and is located along the Tallapoosa River flowing near Daviston, AL. To help better manage the river, the National Park Service was interested in documenting the streambank and channel conditions on the river associated with HOBE. The Tallapoosa River has highly regulated discharge at HOBE as it is downstream of R.L. Harris Dam which is approximately 40 miles upstream. To document the river conditions, TRUTTA was contracted to gather data on water depth, habitat type (riffle, shoal, run, pool) and the condition of the left and right streambank on 5.8 continuous kilometers (3.6 miles) of the Tallapoosa River. A longitudinal High Definition Stream Survey (HDSS) was conducted on 17 May 2019 to collect data on water depth, habitat types, and streambank condition. We surveyed toward the middle of a descending limb of the release pulse to try to have both good conditions for imagery and for downstream passage. A standard set of classification criteria was applied to all three parameters. Additionally, a StreamView video for the entire section, a spreadsheet with results for water depth, habitat type, and streambank condition and a list of the most degraded stream segments were created.

Objectives

This project focused on the following objectives:

1. collect high-resolution, geo-referenced longitudinal surveys on 5.8 kilometers of the Tallapoosa River.
2. produce StreamView video of the survey showing video, sonar, time, and location information collected during the field survey,
3. document water depth, habitat type and left and right bank condition
4. create aquatic habitat GIS layers for water depth, habitat type (riffle, shoal, run, and pool), and left and right bank condition scores,
5. document most degraded segments of streambank.

Methods

The High Definition Stream Survey (HDSS) method was used to collect, classify, and analyze the data required for this project. In general, the HDSS approach followed a standardized series of steps that promotes rapid, systematic collection and processing of large amounts river condition data (Figure 1). The specifics of the data collected may vary with the project's requirements but following the general HDSS process ensures a successful project.

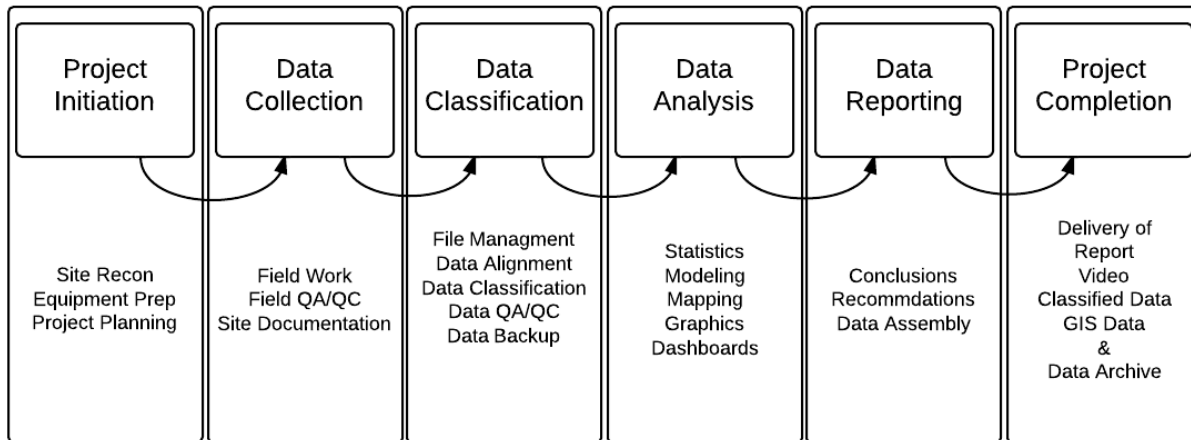


Figure 1: The standardized HDSS project flow chart.

Field Methods

Two 3.9 m long inflatable boats, powered by 2.5 horse power outboard motors, traveled in a downstream direction with each boat attempted to maintain its position at 1/3 the width of the river on each respective bankline (a left and right track). Maintaining an exact position across the river was not possible in some locations as rapids, islands or other obstructions required the boat driver to adjust to path of the boat to safely continue down the river. Each boat was outfitted with a HDSS system consisting of three mounted GPS-enabled Garmin Virb XE video cameras (Garmin, Kansas City, MO) facing forward, left, and right (90°), and Hummingbird Helix 9 side-scan sonar (Johnson Outdoors Inc., Racine, WI), with a recreational grade Garmin GPSMap 64 GPS receiver (Garmin International, Inc., Olathe, KS) to record depth and location measurements, respectively (Figure 2).

Coordinate Position was simultaneously obtained for each sonar depth measurement using the recreational grade GPS receiver. The Garmin GPSMap 64 is a high-sensitivity GPS and GLONASS receiver with quad helix antenna to improve the precision and accuracy of locational data and provides approximately one-meter horizontal accuracy. The Garmin GPS Map64 was also Wide-Angle Augmentation System (WAAS) enabled to improve accuracy and integrity of the coordinates provided. Utilizing this ground connection network, a WAAS-enabled GPS is accurate to sub 7.6 meters in both horizontal and vertical measures 95% of the time, although in practice within the contiguous United States the WAAS correction typically provides better than 1m horizontal accuracy (National Satellite Test Bed 2006).



Figure 2: Sonar, Video Camera Array and GPS units used during the Tallapoosa River Survey.

Data Alignment

Following field data collection, geo-referenced video was combined with the GPS and sonar data such that each data point is associated with a Coordinated Universal Time (UTC) and coordinates (WGS84 datum). The individual files were assembled to form a single, georeferenced, continuous video tracklog (i.e., StreamView), referenced to a common location and time, covering HOBE (Figure 3). The StreamView video and its tracklog were linked using HDSS video coder software which allowed an appropriate score to be applied to each second of the video and associated GPS location for each variable. Data from each survey track were used to document conditions along the river channel. Left and right streambank video were used from the boat closest to that respective bank for visual classification. Given the deliverable, no centerline track was needed in this project.



Figure 2: Example of the StreamView Video created for the Tallapoosa River survey near the Horseshoe Bend National Military Park. Boat location can be seen in the map window in the upper left corner. Video Name is in the upper right corner of the video. As noted in the upper right label, this is the StreamView video from the left boat and thus is used for classification of the left bank. The two-boat survey was necessary so that imagery was of sufficient detail along the riverbank to accurate classification. The right riverbank is clearly too far from the cameras for accurate classification.

Data Quality

Following the assembly of the high definition video into a continuous StreamView tracklog, the quality of the video was assessed to determine the appropriateness of the video for visual classification and use prior to analysis, hereafter referred to as Data Quality. To ensure consistency, data quality classification identified the applicability of data and its use during analysis and defined how the data can be used to deliver specific parameters during analysis. For example, in shallow areas where the sonar transducer was lifted out of the water to avoid striking the bottom (dragging), corresponding depth readings were deemed inaccurate and removed. Additionally, data quality identified locations where the geo-referenced video was obscured, preventing classification. The continuous video file was classified into one of 12 categories listed in Table 1 below. For the Tallapoosa River survey, all 8667 observations were considered good (100%).

Table 1: Data location and type with respective definitions used during Data Quality classification.

Data Location or Type	Definition
Good Data	Video allows for analysis
Restricted data	All video data obstructed, limiting analysis
Right bank obscured	View of right bank obstructed, limiting analysis
Left bank obscured	View of left bank obstructed, limiting analysis
Left bank and streambed obscured	View of left bank and streambed obstructed, limiting analysis

Data Location or Type	Definition
Right bank and streambed obscured	View of right bank and streambed obstructed, limiting analysis
Dragging	Kayak is dragging on in-channel obstacle requiring the navigator to exit the kayak to continue, often over shallow riffles or debris jams.
Transect	Video where cross-sectional transects were performed
Underground	Channel goes underground. inaccessible by foot or kayak
Off-channel	Video identifies a water management related structure (e.g., detention pond, terracing)
Revisit	Video needs additional review by field staff or others for clarification.
Photo Survey	Video will be used for photographic description due to safety and difficulty of survey.

Data Classification

Data were identified and classified using a standard set of criteria provided in the methods below. Software algorithms were used to check and classify water depth and habitat type from digital sonar data while streambank conditions were visually classified from the StreamView video. To avoid observer error based on different observers, all scoring of streambank condition was performed by a single experienced classifier. After classification, every GPS point had an associated collection time, latitude, longitude, depth, habitat type (i.e., riffle, shoal, run, pool), and left and/or right bank condition score. The river condition variables that were assessed for the HOBE included:

- water depth,
- habitat type (riffle, shoal, run and pool), and
- left and right bank condition.

To provide a measure of validation on the classification process. An independent reviewer visually scored 20 randomly selected samples without seeing the classified results. The reviewer provided both the classification score and comments on the score when needed. After the review classification was complete, the scores were compared to assess the overall accuracy of the classification and where and why inconsistencies in the classifications existed.

Water Depth

The data from both the side-scan-sonar and the GPS receivers were integrated using common time stamp associated with each unit's data recording. Depth data were processed and corrected using ReefMaster software (ReefMaster Software Ltd., West Sussex, UK). Anomalous readings were corrected after visual inspection to ensure accuracy (Figure 4). Most corrected anomalous depth readings were likely the result of backscatter from debris floating in the water column or difficulty tracking the correct bottom return in very shallow water. These anomalies are often observed as a shallow depth reading (such as 0.3 m deep) with deep water (3 m) immediately on all sides. Most corrected depth readings were associated with steep drop-offs near the river bluffs. In these situations, shallow and deep depths were correctly found in close proximity.

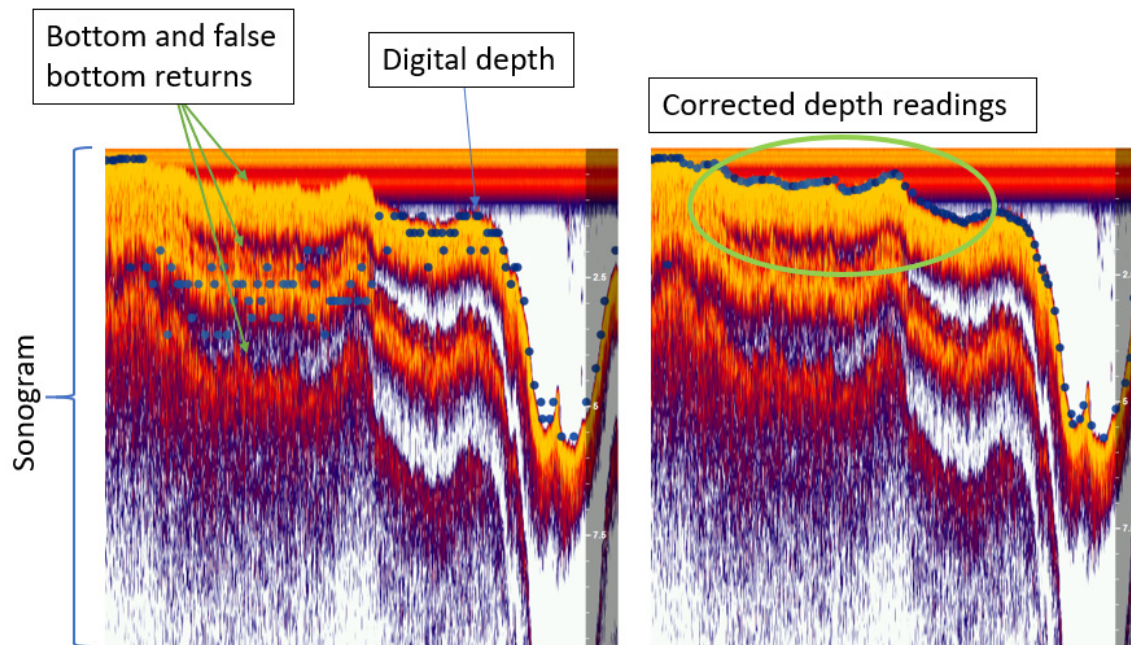


Figure 4: An example of an anomalous depth reading, highlighted in green, collected by the Humminbird Helix 9 G2N sonar.

Habitat Type

Rivers and streams are made up of a series of hydraulic units or habitat types (e.g., riffle, shoals, runs, and pools) which are often used to stratify sampling, identify habitat use of aquatic organisms and assess the effects of anthropogenic activities. In order for classified habitat to be advantageous, each habitat was consistently and objectively delineated by type. Habitat types were classified utilizing depth data derived from sonar data and recorded at approximately one point per second for the entire length of the river surveyed in order to obtain objective, comparable, and repeatable mesohabitat classifications.

A habitat was considered discrete only if its length was greater than or equal to the wetted width (Roper & Scarnecchia, 1995). To avoid misrepresenting exceptionally small habitat units (e.g., non-discrete habitats), such as a large boulder in a run which spans the thalweg and lies just a few inches below the water surface (and could be typed as riffle) the neighborhood mode is used to identify and correct for such instances. The length of the neighborhood mode was set to approximately the wetted width of the channel or 50 meters for HOBE.

The depth data was smoothed using a LOWESS method with a 50m moving window. The depth smoothing eliminates much of the natural roughness of the streambed and highlights the major changes in streambed structure. After smoothing, the depth data is classified into one of four groups. Riffles were defined by segments less than the 85% quantile of the depth data. Shoals were defined by points within the 70% to 85% quantile range and pools were defined as areas deeper than the 30% quantile. Runs were all areas between the 70% and 30% quantiles for smoothed depth. (Table 2). Figure 5 shows an example of a smoothed depth plot for a 1000m segment of the river.

Table 2: Primary habitat type criteria and descriptions.

Habitat Type	Depth	Description
Riffle	Shallow ($\leq 85\%$ quantile)	Area of channel characterized by high current velocities and shallow depth; broken water surface often with partially exposed substrate.
Shoal	Shallow (between 85% and 70% quantiles)	Area of channel characterized by moderate current velocities and shallow depth, water surface turbulent and little or no exposed substrate.
Run	Moderate (between 70% and 30% quantiles)	Area of channel characterized by moderate current velocities and moderate depth; turbulent water surface.
Pool	Deep ($\geq 30\%$ quantile)	Area of channel characterized by slow current velocities and deep depth; smooth water surface

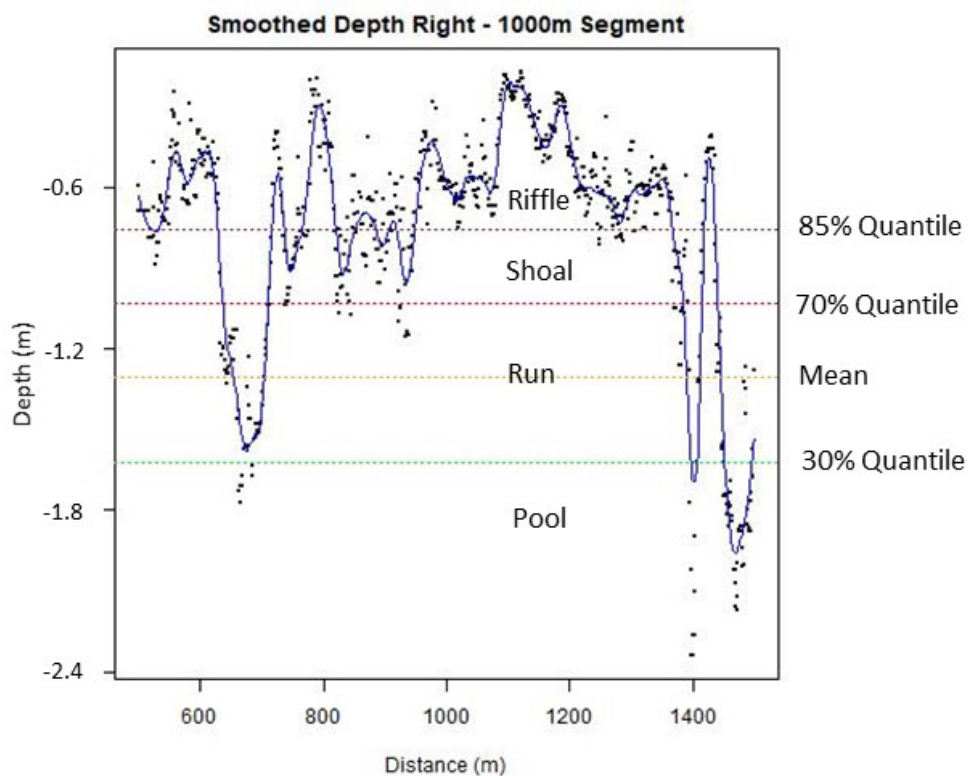


Figure 5: Example of smoothed depth plots for a 1km river segment of HOBE with riffle ($\leq 85\%$ quantile), shoals (between 70% and 85% quantiles), run (between 30% and 70% quantiles) and pool ($\leq 30\%$ quantile) break lines.

Streambank Condition

Streambanks were defined as sloping lands that contain the stream under normal flows. Naturally occurring streambank erosion provides a direct supply of sediment to fluvial systems creating the habitats necessary to support a wide array of species. However, excessive erosion is often damaging the riverine systems by reducing habitat heterogeneity, increasing water temperatures, lowering dissolved oxygen, and smothering and suffocating aquatic life (Wilber & Clarke, 2001). This excess erosion contributes to the total load in sediment impaired streams.

Multiple methods focusing on the streambank condition and erosion potential have been used to determine the source and magnitude of streambank erosion. One commonly used method to assess streambank erosion is the Bank Erosion Hazard Index (BEHI) developed by (Applied River Morphology, 1996). This method requires a trained individual to collect data in the field on bank and bank full height, root depth, root density, surface protection, and bank angle to determine its potential for erosion. The Bank Erosion Susceptibility Index (BESI) developed by (Connell B. A., 2012) collects parameters similar to BEHI but utilized a Streambank Video Mapping System to visually score the habitat, allowing for a rapid assessment of erosion susceptibility at the landscape scale. The HDSS method expands on the Streambank Video Mapping System (Connell, Ayers, Ludwig, Neff, & Parham, 2019) and uses a visual classification to integrate bank conditions to rapidly identify areas susceptible to erosion.

The method used to score condition was a visual classification developed specifically for HDSS surveys to determine for landscape scale assessments of streambank erosion susceptibility. Bank Condition scores reflect the potential for streambank erosion or streambank failure. Bank Condition is a visual integration of streambank angle, height, surface protection, and riparian condition. Compared to the BEHI method developed by Rosgen (2001), our method utilized a riparian condition parameter as a surrogate for root depth and root density and data were viewed on high definition video captured from the HDSS system. (Sass & Keane, 2012) created and validated a similar surrogate for the BEHI root parameters while assessing streambank erosion in Kansas. Additionally, video has been used with success to determine streambank erosion rates (Hensley & Ayers, 2018) and areas susceptible to erosion (Connell B. A., 2012). The major advantages of this method over traditional erosion assessments is the reduction of field time, cost, and uncertainty when extrapolating data to represent the entire river.

Left and right streambank condition was visually assessed utilizing and integration of bank angle, bank height, surface protection, and vegetated diversity (Figure 6) from the high definition video for both sides of the river. Each streambank was viewed independently during the classification process. Condition of each streambank was continuously rated fully functional (1) to non-functional (5) by a single experienced classifier; based on conditions during the survey for the entire sampling area. This classification system is analogous to past HDSS streambank scoring system that ranged from optimal (1) to very poor (2). The change mostly reflects a move away from subjective categories to function-based categories to allow the scoring system to be more easily integrated with other stream corridor assessments.

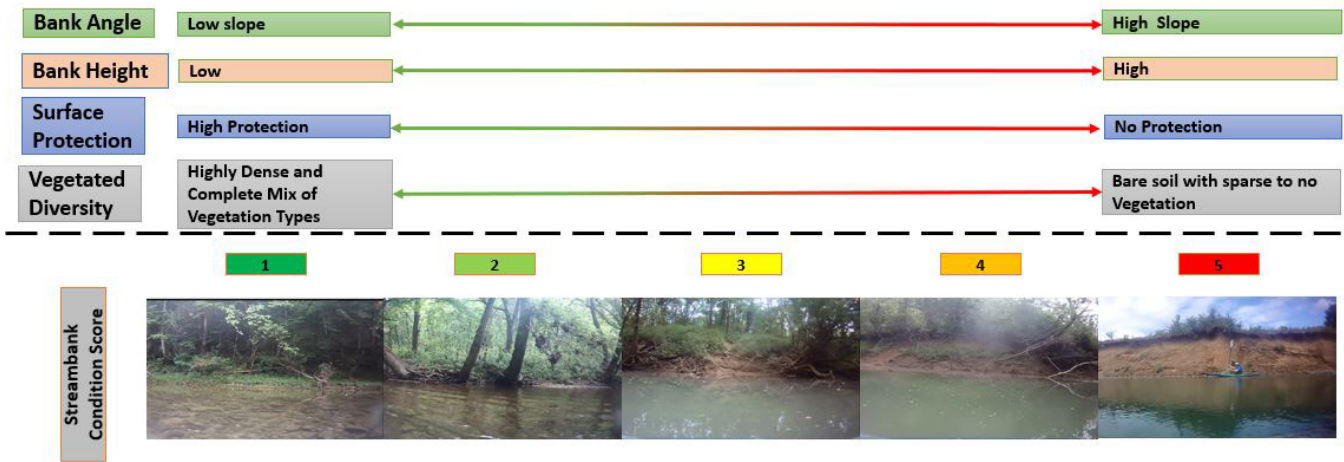


Figure 6: Streambank scoring criteria that is visually integrated to provide an overall streambank condition score (above) and examples of each of the five categories (below) ranging from 1-5, with 1 being the most functional and 5 being the most degraded.

Results

A total of approximately 5.8 kilometers (3.6 miles) of the main channel of the Tallapoosa River was sampled with dual track HDSS methodology during 17 May 2019. The survey started at the easternmost upstream boundary of HOBE and ended at the westernmost downstream boundary of the park. Two boat mounted platforms were used due to the width of the river and provided high-quality imagery of instream and streambank conditions. The boats traveled downstream in roughly parallel tracks, with one boat closer to the left bank and one closer to the right bank. When an island was encountered, we passed on both sides of the island if there was enough water in the smaller channel to allow passage. The choice of going on both sides of an island was determined in the field by looking at the relative size of the smaller channel. During this survey, we surveyed on both sides of the island just upstream of Hwy 49 Bridge. Left and right bank labeling follows traditional methods of identifying left and right bank while looking downstream.

Local Flow Conditions

The stream corridor surveys for the Tallapoosa River along Horseshoe Bend National Military Park was started and completed on 17 May 2019. To understand the local flow conditions observed during, pre-, and post the survey period, we viewed the USGS gage data for the nearest appropriate gage. For this project, the nearest appropriate gage is site number: USGS 02414715 TALLAPOOSA RIVER NR NEW SITE, AL. (HORSESHOE BEND). This gage is located near the Hwy 49 Bridge and is within the survey reach and thus was an appropriate gage to describe general flow conditions.

The Tallapoosa River has highly regulated discharge at HOBE as it is downstream of R.L. Harris Dam which is approximately 40 miles upstream. Water released from R. L. Harris Dam used for power production make daily fluctuations of discharge on the river with changes of 5000 cfs or more commonly observed during a release pulse. The consistent changes in discharge made gathering survey data at a “stable, base flow” nearly impossible. At the peak of a release pulse, much of the streambanks and the stream channel are underwater, while at the minimum flows, much of the channel is exposed and downstream passage is more difficult. We surveyed toward the middle of a descending limb of the release pulse to try to have both good conditions for imagery and for downstream passage.

The short-term trend (Figure 7) indicates that the survey was conducted on the descending limb of the hydrograph, immediately following the daily peak discharge event with discharge ranging from about 3500 cfs to 3000 cfs during the survey period. When viewing the daily mean discharge for a long-term trend (Figure 8 & Figure 9), it appears that average discharge was on a stable to slightly falling trend. During 17 May 2019, the local weather conditions were sunny with scattered clouds. High temperature was in the mid 80's and low temperature was in the mid 60's. No significant precipitation was forecasted during or the week prior to the survey.

The data for the discharge plots were retrieved from the USGS website. Mean daily discharge was calculated by summing the instantaneous data observations, recorded and reported by the USGS every 15 minute, from 00:00 to 23:45 each day and then dividing it by the total number of recorded observations during that period.

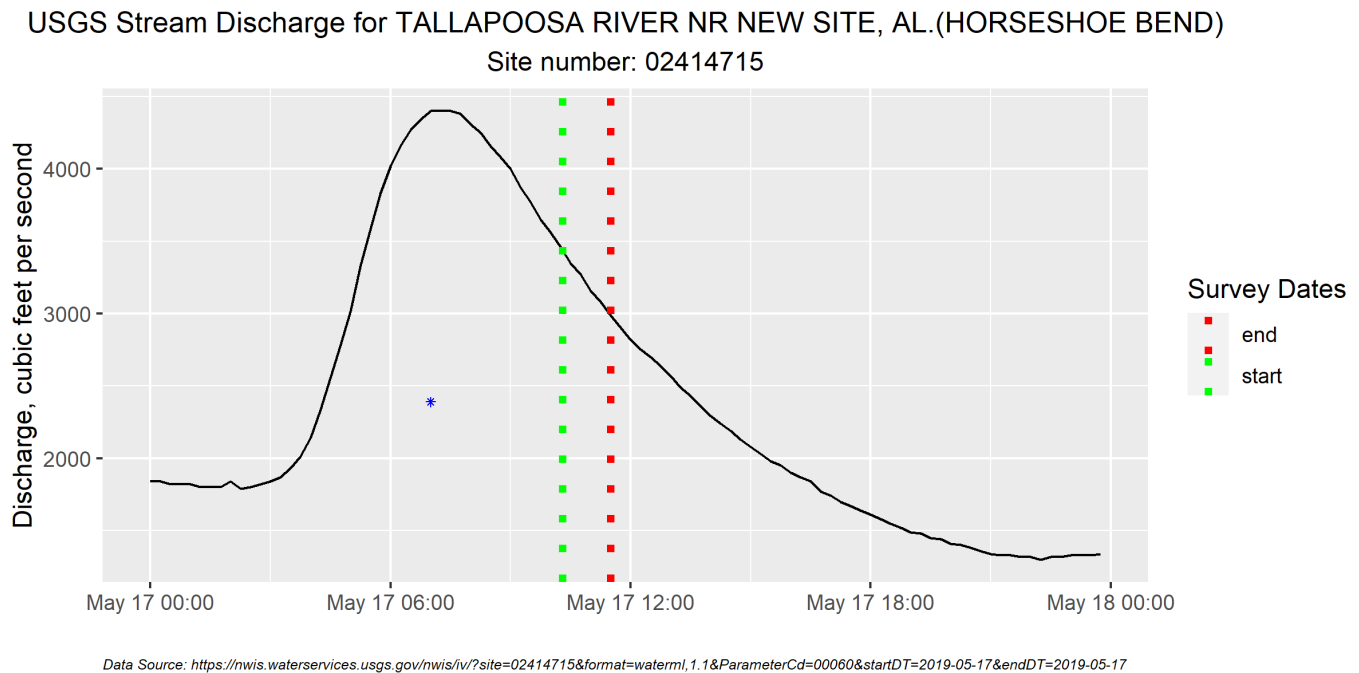
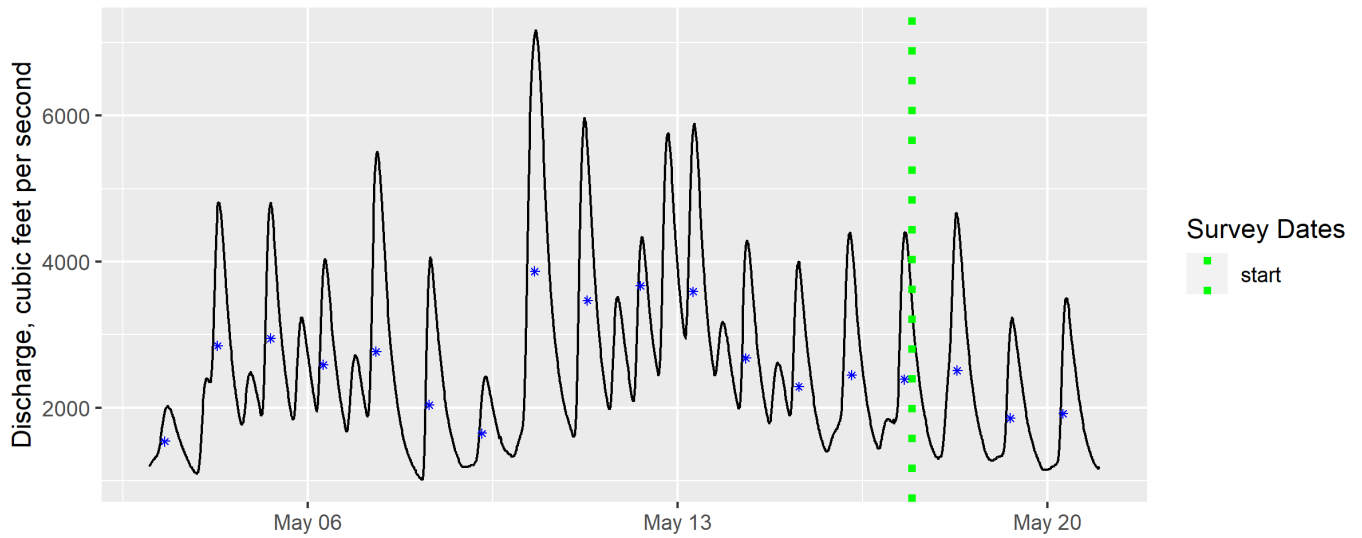


Figure 7: 1-day stream discharge for USGS Site Number: 02414715 on the Tallapoosa River within Horseshoe Bend National Military Park. Blue stars represent mean daily discharge, the green vertical dashed line is survey beginning and red vertical dashed line is survey end.

USGS Stream Discharge for TALLAPOOSA RIVER NR NEW SITE, AL.(HORSESHOE BEND)

Site number: 02414715

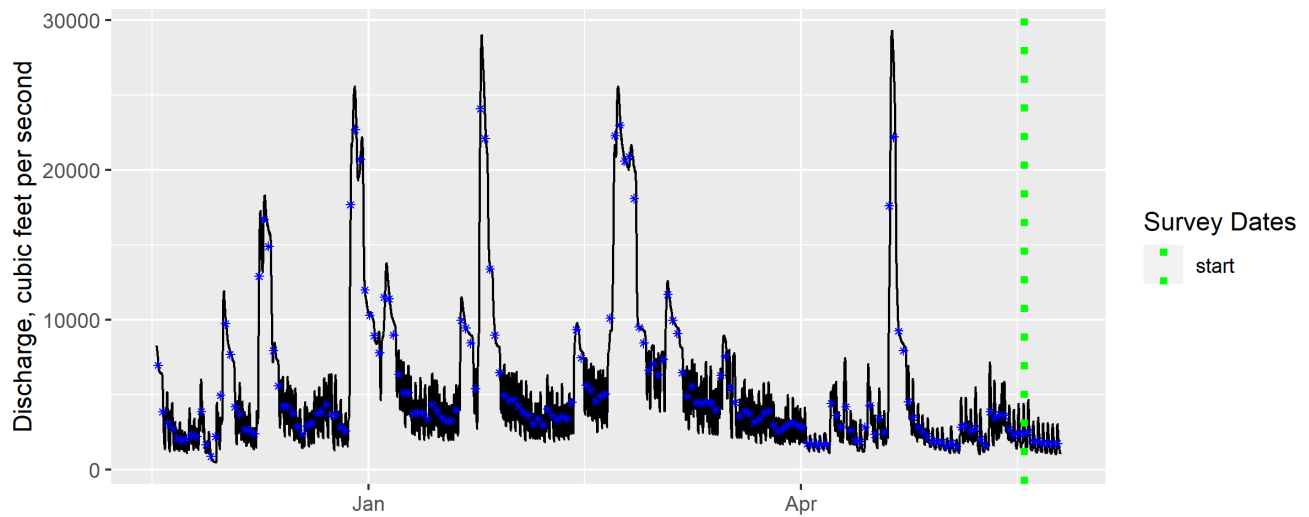


Data Source: <https://nwis.waterservices.usgs.gov/nwis/iv/?site=02414715&format=waterml,1.1&ParameterCd=00060&startDT=2019-05-03&endDT=2019-05-20>

Figure 8: 18-day stream discharge, 14 days prior and 3 days post sampling event, for USGS Site Number: 02414715 on the Tallapoosa River within Horseshoe Bend National Military Park. Blue stars represent mean daily discharge the green vertical dashed line is survey beginning.

USGS Stream Discharge for TALLAPOOSA RIVER NR NEW SITE, AL.(HORSESHOE BEND)

Site number: 02414715



Data Source: <https://nwis.waterservices.usgs.gov/nwis/iv/?site=02414715&format=waterml,1.1&ParameterCd=00060&startDT=2018-11-18&endDT=2019-05-24>

Figure 9: 188-day stream discharge, 180 days prior and 7 days post sampling event, for USGS Site Number: 02414715 on the Tallapoosa River within Horseshoe Bend National Military Park. Blue stars represent mean daily discharge the green vertical dashed line is survey beginning.

Field Surveys

An objective of this survey was to collect and classify high resolution, geo-referenced data along the 5.8 kilometers of the Tallapoosa River as it flows through HOBE. The survey was completed in a single day on 17 May 2019. We used two HDSS boats to gather a right and left track to document the streambank and water depth for the full survey (Table 3). We created StreamView video for both left and right survey tracks (Figure 10 & Figure 11). The StreamView videos all have a Track number associated with them and these track numbers are included in the primary source data sheets so that it is easy to find the appropriate video that goes with the data.

Table 3: Survey Track collection information. The Track Number is a combination of the survey day, boat, and video segment.

Day	Boat	Track	Date	Start Time	End Time
1	1	Left	17-May-2019	10:19:05	11:13:50
1	2	Right	17-May-2019	10:18:24	11:16:42

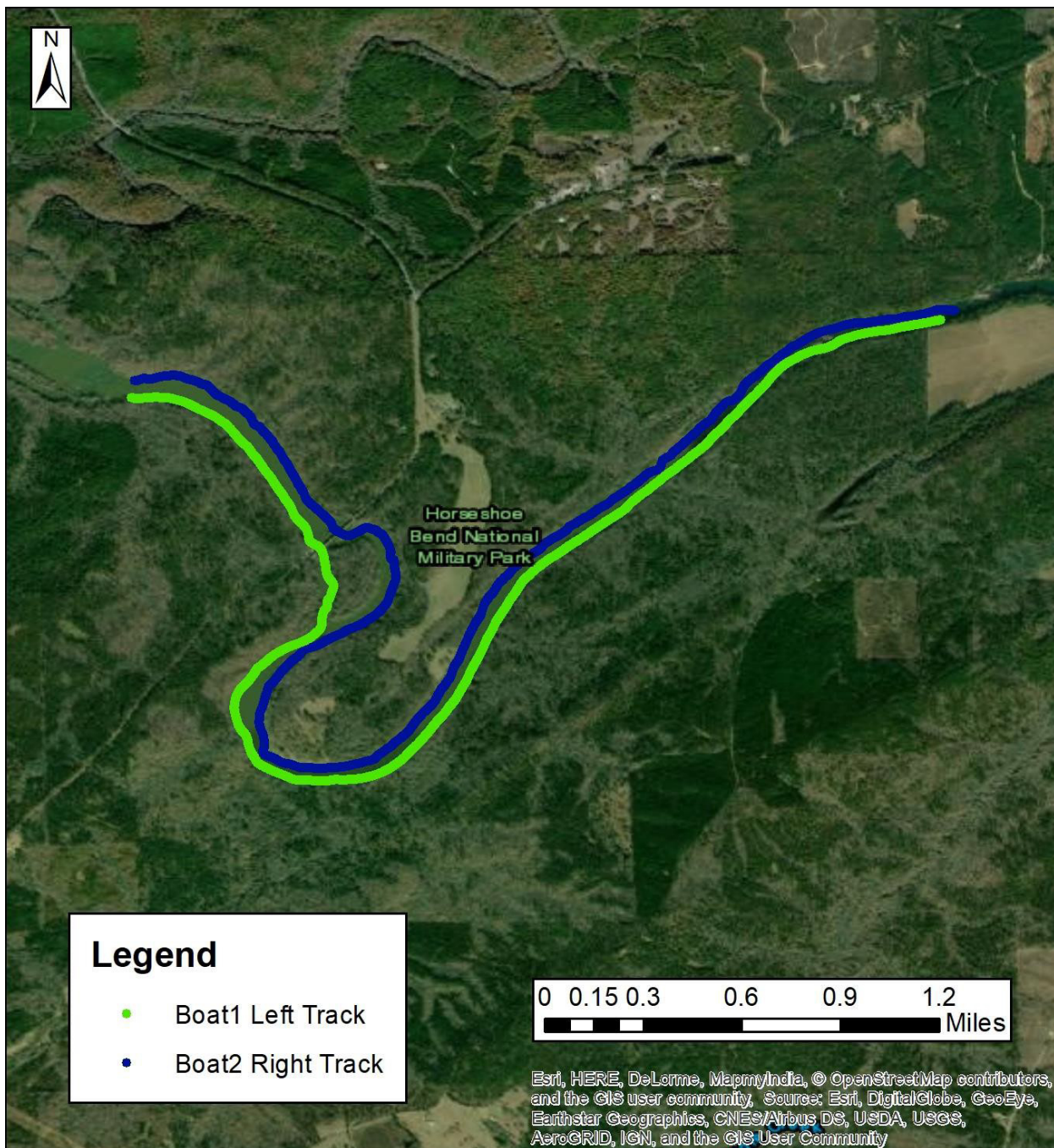


Figure 10: HDSS Video Tracks for the Tallapoosa River adjacent to Horseshoe Bend National Military Park.

Classification Results

Water Depth

The average water depth showed no specific longitudinal pattern (Figure 14). Shallow areas were present throughout the survey segment; however, the right track around the island was relatively shallower than the left track. The deepest water depths were observed in the outside of Horseshoe Bend pool. Point data for water depth

is affected by discharge fluctuations associated with power generation which influences both between-day and during-day water depths and discharge dropped approximately 500cfs from the beginning to the end of this survey. The mean water depth was 2.53m with a minimum depth of 0.15m and a maximum depth of 10.0m. Water depth was recorded as less than 3.18m in 75% of the readings.

Two measures of water depth were collected by the sonar. One is the sonograph of the sonar signal and one is the digital depth reading recorded by Humminbird's proprietary sonar software based on the sonograph. The digital depth readings were generally a good representation of water depth but were not always the correct. To ensure the digital water depth recorded matched the sonograph, the results of each were compared using ReefMaster 2.0 software. Where the digital depth did not accurately represent the sonograph, the depth was corrected manually to fit the depth observed on the sonograph (Figure 12). To compare the results of the corrected digital depth values with the uncorrected digital depths, we randomly selected one depth track to compare the paired results. For this comparison, the water depth track for the boat on the left side of the river was randomly selected.

There were 9,229 sonar recordings in the comparison dataset with 0.433m mean difference between the uncorrected and corrected water depth readings (Table 4). Most of the differences between the uncorrected and corrected were associated with a loss of bottom tracking at deeper depth readings (Figure 13). At water depths about 3m the Humminbird sonar appeared to have trouble holding the first sonar return and often found the next deepest sonar return (second echo) and substituted that depth reading for the echo instead of the depth for the first sonar return. The process of double-checking the digital depth readings against the sonograph proved to be an effecting approach to ensuring accurate depth data. Without the record of the sonograph, it would have been difficult to verify if the deep section shown in Figure 14 was an accurate representation of the river's depth or an erroneous depth associated with the loss of bottom tracking by the sonar unit.

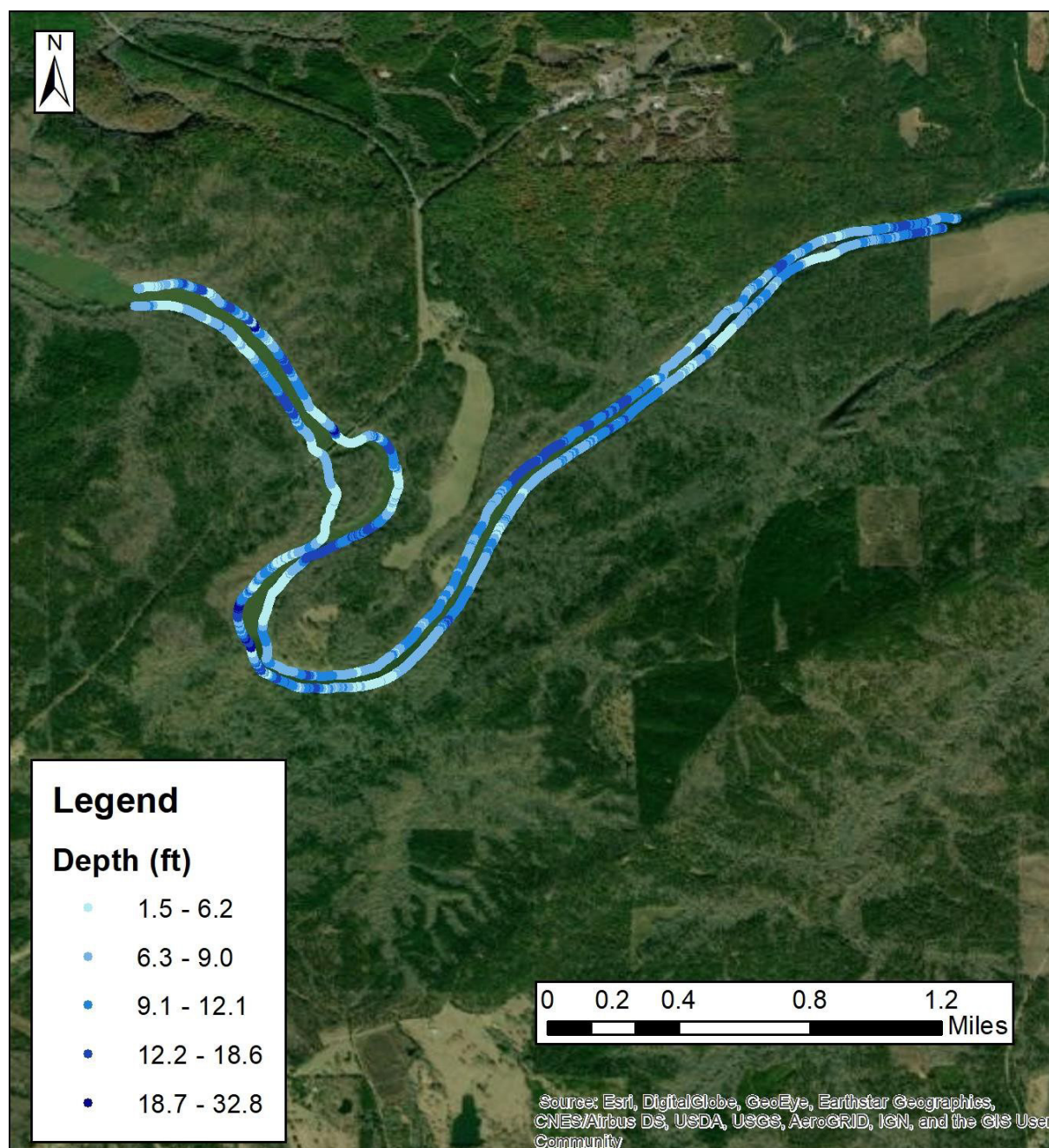


Figure 11: Water depth for left and right tracks for the Tallapoosa River, adjacent to HOBE. Depth classes shown were to aid in visualization and were not analysis groups.

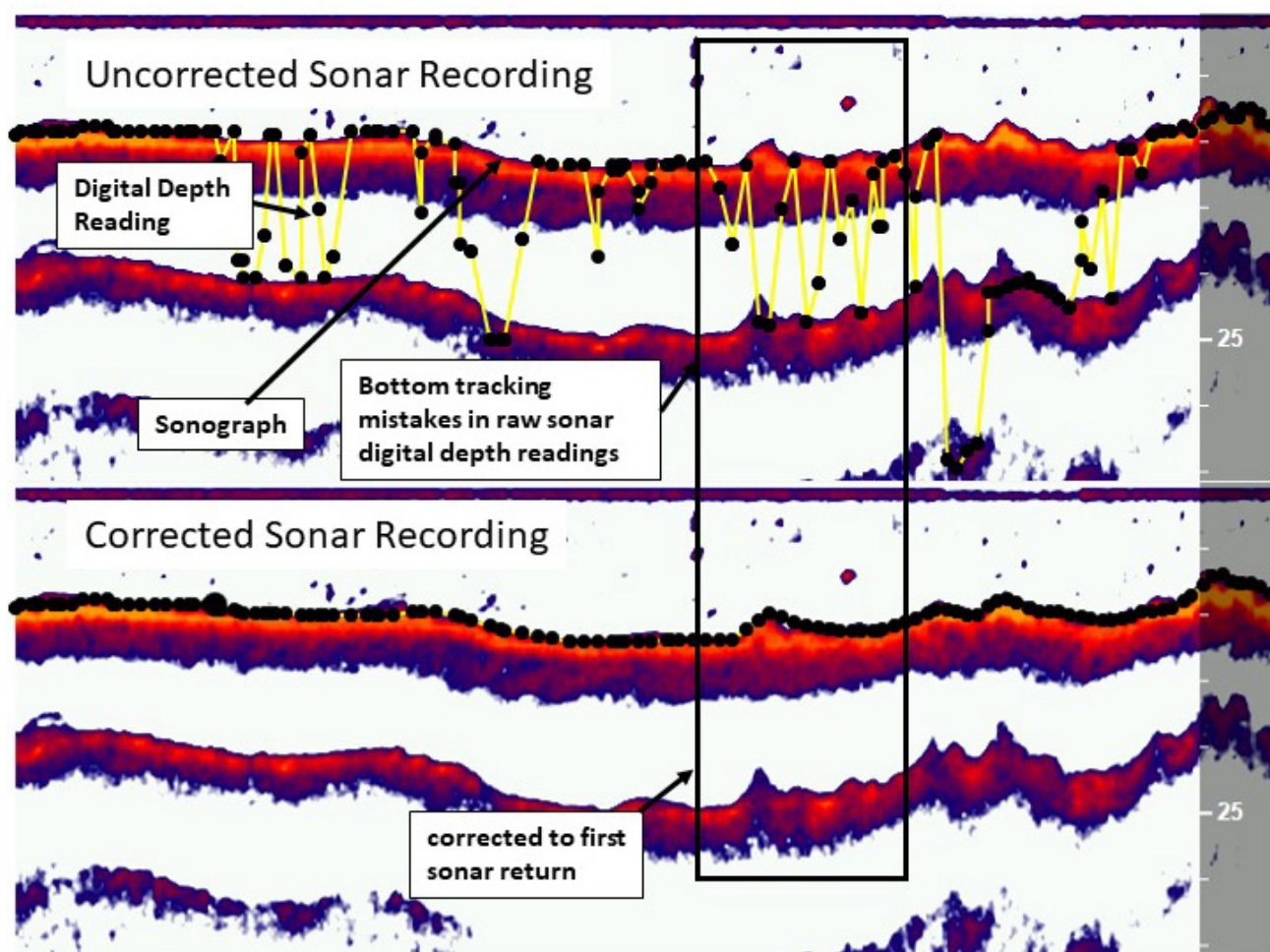


Figure 12: Example of uncorrected sonar recordings and corrected sonar recordings showing digital depth values and overall sonograph for the HOBE survey.

Table 4: Comparison of uncorrected to corrected digital water depth readings from the HOBE survey. All depth measurements are in meters.

Variable	N	Mean	SD	p0	p25	p50	p75	p100	Histogram
Uncorrected Depth	9229	3.000	1.694	0.557	2.057	2.459	2.959	11.05	
Corrected Depth	9229	2.566	0.939	0.423	2.029	2.459	2.983	10.00	
Depth Difference	9229	0.433	1.232	-0.77	-0.00	-4.44	0	9.567	

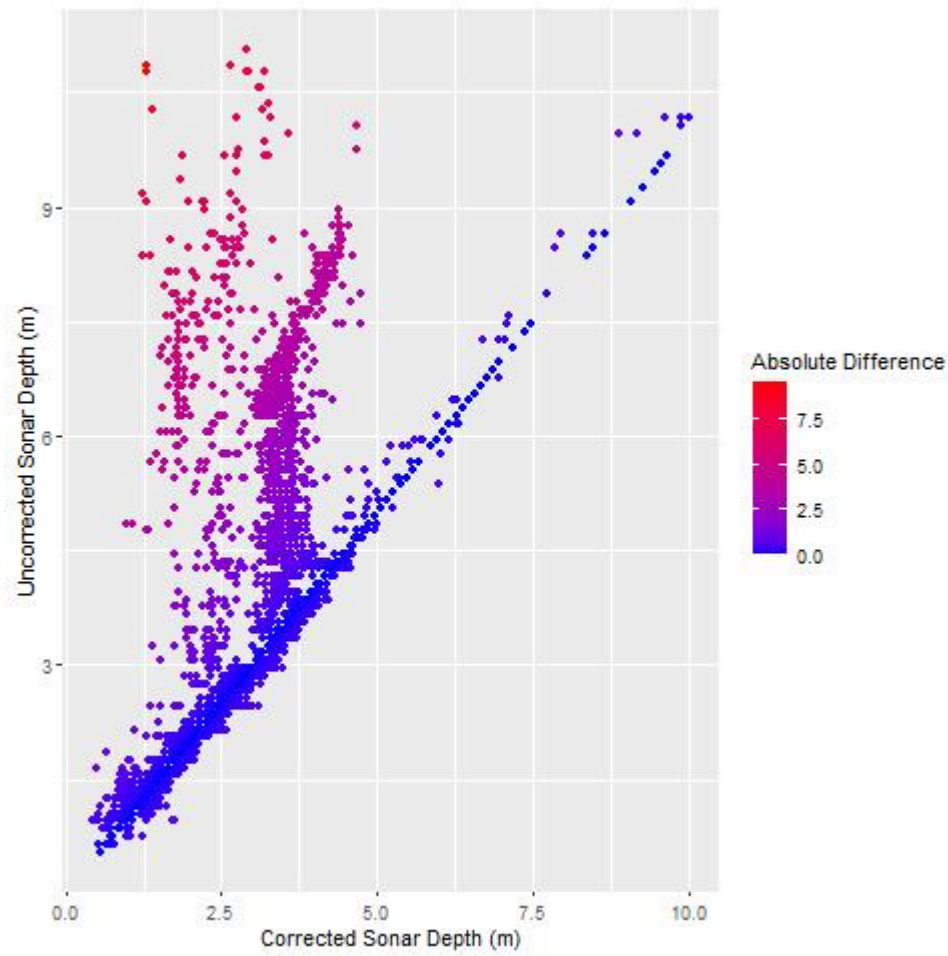


Figure 13: Plot of corrected vs. uncorrected digital water depth readings from the full dataset (N=9,229).

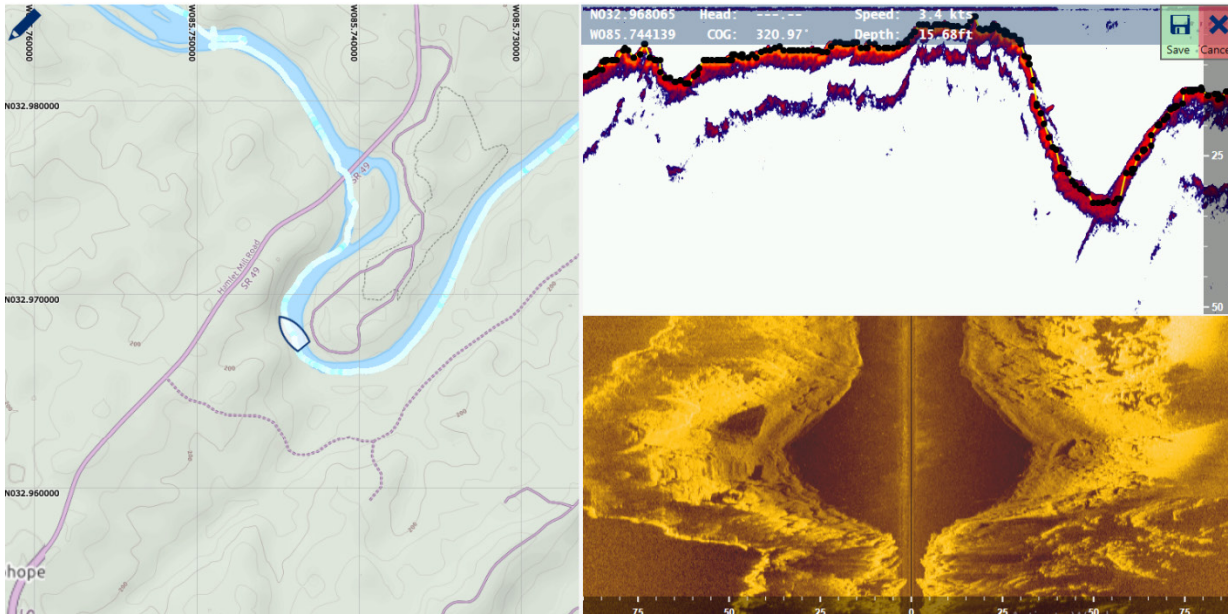


Figure 14: An example of the use of the sonograph and sidescan imagery to make sure the digital depth readings are valid. In this image the deep spot in the river is valid and not an issue with incorrect bottom tracking by the sonar unit.

HABITAT TYPE

The habitat types most frequently observed were runs and pools, although approximately 20% of the river was classified as either riffles or shoals (Figure 15). As expected, outside bends were generally deeper than inside bends of the river and the shoals and riffles were relatively widely distributed (Figure 16). One reason why we have moved from a strictly visual classification of habitat type to one based on quantitative characteristic is highlighted on the Tallapoosa River survey. As previously discussed, the Tallapoosa River has large and frequent change in discharge as a result of upstream dam releases. Visual habitat type classifications are highly dependent of river discharge as at higher discharges much of the visual signatures of habitat types are underwater and not visible (e.g. exposed rocks in a riffle at low flow are underwater at higher flows). The use of proportional depth measures and smoothed depths to characterize bottom shape trends, allows the habitat types to be determined with some independence of discharge. The shallow exposed riffles at low flow are still the shallowest areas at high flow. As an example, the habitat type classification in Figure 17 shows a close up of the habitat type classification and how it changes through an exposed rocky riffle area just upstream of the Hwy 49 Bridge. The image and the data were not collected at the same time or discharge, but it is still appear where and why the habitat type units are changing. This highlights the usefulness of a quantitative classifications system.

To verify and ensure consistency and accuracy of the Habitat Type model, a random set of habitat types were selected and visually assessed by a blind viewer; meaning the viewer was unaware of the score provided by the model. Of the total 247 habitats identified as riffle, shoal, run, and pool, 20 random habitats were selected without replacement using a random seed number of 40. The results from the blind viewer were then compared to that of the model for the same habitat unit. Model accuracy was 95% when compared to a visual assessment with both the model and viewer agreeing on 19 of the 20 predictions (**Table 5**). The only habitat unit where the model and reviewer did not agree was classified as shoal by the model while the reviewer identified it as run. The shoal was the reviewer second choice and noted it may be a shoal. These results support the continued use of this habitat typing model and demonstrate that the objective measure utilizing smoothed depth to define habitat is more consistent and less subjective at habitat typing when compared to the commonly used method for the visual identification (Bisson, Nielsen, Palmason, & Grove, 1981) (Hawkins, et al., 1993) (Kaufmann, 1998) of habitat types used in this verification.

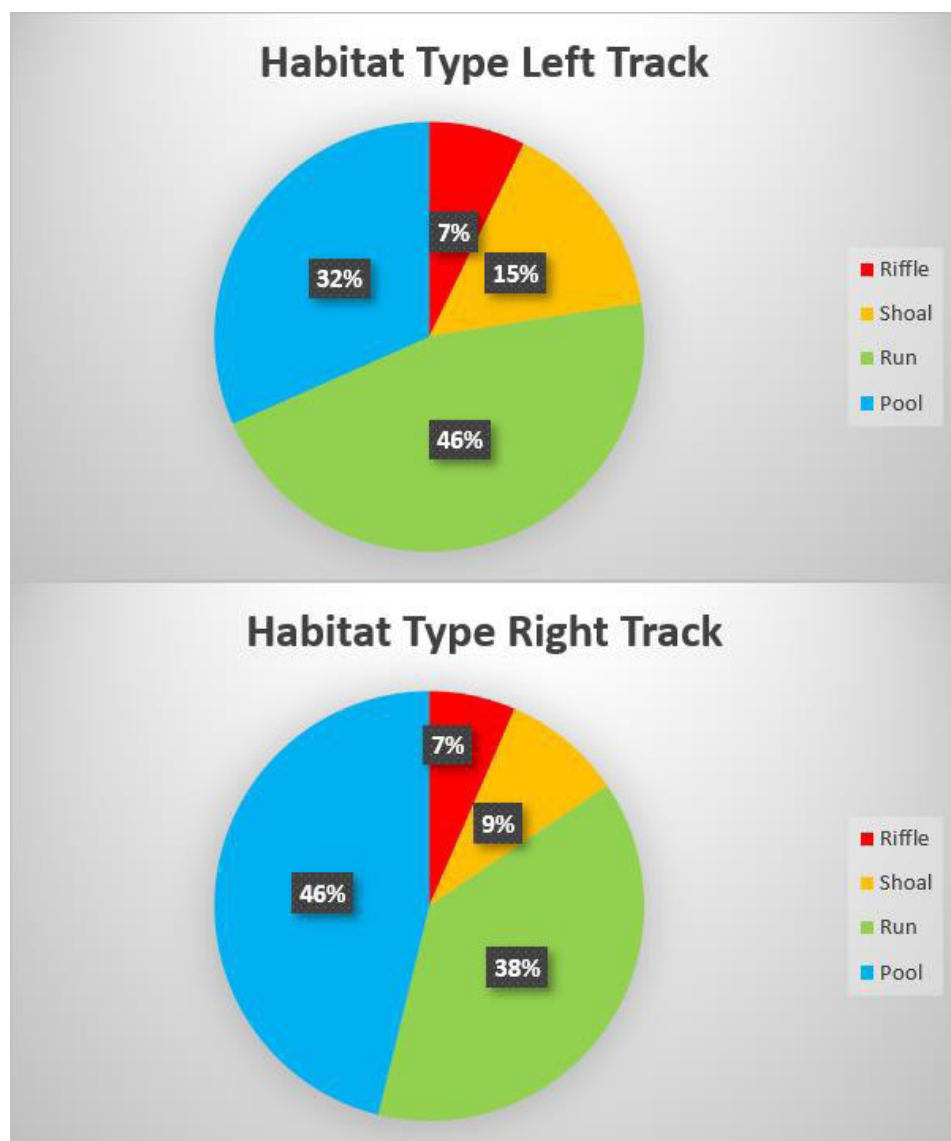


Figure 15: Proportional distribution of habitat types for the Tallapoosa River near HOBE.

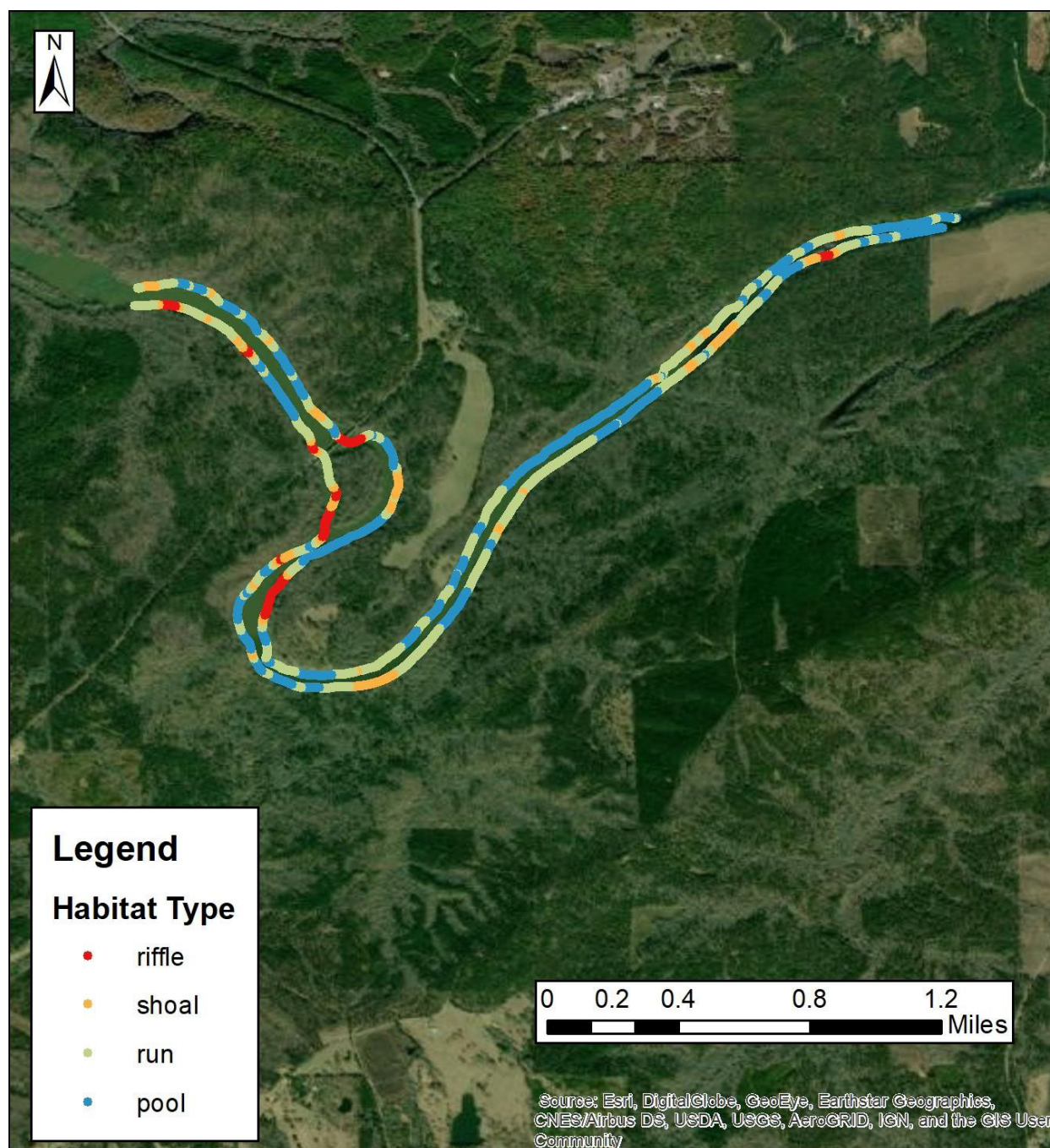


Figure 16: Habitat Type classification for the Tallapoosa River near HOBE.

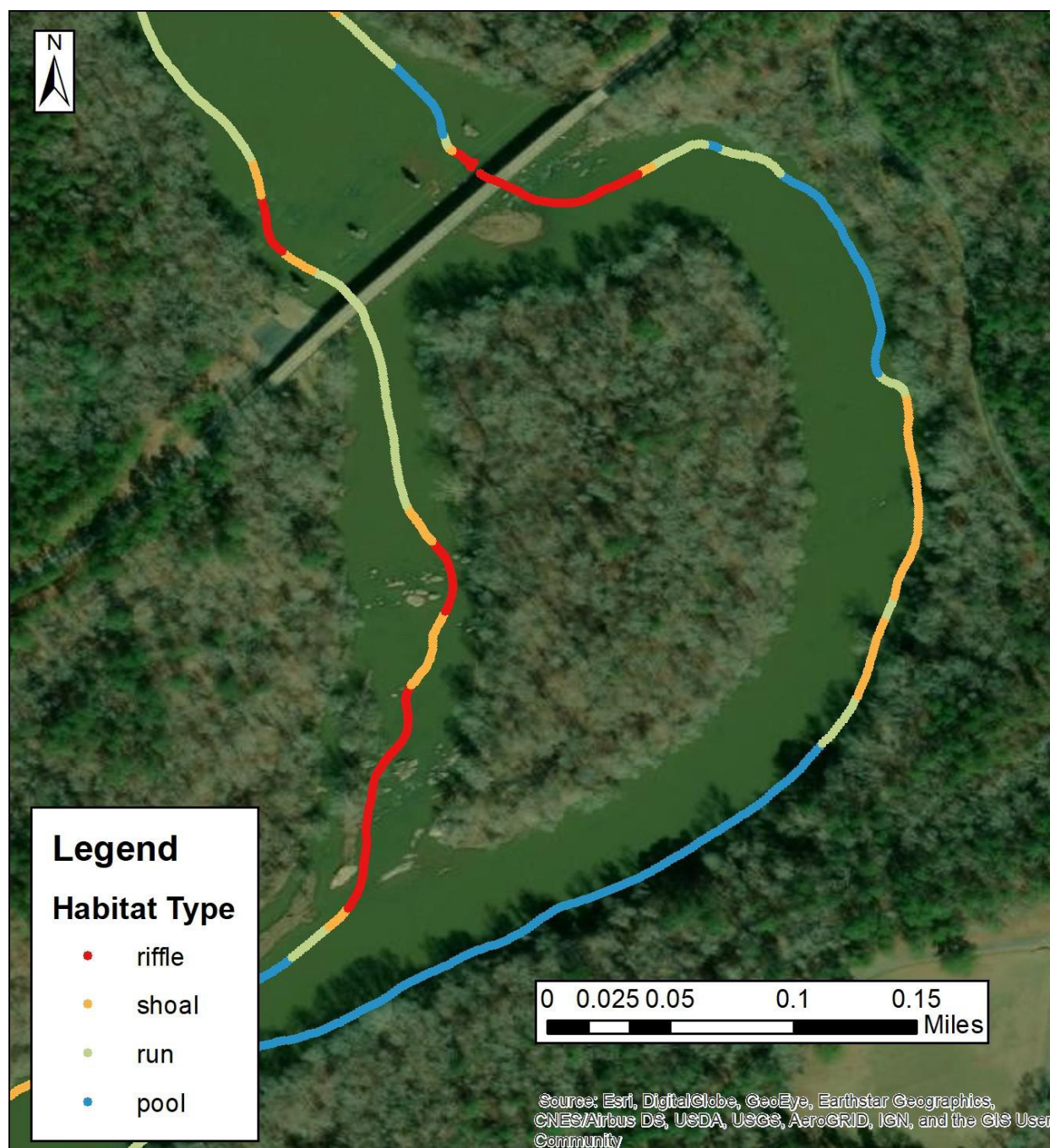


Figure 17: Close up of habitat type classification results.

Table 5: List of 20 random habitat units verified for habitat type. ID is the individual habitat unit visually classified for verification. Track is the StreamView video tracks where the habitat can be viewed, while Start Time, and End Time define the time periods in the StreamView video when these habitat units occurred.

ID	Track	Date	Start Time	End Time	Habitat Code	Review Code	Correct = 0	Reviewer Comment
3	Left	2019-05-17	10:21:52	10:22:15	3	3	0	run
6	Left	2019-05-17	10:24:10	10:24:43	2	3	-1	shallow run maybe 2
7	Left	2019-05-17	10:24:52	10:25:51	4	4	0	pool
8	Left	2019-05-17	10:25:52	10:26:27	3	3	0	run with woody debris and rocks on bottom
20	Left	2019-05-17	10:41:05	10:41:31	4	4	0	in a pool
27	Left	2019-05-17	10:50:25	10:50:46	3	3	0	run going into a pool
29	Left	2019-05-17	10:51:55	10:52:30	4	4	0	drops into deep pool with tree on bottom
35	Left	2019-05-17	10:57:14	10:57:43	2	2	0	almost a riffle but not to surface
47	Left	2019-05-17	11:11:25	11:12:19	3	3	0	run
69	Right	2019-05-17	10:22:06	10:23:14	3	3	0	long run
70	Right	2019-05-17	10:23:15	10:23:35	2	2	0	shoal with rocks
79	Right	2019-05-17	10:29:41	10:30:04	3	3	0	run
82	Right	2019-05-17	10:39:04	10:40:32	3	3	0	long run with fallen trees underwater
84	Right	2019-05-17	10:41:01	10:42:00	3	3	0	run coming out of a pool
91	Right	2019-05-17	10:46:21	10:48:26	3	3	0	run with underwater debris
92	Right	2019-05-17	10:48:34	10:49:26	3	3	0	more run habitat
93	Right	2019-05-17	10:49:27	10:50:53	4	4	0	pool, with easy to see drop off
104	Right	2019-05-17	11:05:00	11:06:36	1	1	0	riffle under bridge
107	Right	2019-05-17	11:07:40	11:08:12	2	2	0	maybe a very shallow run

STREAMBANK CONDITION

Streambanks were classified into one of five condition categories and one of three type categories. Condition categories represented the extent of impairment (fully functional (1) to non-functional (5)) on the streambank. In general, streambank conditions were in functional condition near the HOBE (Figure 18 & Figure 19). The majority of streambanks classified as functional and less than 10% was in the slightly impaired category. Only 1% of the streambanks were considered impaired and none were classified as non-functional. From a streambank function perspective, most of the river has intact riparian zone extending up to the upper lip of the streambank. There was vegetative cover on most of the banks and the banks were neither overly high nor steep considering the size of the river. We also reviewed the tributary confluences within the area including Soapstone Creek, Miller Creek, and an unnamed creek all on the left side of the river and none were causing observable issues.

The comparison of the bank condition classification vs. second reviewer's visual classification supports the categorization process as 90.9% of sites were consistently classified (Table 6). Due to a limited number of sites to choose from, we only compared 11 sites. Many of the streambanks were in a single classification category for long stretches and only 17 distinct segments were delineated in the original classification process. Many sites were easily classified and in the incorrect cases, the reviewer scored the streambank in better condition than the original reviewer. In all cases of disagreement between the reviewer and the model the discrepancies were between consecutive categories, such as functional (2) to slightly impaired (3) and not between non-consecutive categories, such as functional (2) to impaired (4). Overall, we saw good agreement between the independent visual classifications.



Figure 18: Riverbank Condition for the Tallapoosa River near HOBE.

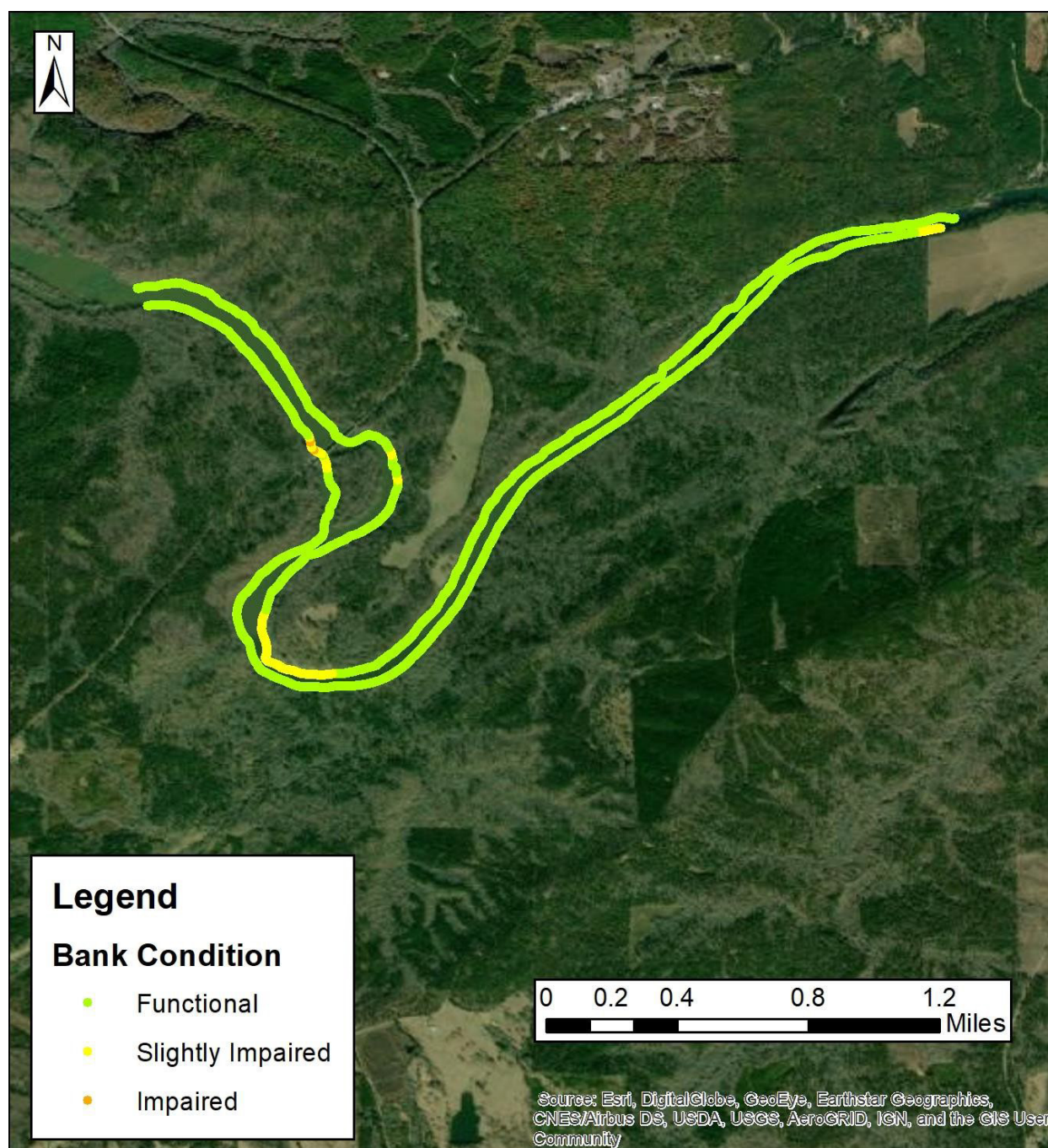


Figure 19: Bank Condition Score for the Tallapoosa River HDSS project.

Table 6: Validation results for the Bank Condition classification.

ID	Track	Date	Start Time	End Time	Bank Code	Review Code	Correct = 0	Reviewer Comment
1	Left	2019-05-17	10:18:50	10:20:12	3	3	0	some issues observed
2	Left	2019-05-17	10:20:13	11:02:42	2	2	0	maybe a few 3 in this section, but overall pretty good
3	Left	2019-05-17	11:02:43	11:03:22	3	3	0	stable but poor cover at boat ramp
6	Left	2019-05-17	11:03:47	11:03:51	4	4	0	small segment of expose bank
8	Left	2019-05-17	11:04:03	11:04:11	4	4	0	small collapsed bank
9	Left	2019-05-17	11:04:12	11:04:17	3	2	1	looks ok
12	Right	2019-05-17	10:49:22	10:54:48	3	3	0	
13	Right	2019-05-17	10:54:49	11:02:10	2	2	0	could be some sections of 3 but the bank angle is very low with good access to floodplain and great riparian zone
15	Right	2019-05-17	11:02:30	11:03:21	2	2	0	
16	Right	2019-05-17	11:03:22	11:03:40	3	3	0	could be 2 but there is clearing in the riparian zone

Most Degraded Streambank Segments

Another objective of the project was to identify the most degraded stretches on left and right streambank locations to allow managers to better understand specific areas where streambank management may be of importance at HOBE. Interestingly, only two very small areas just downstream of the Hwy 49 Bridge on the left bank scored as impaired. (Figure 20). Examples of the worst areas are shown in Figure 21 and Figure 22 and highlight the overall good condition of the streambanks.

The largest area of concern was associated with the inside bend of HOBE and it scored as slightly impaired. This section showed some problems with the streambank condition which was most evident in areas where the trees or brush had been cleared to the streambank. While this section scored as slightly impaired, it is important to understand that the scoring system has been developed for use in a wide variety of streams and rivers. As a result, the scoring system was designed to be comparative among different streams, rivers, or reaches of the same river. The most degraded conditions are reserved for completely failing streambanks where active and extensive erosion is observed. For example, Figure 23 shows a degraded streambank on the Tallapoosa River above HOBE. In the image, the bank was actively eroding with extensive bank sloughing occurring. There was little to no riparian cover and only small plants on the streambank to provide stabilization. No areas with this level of degraded conditions were observed on the Tallapoosa River within HOBE.

While the streambank classification system applied in this report was intended to be broadly comparable, when considering only those sites along the banks of the Tallapoosa River within HOBE, the sites highlighted here were the most degraded site observed. Thus, from a consideration of management actions within the jurisdiction of HOBE, streambank and riparian management would be important at these locations.

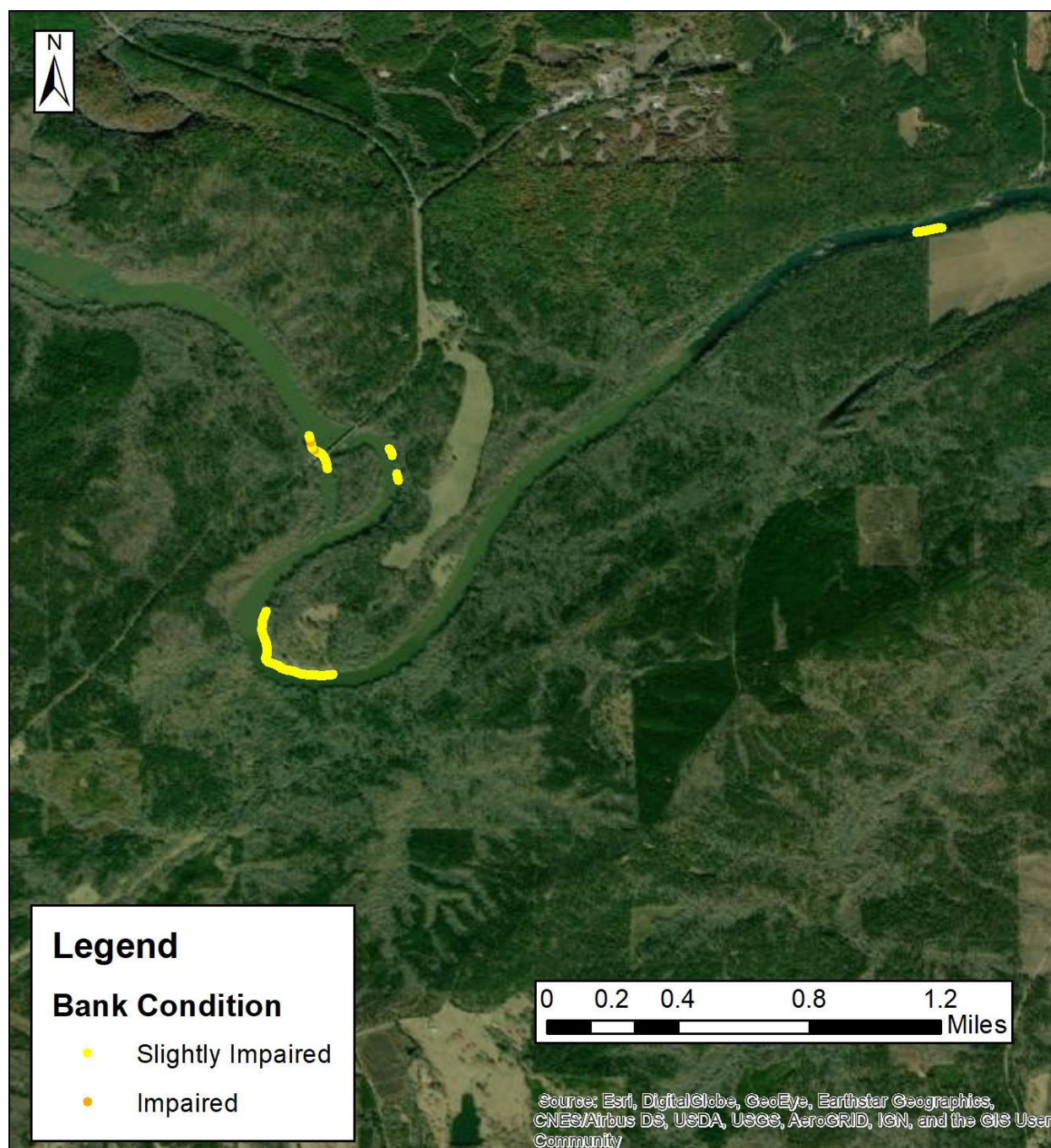


Figure 20: Worst Bank Condition Areas from the HDSS results for the Tallapoosa River.

High Definition Stream Survey of the Tallapoosa River near Horseshoe Bend National Military Park

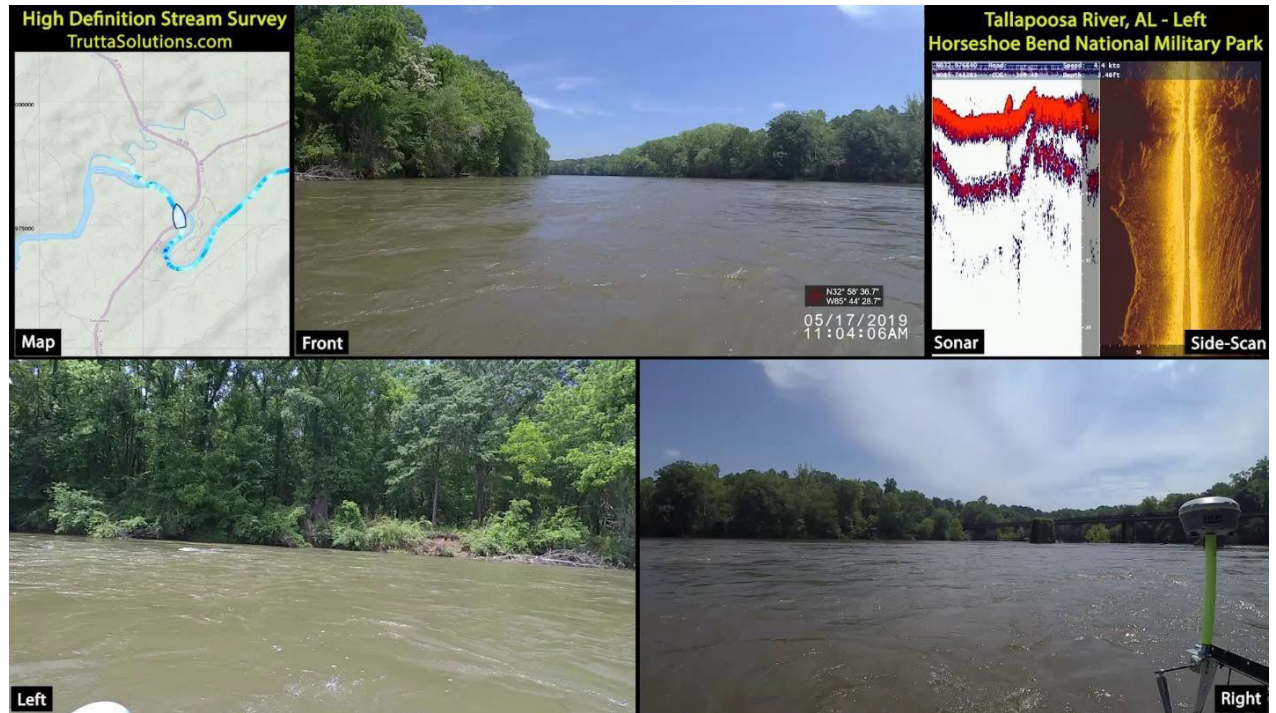


Figure 21: Example images of worst area on left bank of the Tallapoosa River just downstream of the Hwy 49 Bridge.

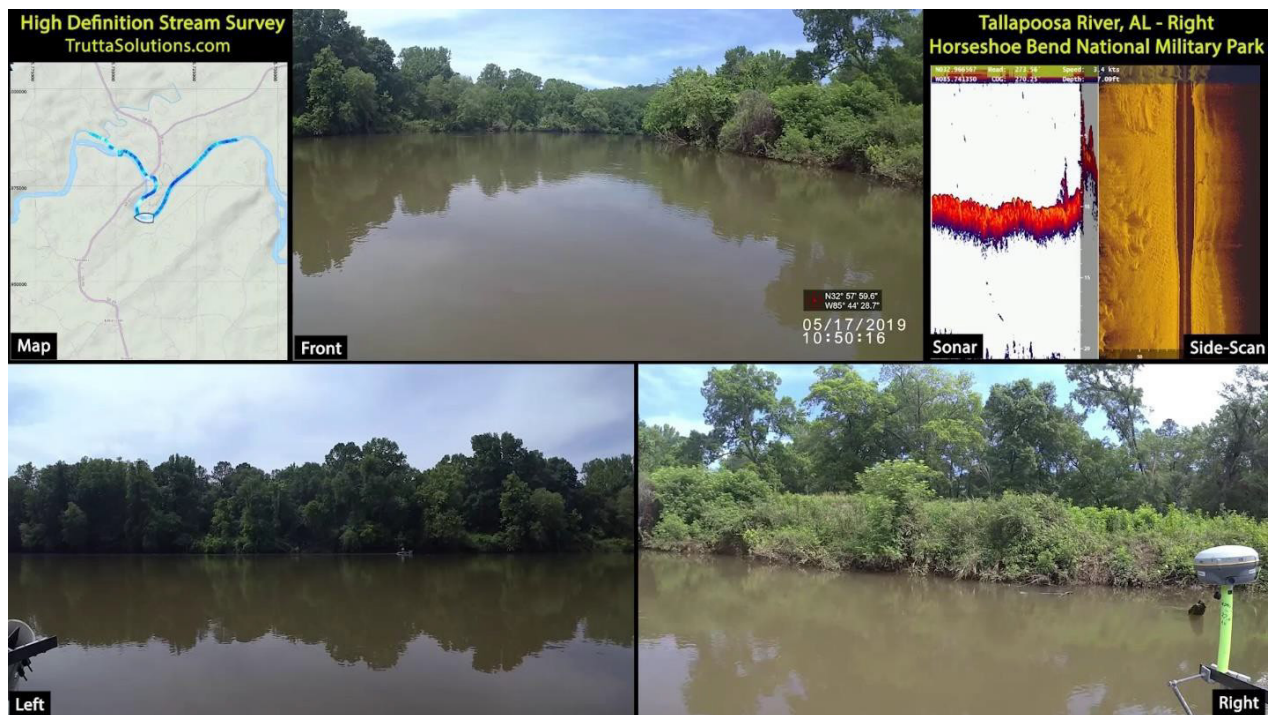


Figure 22: Example images of worst area on right bank of the Tallapoosa River on the inside of Horseshoe Bend.



Figure 23: An example of a degraded streambank observed upstream of HOBE on the Tallapoosa River.

CONCLUSIONS

The High Definition Stream Survey (HDSS) approach proved to be a rapid method to collect a wide range of useful data about in-channel and bank conditions along the Tallapoosa River within HOBE. We surveyed 5.8km and collected water depth, habitat type data, and streambank condition of both riverbanks.

The general condition of the streambanks along this segment of the Tallapoosa River was relatively good. The majority of the river was classified as functional with a small portion classified as slightly impaired or worse streambank condition. Most of the issues with the streambanks within HOBE were associated with areas where riparian trees or brush had been cleared. Allowing those areas to revegetate may help to stabilize the streambanks in those areas. We observed a good range of water depths and habitat types within this segment of the Tallapoosa River and instream physical habitat appear to be diverse with both rocky shallows and deep pools.

A likely problem within this area was the ongoing power-peaking discharges from R. L. Harris Dam upstream of HOBE on the Tallapoosa River. Rapid fluctuations of discharge below large dams are known to cause problems with streambank erosion and change sediment transport dynamics (Kondolf, 1997). Although we did not directly survey areas outside of the main river corridor, if sedimentation issues are observed in this segment of the Tallapoosa main channel, it is likely due to sedimentation coming in from tributary streams or upstream channel streambanks and not from the streambanks associated with HOBE. Changes in river stage due to the hydropower peaking releases changed river conditions rapidly and are likely the biggest problem associated with the river near the HOBE.

The HDSS data and StreamView video should be useful in providing a baseline documentation of conditions throughout the stretch of the Tallapoosa River as it flows through HOBE. If future surveys are completed, comparison with this survey completed in 2019 would allow for the direct comparison of changes in river conditions between surveys. This repeated approach would allow changes in the river corridor conditions to be accurately documented. As a result of the StreamView video, direct site by site comparisons could be made with the new survey. Even if the classifications presented here were not

carried out in a similar way by the new survey observer, the StreamView video can easily be rescored to meet new or different classification systems. Part of the difficulty of using past traditional survey data to compare with new survey results is it is difficult to collect and analyze data with the same process. The HDSS approach attempts to minimize this problem by allowing future surveyors to view the conditions and compare the scoring results with any new survey. The StreamView video can also be completely reanalyzed by different observers or with different scoring systems to produce novel results. The ability to review the video of the survey conditions allows the results to be further validated, updated, or changed as future observers require.

Finally, use of the HDSS video allows for a wide range of interested viewers to see the conditions throughout the river. It is unlikely that most river managers, public officials, decision-makers, or other interested parties will have time to spend boating down the Tallapoosa River to look for problem areas. With the HDSS video, it is easy to review the instream conditions and view specific problem areas. The availability of this video should help inform decision-makers throughout the river system and as issues are identified they can be addressed using a comparative prioritization scheme.

The HDSS method provides water managers with an integrated suite of stream corridor information to support effective decision-making. We collected continuous geo-referenced imagery of instream and streambank data over the HOBE reach of the Tallapoosa River. Using the HDSS approach, we delivered to managers and stakeholders more data at lower cost as compared to traditional methods. The HDSS platform allowed us to provide data-rich, 1-meter resolution GIS layers representing numerous instream and streambank parameters. These parameters can be combined in informative ways to create powerful decision-support tools allowing for a new holistic approach to river and stream management. The value of this project is not this report, but the videos and spatial data provided with the report.

Deliverables

The StreamView videos for HOBE were provided on an external hard drive with the first draft of the report. All GIS and Tabular Data that supported the maps and graphics in this report submitted via electronic file transfer with the report. These files included:

- HOBE_Left_HDSS.csv – Tabular data of the Left Track survey data and classifications.
- HOBE_Right_HDSS.csv – Tabular data of the Right Track survey data and classifications.
- HOBE_Depth_Comparison.xlsx – Spreadsheet data for the water depth comparison of uncorrected vs. corrected water depth.
- HOBE_HabType_Validation.xlsx – Spreadsheet data associated with the independent review of the habitat type classification results.
- HOBE_BankCondition_Validation.xlsx – Spreadsheet data associated with the independent review of the bank condition classification results.
- HOBE_Left_HDSS_GIS.gpkg – QGIS file with Left Track survey data and classifications.
- HOBE_Right_HDSS_GIS.gpkg – QGIS file with Right Track survey data and classifications.

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