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River Cane's Impact on Riparian Bank Erosion After Hurricanes

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Abstract

In the aftermath of Hurricane Helene, Western North Carolina experienced extreme damage and erosion to riparian banks. River cane, also known as *Arundinaria gigantea*, is one of the only four bamboos native to North America. Known for its strong rhizomatous root systems, river cane may have the potential to mitigate river and stream bank erosion. Natural disasters, such as hurricanes, are likely to increase due to the current worsening climate crisis, making it even more important to understand the role that river cane plays in stabilizing stream and river banks in the region. On-site assessments used the Bank Erosion Hazard Index (BEHI). Each selected site contained at least one continual patch of river cane, also known as a canebrake, with a proximity of approximately ten feet to the nearby body of water. Non-cane sites were measured ten feet away from cane sites, in ten-foot continual patches. Current results indicate potential for river cane to maintain riparian bank stability. Through on-site assessments of riparian bank erosion hazards, this project examines the role of river cane in reducing riparian bank erosion and maintaining bank stability following the recent hurricane.

1. Introduction

River cane, also known as *Arundinaria gigantea*, is one of the four bamboos native to North America. It is a member of the grass family, Poaceae (Griffith et al., 2009). It used to be highly prevalent along the East Coast (Harkness, 2024). Now, it only occupies two percent of the land that it used to (Harkness, 2024). Much of its decline began with European colonization. In Western North Carolina, Cherokee women primarily used river cane for basket making (Walker, 1998). It was bountiful and well protected, with its value understood and appreciated by Cherokees. European farmers allowed their livestock to overgraze and destroy river cane, affecting river cane's prevalence to this day (Walker, 1998). This has been exacerbated by the influx of non-native bamboos and grasses, such as golden bamboo and Johnson grass. River cane possesses a unique root system that may stabilize river and stream banks (Griffith et al., 2009). This is because of its compact, rhizomatic root shape. Rhizome root types grow through cloning or lateral spreading (Guo et al., 2021). The apical meristems of the rhizomes are covered in several layers of scale leaves for protection so they can push through the soil (Guo et al., 2021). The nodes in the rhizomes create adventitious roots (Guo et al., 2021) that continue the river cane's root system. These systems create a large network that strengthens streambank stability. The root systems and durability of river cane may help protect and restore riparian areas after a hurricane.

Figure 1. Close-up picture of river cane rhizomatic root structure.

Figure 2. A picture of a single river cane rhizome.

Hurricane Helene caused historical flooding in Western North Carolina (WNC). Between ten and thirty inches of rain poured down across the region, disrupting nearly every riparian buffer in the WNC area. The Swannanoa River reached the highest point it has ever been since North Carolina became an official state in 1789 (Miller & Foubert, 2025). The state was unprepared as a whole. Asheville and the surrounding rural communities have a unique topography that worsens excessive flooding. The high mountains turn Asheville and the surrounding small communities into a basin, collecting rain and runoff from over 4,000 feet (Miller & Foubert, 2025). The aftermath of this kind of rainfall was devastating to all riparian areas, with excessive flooding causing mudslides that destroyed massive portions of local forests (Miller & Foubert, 2025). The French Broad, Watauga, Catawba, and Swannanoa flooded well above flood stage, with some rivers' highest point unknown due to gauges being ripped out by flood waters (Miller & Foubert, 2025).

Accounting for the knowledge of river cane's root systems and the impact of Hurricane Helene on WNC, the research in this article investigates how river cane might aid in protecting riparian areas from climate change weather events.

2. Methods

The main part of the river cane that makes it a good potential candidate for repairing and maintaining riparian buffer zones is its root system. To understand and assess its potential for stabilizing riparian buffers, the Bank Erosion Hazard Index (BEHI), which measures a riparian buffer's potential to erode, was used. In each site along a stream or river, riparian areas with and without river cane were assessed. Nine sites were selected and measured. Sites were selected based on river cane presence. To be measured, canebrakes had to be at least ten feet in length and within ten feet of the nearby body of water. Canebrake density was not used to select sites. Sites were found based on general knowledge of conditions in which river cane grows (close to water, with other native species, not overdeveloped) and driving to visit areas suspected to contain river cane. The free app iNaturalist was also used as a reference by searching for river cane in the area, and then sites with the most reports, backed by visual data in the app, were then visited and selected if they met the length and proximity requirements listed above. After selection, each ten-foot canebrake was broken into three sections, with one area measured every three feet within the ten-foot-long canebrake. The same field assessment protocol (BEHI) was used at every selected area, meaning that each ten-foot canebrake was measured three separate times, in three separate areas. Locations with river cane were also used to find sites without river cane. The sites without river cane had to be at least ten feet away from the end of the canebrake, ensuring the roots were not extending out to that site. The same method of taking three measurements approximately three feet apart within a ten-foot section was used for measuring sites without river cane. Locations were used for both measurements (with/without river cane) to reduce outside variables that affect erosion (changes in water flow, different plant root structures, different soil, etc.). The data was collected from October to early December, with most initial measurements taken from mid-October to mid-November. Sites were revisited at least one more time, up to four times, to ensure no large condition changes were overlooked during initial measurements and that measurements remained consistent.

2.1 Field Assessment Protocol

Bank erosion potential was measured using a Bank Erosion Hazard Index (BEHI) created by Dave Rosgen of Wildland Hydrology, Inc. It is one of multiple procedures used for assessing both the riparian buffer zone erosion condition and potential. It does this by giving several different aspects of bank erosion point values. The overall score can then be used to inventory bank conditions over expansive areas.

There are five different categories that the BEHI measures: bank height, root depth, root density, surface protection, and bank angle. The BEHI index also accounts for surface material adjustment and stratification adjustment. Each of these factors is then given a BEHI rating with a respective score that contributes to the overall BEHI. The higher the BEHI, the more prone a bank is to failure, while a lower BEHI score indicates greater stability. Table 1 shows each point value assigned and the subsequent score/category that the BEHI measures. Table 2 shows each point value assigned to the material adjustment and stratification adjustment.

BEHI category	Bank height	**BH score**	Root depth	**RDH score**	Root density	**RD score**	Surface protection	**SP score**	Bank angle	**BA score**
Very low	1.0 - 1.1	**1**	90 -100	**1**	80 - 100	**1**	80 - 100	**1**	0 - 20	**1**
Low	1.1 - 1.2	**3**	50 - 89	**3**	55 - 79	**3**	55 - 79	**3**	21 - 60	**3**
Moderate	1.3 - 1.5	**5**	30 - 49	**5**	30 - 54	**5**	30 - 54	**5**	61 - 80	**5**
High	1.6 - 2.0	**7**	15 - 29	**7**	15 – 29	**7**	15 - 29	**7**	81 - 90	**7**
Very high	2.1 - 2.8	**8.5**	5 - 14	**8.5**	5 - 14	**8.5**	10 - 14	**8.5**	91 - 119	**8.5**
Extreme	> 2.8	**10**	< 5	**10**	< 5	**10**	< 14	**10**	> 119	**10**

Table 1. Table showing each BEHI category along with the values required to receive each score. The values under bank height are based on the ratio between bankful height and top of bank height. The root depth values are based on the ratio between rooting depth and the top of bank height. Root density and surface protection are percentage-based. Bank angle is the raw measurement, measured in degrees. *Note*. From *Assessing Bank Erosion Potential Using Rosgen's Bank Erosion Hazard Index (BEHI)*.

Material adjustment	
Bedrock - automatically	Very low
Boulder - automatically	Low
Cobble	(-) 10
Gravel or mostly gravel	(+) 5
Sand or mostly sand	(-) 5
Silt/loam	No adjustment
Clay	(-) 20

Stratification adjustment	
No layer	No adjustment
Single layer	(+) 5
Multiple layers	(+) 10

Table 2. Table showing how to adjust BEHI based on material and stratification. *Note*. Adapted from *Assessing Bank Erosion Potential Using Rosgen's Bank Erosion Hazard Index (BEHI)*.

There are two measurements used to determine the bank height: top of bank height and bankfull. The top of the bank is the highest point of the bank, and bankfull height is the point that represents the height of the channel-forming event, usually interpreted as a 1.5-year flow event. Bankfull height was typically identified as the point where vegetation becomes sparse to nonexistent or the height of the back edge of a point bar in a channel. Bank height is calculated by dividing the top of the bank height measurement by the bankfull height measurement. Root depth is determined by the ratio of rooting depth (indicated by how close to the water the roots run) to overall bank height. Root density measures how densely packed the roots in the bank are. This is done through visual assessment. Surface protection is how much vegetation or rock covers the bank area, determined through visual inspection. The bank angle measures the angle of repose of the bank. This is to see where the bank is most prone to failure. Material adjustment accounts for the soil composition of the stream/river bank. The stratification adjustment accounts for unstable soil horizons in the bank. This measurement was unused, as stratification was only noted at one site, and it was difficult to determine if the stratification in fact undermined bank stability. This observation is noted in the results but not used in the final BEHI calculations.

3. Results

Site Name	With River Cane Score Average	Without River Cane Score Average	BEHI Ranking
Reed Creek 1	29.7		moderate
Arboretum 1	22.3		moderate
Arboretum 2		23	moderate
French Broad 1	20		moderate
French Broad 2	18		low
Warren Wilson 1	23.7		moderate
Warren Wilson 2	23.2		moderate
Warren Wilson 3		25.2	moderate
Warren Wilson 4		26.5	moderate

Table 3. Table showing average BEHI scores for each location. The three measurements taken per ten-foot canebrake or area without river cane were compiled into one score, showing the average BEHI score for the total ten-foot area. If the site received a score in the “With River Cane Score Average” column, that site contained river cane, and if the site received a score in the “Without River Cane Score Average” column, that site did not contain river cane.

Site Name	Soil Type	Stratification	Overhang
Reed Creek	Silt/Loam	None	Small
NC Arboretum	Silt/Loam	None	Small
French Broad	Silt/Loam	None	None
Warren Wilson	Silt/Loam	Possible	Small

Table 4. Table showing soil and stratification adjustments, as well as overhang observations. Every site had silt/loam, which requires no adjustment to the BEHI score. All but one site contained possible stratification. This site was measured on the Swannanoa River, directly adjacent to the Warren Wilson College campus. The area had a higher amount of silt present in several sections. Site number four, with no river cane, showed signs of possible stratification. Both piping and a change in soil colors, indicating layers, were present. However, stratification occurred low in the river and was not considered to be an erosion hazard. There was definite stratification adjacent to site number six, with river cane; however, there was none present directly at site six, with river cane. Overhang accounts for the subjectively observed phenomena of several ten-foot sections of

river cane resting in an overhang. The soil at several of the sites was undercut, allowing water to flow beneath the bank, indicating an overhang.

4. Discussion

Currently, there is not enough numerical data to draw any definite conclusions, as research is still ongoing. However, current data has only shown areas with river cane to score mostly low - moderate BEHI index score. All areas without river cane received a moderate score. There is more variability in river cane sites. All sites measured had silt/loam soil composition, which is erosion neutral, meaning that it does not affect the score one way or the other. Current data showing river cane sites receiving a low-moderate BEHI score is indicative of river cane's potential to stabilize stream banks. Additional research is needed to confirm this potential. The presence of overhangs and undercut bank soil at a few of the river cane sites is worth noting. While additional research is needed to substantiate any formal conclusions, assessing why this occurs could be beneficial. The bank could have eroded in such a way during Helene, over a long period of time, or even after Helene. However, current literature supports the hypothesis that river cane stabilizes streambanks by stabilizing the soil along waterway banks, preventing erosion (Harkness, 2024).

Reed Creek received the highest BEHI score. The exact cause of this is unknown. A possible contributor is that the canebrake in this section was very thin, while still meeting the ten-foot length and proximity to water requirements. The French Broad site that was classified as low had extremely dense canebrakes, with river cane too dense to walk through without causing damage to the river cane. Exact density is unknown, but visual assessment indicates high density.

The findings show that bank angle and root density are the most important BEHI criteria for sites with river cane. Many sites had low BEHI scores until bank angle was accounted for. Overhangs impacted the bank angle as the undercut soil caused a severe score increase. Root density means high overcall soil compaction and strength, which prevents erosion.

Findings are consistent with previously cited literature. River cane is sparsely populated in the WNC region in comparison to how prevalent it once was (Walker, 1998). Accurate identification requires observing the vertical branches of river cane, as opposed to non-native bamboos with stems that grow at a 45-degree angle, outward from nodes (Harkness, 2024). River cane grows primarily in silt, clay, and sandy soils (Griffith et al., 2009), which were the only soil types observed during this research, with river cane only appearing in silt/loam at the selected WNC sites. This positively supports its potential to stabilize riparian buffers in WNC. Further, silt/loam soil types do not impact BEHI scores, as indicated in Table 2, which is good.

There are several limitations worth discussing. Hurricane Helene significantly altered the topography of every stream and river measured. Having data to compare current findings with might be helpful in determining the resilience and anti-erosive potential of river cane. Areas with lower BEHI scores may have potentially eroded more during Helene than areas with higher BEHI scores. Using remote sensing to obtain topographical data for comparison with current findings may prove beneficial. Future research should focus on measuring sites with more geomorphological variability. More sites should be measured for concrete results. Time constraints limited the availability for measuring more sites, with an ideal number of sites being twenty; ten sites with river cane and ten without.

5. Conclusion

This study aims to determine whether river cane could aid in preserving riparian zones during and after climate change-related weather events. While research is still ongoing, current findings suggest that river cane could provide the bank stabilization needed to preserve riparian buffer zones. River cane is an affordable and easily accessible resource for both private and public use. Planting it along rivers, streams, and ponds on private and public lands may help during future storms. While river cane does not directly stop flooding, it can potentially maintain bank stability, reduce erosion during floods, and help direct water flow.

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