Going with the flow: Movement of large wood in a flashy urban headstream

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Introduction

Urbanization often increases the amount of impervious surface that does not allow storm runoff to percolate into the ground. As more concrete or asphalt surfaces are added, the water that would normally be absorbed into the ground instead finds its way to urban streams. This forces flashy flows during storm events that can attribute to elevated nutrient and contaminant concentrations, reduced species richness and simplified habitats often associated with urban stream syndrome.[1]

Large woody debris—defined as fallen trees, logs, or branches with a diameter greater than 10cm— may provide benefits to urban streams. The large pieces of woody debris can change the flow of the stream, decrease bank erosion, and scour deeper pools while also providing overhead coverage for aquatic life. These benefits can only develop over time, but in flashy urban streams the pieces of wood may be moved by storm events.

What characteristics make wood tend to move?

I hypothesized that:

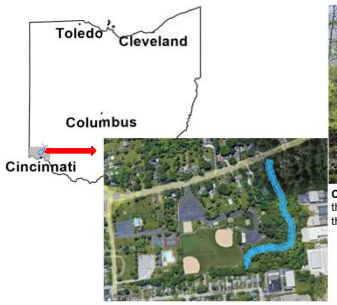
- Wood shape and structure can impact movement
- Wood that is more securely situated will be less likely to move

What measure of flow causes wood to move?

I hypothesized that higher flows are more likely to cause wood movement.

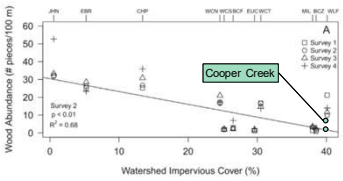
Site location

Cooper Creek, a small headstream of the Mill Creek Watershed, resides in Bechtold Park located in Sycamore Township, Ohio. Bechtold Park is a 22-acre metropolitan park that holds commonly used nature and walking trails, playgrounds, sports fields, and more. Cooper Creek has a 40% impervious surface coverage. For this project, approximately 400m of Cooper Creek was monitored.



Cooper Creek. Part of the stream running through the park.

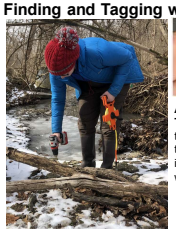
Bechtold Park: This imagery displays Cooper Creek and the surrounding impervious surfaces.



Blauch and Jefferson's wood abundance by impervious surface relationship of Northern Ohio.[2] The relationship suggests Cooper creek would have 3 pieces/100m, but I observed an average of 10 pieces/100m.

Materials and Methods

Finding and Tagging wood:



Inserting PIT tags: After drilling a hole in the wood, a PIT tag was glued in and the spot was spray painted.

A Passive Integrated Transponder. Each PIT tag has a unique number that can be used to identify each piece of wood.

Relocation and Recharacterization: I am holding a PIT tag antenna scanning for tagged pieces of wood. After being located, the wood could be characterized. After storm events, wood was relocated and recharacterized if it had moved or characterizations changed.

Discharge during storm event. Peter is shown measuring discharge using an electromagnetic flow meter. Stream discharge, the volume of water moving through the stream per second, was measured at multiple cross sections.

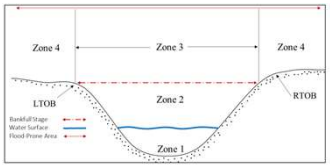
Orientation. The angle related to the flow was used to characterize each piece of wood.

Characterization of Wood Pieces[3]

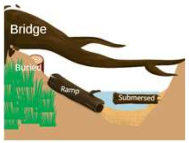
Structure. Wood was classified by its shape and features.

Data Collected:

- Size of each piece: length and diameter
- Bankfull width and depth
- Floodprone width
- Location to the nearest meter mark



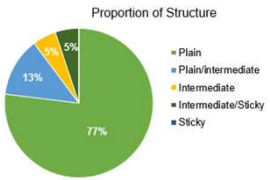
Stream bank zones: As determined in the Large Woody Debris Index manual.[3]



Type. Each piece of wood was categorized as one of four options.

Stability. How the wood is situated can impact its ability to move.

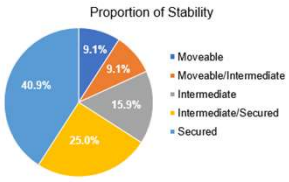
Results



Wood Structure at Cooper Creek. Most wood in Cooper Creek is plain structure, while there is not any sticky.

Structure (Percentage present in Cooper Creek)	Observed	Total number of pieces*percentage =Expected
Plain (76.9%)	10	13(0.769) = 10
Plain/Intermediate (12.8%)	3	13 (0.128) = 1.6
Intermediate (5.1%)	0	13 (.051) = 0.7
Intermediate/Sticky (5.1%)	0	13 (.051) = 0.7

Chi-square of Structure and Movement: There is not a significant relationship between structure and movement (χ^2=2.625, df=3, P=0.453).

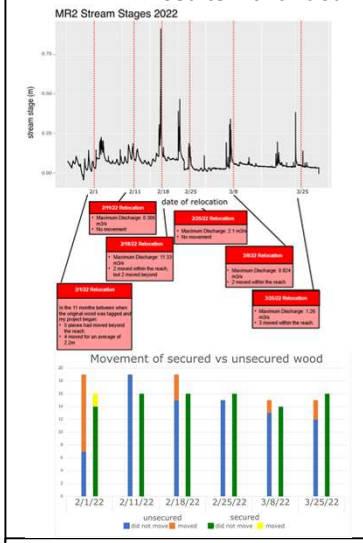


Stability. Nearly half of the wood in Cooper Creek is stable.

Stability (Percentage present in Cooper Creek)	Observed	Total number of pieces*percentage =Expected
Moveable (15.9%)	4	14(0.159)= 2
Moveable/Intermediate (40.9%)	2	14(0.409)= 6
Intermediate (9.1%)	2	14(0.091)= 1.25
Intermediate/Secure (9.1%)	4	14(0.091)= 1.25
Secure (25.0%)	2	14(0.25)= 3.5

Chi-square of Stability and Movement. There is a statically significant relationship between stability and movement (χ^2=11.81, df=4, P=0.0019).

Results Continued



Movement of Wood and Degree of Storm Event. The largest storm event had a maximum discharge of 11.33m^3/s and caused 4 pieces to move.

Movement of secured and unsecured wood. The only secured wood that moved occurred sometime in the 11 months after initial tagging, before spring 2022.

Conclusions

- During the first 11 months after initial tagging (40 pieces), 5 (8%) left the reach entirely and 9 (23%) moved within the reach
- Over the course of 6 storms in early 2022, 2 pieces left the reach entirely and 6 moved within the reach
- Wood that was not stably oriented in the stream was more likely to move
- Our ability to observe a relationship between flow and movement was limited by the number of storm events during the study period and potentially impacted by other factors (e.g., availability of mobile wood)
- In the future, wood movement and discharge during storm events will be continued to measured.
- A wood addition project will be completed later this spring and wood will be analyzed to compare movement before and after the wood addition project.

References

1. Walsh, et al. (2005). The urban stream syndrome: current knowledge and the search for a cure. *Journal of the North American Benthological Society*, *24*(3), 706-723.

2. Blauch, G. A., & Jefferson, A. J. (2019). If a tree falls in an urban stream, does it stick around? Mobility, characteristics, and geomorphic influence of large wood in urban streams in northeastern Ohio, USA. *Geomorphology*, *337*, 1-14.

3. Harman, et al. 2017. Application of the Large Woody Debris Index: A Field User Manual Version 1. Stream Mechanics and Ecosystem Planning & Restoration, Raleigh, NC.

Acknowledgments

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