Geomorphic Patterns of Riparian Tree Mortality and Recovery After a 500-Year Flood Event on an Ozark Highlands River

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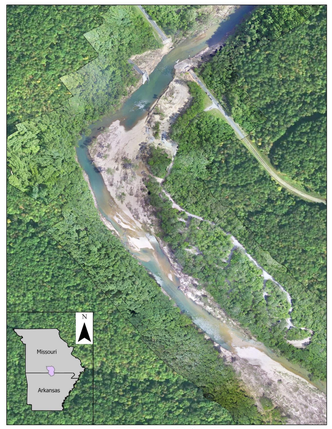
Abstract

Climate change has increased the frequency of large floods in rivers draining in the Ozark Highlands resulting in higher rates of channel sedimentation, bank erosion, and damage to infrastructure. However, the effects of flood events on riparian forests in the Ozark Highlands are not well understood. This study assesses the effects of a large flood (> 500-year recurrence interval) during April-May 2017 on riparian forests on the North Fork of the White River, Missouri. Two post-flood (August 2017 and March-August 2021) field surveys were conducted to assess patterns of riparian forest damage, mortality, and recovery. Initial post-flood riparian tree mortality was 43% of 511 trees surveyed. Repeat surveys in 2021 showed mortality increased to 79%. Additionally, patterns in canopy cover and forest damage were examined spatially and temporally through ArcGIS and aerial imagery. Post-flood canopy cover was reduced to 17% of the pre-flood extent, increasing to 37% in 2020. Damage patterns are related to landform with recovery rates increasing downstream from head to tail of a large bar-floodplain complex. This information can be used to understand ecological disturbance by floods and to improve management practices in Mark Twain National Forest.

Study Area

This study examines a 650 m reach of the North Fork of the White River at North Fork Recreation Area (NFRA) within Mark Twain National Forest (MTNF) in southern Missouri. The North Fork River basin, 3,597 km^2 (1,453 km^2 at NFRA), is primarily forested (62%) and grassland/cropland (38%), with less than 1% urban land. The NFRA site was chosen due to an ongoing (2016) study in which engineered log structures were installed as a restoration practice to promote aquatic habitat, bank stability, and flood mitigation. The reach begins approximately 200 m downstream of the State Route CC bridge and continues downstream 650 m. The left floodplain is used recreationally and has a canoe boat ramp near the beginning of the surveyed reach, the right side of the channel is confined by a high bluff wall. Karst features such as caves and springs are present throughout the watershed and are also in close proximity to the surveyed reach at the NFRA.

NFRA - 2016



NFRA - 2017

NFRA - 2020

Methods


NFRA Bluff Wall, 2016

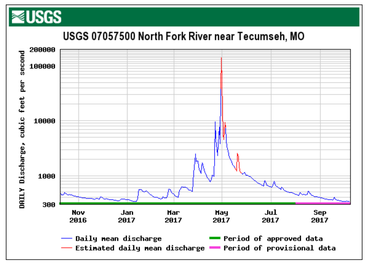

NFRA Bluff Wall, May 2017

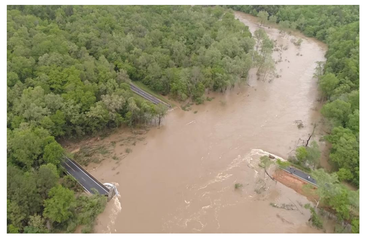
Field surveys were conducted following the flood event in August 2017 and in March and August of 2021 to collect location, mortality, tree type (standing, toppled, uprooted, transported), diameter, and length data of the NFRA riparian trees. Trees were also tagged to identify them in repeat surveys. Additionally, high resolution sUAS (drone) imagery was collected in 2017 and used in connection with ArcGIS to help identify landforms and forest damage patterns.

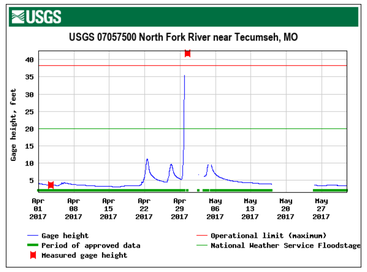

NFRA Bluff Wall, March 2021

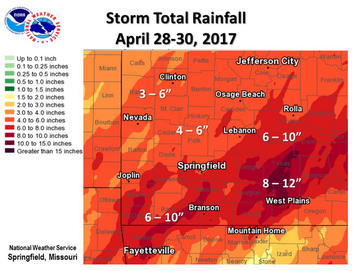
Background

In late April of 2017, 10-15 inches of rain fell in the counties of Douglas, Howell, and Ozark (the majority of the North Fork River Basin falls in these counties) in just a couple of days (US Department of Commerce 2017). This led to major flooding of the North Fork River. Buildings, roads, and bridges were destroyed by the flooding. 14 rivers in southern Missouri had record breaking gage levels including the North Fork River (Erdman 2017). The effects of the flooding on roads and bridges was clear however, the effects on the river channel and riparian forest were not. This study aims to quantify floods effects on riparian forest area.

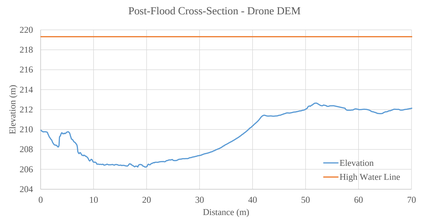


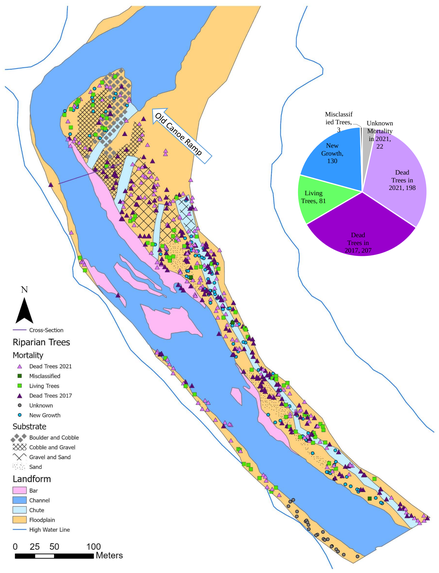


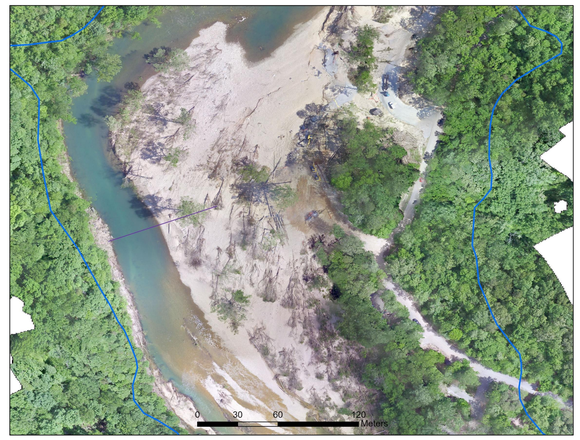


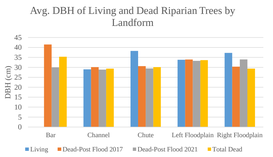


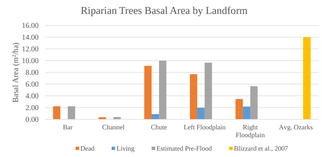
Results

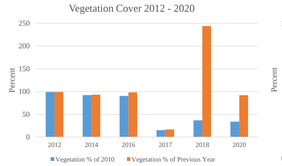


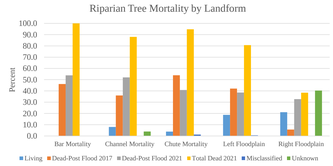












Conclusions

This study examines the mortality and distribution of riparian trees following a >500-year flood event in Southern Missouri.

1. Initial post-flood mortality was 43% of the 511 riparian trees surveyed, but increased to 70% in repeat surveys in 2021.
2. Mortality was greatest on the inside of the channel bend (left floodplain) at the bar/floodplain head and decreased downstream.
3. Vegetation cover was reduced by 83% and has increased to 37% of the pre-flood extent.
4. Average DBH did not vary greatly across living or dead trees or by landform, however, living trees had slightly larger diameters in chutes and on the right floodplain compared to dead trees.
5. Basal area was estimated to be reduced by 77% across floodplains and chutes.

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