4 Years After Tropical Storm Nate: The Recovery of Macroinvertebrate Community Composition in a Neotropical Stream in Costa Rica

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Background

Tropical storms are predicted to increase in intensity and rainfall (Knutson, 2021). These more frequent intense disturbances have significant impacts on stream ecosystems and their macroinvertebrate communities (Gutiérrez-Fonseca et. al., 2018).

In October of 2017 Tropical Storm Nate devastated the Monteverde, Costa Rica area with 20.45 inches of rain falling in two days resulting in landslides, and canopy cover destruction. Our study stream, Alondra, was particularly devastated (Figure 1).

Question

*How does the **current composition** of the **macroinvertebrate community** in Alondra **compare to** the community composition of the stream **before Tropical Storm Nate?***

Methods

We sampled 5 transects in a 100-meter reach. At each of the five transects we measured canopy cover, discharge, water pH, temperature, total dissolved solids, salinity, and conductivity. We collected macroinvertebrate samples (n=5) using a 250 um surber net. All samples were collected in September and October from 2016 to 2021

We identified macroinvertebrates to the lowest possible taxonomic level in the lab (usually genus), and each individual was measured to the nearest mm to estimate biomass.

Hypothesis

As Alondra recovers, the 2021 macroinvertebrate community will have higher richness than 2018 & 2019 and will shift in community composition becoming more similar to pre-Nate.

Site Description

Alondra is a premontane perennial stream characterized by year-round flow during both the wet and dry seasons. It has a rocky bottom with large boulders, areas of pools and riffles, and is mostly shallow with some deeper pools. The gradient is steep, resulting in a fast-flowing stream.

Figure 1: Photos depict Alondra one year before tropical storm Nate in 2016, directly after in 2017, and in 2018, 2019,and 2021. The percent canopy cover is written after each date. We found that canopy cover decreased ~36% from 79% to 43% after Nate, but subsequently increased to 55.2% in 2021.

Results

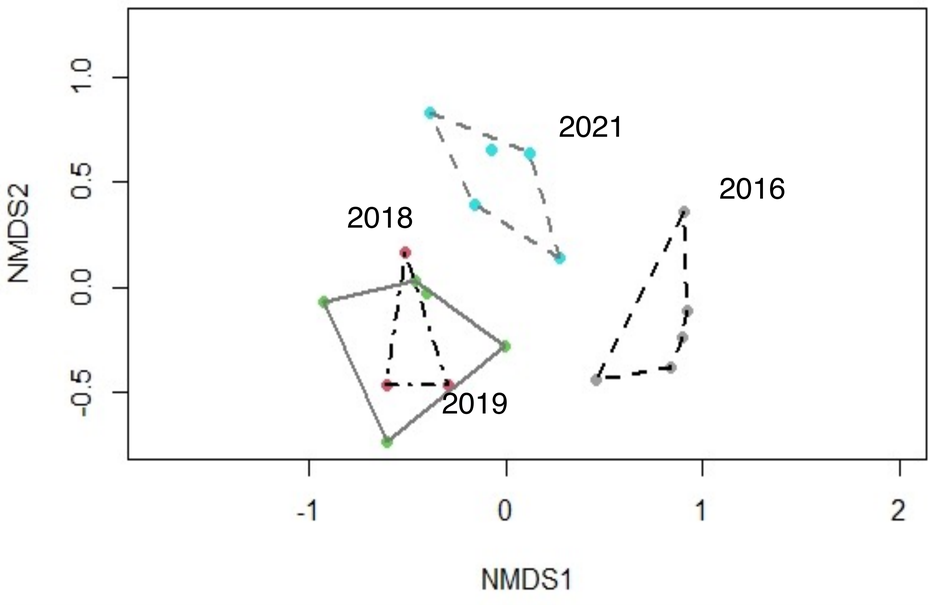

Figure 2: NMDS ordination plot showing macroinvertebrate assemblages based on abundance in 2016, 2018, 2019,& 2021. 2018 & 2019 diverge from 2016. The two years after Nate were most similar with a shift in community composition in 2021.

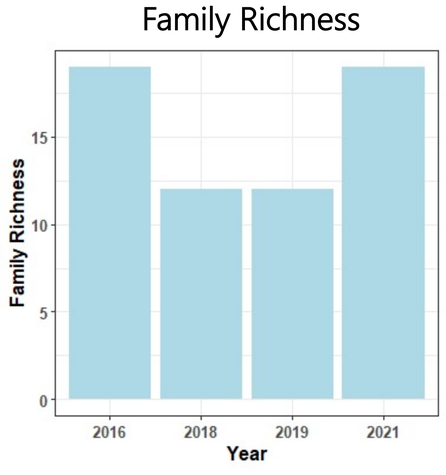

Figure 3: Macroinvertebrate family richness in Alondra one year before Tropical Storm Nate (2016), one year after (2018), two years after (2019) and four years after (2021). **Richness in 2021 was similar to 2016.**

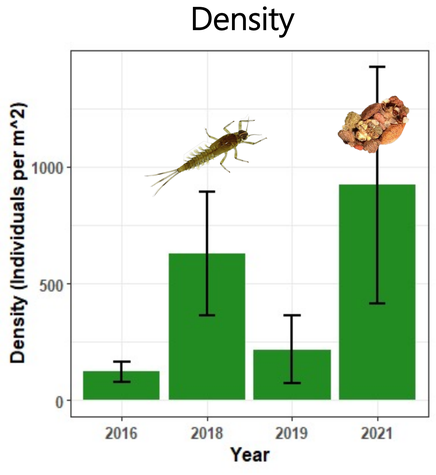

Figure 4: Density of macroinvertebrate individuals (no. /m^2) in Alondra. Error bars indicate ±1SD. **After the initial disturbance, we saw a spike in density from more disturbance-adapted taxa (e.g, *baetodes*).**

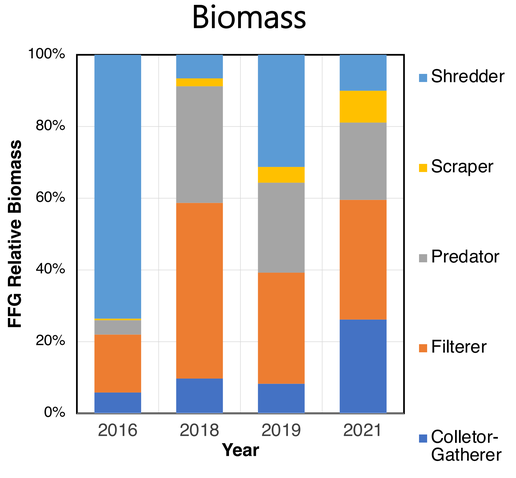

Figure 5: Functional feeding group relative biomass in 2016, 2018, 2019, and 2021**.** ***Shredders dominated biomass pre-Nate while filterers post-Nate.***

Conclusions and Next Steps

We have observed recovery in physical conditions and riparian habitat (Figure 1), and therefore we expect the macroinvertebrate community to reflect those changes. We found that four years after the initial disturbance, Alondra is showing signs of recovery. For this study we define recovery as the rate and manner in which an ecosystem returns to either its undisturbed condition or the path of chronological development after the disturbance.

Quantifying recovery is complex because the stream may never return to its pre-disturbance state (Kelly, 1990). However, the fact that the stream has increased in richness and shifted community composition indicates that the physical environment of the stream is recovering providing greater habitat diversity (Figure 3).

Our study is one of only a few to document macroinvertebrate community changes in a tropical stream following a major disturbance. As tropical areas experience more frequent and intense disturbances, data like ours can provide insights into the process of stream recovery. A better understanding of stream recovery can better inform conservation and management decisions.

More Information

Scan this code for more figures and background information on the project, as well as my contact information. I'm looking for graduate opportunities in Ecology and Genetics!

Works Cited

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