

Effects of Tropical Storm Nate on the Recovery of Macroinvertebrate Community Composition in Two Neotropical Streams in Costa Rica

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Abstract

Our study examines the long-term effects of Tropical Storm Nate on macroinvertebrate community composition in two Costa Rican streams. Two streams were sampled monthly one year prior to Nate (2016) and in October 2018. We continued sampling in October 2019 to monitor macroinvertebrate community recovery. We measured canopy cover and macroinvertebrate community composition from 5 transects in each stream. Macroinvertebrates were classified to their lowest taxonomic level and functional feeding group (FFG). We calculated relative abundance by family and FFG, species richness, and density. Canopy cover over Alondra decreased by 40% following Nate while Bruja experienced a slight increase but has not increased in 2019. Following the storm, taxa richness decreased ~30% in Alondra and ~50% in Bruja and has remained lower in 2019. Disturbance adapted taxa also continue to dominate both streams and grazers are the most prevalent FFG. This change in environmental conditions has impacted community composition which is still dominated by disturbance adapted taxa in both streams.

Question & Hypothesis

How has the aquatic macroinvertebrate community composition changed 2 years after tropical Storm Nate in Alondra and Bruja?

How does the macroinvertebrate composition compare to pre-Nate?

Study Sites

- We collected biotic and abiotic variables from two headwater tropical streams ~125 m apart in the pre-montane wet forest of Monteverde, Costa Rica
- Alondra is a perennial stream that experienced debris flow and canopy cover loss
- Bruja is an intermittent stream with variable water levels during both the wet and dry season that experienced minimal canopy disturbance
- Dry season is from November to April and the wet season occurs from May to October

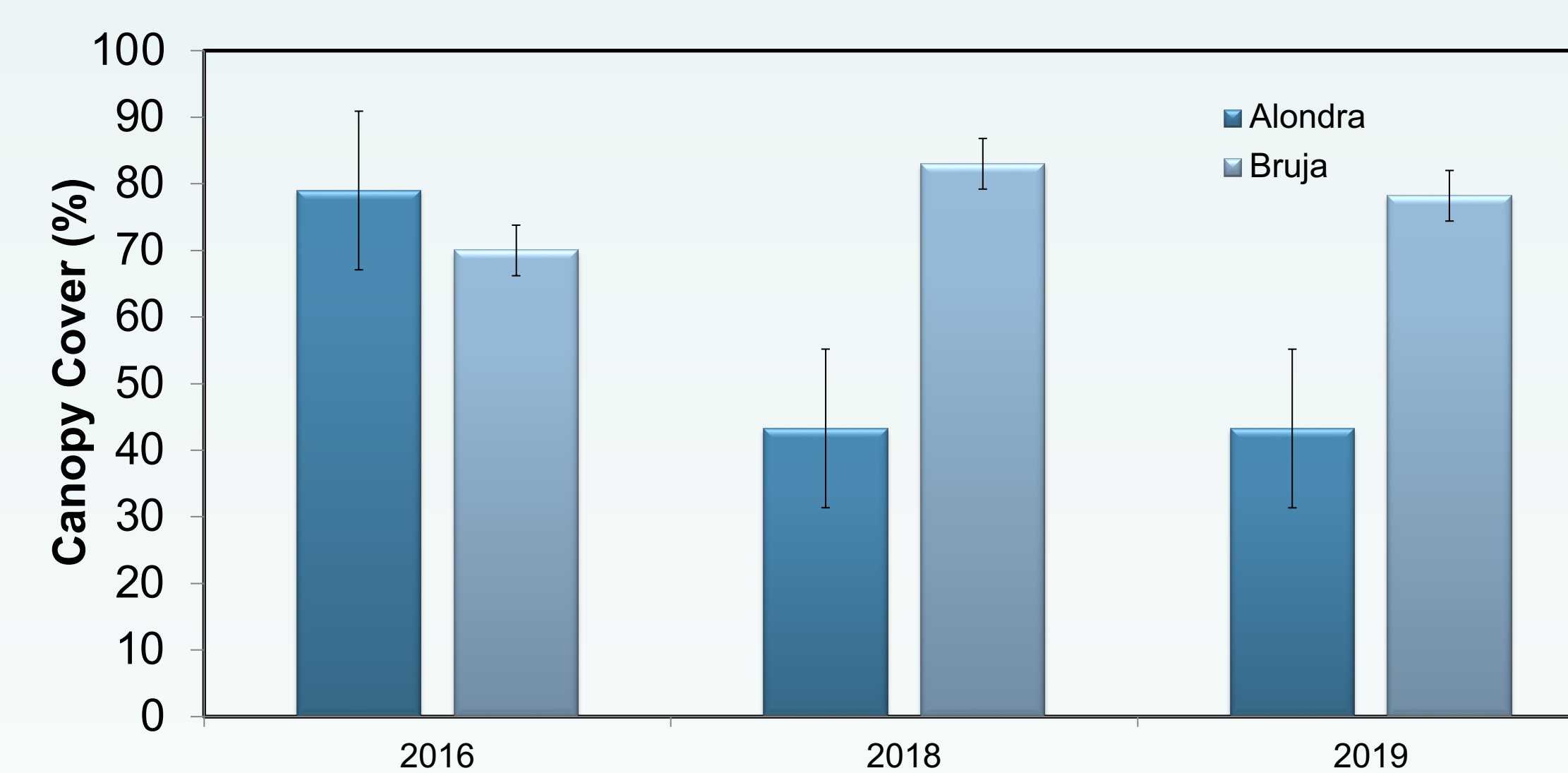


Figure 1: Average canopy cover in both streams one year before (2016) and one (2018) and two years (2019) after storm Nate. Canopy cover in Alondra decreased ~40%, while Bruja showed a slight increase, but remained relatively similar

Methods

Biotic:

- We collected macroinvertebrates in October 2019 using a 250µm surber net from 5 transects in both Bruja and Alondra
- We also collected leaf litter from 3 transects in Alondra to obtain macroinvertebrates
- We identified macroinvertebrates to lowest taxonomic level and FFG and calculated relative abundance, richness, and density and biomass

Abiotic:

- In both streams, we measured canopy cover using a densiometer, water quality (salinity, pH, conductivity, TDS) using a water quality multiprobe and recorded stream temperature hourly during our sampling period.

Results

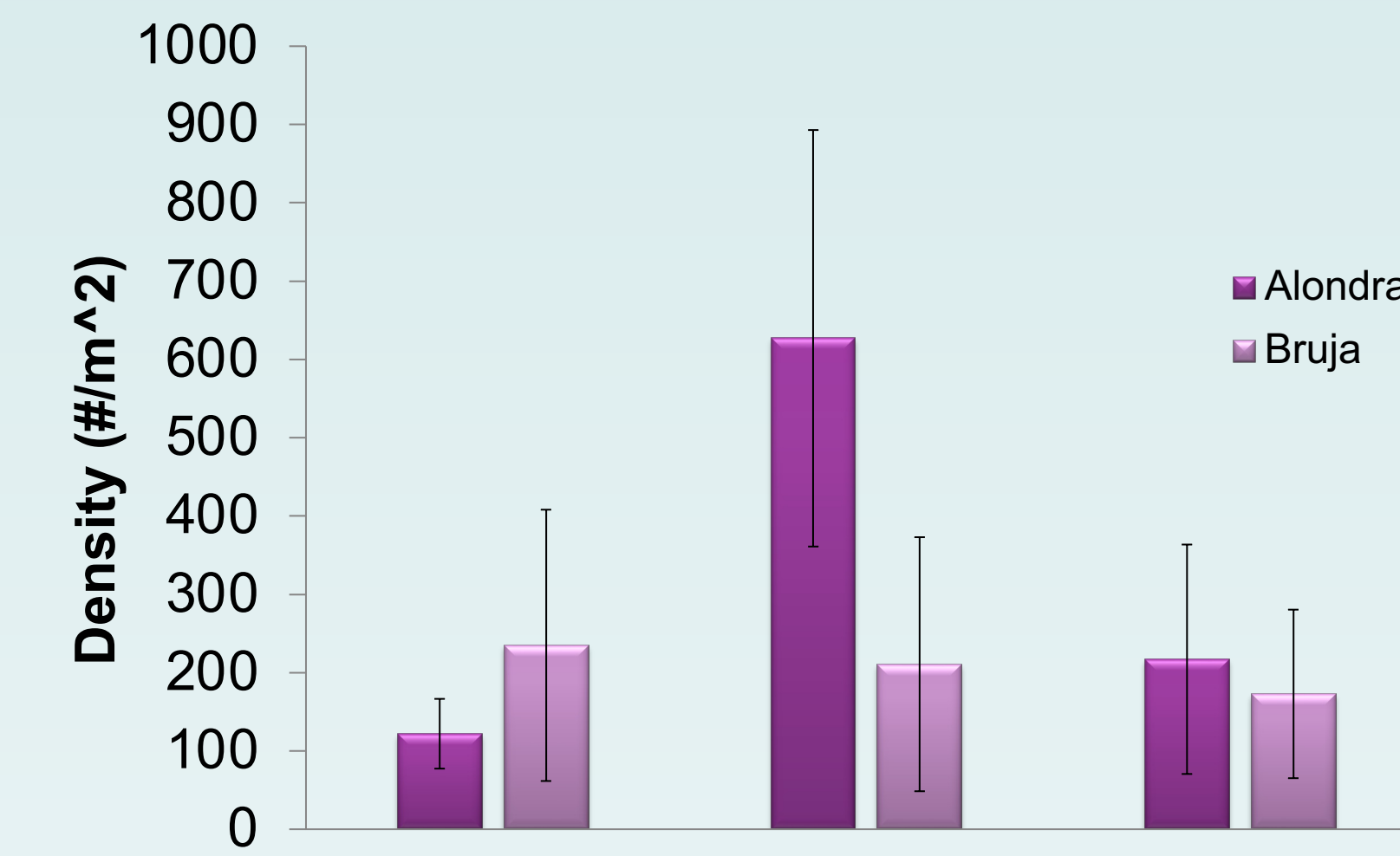


Figure 2: Macroinvertebrate density (#/m²) in Alondra and Bruja before (2016), one year after (2018), and two years after (2019) the disturbance.

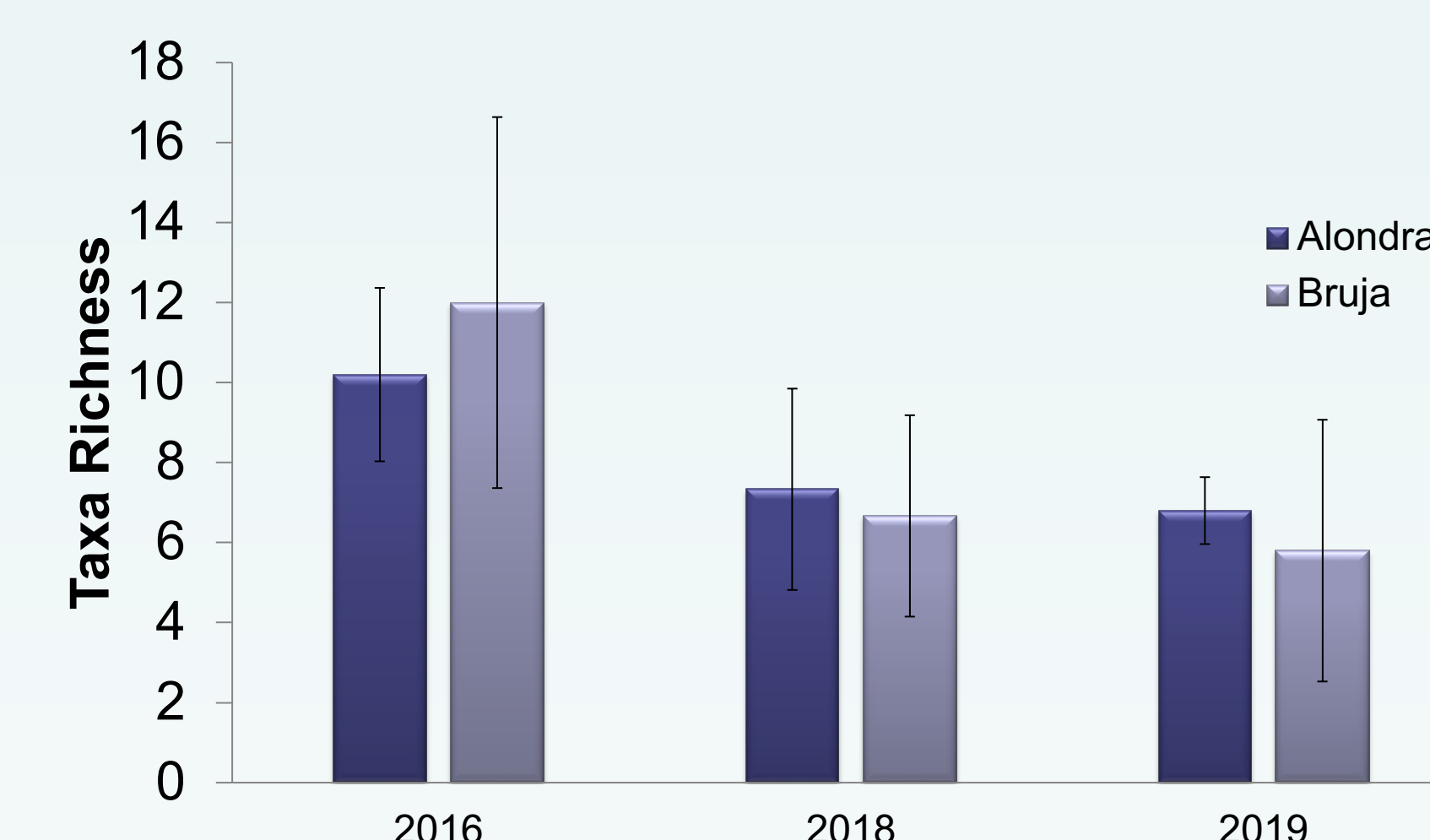


Figure 3: Taxa richness in Alondra and Bruja before (2016), one year after (2018), and two years after (2019) the disturbance. Taxa richness decreased ~30% in Alondra and ~50% in Bruja in 2018 following Tropical Storm Nate and remains low in 2019.

- Macroinvertebrate density was 5X higher in Alondra after Nate, and then decreased in 2019, though density is still higher than before Nate. Density in Bruja remained similar across years.
- There was a sharp increase in the number of grazers and disturbance adapted taxa following the storm.
- In 2016, Diptera was the most abundant order in both streams. In 2018, the Mayfly *Baetodes* was found to be the most abundant genera in both streams followed by *Baetis*.
- Alondra was severely disturbed and was recolonized by *Baetodes* and *Baetis*. Similarly Bruja also saw an increase in these genera, but saw a complete loss of shredders at the time sampling occurred (Figure 4).

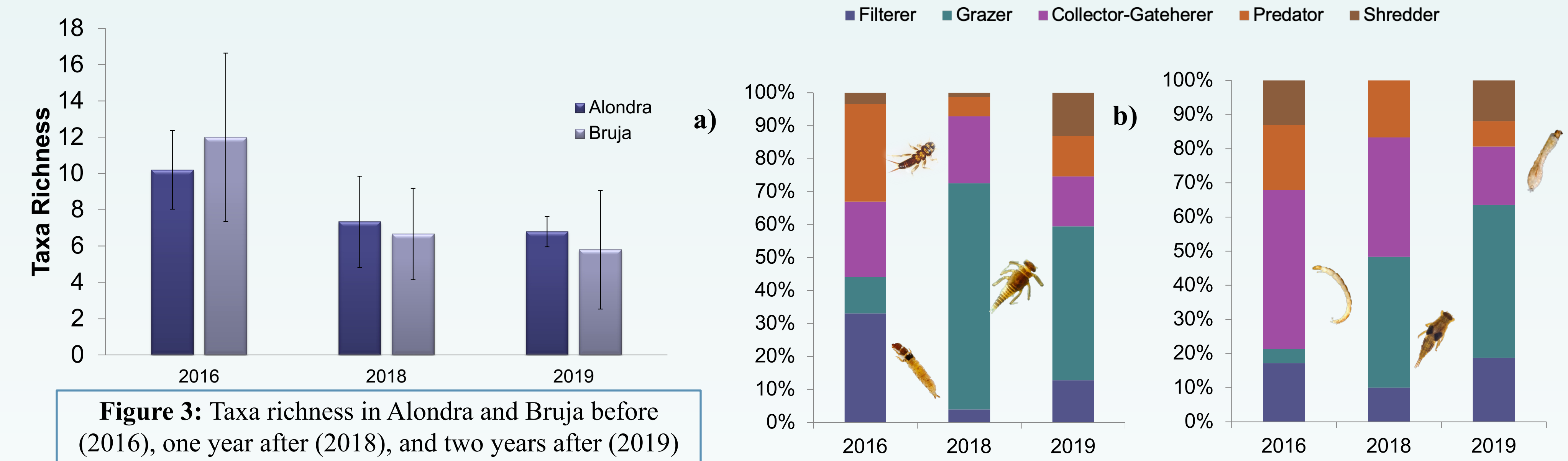


Figure 4: Relative abundance of functional feeding groups in Alondra (a) and Bruja (b) before and after tropical Storm Nate.

Discussion

- The increase in grazer abundance from 2016 to 2018 is hypothesized to be due to increased sunlight from canopy loss, while a loss of leaf litter may have caused a decrease in shredder and filterer FFGs
- Both streams were dominated by disturbance adapted taxa. The perennial stream Alondra was severely disturbed and was recolonized by *Baetodes* and *Baetis*. Similarly Bruja also saw an increase in these genera, but saw a complete loss of shredders
- The streams continue to have lower species richness, suggesting the macroinvertebrate communities have not yet recovered to pre-Nate values.
- The initial rise in species density following storm Nate could be due to a re-colonization of macroinvertebrates in the area following the storm, but as their abundances increased once more, they outcompeted and have returned to lower densities similar to before the storm
- Climate change is projected to increase the frequency and severity of tropical storms, leading to an increase in disturbance events with less recovery time., leading to more adapted taxa species (Knutson et al. 2009).

Acknowledgements

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