Fire History and Climate Drive Patterns of Post-Fire Recovery in Everglades Upland Ecosystems

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Introduction

- In fire adapted landscapes, regular disturbance by fire maintains biological and structural diversity, supporting ecosystem function, and maintaining resilience [1–3].
- Fire regimes are the spatial, temporal, and magnitudinal patterns at which fires occur [4–8].
- In the Florida Everglades, diverse fire regimes have created a mosaic of upland ecosystems (Fig. 2)[9].

Figure 1. *Pine rockland ecosystems are fire dependent and lose biodiversity after five years without fire.*

Figure 2. *Hardwood hammocks are fire adverse and only burn past the edges in very dry conditions.*

- Changes in land management and climate change have altered plant communities and fire ecology [9–11].
- Using long-term data, we can evaluate past fire regimes across Everglades upland ecosystems to understand how variability in regimes could affect ecological responses to fire (Fig. 3).

Figure 3. *Fire managers use fire to meet ecosystem restoration objectives, but burn planning and wildfire management practices may need to be adjusted as climate change shifts ecological responses to fire [11-12].*

Methodology

- Fire history data (1978-2020) was obtained from Everglades National Park and Big Cypress National Preserve.
- Uplands ecosystems were identified using the *Vegetation Mapping Project of Everglades National Park and Big Cypress National Preserve* [13](Fig. 4).
- Fire history raster layers were generated in R and masked to upland ecosystems.

Table 1*: Description of fire history raster layers*

Layer	**Description** (per 30x30m grid cell)
Number of fires	Sum of all fires (1978-2020) **Results*
Time since fire	Years since last fire from 2020
Mean fire return interval	(last fire year - first fire year) / (total number of fires -1)
Previous interval	Years between last and penultimate fire

Results

- Uplands (648 km^2) were dominated by pinelands (58%, 373 km^2), followed by hammocks (19%, 124 km^2). Other vegetation types accounted for less than 10% or fewer than 50 km^2 of the total upland area (Fig. 4).
- Pinelands burned more frequently (mean=5.6, max=17; Fig. 5a) compared to hammocks (mean=2.3, max=14; Fig. 5b).

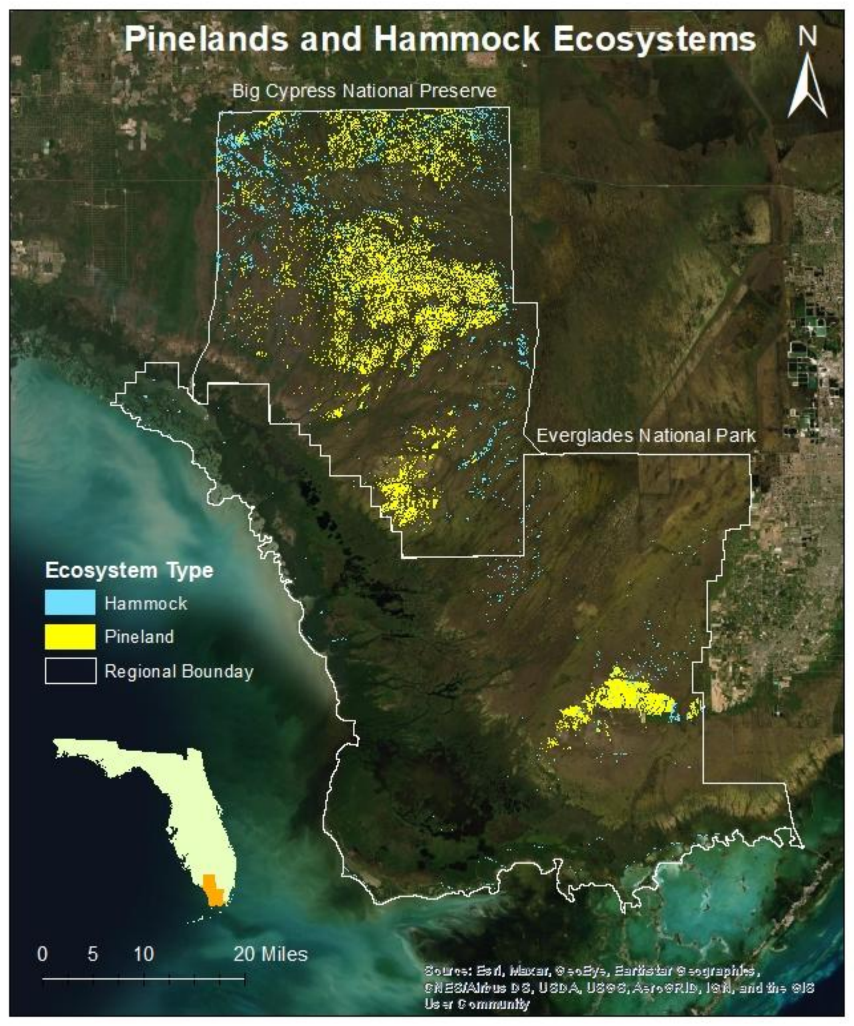

Figure 4. *Spatial distribution of dominant upland ecosystems in Everglades National Park and Big Cypress National Preserve.*

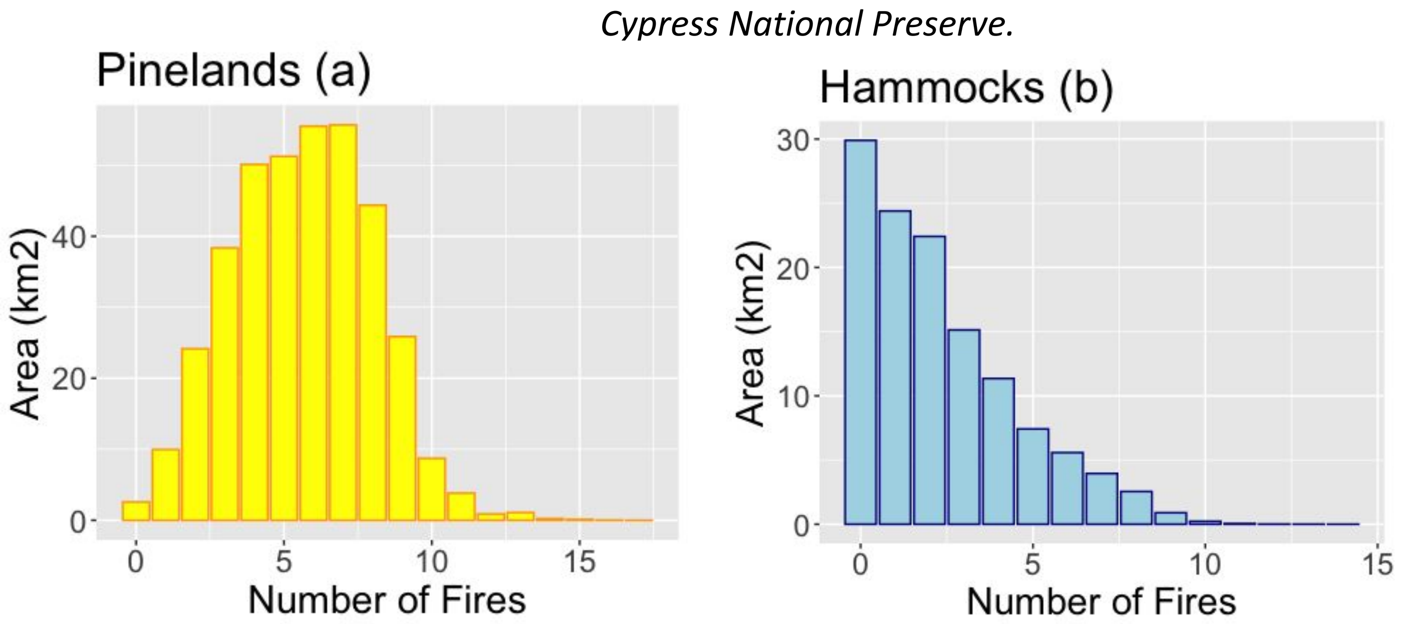

Figure 5. *Fire frequency distribution in Everglades pineland (a) and hammock (b) ecosystems. *Fire frequency calculations were based on total number of fires per 900 m^2 from 1978-2020.*

- Area burned by both wild and prescribed fire was greater in pinelands (Fig. 6a) than hammocks (Fig. 6c). The rate of change in area burned over time was more variable for wild than prescribed fire in both ecosystem types (Fig. 6d, 6d).

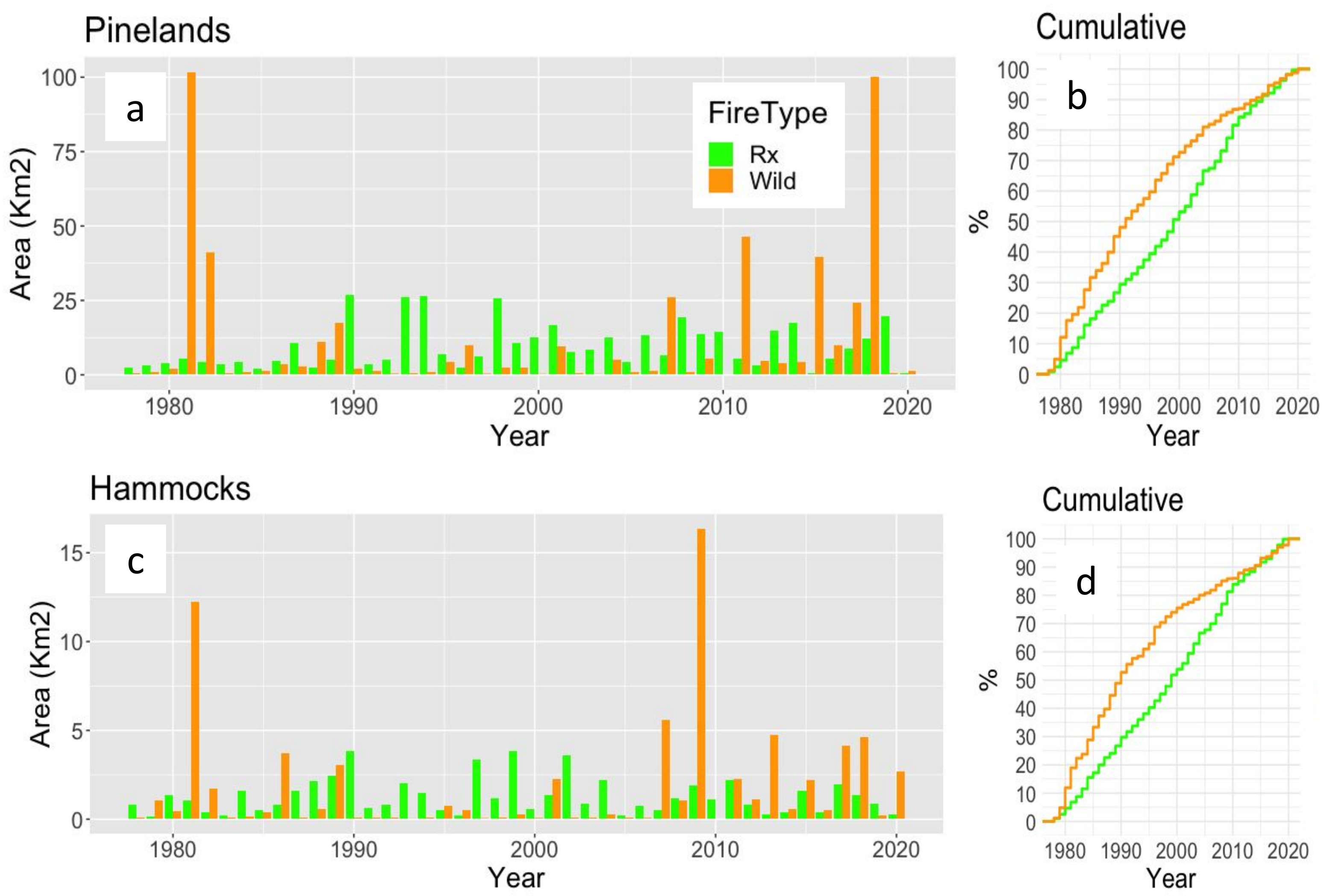

Figure 6. *The temporal distribution of wild and prescribed (Rx) fire by area in pinelands (a) and hammocks (c), 1978-2020. Plots b and d show the cumulative distribution of burned area by fire type.*

Discussion

- Pinelands are more prone to fire compared to hammocks. Frequent fire drives adaptation for increased flammability and rapid regeneration in plants, promoting more frequent, low intensity fire when sufficient fuel re-accumulates [14,15].
- Pinelands show a range of fire frequencies, which likely have differing effects on post-fire recovery. It is probable that shorter return intervals result in faster post-fire recovery.
- In hammocks, fire can consume peat soils and inhibit regeneration [9,16,17].
- The variation in burned area per year is likely due to climatic variability and political and resource related restraints on prescribed fire.
- Hydrological alterations [18] and the Comprehensive Everglades Restoration Plan [19] may also have contributed to variation in fire frequency and burned area patterns.

Figure 7. *The rate at which vegetation recovers from fire can be indicative of its level of fire adaptation [20], as well as its degree of resilience to change [21].*

Next Steps

- Understanding how ecosystems respond to regime change is necessary to anticipate future fire effects.
- By measuring the time required for vegetation to recover after a fire, we can quantify important changes in fire regimes.
- Satellite imagery from NASA's Landsat Mission dates back to 1972. Spectral data will be paired with fire history records to measure changes in spectral signatures following fires. This will also allow for assessing the accuracy of burned area records in the Everglades fire history database.
- Recovery will be measured as the time in years required for the spectral signature of a burned point to reach a modeled unburned value.
- By assessing differences in spectral recovery across upland ecosystems under varying fire history scenarios, while controlling for fire severity, we will determine the degree and direction to which fire history and climate influence post-fire recovery.

Grace is currently pursuing a M.Sc. through the Malone Disturbance Ecology Lab at FIU. She is interested in using remote sensing to answer landscape-scale questions that can inform adaptive management solutions for biodiversity restoration and climate change mitigation.

Contact and CV

References

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