Orders of Magnitude: Changes in Area Burned Per Year in the NE United States Dropped from Millions to Thousands of Acres Per Year

Celeste Basken, Montgomery Blair High School, Silver Spring, MD, and
Randy Swaty, The Nature Conservancy, Marquette, MI

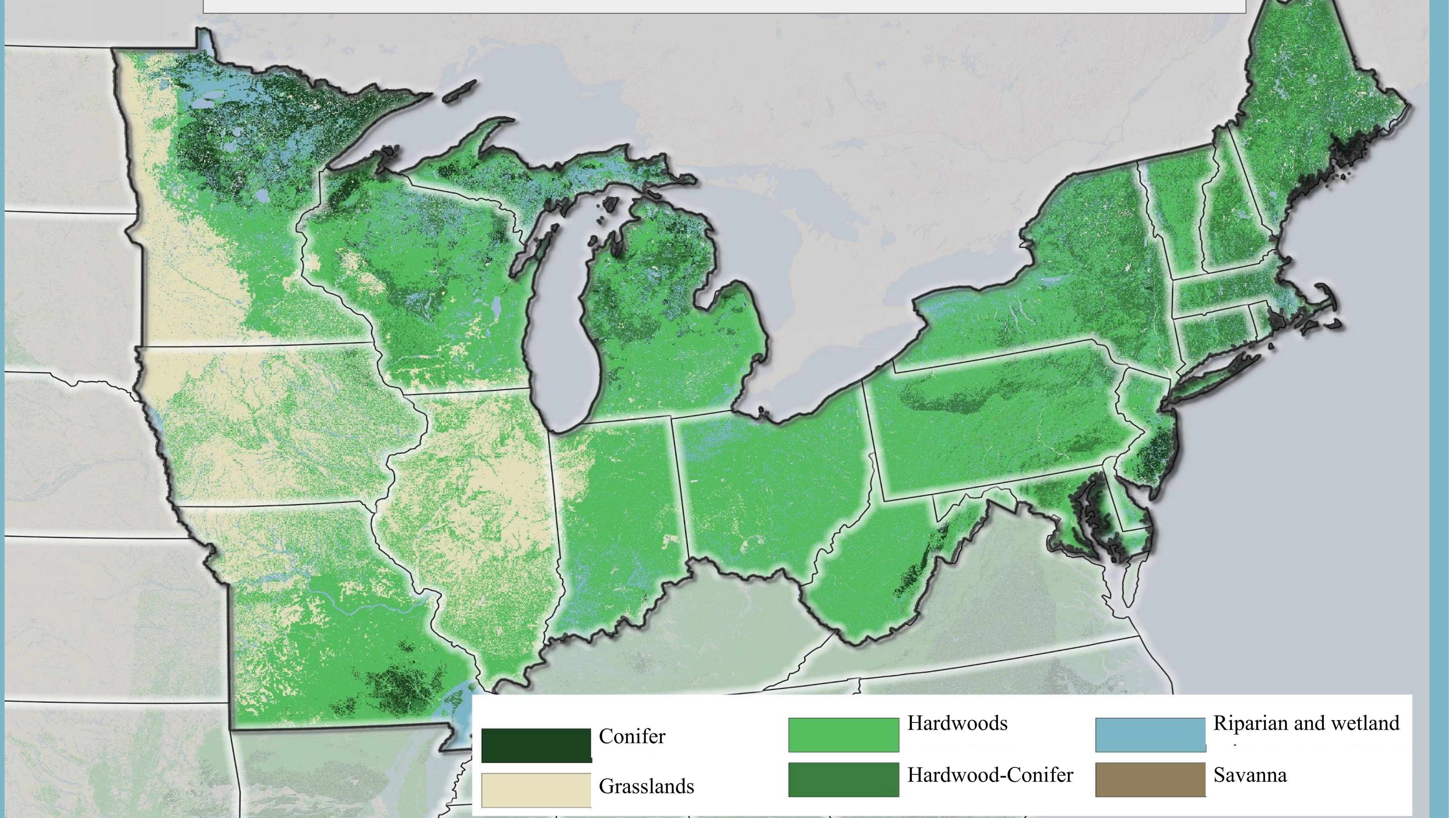
Introduction and Methods

- Fire is a key ecological process in many ecosystems, regulating nutrients, vegetation structure and composition, and also posing a challenge for communities embedded in fire-adapted ecosystems.[1]
- While most wildfires are in the western US currently, many ecosystems of the eastern US were fire dependent historically, ranging from grasslands to oak-hickory and coniferous systems.
- While there have been many studies looking at historical fire patterns at local and landscape scales, there are few regional or national studies. The LANDFIRE program[2] produces many datasets and models including ones that help characterize vegetation and fire traits of the United States historically (pre-European influence).
- With fire suppression many fire-dependant ecosystems are succeeding to less fire-adapted species. This may have implications for biodiversity and resilience to climate change.

LANDFIRE is a federal program that delivers dozens of datasets and models regarding vegetation and fire, past and present. LANDFIRE Biophysical Settings (BpS) spatial data represents vegetation systems locations historically. Using LANDFIRE data we characterized the historical fire patterns of the northeastern quarter of the U.S. reporting and mapping amounts, parsing by fire type and broad vegetation groups (an attribute of the BpS data). The BpS models are state and transition models parameterized with historical disturbance regimes in SyncroSim. The disturbances (e.g., flooding, wind, fires) are inputted as annual probabilities (e.g., a 100 year return interval = 1/100 = 0.01). To calculate annual amounts of fire we multiplied the annual probabilities of 3 fire types (surface, mixed and replacement) for each BpS by the acreages of the BpSs (e.g., if BpS x covered 1,000 acres and had a replacement fire probability of .001, the annual amount of replacement fire would have been 1 acre). These calculations were the inputs for all charts and maps. All maps created in QGIS, analysis and charts in R.

Current Fire amounts are from the Monitoring Trends in Burn Severity dataset[3]. Annual fire amounts are averages of annual fire amounts from 1984-2018.

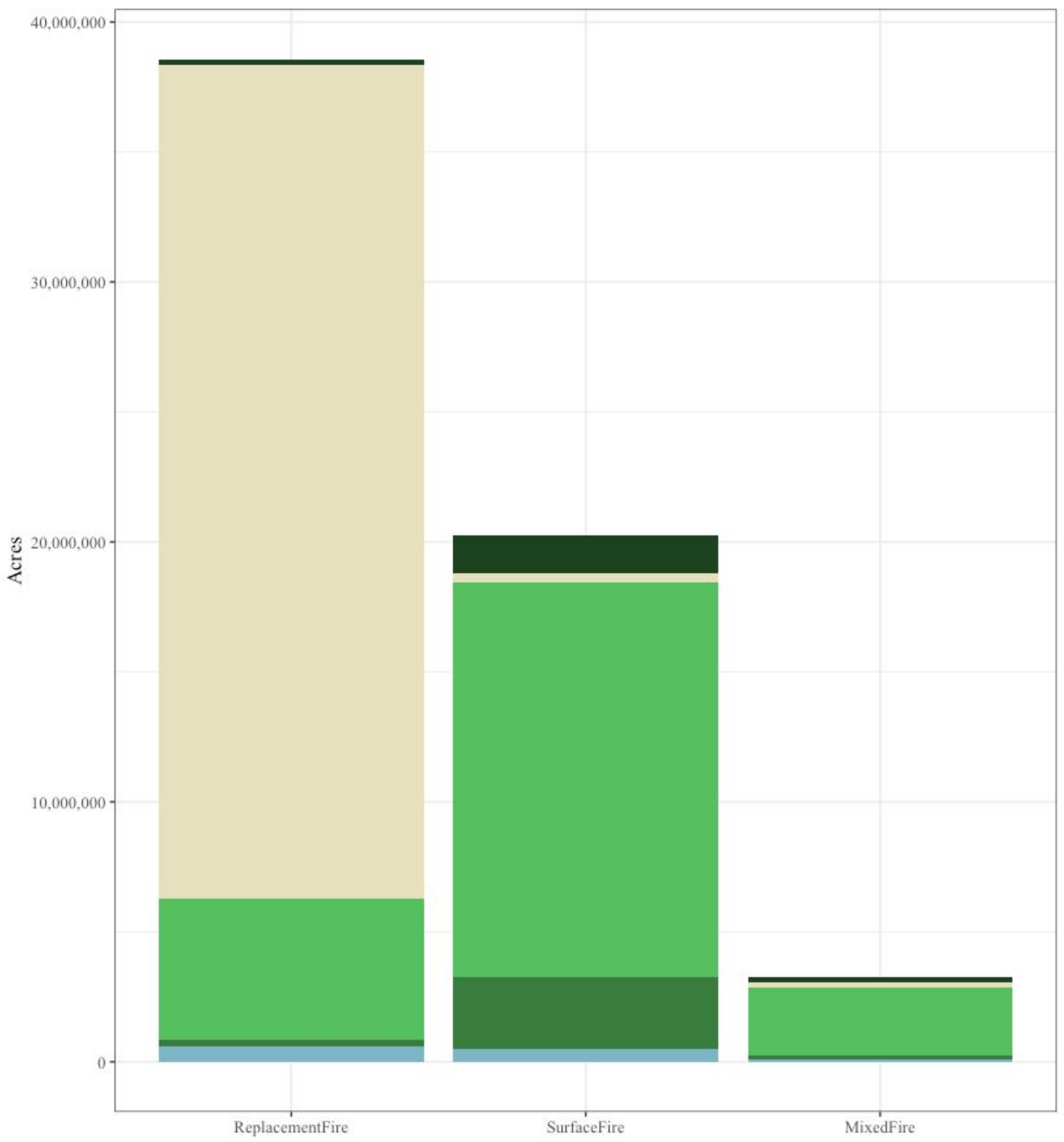
Historical Vegetation Groups (from LANDFIRE BpS data)



Summary of historical fire in the Northeastern U.S.

- Mean fire return interval (MFRI) is a composite of all fire types and represents the years that would pass between a fire of any time at a particular spot. Over 80 million acres experienced a MFRI of less than 5 years.
- In westernmost states of the region, grasslands were more prevalent and burned at higher rates in replacement fires, with some grasslands burning every 2 years.
- Hardwood forests were dispersed throughout the NE region. They range from mesophylic northern hardwoods to very fire adapted oak-hickory systems that had surface fires every 5-10 years.
- The number of acres burned per year decreased 99.8% from 36M acres historically to 66K acres on average currently.
- Riparian areas include floodplains, swamps, stream/river riparian systems, and lakeplain prairies, and had widely variable fire return intervals ranging from 15 years (e.g., graminoid dominated wetlands) to over 1,000 years (e.g., alkaline-hardwood swamps).
- Coniferous forests are peppered throughout much of the region and share fire regimes with many of the oak-hickory forests. Many would have had surface fires every 5-10 years, with relatively rare replacement fires.

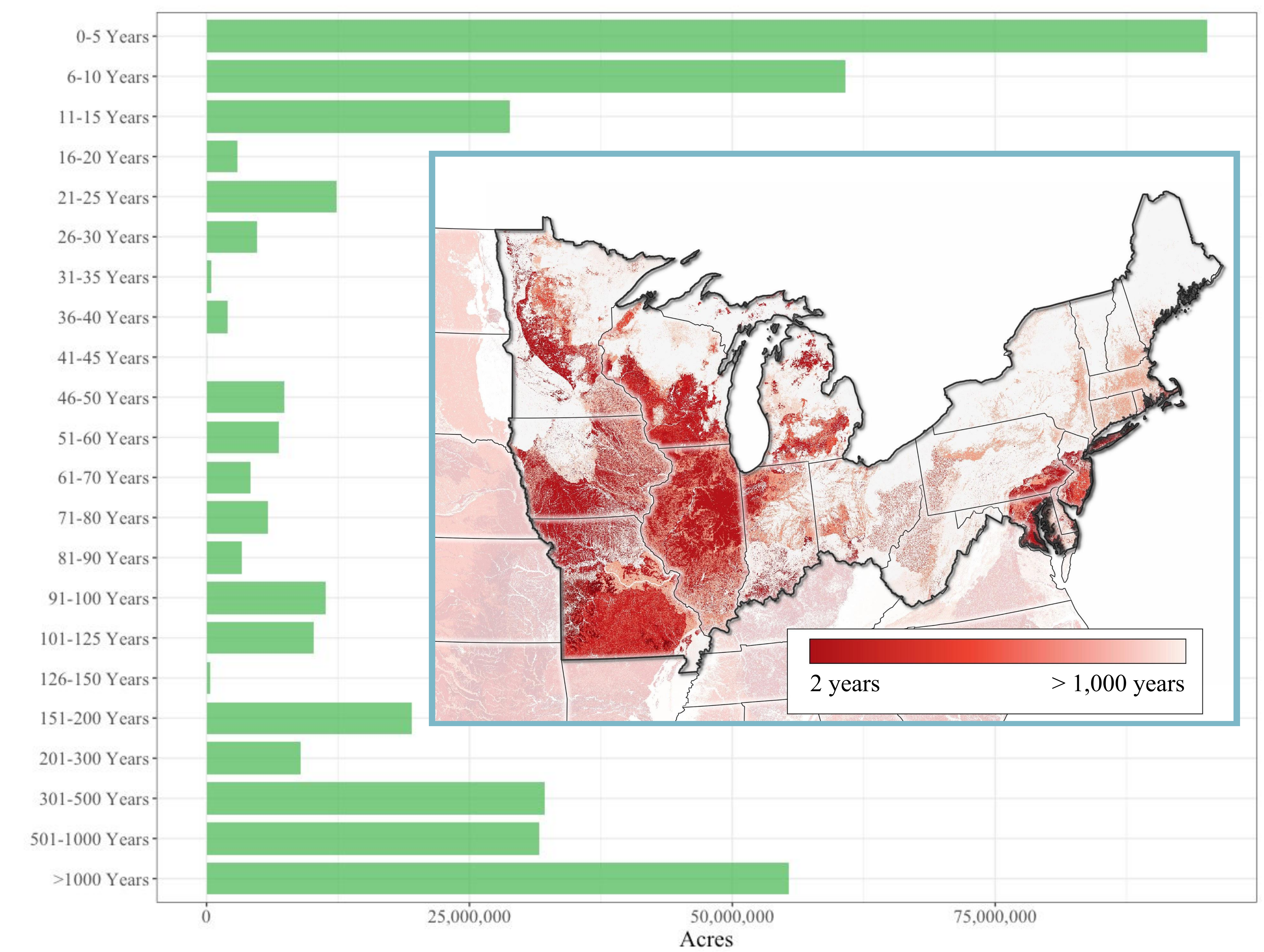
Acres of Historical Fire by Fire Severity



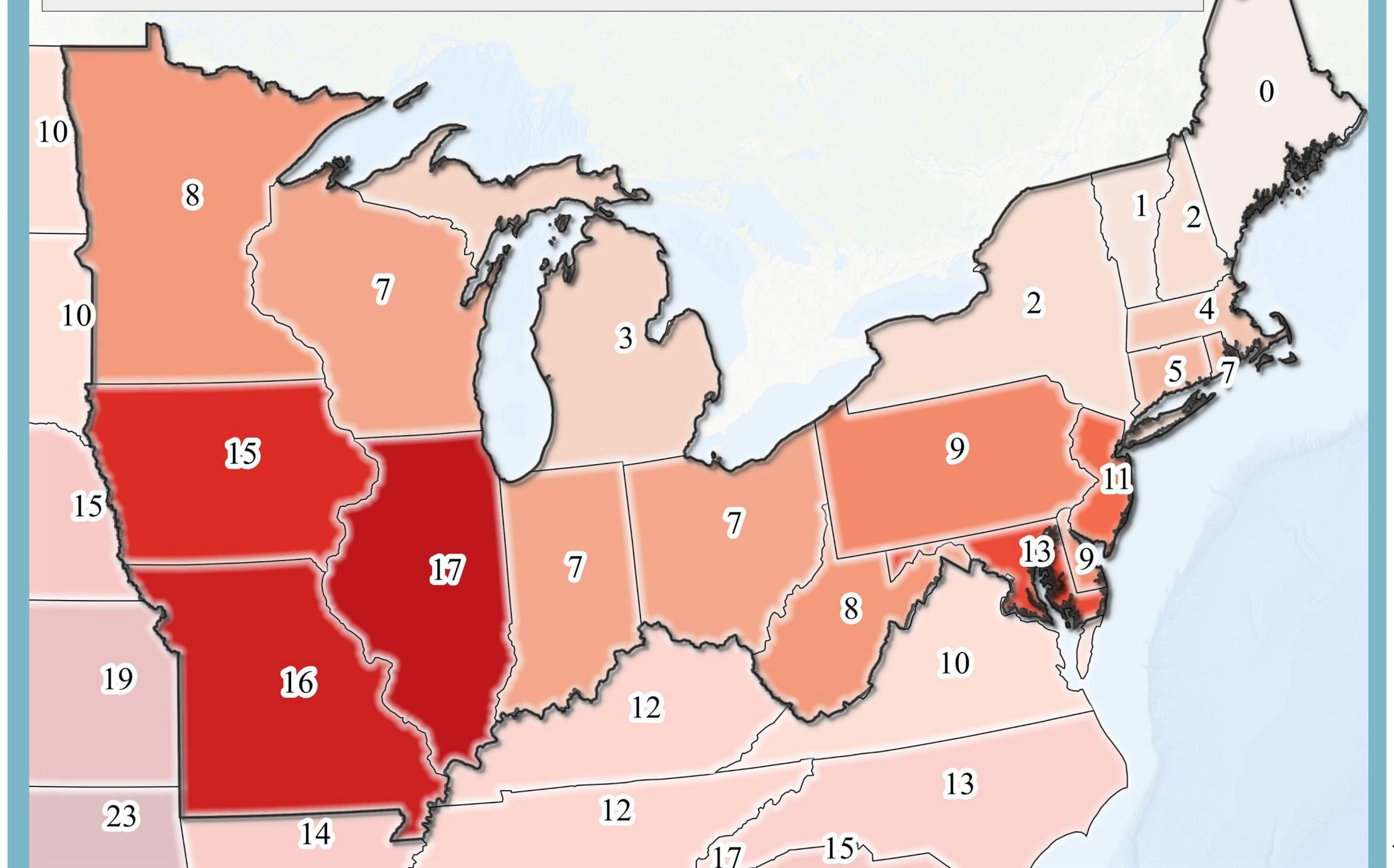
Fire Type:	Surface fire	Mixed fire	Replacement fire
% Top killed:	0-25%	26-75%	> 75%

Savanna and Shrubland were excluded due to negligible amounts (<10K acres).

Historical Mean Fire Return Interval



Difference between annual historical and current fire percentages



Implications

Conversion of fire adapted ecosystems to more mesophytic ecosystems due to fire suppression coincides with predicted changes in climate[4]. We hypothesize that fire adapted ecosystems may be more resilient to a warming and drying climate than the ecosystems that are replacing them. It could be increasingly important to restore these ecosystems, especially on drier sites.

In the western U.S. modeling suggests that increased prescribed fire and thinning in fire-adapted ecosystems, while incuring a short-term carbon cost can result in a net carbon benefit through reduction of fuels and the potential for replacement fires[5]. It is unclear if these patterns would hold up in eastern forests. We suggest increased research in this area.

One major impact of fire is in structuring of vegetation. As fires are suppressed, canopies close and light reaching the forest floor is reduced, benefitting shade-tolerant species. Further, litter of more mesophytic species can essentially serve to slow fires. For example, consider relatively flat and thin red maple leaves compared to thick and often curly oak leaves which promote air flow and therefore fire. In this example, we see self-perpetuating cycles where maples move in, and essentially promote themselves at the cost of oaks. Restoration after this has happened is difficult.

While restoration of fire adapted ecosystems is challenging, they just might be more resilient to climate change, and key to conservation in the eastern U.S.

References

1. McLauchlan, K.K., Higuera, P.E., Miesel, J., Rogers, B.M., Schweitzer, J., Shuman, J.K., Tepley, A.J., Varner, J.M., Veblen, T.T., Adalsteinsson, S.A. and Balch, J.K., 2020. Fire as a fundamental ecological process: Research advances and frontiers. *Journal of Ecology*, *108*(5), pp.2047-2069.
2. LANDFIRE: https://www.landfire.gov/. Spatial data LANDFIRE, 2016, Biophysical Settings Layer, LANDFIRE 2.0, U.S. Department of the Interior, Geological Survey. Accessed 28 January 2021 at http://landfire.cr.usgs.gov/viewer/. Models from LANDFIRE, 2016, Biophysical Settings Models, LANDFIRE 2.0 U.S. Department of the Interior, Geological Survey. Accessed 28 October 2010 at https://www.landfire.gov/bps-models.php
3. MTBS Data Access: Fire Level Geospatial Data. (2017, July - last revised). MTBS Project (USDA Forest Service/U.S. Geological Survey). Available online: http://mtbs.gov/direct-download [2017, July12]
4. Nowacki, G.J. and Abrams, M.D., 2015. Is climate an important driver of post-European vegetation change in the Eastern United States?. *Global Change Biology*, *21*(1), pp.314-334.
5. North, M.P. and Hurteau, M.D., 2011. High-severity wildfire effects on carbon stocks and emissions in fuels treated and untreated forest. *Forest Ecology and Management*, *261*(6), pp.1115-1120.