North Central Climate Adaptation Science Center

Earth Lab

CIRES

Future fire and adaptation in grasslands

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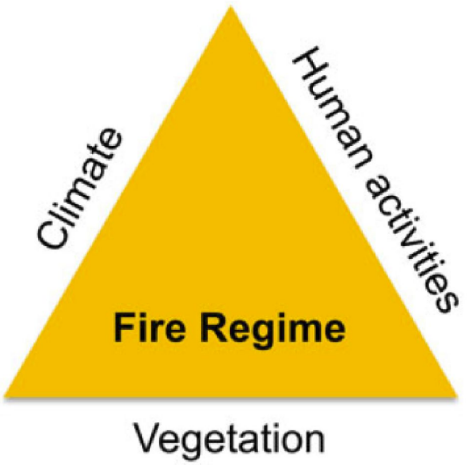
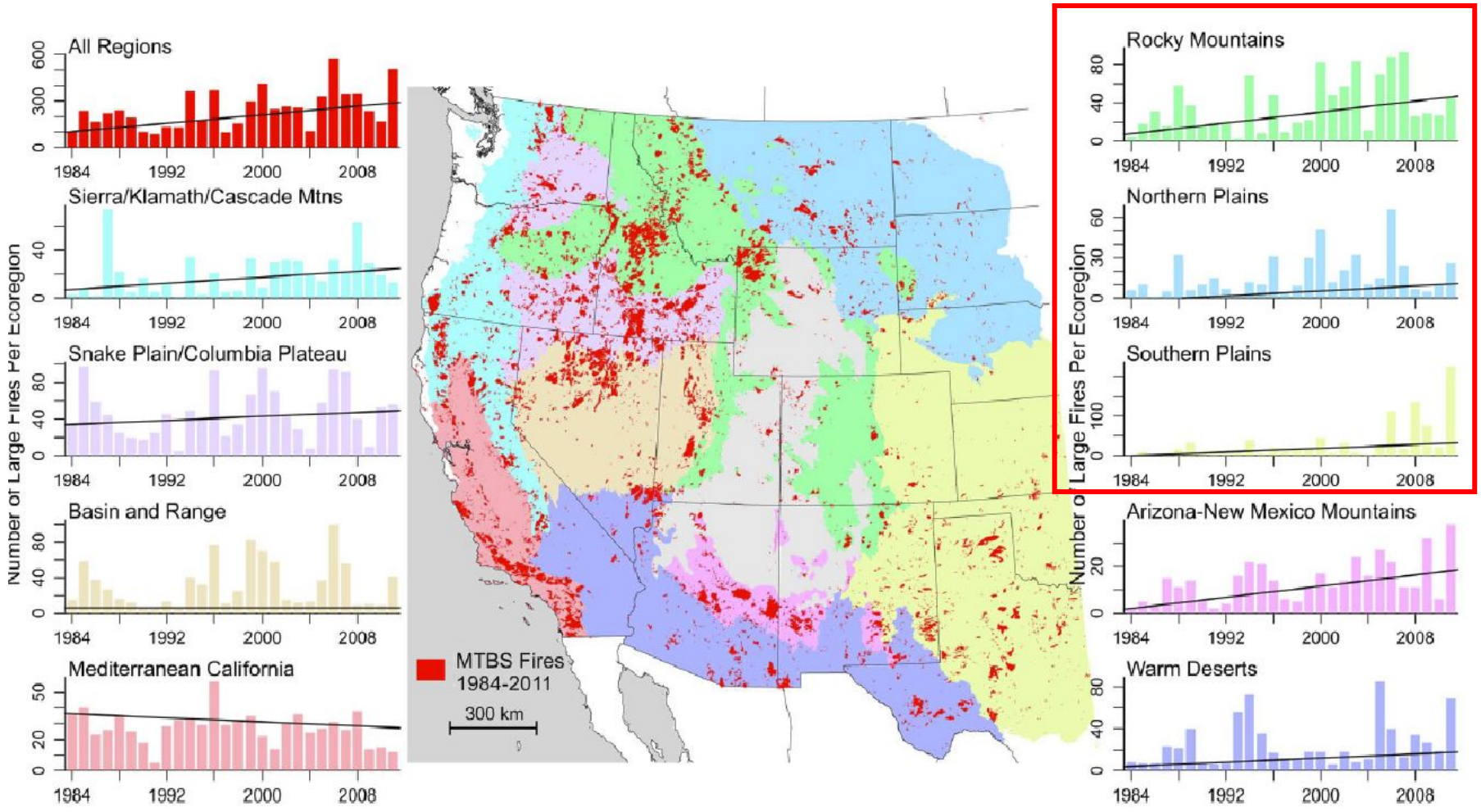
Fire Regime

- Wildfires need a source of ignition, dry, combustible material and favorable weather conditions to spread
- Fuel limited-fires in drier and warmer ecosystems
- Climate Limited- fires in cooler and wetter ecosystems
- A high-resolution paleo-climate record in the Great Plains revealed
  - high fire activity during moist intervals when grass cover was extensive and fuel loads were high
  - low fire activity when fuels loads decreased as a result of greater aridity (Brown et al., 2005)



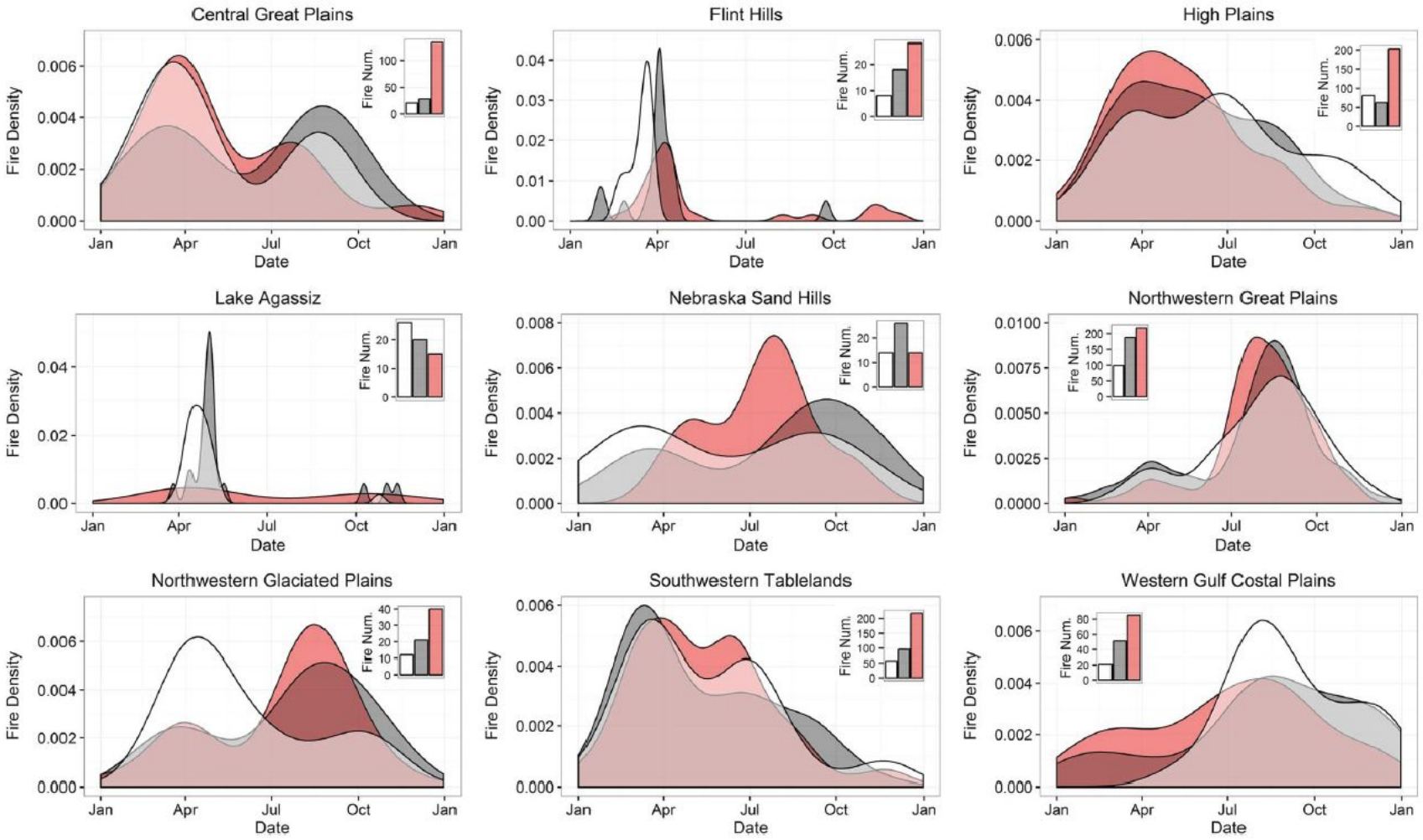
Observed Increases in Wildfire



- In western steppe ecosystems cheatgrass is well known for greatly increasing the frequency of fire (Balch et al., 2013)
- In the mixed-grass prairie of the Great Plains, increased annual brome grass was associated with less frequent fires (Ashton et al., 2016).

Dennison et al., 2014 (10.1002/2014GL059576)

Fires in the Great Plains



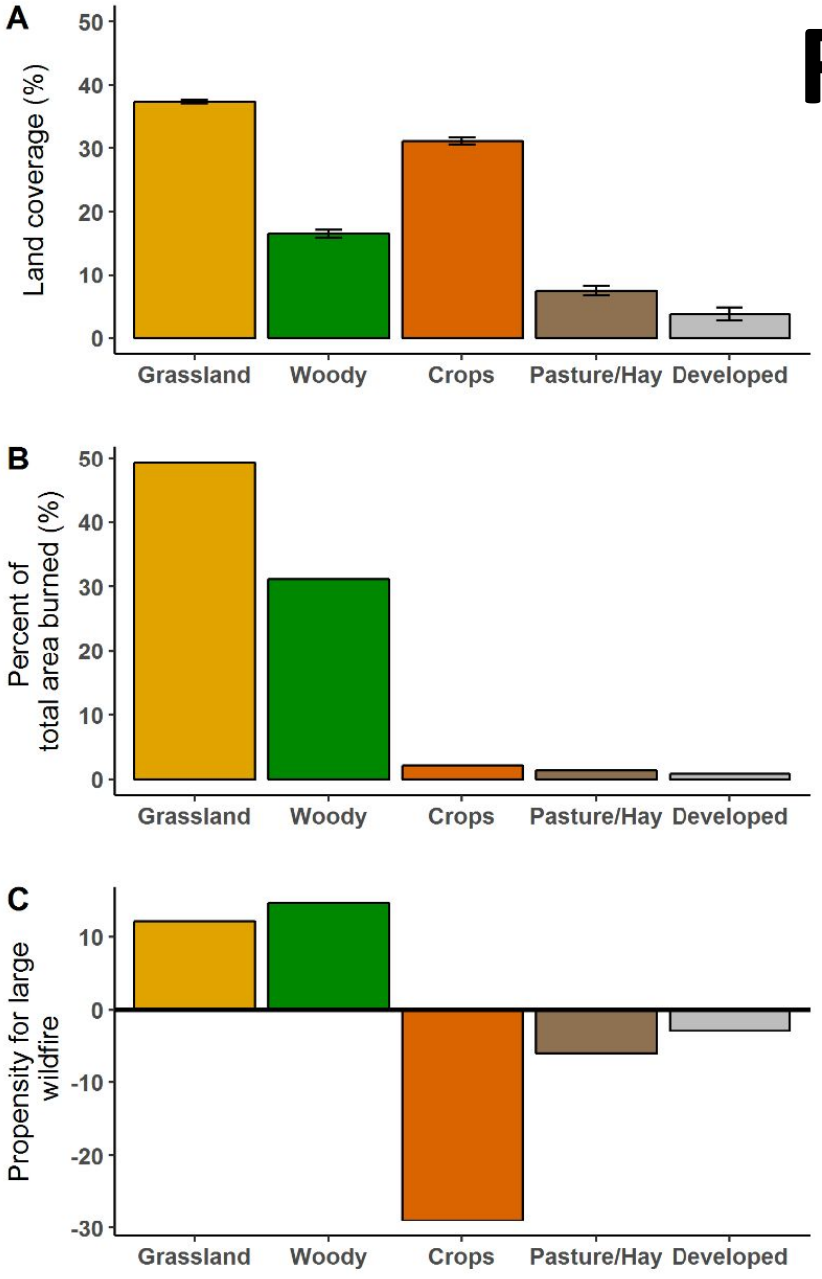
White: 1985-1994 Grey: 1995-2004 Red: 2005-2014

From 1980 to 2014

- Number of large wildfires have increased 3 fold
- Area burned increased by 400%
- Probability of large wildfires increased by 70%

Donovan et al., 2017 (10.1002/2017GL072901)

Fires by landcover type

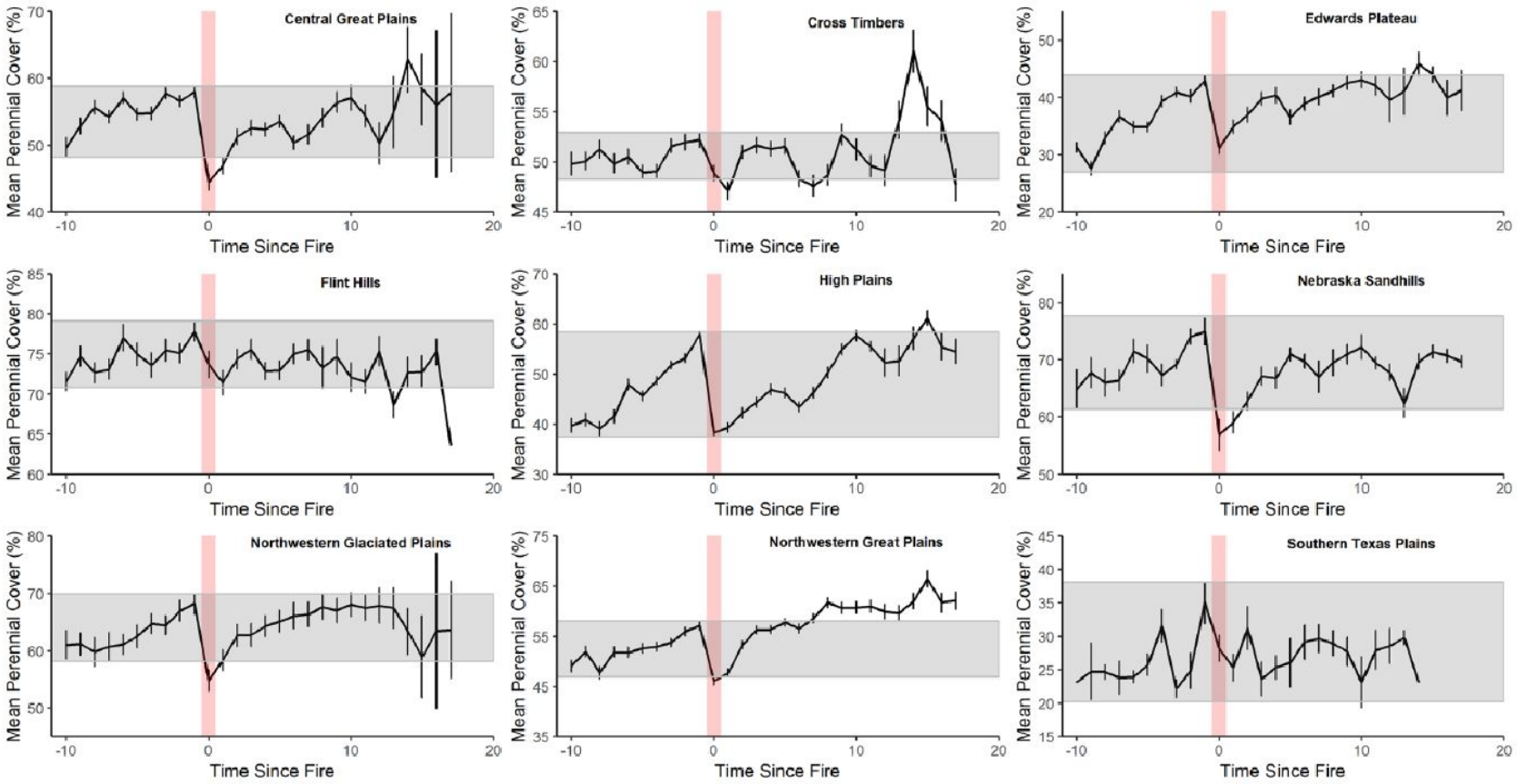


Large fires in Great Plains (1993-2014)

- Woody vegetation and grasslands had the greatest propensity for large fires
- Woody vegetation burned disproportionately more, over two times its proportional land cover
- Crops occupy ~ 30% land cover in Great Plains but they burned over 15 times less than their proportional land cover

Donovan et al., 2020; doi:10.3390/rs12111869

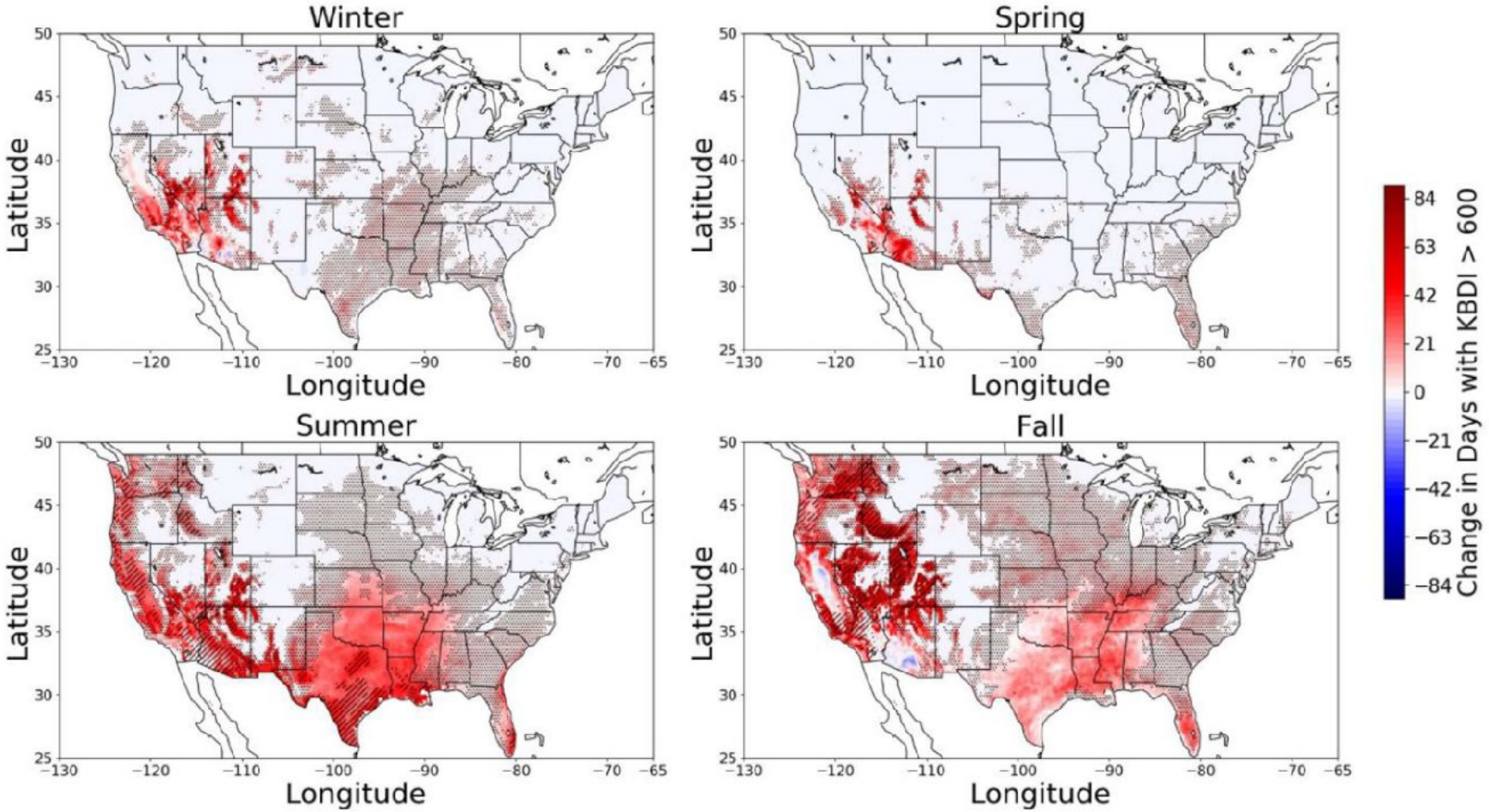
Fire Impacts to Grassland Vegetation



- No evidence of persistent shifts in vegetation cover driven by wildfire
- All vegetation groups exhibited relatively rapid recovery to pre-wildfire levels
  - except a persistent decrease in the abundance of trees in Northwestern Great Plains
- Variation in annual forb and grass cover more influenced by climate or grazing

Donovan et al., 2020 (10.1029/2020EF001487)

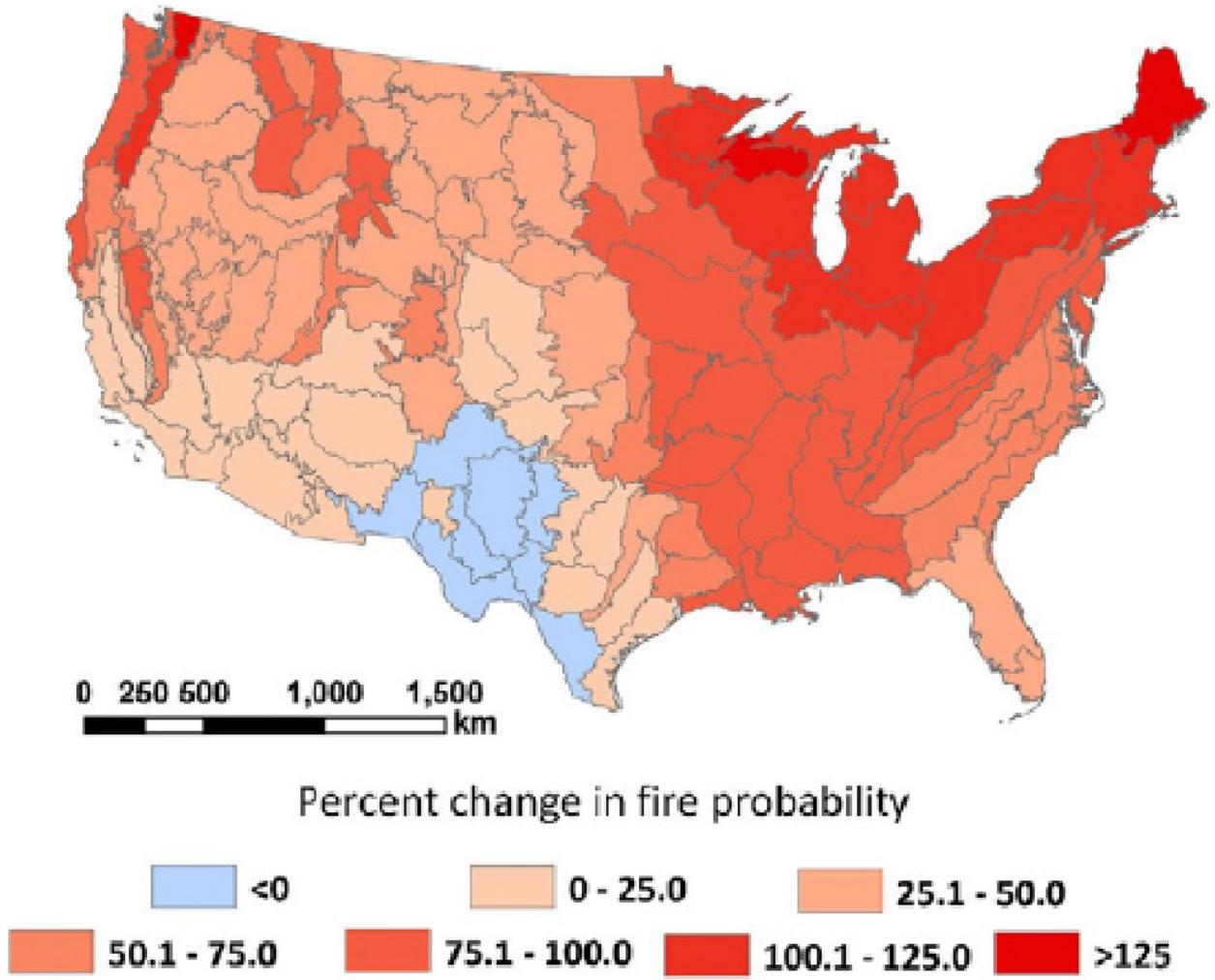
Modelled index to determine future fire potential



- Regions that already have high fire danger: the fire season will be longer
- Regions that used to have low wildfire potential, such as the NGP, there is a large increase in periods with high KBDI: in the future these regions could experience high wildfire danger

Brown et al., 2021 (https://doi.org/10.1088/1748-9326/aba868)

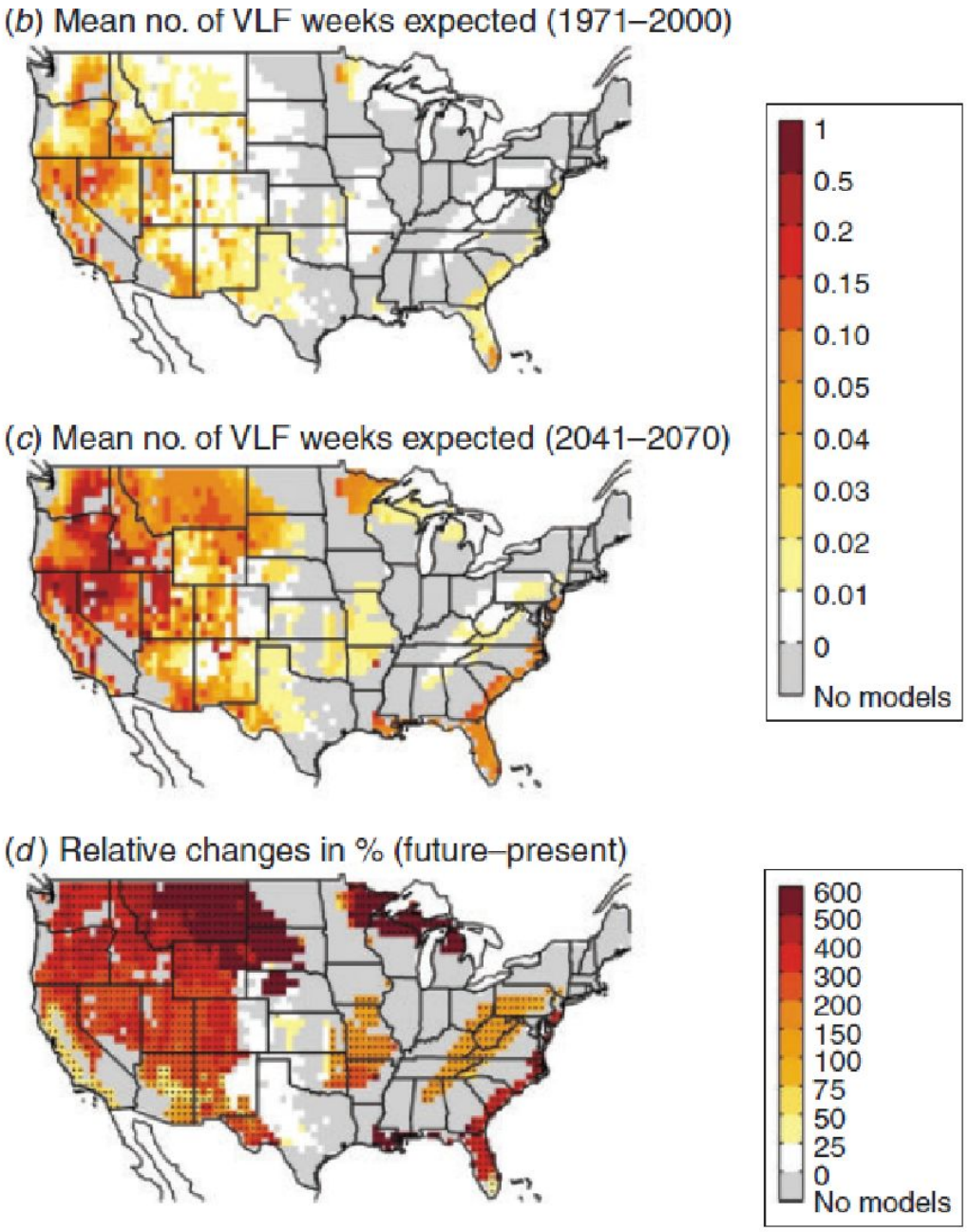
Future Fire Probability



Change in Annual fire probability from 1971-2000 to 2070-2099 based on RCP8.5

Gao et al., 2021 (https://doi.org/10.1016/j.scitotenv.2021.147872)

- Rising temperatures are the primary cause of modeled increases in fire probabilities
- Fuel is the most important driver of high-severity fire followed by fire weather, climate, and topography



Barbero et al., 2015

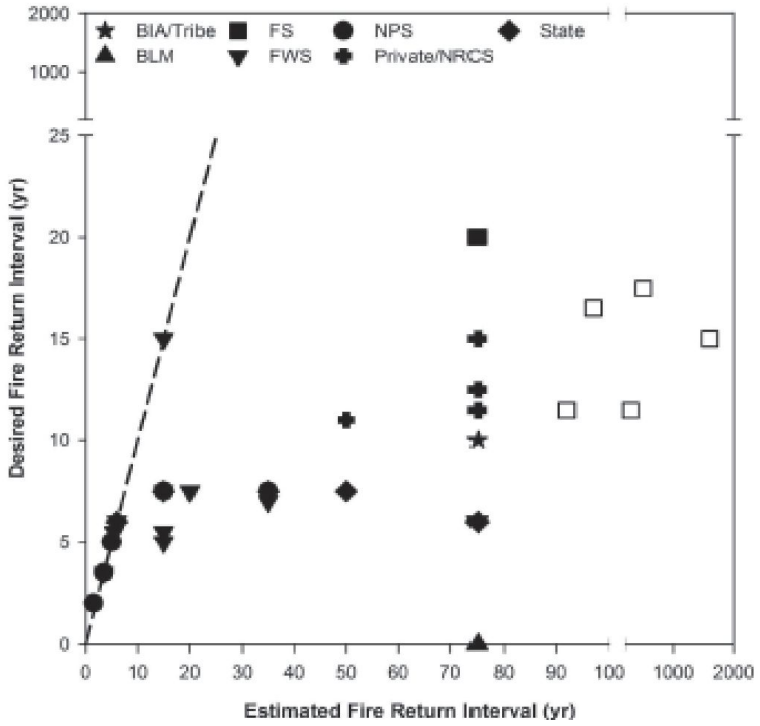
Future Very Large Fires

- The largest relative changes in fire probability were found across the northern tier of the US
  - changes result in moderate increases in # of fires in regions that had historically low fires
- Lack of information for large parts of the Great Plains

Prescribed burning

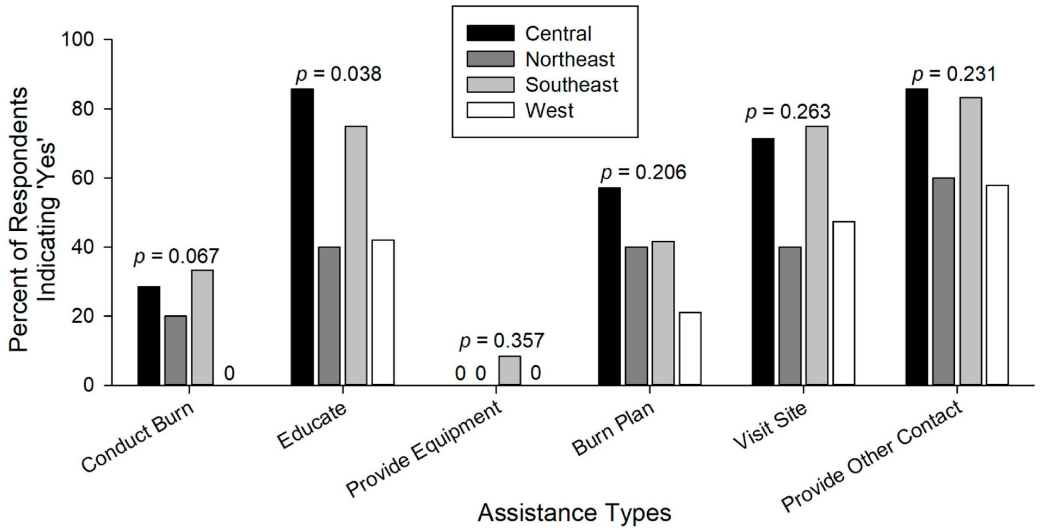
- A prescribed fire is the application of fire to achieve pre-specified objectives such as restoration and maintenance of ecosystem services
- Successful prescribed fires require sufficiently warm temperatures, low to moderate relative humidity, at least some wind, and sufficiently dry fuels.
- From 2003-2015 the number of acceptable spring fire weather days decreased, but the number of late summer and early fall fire weather days increased (Yurkonis et al., 2019).

Current Manager Burning Practices



Symstad & Leis, 2017

- surveyed NGP land managers: their desired fire return interval is much smaller than the estimated fire return interval on their manage lands
- NRCS mostly provide education to private landowners, rarely conduct burns or provide equipment

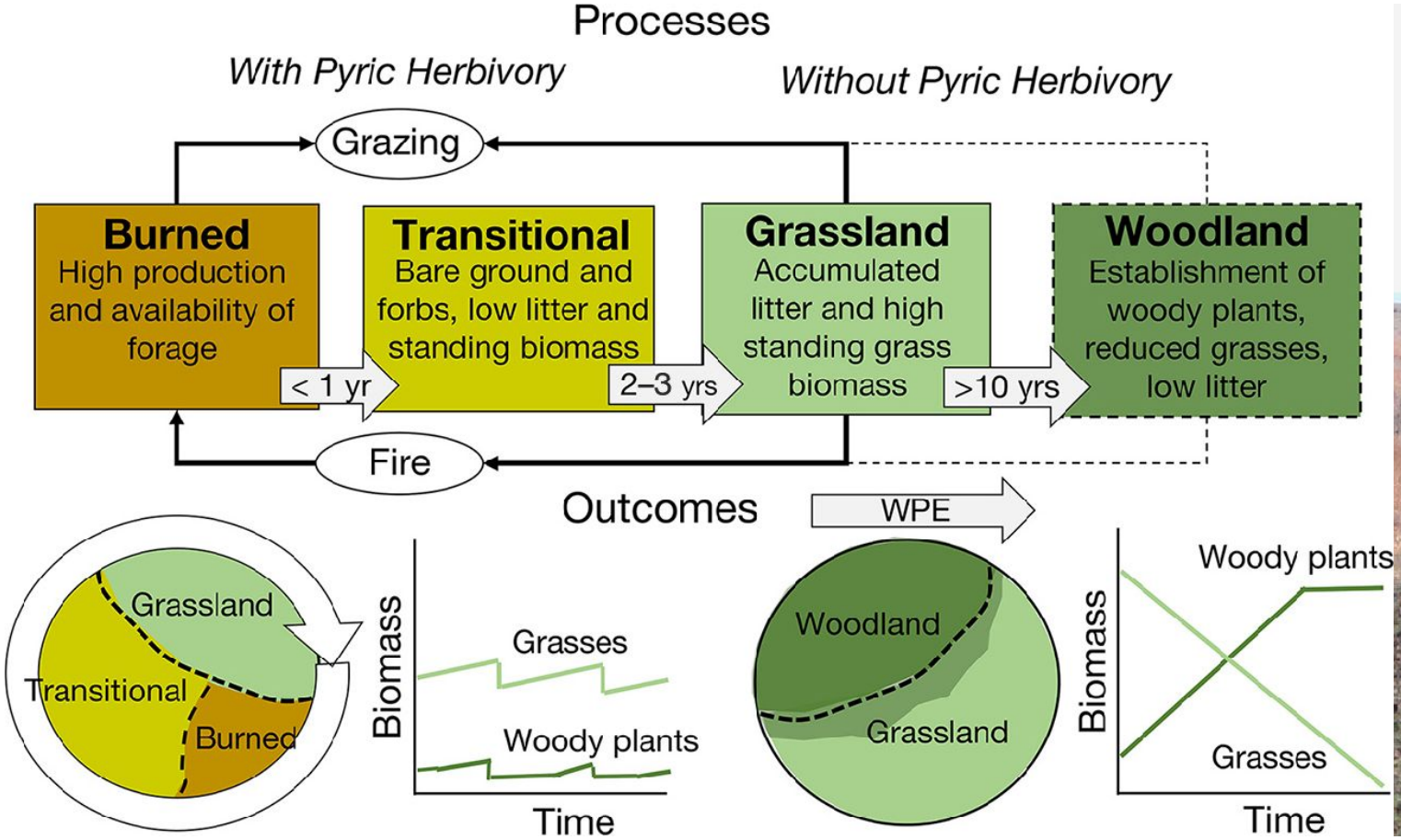


Wilbur et al.2021 https://doi.org/10.3390/fire4030047

Grazing

- Excessive litter can buildup under light or no grazing
- In the North American tallgrass prairie one of the most common invasive plant species is Sericea lespedeza
  - substantially reduces native grassland flammability via changes in fuel bed properties (i.e., increased fuel bed density and moisture retention) (Barnes et al., 2022)
- Grazing can have the undesired effect of increasing Sericea lespedeza
  - a positive if only minimizing fire is the objective, but for managers trying to minimize ecosystem transformation (i.e., limiting further woody encroachment)

Pyric Herbivory (Patch-Burn Grazing)



- Cattle spend 75% of the time grazing on the most recently burned patches.

Wilcox et al. (2022); doi:10.1002/fee.2448