CALIFORNIA FIRE SCIENCE CONSORTIUM

Research Brief for Resource Managers

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Proximate Causes of Abrupt Fire-Regime Changes

Pausas, J.G., and J.E. Keeley. 2014. Abrupt climate-independent fire regime changes. Ecosystems 17:1109-1120. DOI: 10.1007/s10021-014-9773-5

Ultimately, future climate changes are expected to result in dramatically altered fire regimes. However, forecasting such altered fire regimes requires a better understanding of the more proximate drivers, particularly in the case of abrupt fire regime changes. In the case of abrupt fire-regime changes, the drivers are not necessarily linked directly to climate change. This paper uses a retrospective approach to investigate this issue.

The authors identify a number of cases that have resulted in abrupt shifts in fire regimes, including ones directly driven by changes in animal community composition and plant invasions, as well as sociological changes in human economics and land management policies.

Specifically, faunal impacts and invasive plants directly affect fuel quantity and structure, while human socioeconomic changes modify fuels and ignition frequency and timing (e.g. season). The result is that animals, plants and humans all affect vegetation structure and continuity, which then changes local fire thresholds in turn. In

Management Implications:

- In many past and present ecosystems, changes in animal, plant, and human communities have been more influential in rapid local fire regime disruption than climate.
- The good news is that, unlike climate change, these direct, proximate community causes can be practically addressed by fire and resource managers.

Figure 1, a theoretical threshold toward an abrupt change in fire pattern occurs between time step 75 and time step 125 with increasingly contiguous vegetation. Obviously, this kind of scenario could potentially be monitored and controlled.

The authors illustrate their theoretical point with real life global and/or historical examples. Insect epidemics (bark beetles & moths), Pleistocene megafauna extinctions (North America), and livestock grazing (Texas & the Serengeti) are just some of the examples. Invasions by *Eucalyptus*, succulents, and flammable perennial and annual grasses (Fig.2a,b) are described. Tree plantations, native human cultural practices and the land use histories of both North America and Europe illustrate how human socio-economics have directly changed local fire regimes. While climate change may certainly

be a contributing factor in all these examples, especially in the modern examples, the abrupt fire regime change trigger illustrated in Fig.1 is always something more local and more manageable.

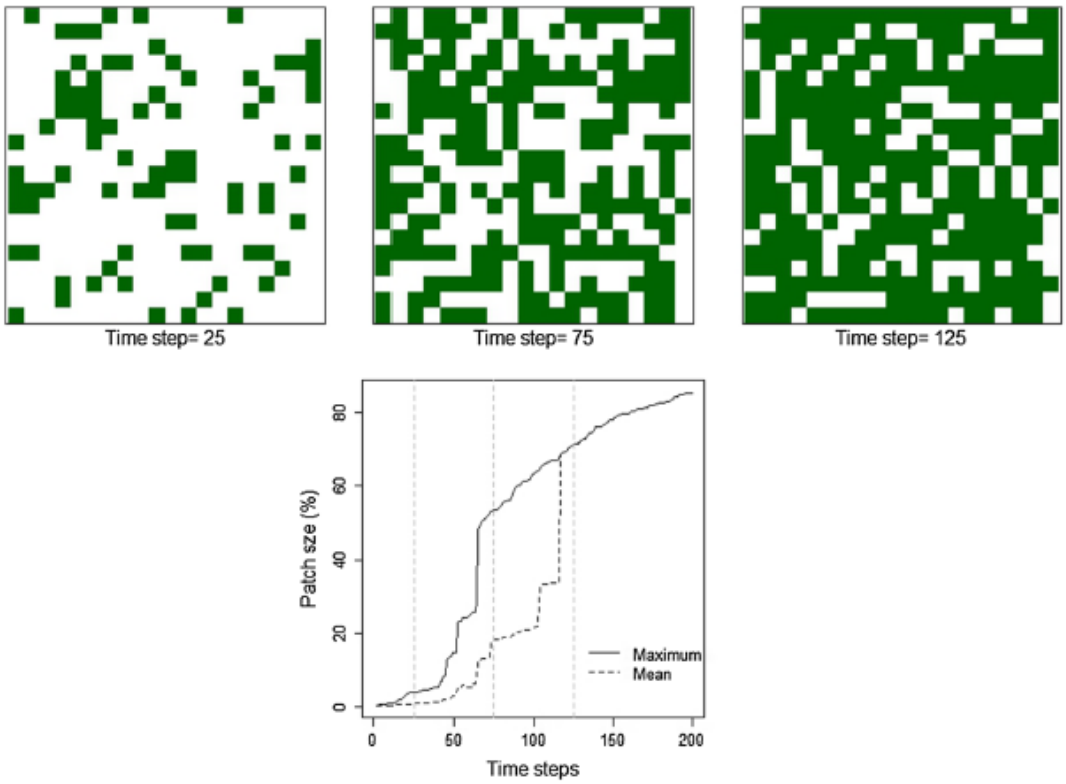

Figure 1. Schematic representation of how a gradual change in a driver (for example, a constant colonization/invasion of a flammable plant) can produce an abrupt change in landscape structure (for example, continuity of the flammable vegetation). The *bottom panel* represents the changes through time in mean and maximum patch size in an idealized landscape that is invaded by plants (*dark cells*) with a constant probability ($P = 0.01$ in each time step). The *upper panel* shows three snapshots of these dynamics (time steps = 25, 75, and 125, also represented by *vertical lines* in the *bottom panel*).

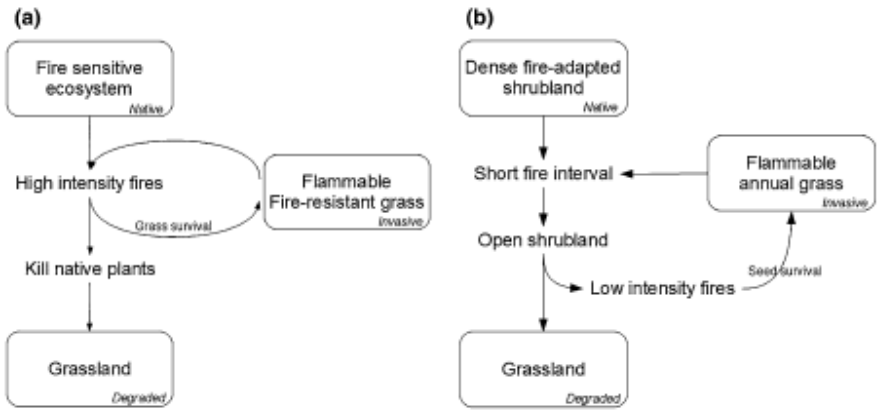

Figure 2. Two types of positive feedback fire cycles in which the invasion of a flammable plant (*right box*) can generate a type conversion from native vegetation (*upper box*) to invasive dominated (*degraded*) ecosystem (*lower box*): the herbaceous perennial plant-fire cycle (**A**) and annual plant-fire cycle (**B**).