CALIFORNIA FIRE SCIENCE CONSORTIUM

Research Brief for Resource Managers

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Distinguishing Disturbance from Perturbations in Fire Regimes

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Management Implications

- Natural fire disturbance is a necessary ecosystem process in fire-adapted ecosystems.
- Human-caused changes to the natural disturbance pattern produces **perturbations** that can result in vegetation shifts, or type-conversion.
- Destructive changes in the natural fire regime that can produce permanent alterations in ecosystems include changes in fire frequency, patchiness of burns, switches in fuels consumed and increased fire intensity.

Fire is not intrinsically a problem for a fire-adapted ecosystem, unless it's an unusual fire with characteristics outside the normal fire regime. That is, fire only becomes a destructive force if it falls outside of the ecosystem's normal range of fire regime parameters. If the fire has characteristics that do not fit the historical fire regime with which the fire-adapted ecosystem has developed, then it may impact resilience and cause a shift in ecosystem characteristics. Specifically, anthropogenically driven changes in: **1)** fire frequency, **2)** fire patchiness and size, **3)** fuels consumed, and **4)** fire intensity, are all to blame for turning otherwise natural fire disturbances into destructive perturbations.

For example, chaparral and Rocky Mountain lodgepole pine forests are particularly susceptible to increases in fire frequency (i.e., shortened fire return intervals), which cause vegetation shifts for both (Fig.1).

In contrast, mixed conifer forests subjected to a century of successful fire suppression are vulnerable to shifts in fuel consumption from surface fuels under natural disturbance cycles to crown fires in the canopy due to this human perturbation to the fire regime. The result is larger patches of dead trees and loss of patches of parent seed trees for regeneration resulting in type conversion to shrublands (Fig.2).

In the case of Great Basin sage scrub, land use changes from increased livestock grazing and prescription burning have led to alterations in burning patterns and patchiness. The primary culprit is cheatgrass invasion that has caused normally patchy fires to become contiguous and large. Since the dominant shrubs depend on unburned patches to disperse into burned areas, this change has diminished the resilience of this ecosystem.

Another example is boreal forests, which have become vulnerable to global warming. Higher temperatures have increased fire intensity that has severely impacted the peat moss substrate making it less suitable for spruce regeneration (Fig. 3). This has placed these forests on a trajectory towards greater hardwood dominance.

The main point is that for all these examples, as well as for all other fire-adapted ecosystems, fire disturbance is not the problem. Instead, the real problem is perturbations to the natural fire disturbance regime. Ultimately, perturbing otherwise healthy fire disturbance regimes can cause type-conversion.

Fig. 1 Impact of unnaturally high fire frequency: (a) entire chaparral landscape in the frame burned in 1970, half of the foreground burned again in 2001 and the lower right third of the foreground burned a third time in 2003, all by human-caused ignitions. Vegetation recovery following the 2001 fire comprises native shrub and subshrub regeneration, those areas burned a third time in 2003 are dominated by alien red brome grass invasion (photo by R. W. Halsey). (b) Massive lodgepole forest regeneration following the 1988 North Fork Fire, which burned over 200 000 ha of Yellowstone lodgepole forests, was partially reburned after 28 years in the 2016 Maple Fire of 18 200 ha. Although the proximal cause of this reburn was a natural lightning ignition, the ultimate cause was likely tied to anthropogenic global warming that increased young fuel aridity. This atypical short interval resulted in very little lodgepole regeneration (photo by J. E. Keeley).

Fig 2. Wildfire in ponderosa-dominated forests where the more natural low-intensity understorey burning seen in the foreground is replaced by high intensity evident in the background (photo by J. E. Keeley). As these pines require surviving parent trees for seed sources, the background landscape, owing to limited dispersal ability and lack of seed sources, is likely to lack forest recovery for a century or more.

Fig 3. In Alaska taiga north of Fairbanks: (a) post-fire recruitment of black spruce (*Picea mariana*) in sphagnum substrate; and (b) higher-intensity burned spots where safe sites for spruce are eliminated, leaving substrate more suitable for broadleaf tree establishment (photos by J. E. Keeley).