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# Research Brief for Resource Managers


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# The "Interval Squeeze"- Fire and Climate Change Combine to Accelerate Woody Plant Loss in Dry Climates


*Enright, N.J., J.B. Fontaine, D.M.S.J. Bowman, R.A. Bradstock, and R.J. Williams 2015. Interval squeeze: altered fire regimes and demographic responses interact to threaten woody species persistence as climate changes. Front Ecol Environ 13(5):265-272.*
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Loss of species, shifts in distributions, and altered community structure and function are all predicted outcomes of climate change. Enright et al. show that these impacts are likely to be more severe in areas predicted to have hotter drier climates and increased fire frequencies than the distribution changes predicted by simple climate envelope models. The **Interval Squeeze model** describes how demographic changes associated with hotter drier climates and more frequent fires could combine to "squeeze" the survival envelope of woody plant species after fires (Fig.2).

The **demographic shift** is the reduced rate of growth from warmer and drier conditions. Under these conditions, woody plants reproduce later, produce fewer seeds, and have lower seedling survival. A longer fire return interval (FRI) is required for self-replacement and population persistence (Fig. 2a). The **post-fire recruitment shift** is the decrease in recruitment due to more frequent drought after fire (Fig.2b). When the demographic shift and post-fire recruitment shift are combined the demographic envelope of species persistence is severely reduced (Fig. 2d).

## Management Implications

- Hotter, drier climates resulting from climate change will reduce the ability of woody plants to recover after fire. When combined with shorter fire return intervals, the resulting "interval squeeze" increases the risk for individual species extirpation.
- Mediterranean Type Climate regions like southern California are at the highest risk for ecosystem change from interval squeeze because they are biodiversity hotspots with restricted distributions that will become both hotter and drier.
- Overstory loss in temperate forests, mixed conifer forests, and Mediterranean Type Climate regions, could result in type conversion, reduced biodiversity and impaired ecosystem services.

The **fire-interval shift** occurs when warmer conditions lengthen the fire season, increase the annual number of extreme fire days, and increase dry fuel abundance. This will shorten the fire return interval (FRI), making fire more frequent and more likely for a longer time each year (Fig.2c).

When reduced fire return intervals (FRI's) "squeeze" an already reduced demographic envelope, extinctions are likely to follow (Fig. 2e).

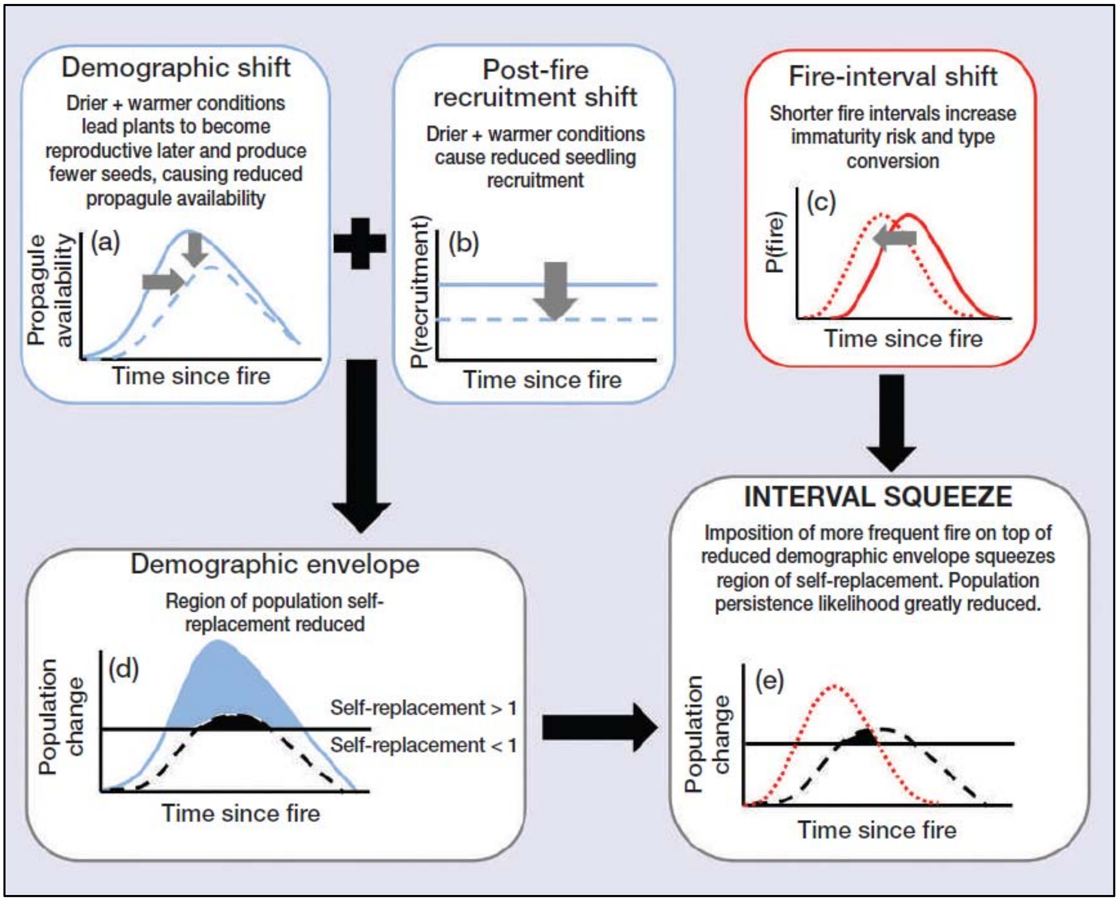


*Figure 2. Conceptual model showing how changes to demographic rate, post-fire recruitment rate, and fire interval combine to reduce the fire-interval envelope compatible with post-fire self-replacement (i.e. leads to interval squeeze) for a fire-intolerant perennial plant species as climate warms and dries (as projected for all of the world's high biodiversity, Mediterranean-type ecosystems). (a) Demographic shift is represented by the relationship between propagule availability and stand/cohort age. The solid curve depicts the pre-change distribution of age-related propagule availability, and the dashed curve represents the changed distribution as climate dries. (b) Probability of post-fire recruitment shift is shown as a uniform decrease (dashed line) in recruitment in response to an increased incidence of drought after fire. (c) P(fire) represents the probability that a stand will have burned by a given age (i.e. the probability density form of the fire-interval distribution, including age dependency; after Moritz [2003]). The solid curve and the dotted curve depict the pre-change distribution of fire intervals and the changed distribution as climate dries, respectively. (d) Combined demographic shifts (a and b, above) slow the rate of propagule production, and thus availability at time of fire, while reduced post-fire recruitment levels decrease stand density and seed availability after fire, shortening the range of fire intervals for which self-replacement is possible (indicated by the width of the area filled in black). (e) Interval squeeze resulting from fire-interval shift (c) and combined demographic shifts (d) further constricts the envelope of fire intervals compatible with stand self-replacement (width of the area filled in black), reflecting the intersection of the fire (dotted) and demographic (dashed) curves and the self-replacement (solid horizontal) line.(e) intervals and the changed distribution as climate dries, respectively. (d) Combined demographic shifts (and b, above) slow the rate of propagule production, and thus availability at time of fire, while reduced post-fire recruitment levels decrease stand density and seed availability after fire, shortening the range of fire intervals for which self-replacement is possible (indicated by the width of the area filled in black). (e) Interval squeeze resulting from fire-interval shift (c) and combined demographic shifts (d) further constricts the envelope of fire intervals compatible with stand self-replacement (width of the area filled in black), reflecting the intersection of the fire (dotted) and demographic (dashed) curves and the self-replacement (solid horizontal) line.*