Research Brief for Resource Managers

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Understanding the Complex Nature of Resprouting

Pausas, J.G., R. B. Pratt, J.E. Keeley, A.L. Jacobsen, A.R. Ramirez, A. Vilagrosa, S. Paula, I.N. Kaneakua-Pia, and S.D. Davis. 2016. Towards understanding resprouting at the global scale. New Phytologist 209:945-954. doi: 10.1111/nph.13644

Resprouting plants are common throughout the world and resprouting is a familiar response to any kind of disturbance that kills living tissue. Resprouting is a seemingly simple trait that has complex underlying morphological and anatomical origins among diverse evolutionary lineages. New growth from regenerative buds may be located in underground roots, root crowns, lignotubers, rhizomes, bulbs or stems, and sprouting tissues can be buried safely under thick bark, or merely hidden deeper into stem tissue under thin bark. These differences in resprouting morphology and anatomy were evolutionarily shaped by differing disturbance types, creating marked differences in resprouting response across biomes and disturbance regimes.

The authors ask three questions to determine if the resprouting trait might be useful for making predictions about post disturbance responses as disturbance regimes change: 1) to what extent is a single qualitative trait such as resprouting useful for predicting global change response? 2) how do the differences between resprouters and nonsprouters affect their resistance to drought? 3) can resprouting be used to improve our predictions of vegetation response to global change in global vegetation models?

Management Implications:

- Resprouting is a complex response to disturbance.
- In global Mediterranean biomes, resprouting is related to drought resistance: resprouters are less dehydration tolerant and are **drought avoiders.** Nonsprouters are **dehydration toleraters** (Figure 1).
- Nonsprouters are more sensitive to intense droughts and sprouters to longer droughts. Resprouters that normally recover after fires may be vulnerable during drought (Figure 2).

Fire is considered the most extreme type of disturbance, because of defoliation combined with lethal temperatures; but wind, freezing, drought, and herbivory also cause dieback. Plants that resprout after fire are considered more likely to be able to recover from other disturbance types, but the converse is not true, e.g. plants that can resprout after herbivory or freezing or wind damage may not survive the heat of a fire. However, even strong fire resprouters may not recover from drought stress. The conclusion is that postfire resprouting ability may not be a reliable predictor of the ability to resprout with other disturbance types. Similarly, if the severity of the disturbance type changes (e.g. low intensity surface fire to high intensity crown fire; intra-annual to multiyear or decadal droughts), the ability to resprout may be compromised.

Resprouting depends on plants having adequate carbon reserves to mobilize new growth after disturbance, to build structures to protect sensitive buds and to access more stable water resources. Nonsprouters on the other hand can use that carbon to grow more rapidly or increase reproduction but have relatively less root biomass. In order for sprouters and nonsprouters to co-exist in the same landscape, nonsprouters must be physiologically more dehydration-tolerant than resprouters. There is evidence for this relationship in the well-studied Mediterranean biome. Nonsprouters are more resistant to dehydration-induced cavitation (P_{50}; Figure 1) and possess other associated dehydration traits including more structurally robust leaves, greater xylem tissue density with lower water storage capacity, and lower leaf area to xylem area of shoots.

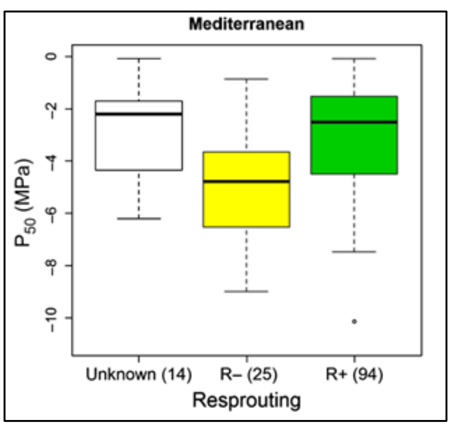

Fig. 1 Relationship between resistance to xylem cavitation (P50, MPa) and resprouting ability in angiosperm species from the Mediterranean biome. Resprouting =R+, Nonsprouting =R-, (#) Number of species. Resistance to xylem cavitation is expressed as the water potential (MPa) at which a plant loses 50% of hydraulic conductivity.

In southern California chaparral, resprouter and nonsprouter species respond to drought stress along a continuum from **drought avoiders** (resprouters) to **drought toleraters** (nonsprouters). How each functional group responds to drought stress without fire (undisturbed) and with fire (during resprouting) is illustrated in Figure 2. During drought in unburned vegetation resprouters are at greater risk of death from carbohydrate starvation from longer, less intense droughts, while nonsprouters are more likely to die from hydraulic failure during more intense droughts of shorter duration (left panel). Following fire, resprouters are more sensitive to drought and have a lower threshold for carbon starvation and hydraulic failure (right panel).

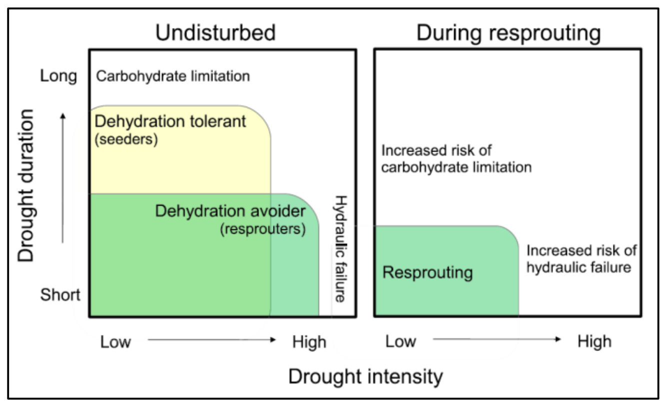

Fig. 2 Conceptual model of functional group responses to drought duration and intensity. Colored areas are the safety zones for each type of species; blank regions correspond to the risky drought conditions – the risk of carbohydrate limitation (under a long drought) and the risk of hydraulic failure (under an intense drought).

Depending on the disturbance regime and evolutionary history, resprouting is likely to be related to other functional traits in species across different biomes. These trait combinations need to be better understood to be effectively incorporated into global vegetation dynamic models of changing disturbance regimes.