

Influence of the summer marine layer on patterns of chaparral diversity in west central California

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The summer marine layer viewed from a coastal upland on Cuesta Ridge above San Luis Obispo, CA (left). Maritime chaparral along Big Sur coast in Monterey Co., CA. *Arctostaphylos edmundsii*, a rare coastal endemic seeder, in the foreground (right).

Context

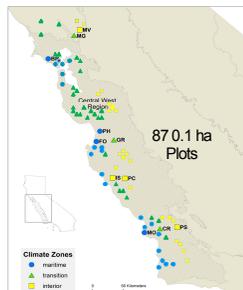
- Mediterranean-type climate regions have long dry summers and mild wet winters
- They are renowned for fire-adapted life history traits and species diversity in evergreen shrublands
- Fire regimes and soils are considered to be important environmental factors that drive shrub diversity patterns
- A potential additional factor is **intra-regional patterns of rainfall reliability** (Cowling et al. 2005).

Question: *Is summer maritime fog and low clouds (the summer marine layer) comparable to rainfall reliability as a driver of chaparral diversity patterns in California?*

Design



Ecophysiology sites: Detailed climatic and physiological data were collected along three climatic gradients at different latitudes.

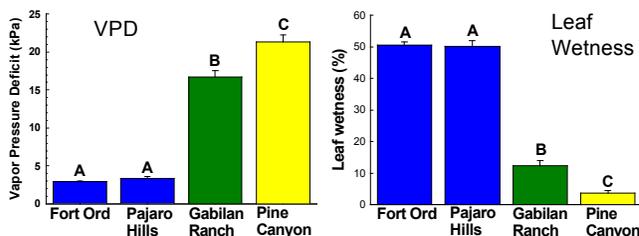


Diversity plots: Detailed composition and abundance data were collected from 87 0.1 ha plots. Soil analyses, climate variables, and other factors were assessed for each plot.

Hypotheses and Results

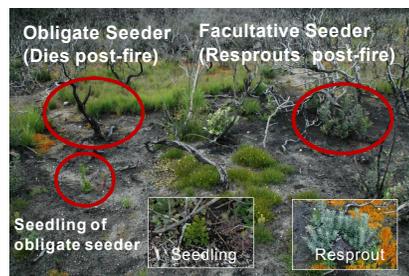
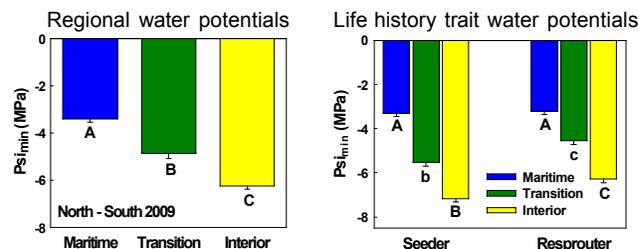
(H₁) Local dry season climate variables; e.g. vapor pressure deficit (VPD) will correspond to the summer marine layer (SML) gradient (Johnstone & Dawson 2010).

Met station data shows that there is a gradient of VPD and percent leaf wetness (fog condensation) from coast to interior. **(H₁) is generally supported.**



(H₂) Shrubs will exhibit an ecophysiological response to the SML gradient, particularly Ψ_{smin} (minimum seasonal water potential).

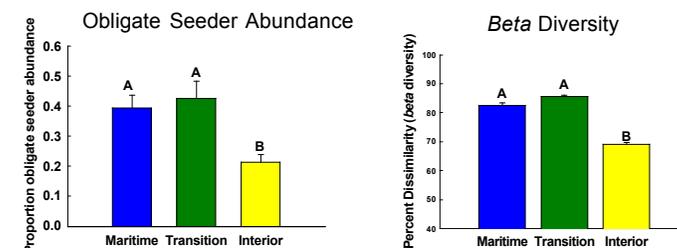
Ψ_{smin} values are significantly different among *Arctostaphylos* shrubs in the different climate zones. Since resprouters are generally more deep-rooted than seeders, their similarity in the Maritime zone implies more mesic conditions in that zone. **(H₂) is supported.**



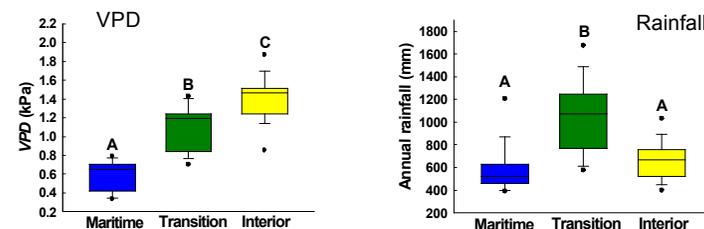
Two life history traits in *Arctostaphylos* respond to fire: (1) obligate seeders are killed by fire and recruit by fire-stimulated seeds; (2) facultative seeders survive and resprout from dormant buds in burls at the base of shrubs. Seeds of *Arctostaphylos* resprouters are also stimulated to germinate after fire.

(H₃ & H₄) Obligate seeders will have higher proportional abundance and beta diversity will be higher at the Maritime end of the SML gradient and decrease towards the Interior. Transition plots will be intermediate.

Proportional abundance of seeders and beta diversity are not significantly different between the Maritime and Transition groups whereas the Interior group is significantly lower. **(H₃) and (H₄) are not fully supported because upland coastal (Transition) plots are not intermediate.**



SML climate variables (e.g. VPD) are consistent with an expected SML gradient; however, winter rainfall is greater in upland coastal (Transition) sites than either Maritime or Interior. A combination of the SML and increased rainfall may account for a greater proportion of seeder abundance and higher beta diversity in upland coastal chaparral than would otherwise be expected if the SML were the only factor involved.



Conclusion

The SML creates a gradient of local climates which range from relatively cool and moist along coastal lowlands to hot and dry in the interior. Evergreen shrubs respond by being comparatively well-hydrated during summer in coastal lowlands. However, coastal lowlands and uplands are both more mesic than chaparral in the Interior and have greater proportional abundance of obligate seeders and higher beta diversity compared to Interior chaparral. These findings tend to support the diversity and "rainfall reliability" nexus. However, while the SML drives enhanced water availability in lowland coastal chaparral, both the SML and total annual rainfall are probably critical to the mesic status of upland coastal chaparral.

References

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Johnstone JA & TE Dawson. 2010. *PNAS* 107: 4533-4538.
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