NCB 2017

Redistribution of soil-water by coyote brush in a shrub-grassland ecotone

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Background

Coyote brush (*Baccharis pilularis* DC, Asteraceae) has been invading the threatened coastal prairie plant community, which has prompted CA State Parks to treat it as a land management problem. Yet, little is known about variable effects on soil-water from shifts in vegetation type.

A. Coastal prairie with coyote brush on marine terraces at Wilder Ranch State Park, Santa Cruz, CA.

Problem

This project asked whether soil-water dynamics vary across the coyote brush-grassland transition zone (the 'ecotone') and to what extent, if any, does coyote brush redistribute soil-water in the top 1-meter of the soil profile.

B. Shrub-grassland ecotone used in this study.

Methods

ERT to test below-surface electrical changes which are related to moisture change

- ERT transects were oriented east-west across the ecotone (image B).
- 48 probes; spaced 0.25 m; IRIS Syscal Pro-Switch 96 (IRIS Instruments, Orleans, France); standard 2-D Wenner array.
- ERT modelled data were bimodal above vs. below -0.4 m, so were statistically tested separately. Binomial tests on coded grid data evaluated whether resistivity increases and decreases across the time intervals were significantly different.

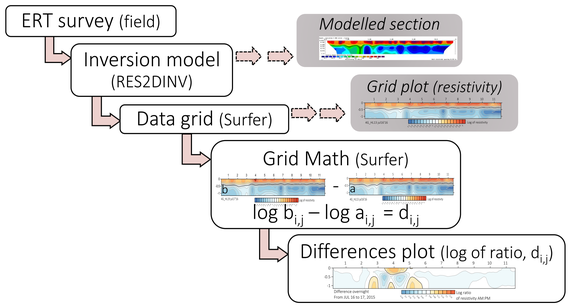


Figure 1: Flow chart of data processing. Field data were inverse modelled in RES2DINV (v 3.57 Geotomo Software, Malaysia). Resistivity changes between two time points were obtained by subtracting their data grids in Surfer (Golden Software, Inc., Boulder, CO). Contour intervals are the **log of the ratio** (logB – logA = log(B/A) between the morning and the prior night. Positive contour intervals represent areas where resistivity increased (less moist) overnight; and negative intervals, decreased resistivity (more moist).

ERT measured AM and PM to detect overnight differences across the ecotone

- Four repeats of evening-morning pairs of ERT surveys were taken MAY-JUNE 2016.

Covering of coyote brush to suppress transpiration and highlight root zone hydraulics

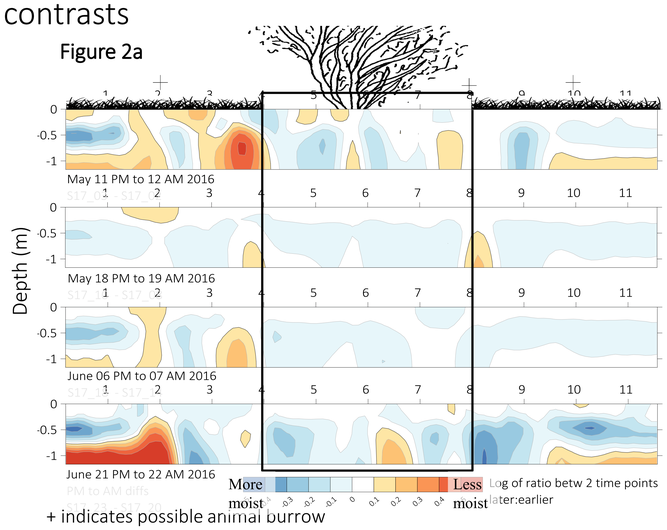
- Coyote brush was covered in AUG 2016 with several layers of landscape cloth and a shade canopy to observe non-transpiration-driven moisture change.
- ERT was surveyed before and during the cover period.
- Pre-dawn and mid-day plant water potential (Ψ) was measured before and during the cover period. These were at or near sunrise and 1pm respectively. Mid-day Ψ indicates plant xylem water status and pre-dawn Ψ, root zone water status.

Tests for cross-ecotone hydraulic contrasts

Figure 2a: Difference plots of 4 repeated overnight intervals without covering (PM to AM change) in May-Jun2016 revealed fewer differences among repeats beneath coyote brush than grassland. The shallow soil increased in resistivity (drier) overnight in all 4 repeats (all p<0.001) beneath coyote brush. The deeper soil resistivity declined (moister) overnight in 3 repeats and was unchanged in 1 repeat (May11 p=0.385, all others p<0.001). This contrast was similar but weaker beneath grassland. *Repeatability was higher beneath coyote brush.*

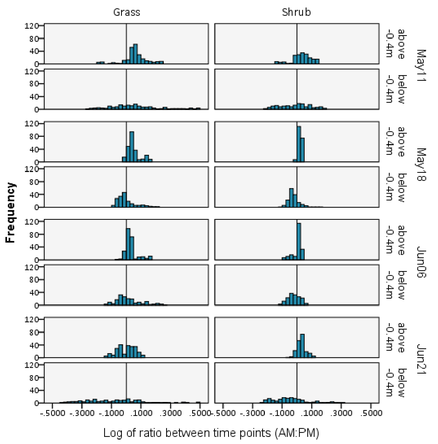
Figure 2b: Histograms of contour data in Figure 2a.

Figure 2a



+ indicates possible animal burrow

Figure 2b



Tests for non-transpiration hydraulic effects

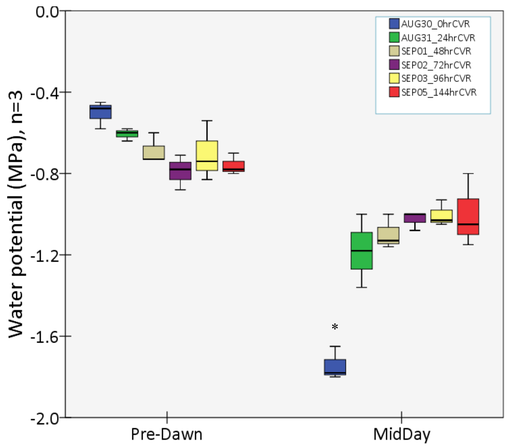


Figure 3: Plant water potential (Ψ) mid-day increased significantly once the covering was applied ($F_{1,2}$ = 124.72, p=0.008). After covering, there was no significant change in Ψ regardless of time of day ($F_{4,16}$ = 2.175, p=0.118). *Transpiration suppression resulted in removal of the plant-soil water pressure gradient.*

Figure 4a

Covered

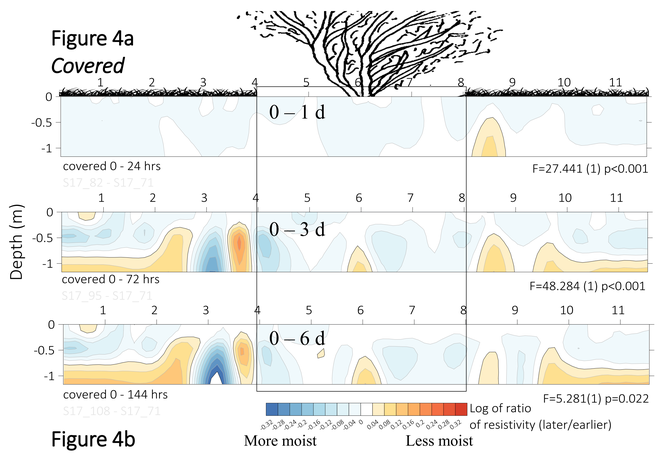


Figure 4b

Not covered

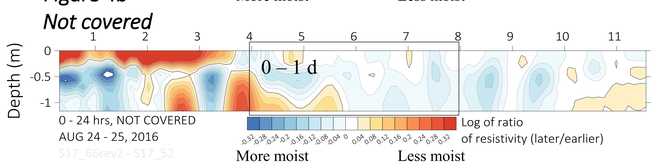


Figure 4a: Difference plots of 3 different time intervals with covering in Aug2016. From before covering (0 d) to 1, 3, & 6 days covered, the soil moisture increases were significant.

The 0 – 1 d intervals Covered vs. Not covered were significantly different (Z=-5.2, p<0.001). The changes were independent of soil-water impact from transpiration, which was suppressed. From this, change due to plant roots acting as soil-water conduits can be inferred.

Figure 4b: Difference plot of 1-day interval without covering in Aug2016.

Conclusions

- Overnight resistivity changes were similar across the ecotone, but stronger and more repeatable under coyote brush. This suggests coyote brush modulation of its root zone moisture.
- Ψ data showed the plant-soil water pressure gradient was removed during experimental transpiration suppression (covering). ERT data indicated soil beneath coyote brush became more moist while covered than without covering.
- Together these indicate that deep soil-water was shunted via roots toward the shallow soil during transpiration suppression.

Implications

- The coyote brush affect on its root zone was different from grassland dynamics.
- Under transpiration suppression conditions, upward coyote brush hydraulic redistribution was discernable using ERT and plant water potential.
- Use of these techniques in tandem enables assessment of water balance parameters in a mixed ecosystem.
- Such changes may inform vegetation management decisions in coyote brush-dominated areas.

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Acknowledgements: ERT equipment from Kim Perkins & John Nimmo at USGS and the San José State Botany Lab; funding from Geological Society of America grant #10801-15, SJSU John and Betty Davison Research Fellowship, 2015, and SJSU Arthur and Karin Nelson Scholarship, 2014; and field support from Allison Harness and Denis De Ceuster.