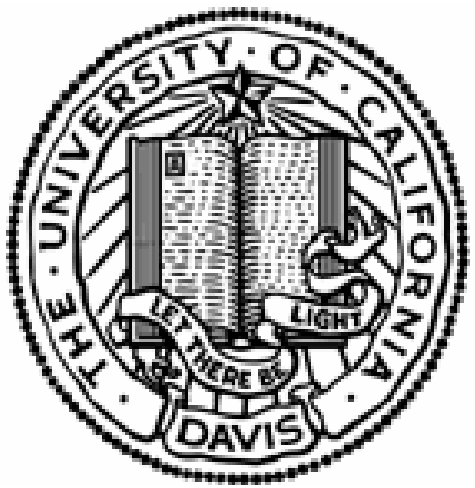
The Impact of Invasive Plants on Water use in the Annual Grasslands



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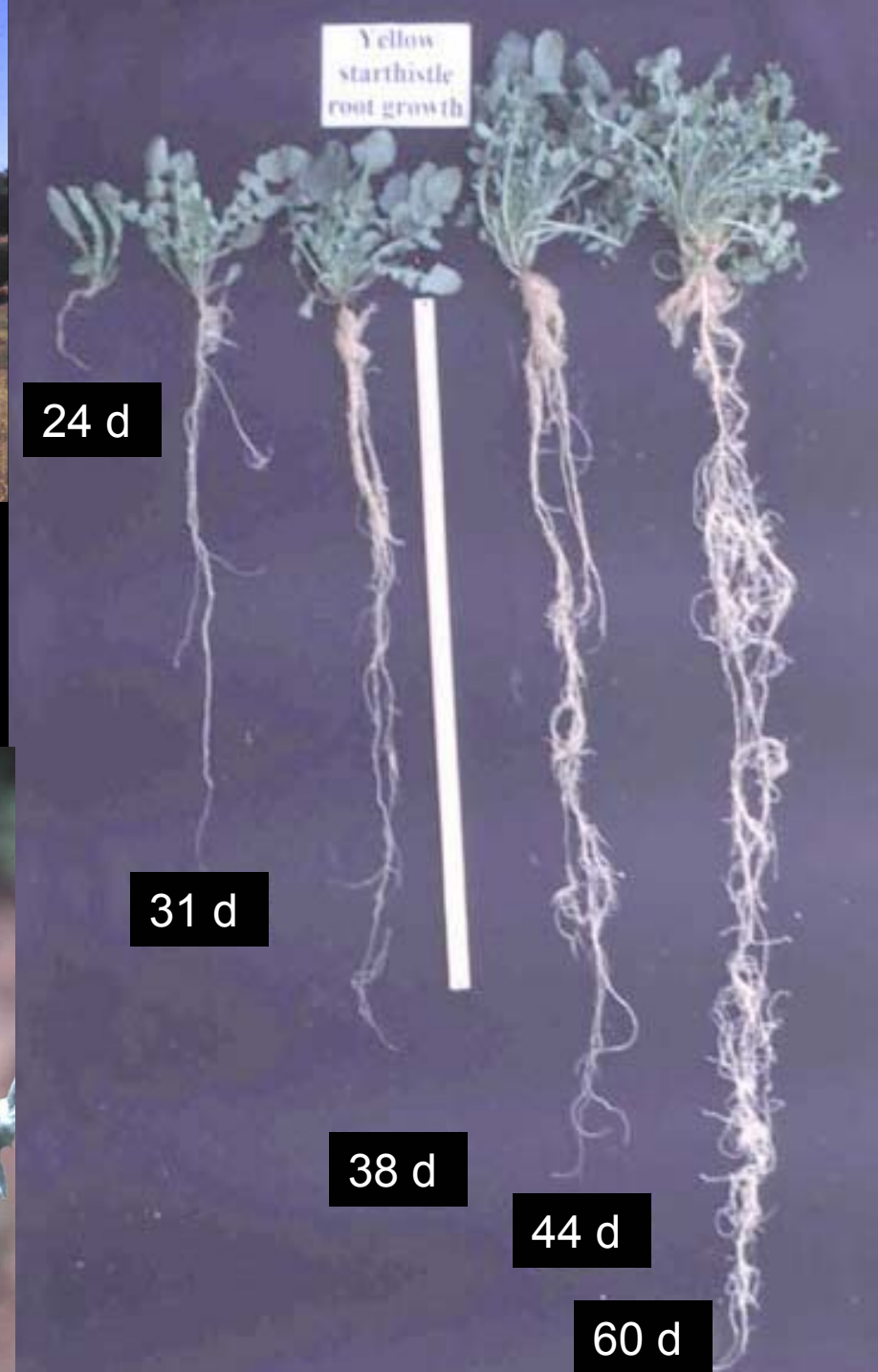
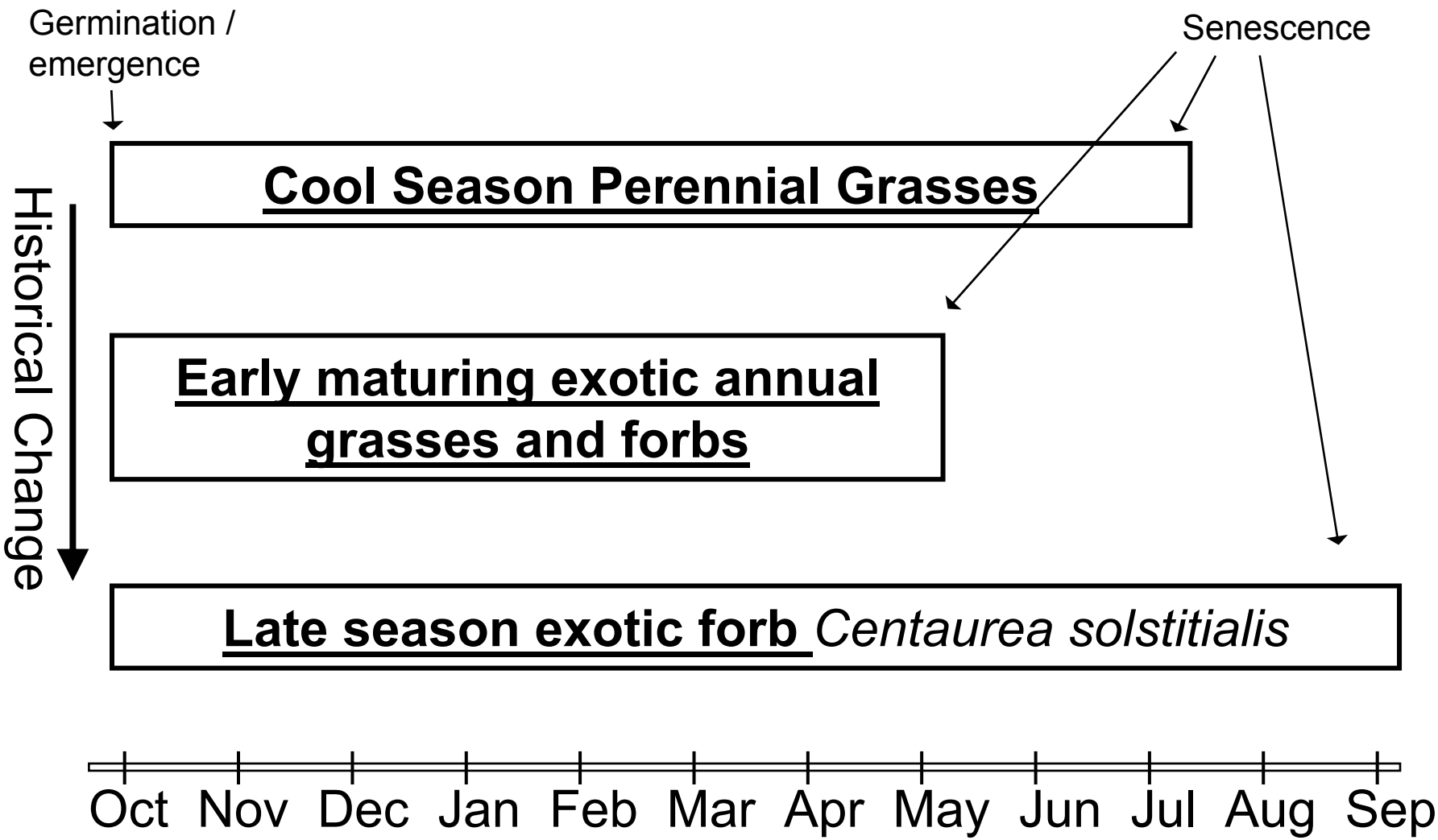

Yellow starthistle root growth
24 d
31 d
38 d
44 d
60 d

How Invasions Alter Plant Community Phenology



Can Invasion Alter Soil Water Use Patterns?

- Are soil water use patterns different between three plant communities that represent significant changes that have occurred in California's grasslands?
  - Spatial and temporal differences
    - By depth
    - Over the growing season and years

Experimental Design and Analyses

- 3 community types
  - Perennial grass, annual grass, yellow starthistle
- 5 depths sampled
  - (30, 60, 90, 120, 150 cm)
- 9 Sampling dates / season
  - (March-December)
- 4 years
  - (1998, 1999, 2000, 2001)
- 4 replicate plots / community (RCBD)
- Repeated Measures ANOVA

Cumulative Annual Precipitation (Oct. 1997-Sept. 2001)

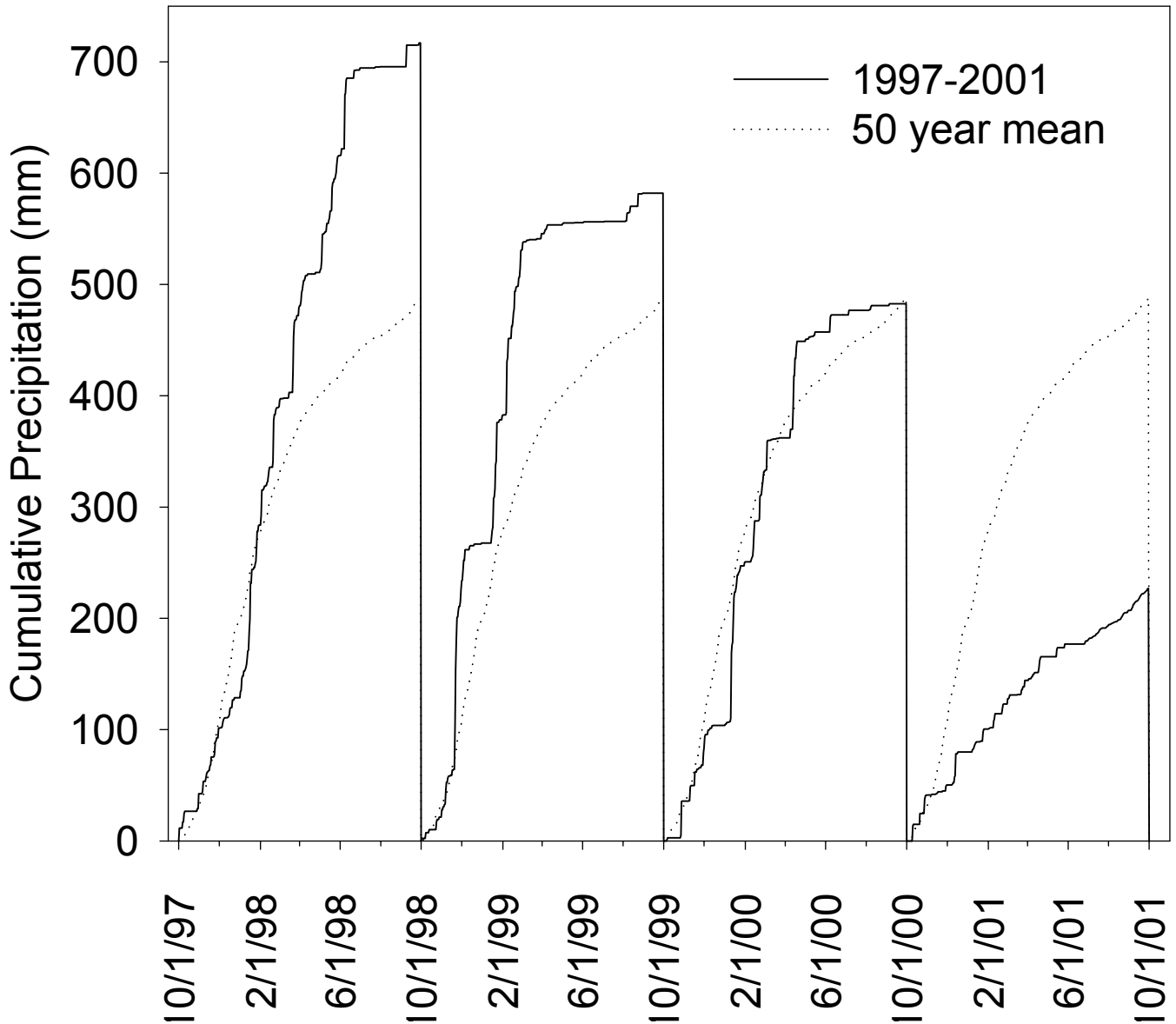


Table 1. Univariate Repeated Measures Tests of Hypotheses for Between and Within Subject Effects.

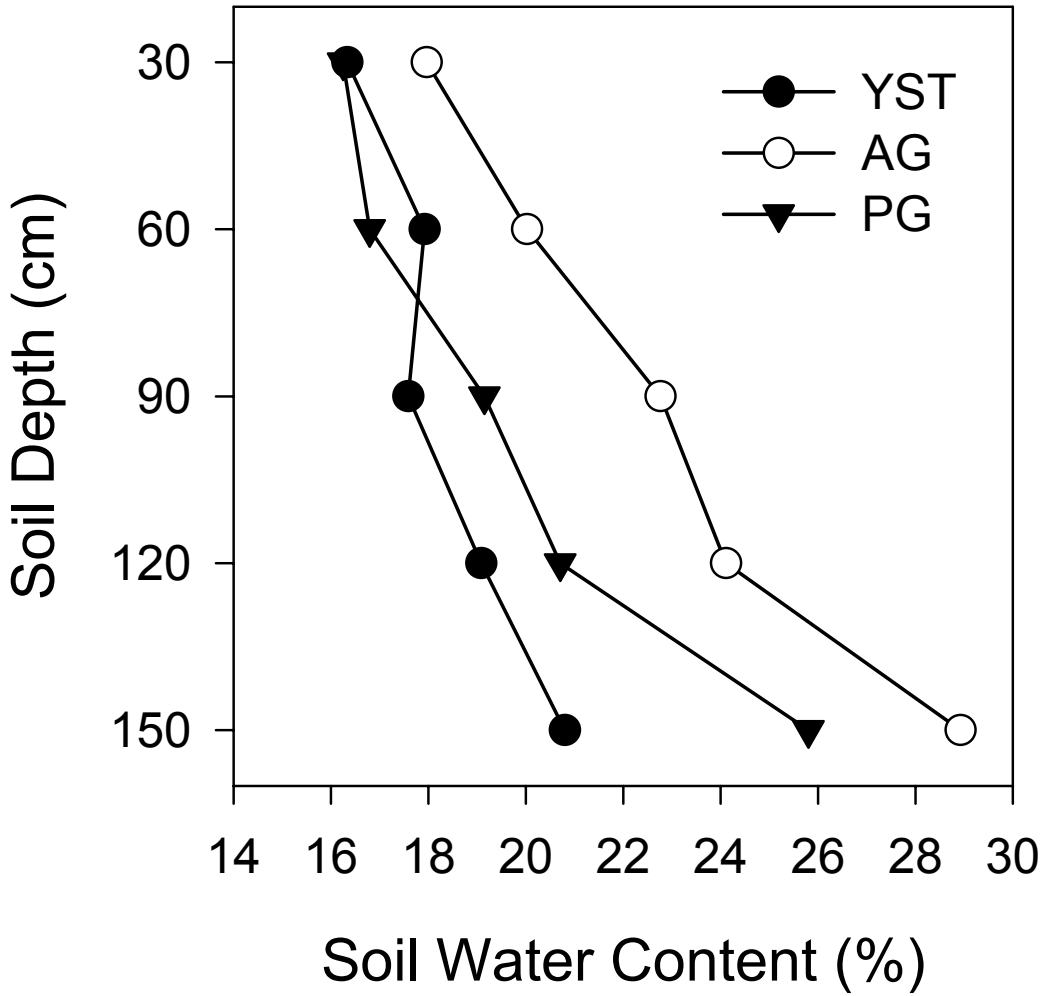
Source	DF	SS	MS	F	Pr > F
Community	2	5491.4	2745	3.03	0.098
Error	9	8154.3	906		
Year	2	1601.6	800	14.68	0.0005
Year*Community	4	470.4	117	2.16	0.1332
Error (Year)	18	981.5	54		
Depth	4	13327	3331	29.55	<0.001
Depth*Community	8	1861.6	232	2.06	0.0773
Error (Depth)	36	4059.6	112		
Season	8	15300.	1912	261.7	<0.001
Season*Community	16	905.0	56	7.74	0.0005
Error (Season)	72	526.0	7		
Year*Season	16	1373.3	85.83	17.16	<0.001
Year*Season*Community	32	280.6	8.77	1.75	0.0951
Error (Year*Season)	144	720.4	5.00		
Year*Depth*Season	64	486.1	7.59	9.06	<0.001
Year*Depth*Season*Com	128	194.4	1.51	1.81	0.0037
Error (Year*Depth*Season)	576	482.6	0.83		

Table 2. Plant community soil water content averaged across depth, season, and year.

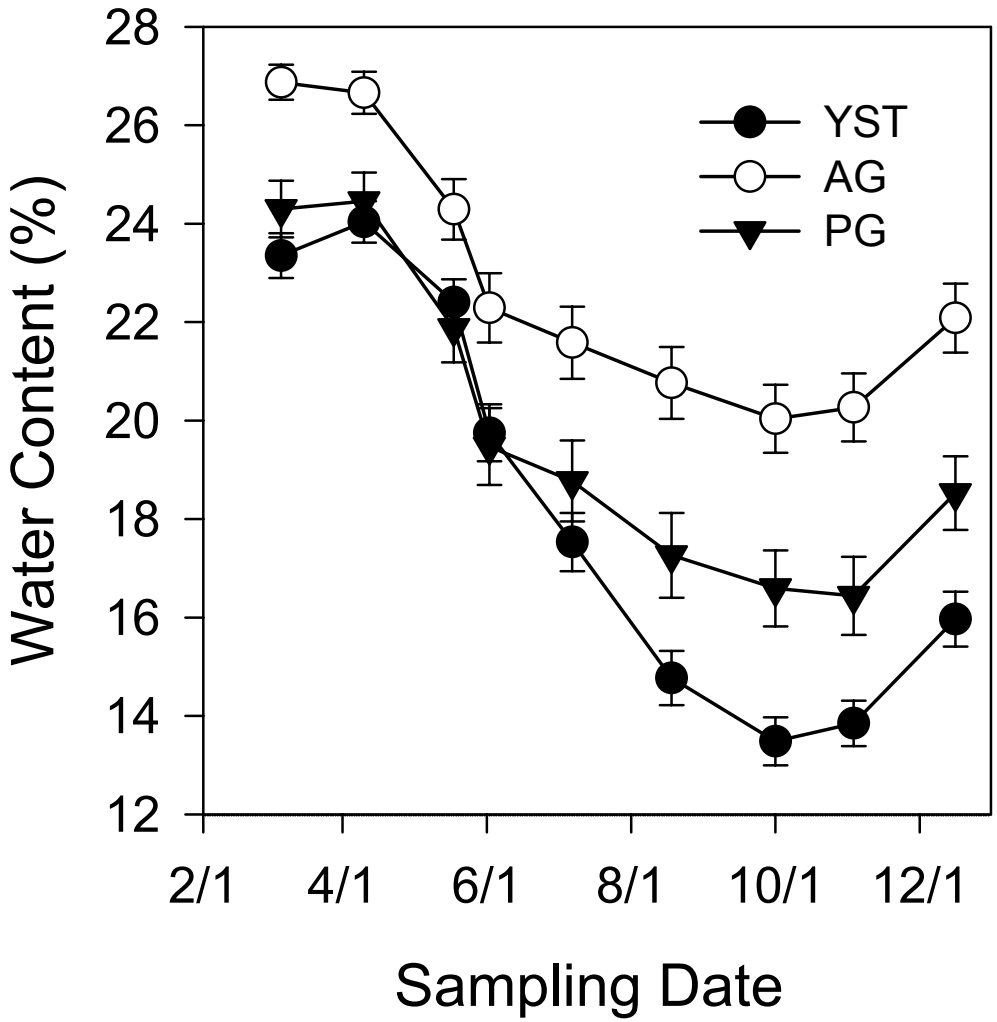
Community	Water Content (%) (Mean ± SE)	Total Soil Water Content (cm / 150 cm)[1]
Yellow starthistle	18.35 ± 0.24	27.52 b
Annual grass	22.76 ± 0.24	34.14 a
Perennial grass	19.74 ± 0.28	29.61 ab

[1]Means followed by the same letter are not significantly different ($P < 0.10$).

Soil Water Content by Depth Averaged Across Season and Year



Total Soil Water Content by Season Averaged Across Years



Max-min water content

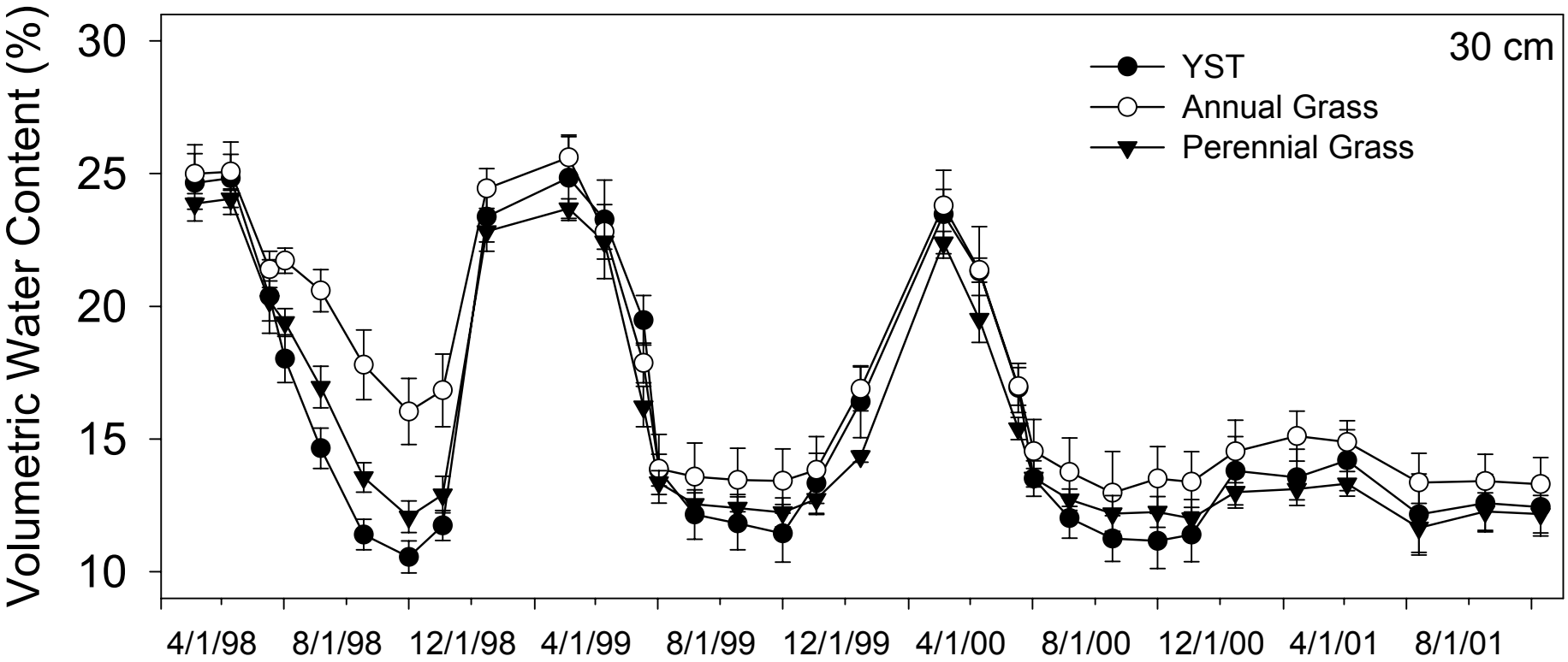
(cm H_20 / 150 cm soil depth)

YST = 15.8 cm

PG = 11.8 cm

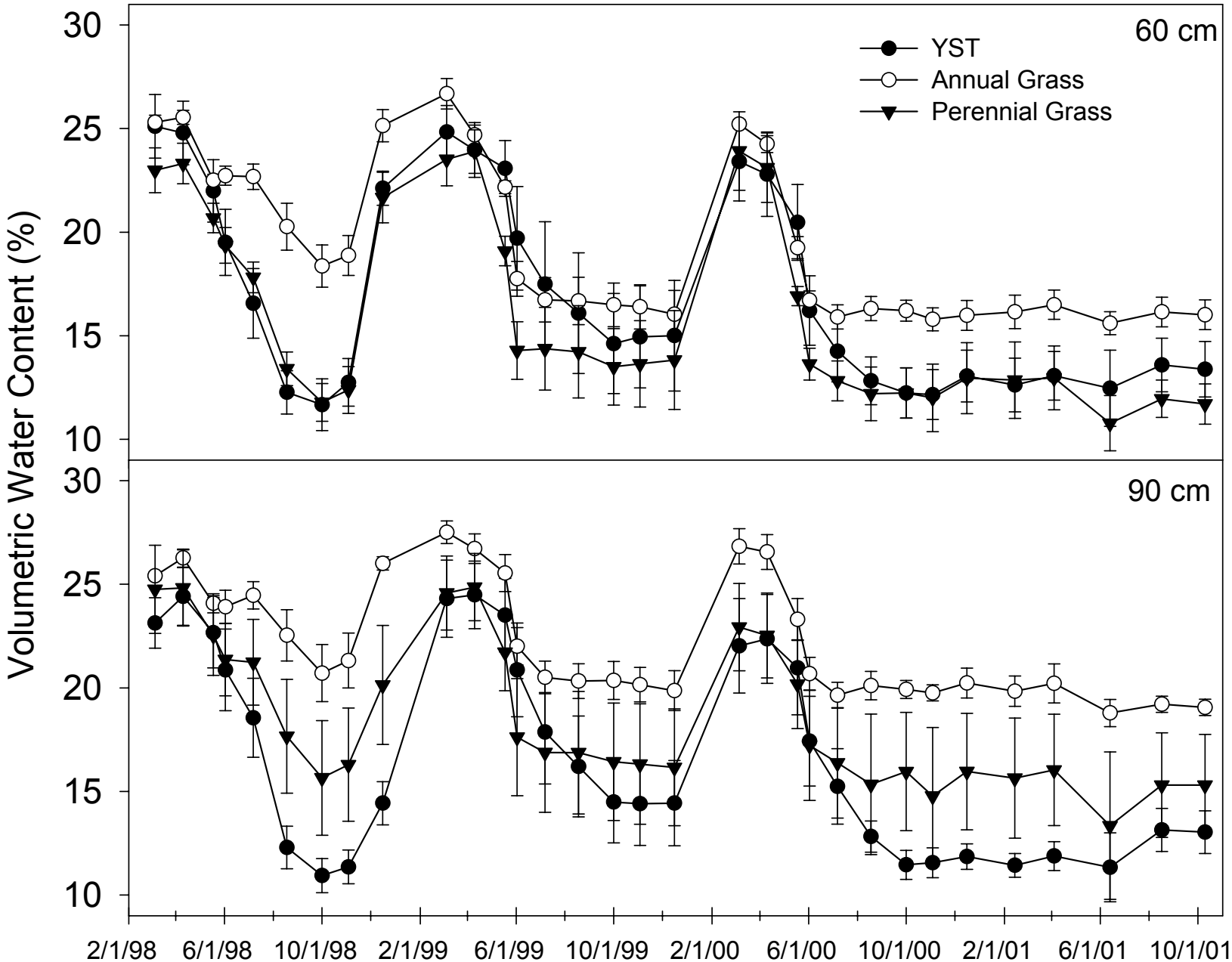
AG = 9.9 cm

Year*Depth*Season*Community

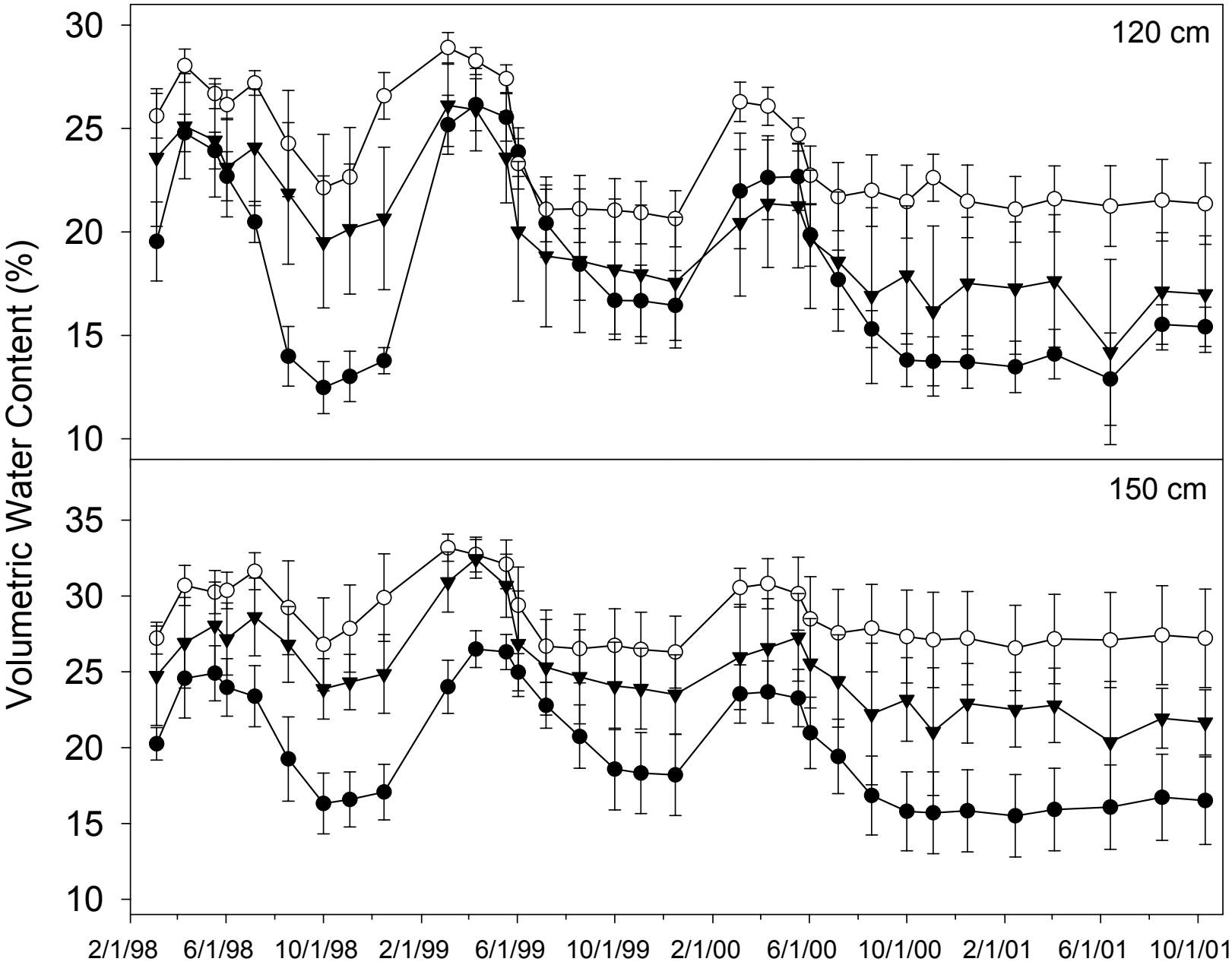


Contrast	P Value
YST v/s AG	0.013*
YST v/s PG	0.017*
AG v/s PG	0.030*

Year*Depth*Season*Community



Year*Depth*Season*Community



Potential Water Cost Estimates

- Yellow starthistle maintained a drier soil profile by 6.6 cm H_2O compared to the annual grasses
  - (0.066m H_2O) x 10,000 m^2/ha = 660 m^3/ha
    - 0.21 acre feet of water
    - ($12.00-30.00/Acre ft) = ($2.58-6.47 lost)
- A higher estimate by Gerlach (2000)
  - (0.12m H_2O) x 10,000 m^2/ha = 1200 m^3/ha
    - 0.39 acre feet of water
    - ($12.00-30.00/Acre ft) = ($4.72-11.70 lost)

Statewide Water Loss Estimates

- Low end estimates:
  - (660 m^3 / ha) x (9.6 x 10^6 ha) x (1%) = 63,360,000 m^3 = 16.6 billion gallons
- High end estimates:
  - (1200 m^3 / ha) x (9.6 x 10^6 ha) x (1%) = 115,200,000 m^3 = 30.4 billion gallons

Final Caveat

- Using annual grassland as a baseline comparison may not be sound for restoration purposes
- Possible that YST is currently occupying deep soil niche previously held by native summer water using plants
  - Shrubs, perennial grasses
  - *Grindelia*, *Hemizonia, Holocarpha*, *Madia, Trichostema*