

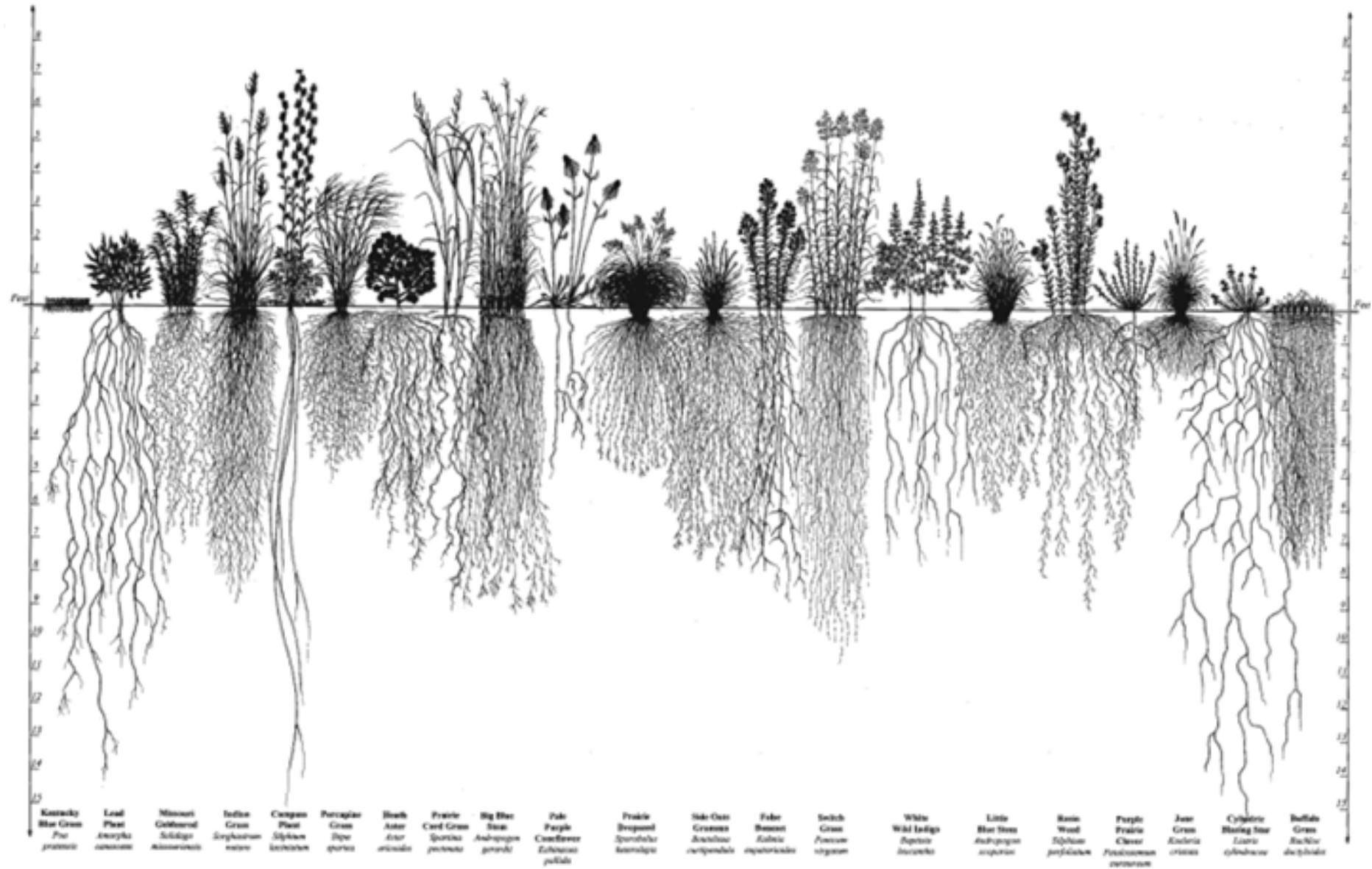
Measuring roots, *in situ*, of *Centaurea solstitialis* and two late summer perennial plant species, *Grindelia camporum* and *Elymus glaucus*

Steve Young, Vic Claassen and Joe DiTomaso - LAWR and Plant Sciences Departments - University of California, Davis

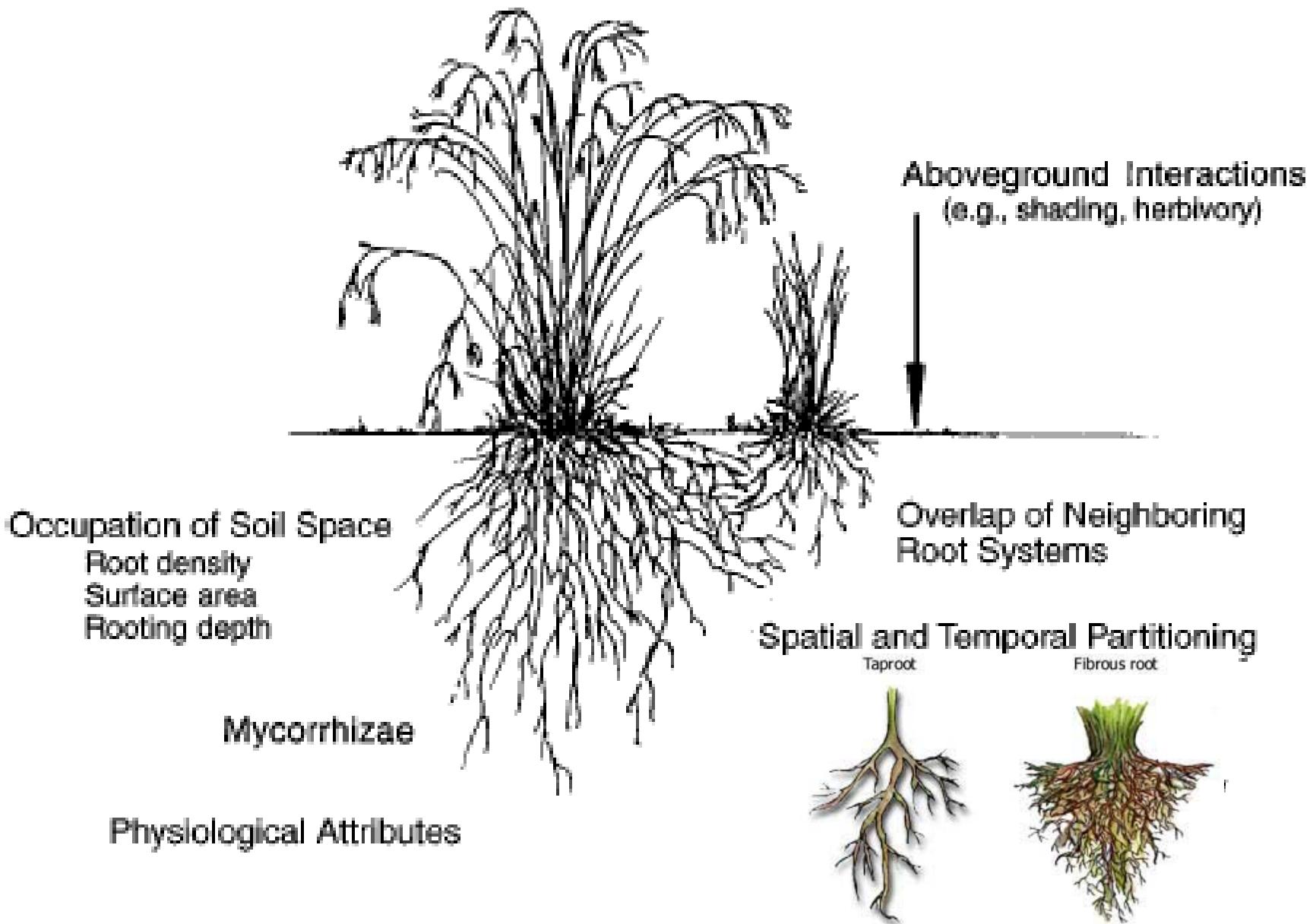
California Grasslands – history and dynamics

Past to Present:

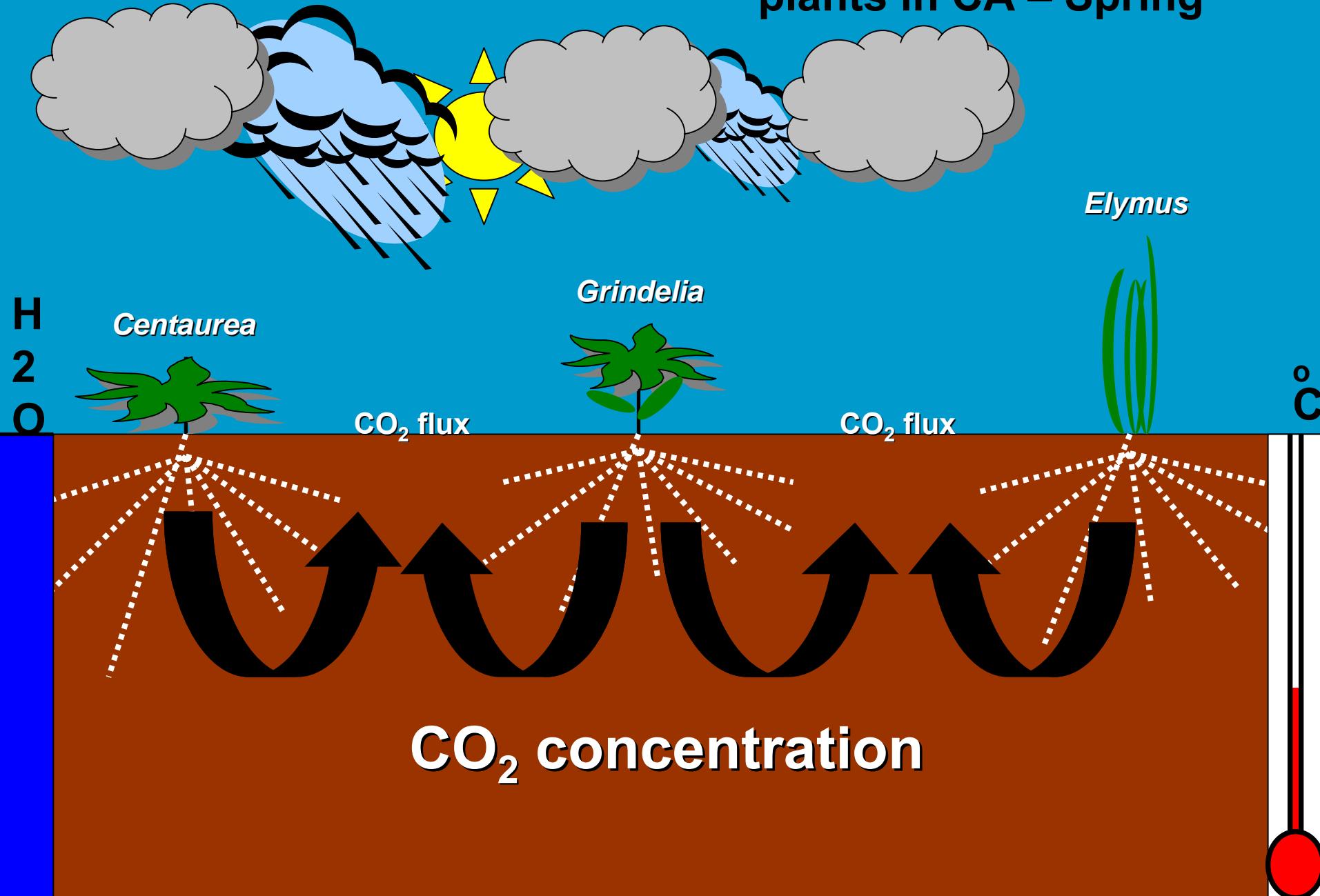
- Decline in native species - aggressive non-natives
- Large-scale replacement of natives by exotic species
 - Introduction of non-native seed
 - Overgrazing
 - Periods of drought
 - Fire suppression
- Total grasslands in California = 9.2 million ha and native grasslands < 800,000 ha (~9%)



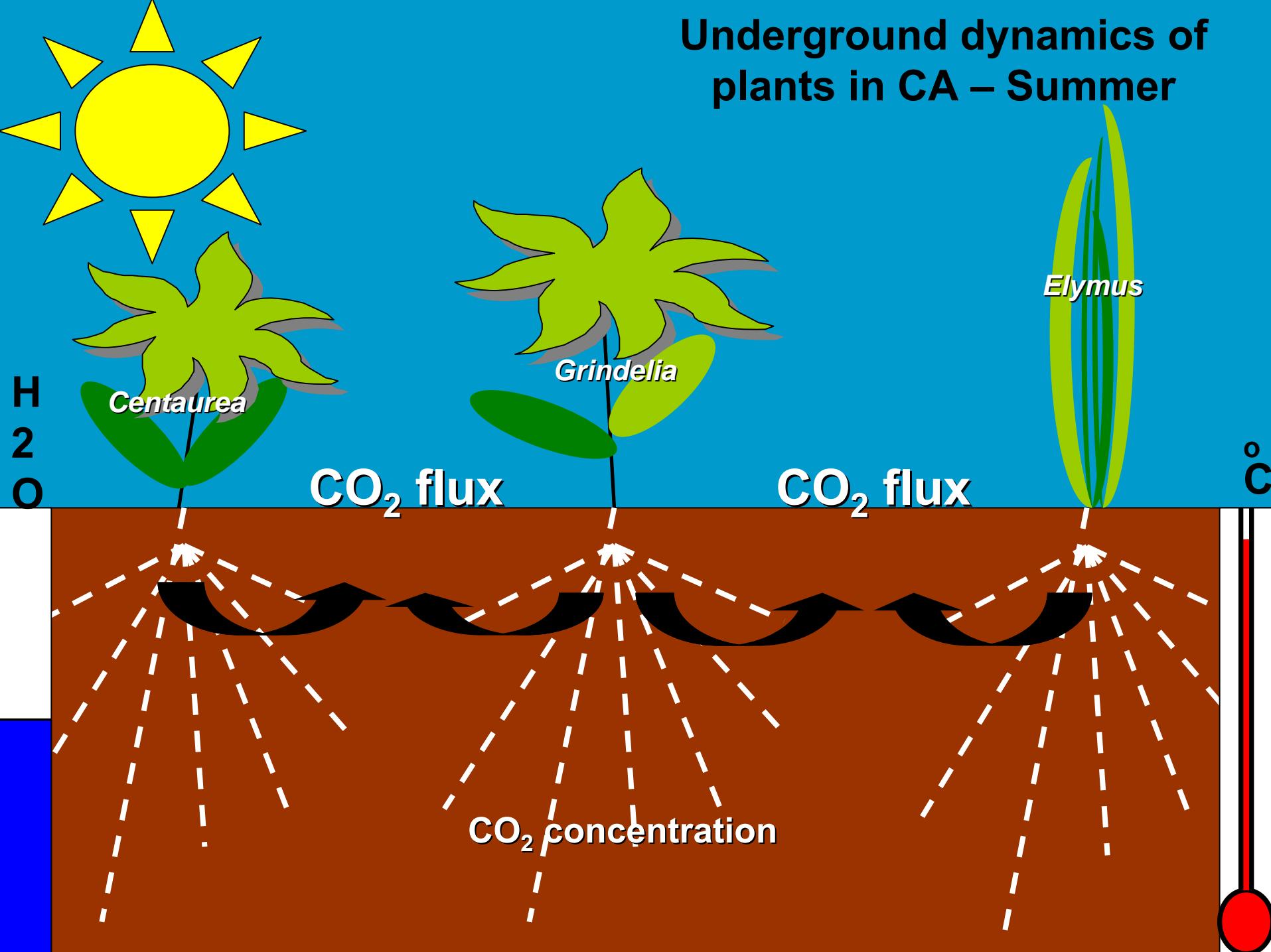
Root morphology



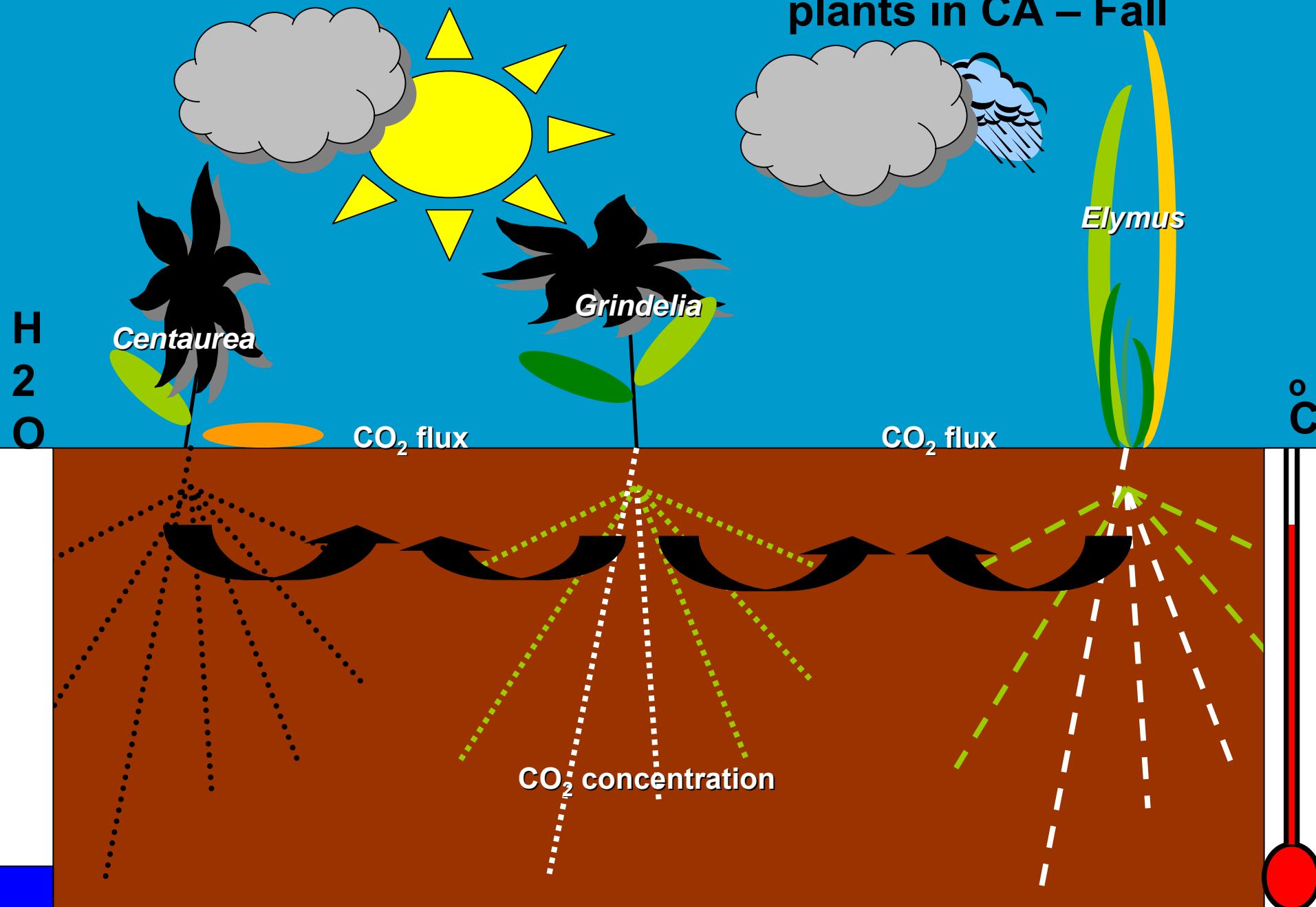
Underground dynamics of plants in CA – Spring



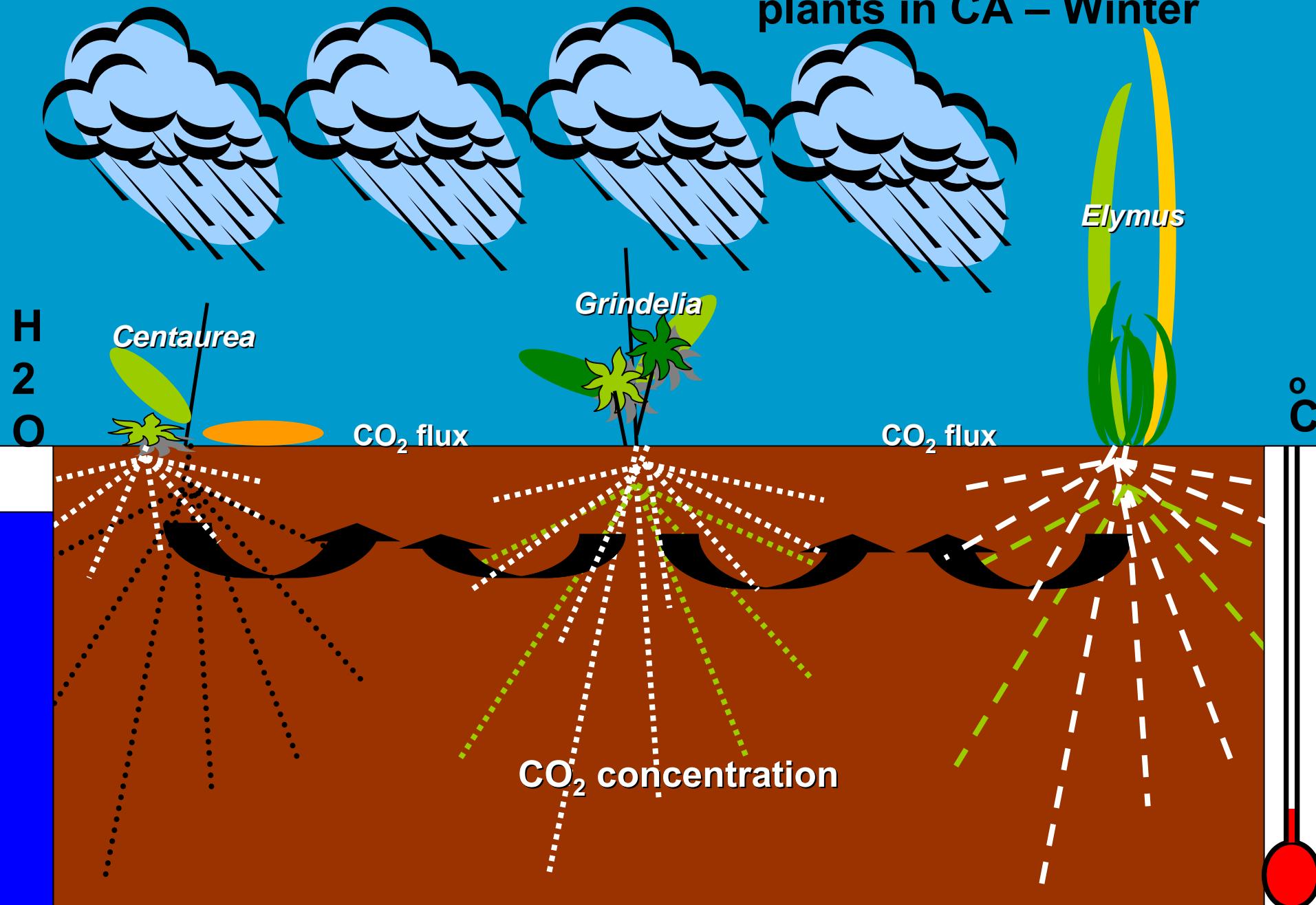
Underground dynamics of plants in CA – Summer



Underground dynamics of plants in CA – Fall



Underground dynamics of plants in CA – Winter



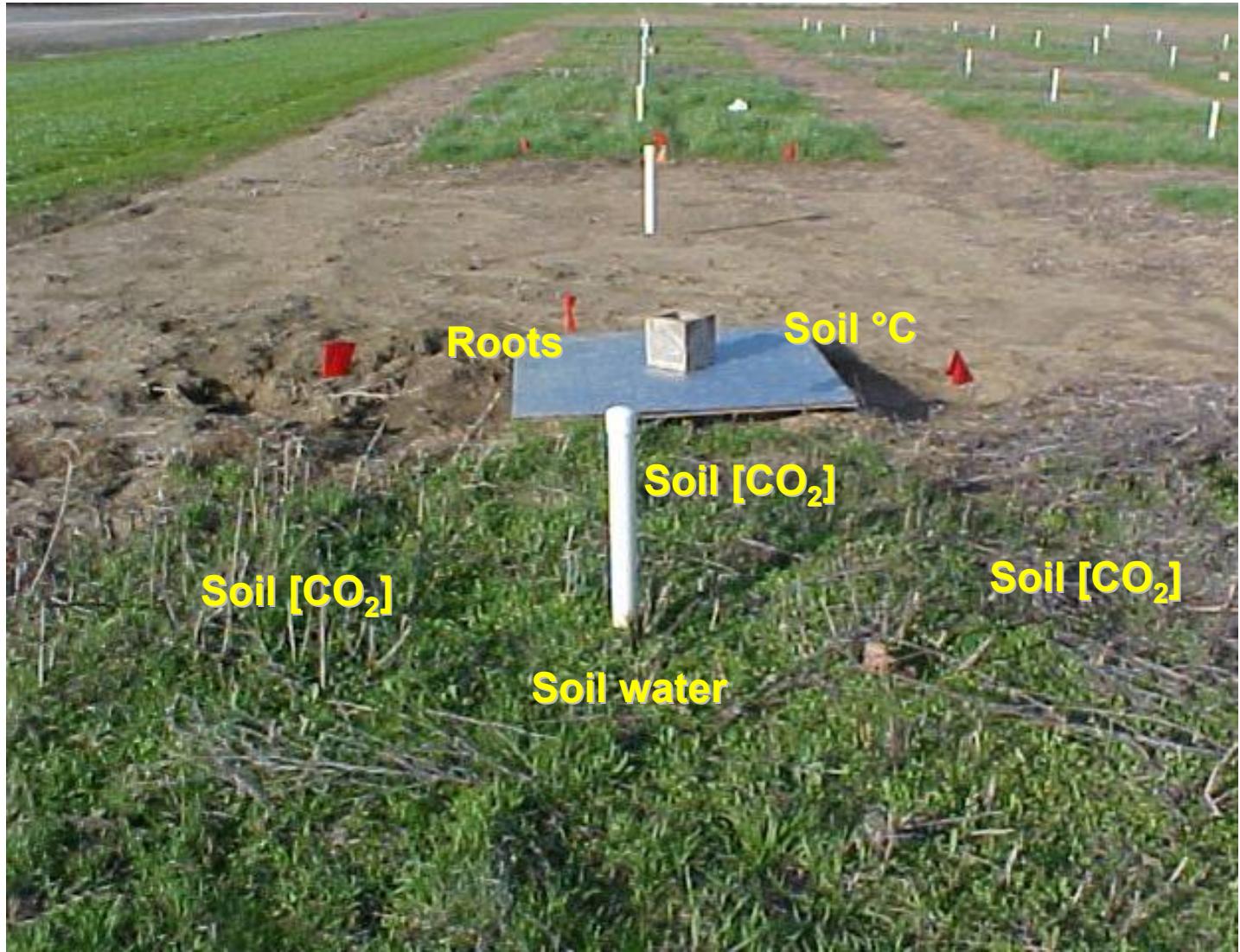
Field studies were conducted with above- and belowground measurements to better understand resource allocation and timing of late season plant species.



Plot scale



Soil atmosphere
probe ($[CO_2]$)



Root growth - methods

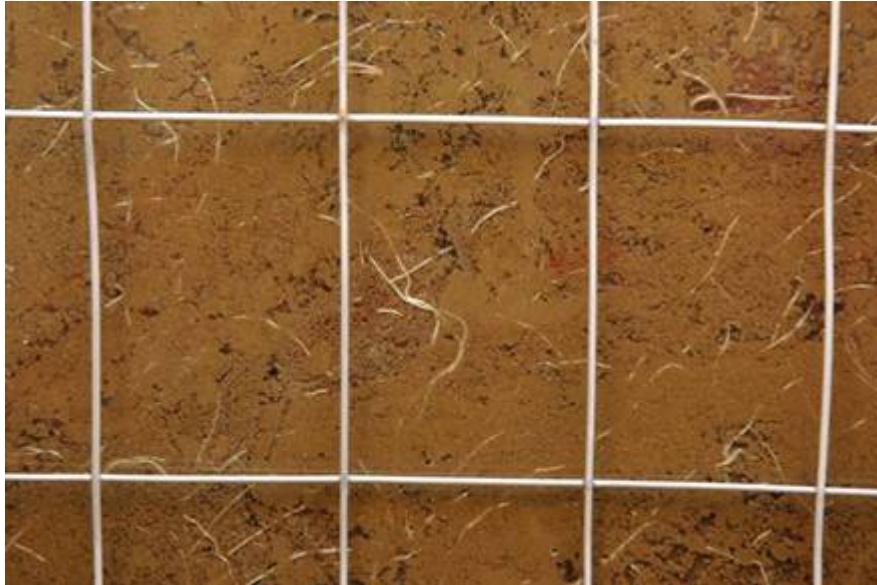
Root chamber

- viewing window below the soil surface**
- vertical area covers approximately 2 m²**



Root growth - methods

- Weekly root counts**
 - First root appearance (February 21, 2006)**



- Final root senescence (November 1, 2006)**



Centaurea root distribution at 30 cm

roots/cm²

1.0

0.8

0.6

0.4

0.2

0.0

Spring rain: 4/16

Bolt (5/24)

Bud (6/7)

Flower (7/5)

Seed (8/23)

Fall rain: 11/1

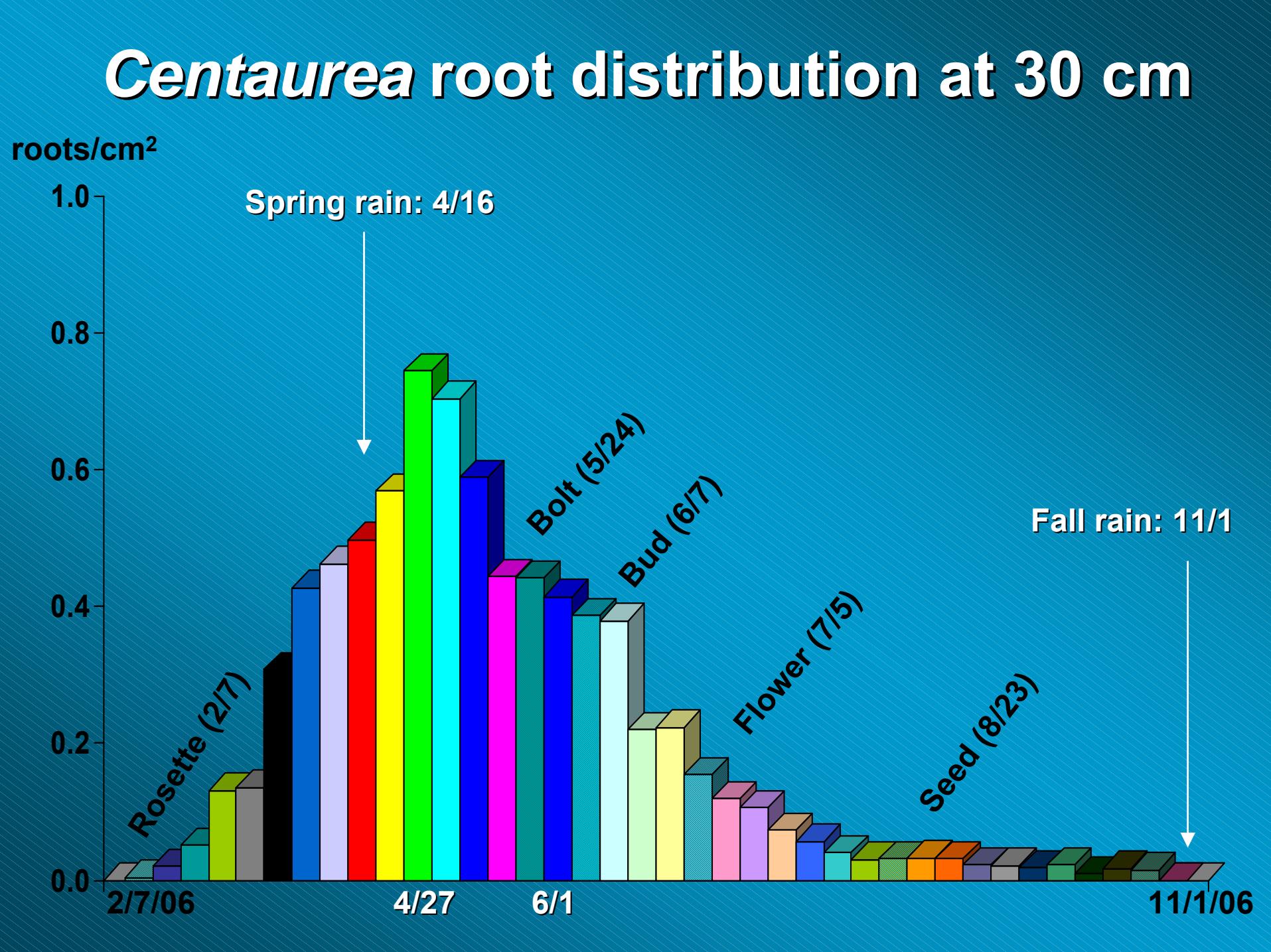
Rosette (2/7)

2/7/06

4/27

6/1

11/1/06



Centaurea root distribution at 180 cm

roots/cm²

1.0

0.8

0.6

0.4

0.2

0.0

2/7/06

4/27

5/25

6/1

6/15

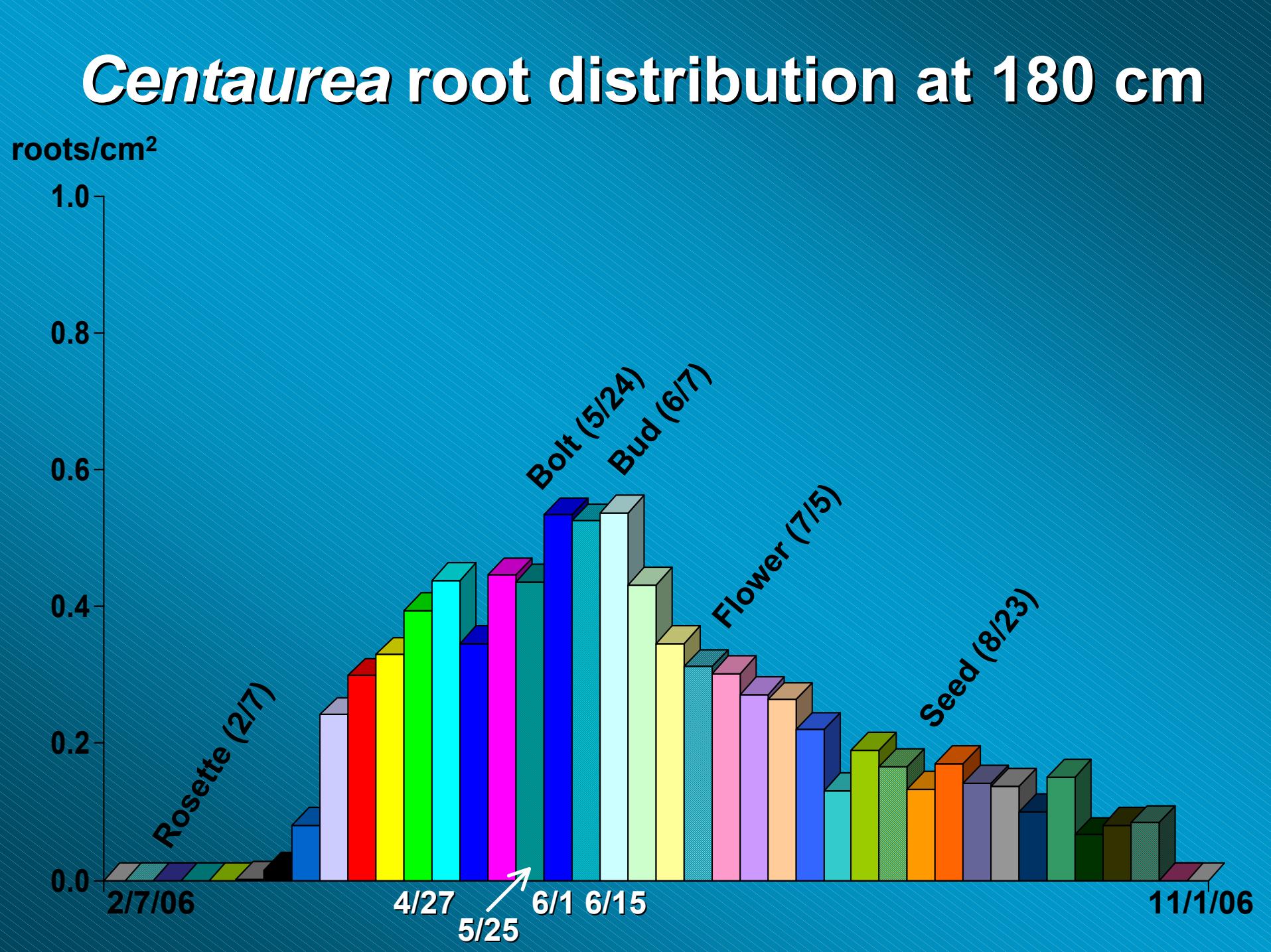
11/1/06

Rosette (2/7)

Bolt (5/24)
Bud (6/7)

Flower (7/5)

Seed (8/23)



Grindelia root distribution at 30 cm

roots/cm²

1.0

0.8

0.6

0.4

0.2

0.0

Fall rain: 11/1

Bud (5/24)
Flower (6/14)

Seed (11/1)

New shoots (10/17)

2/7/06

11/1/06



Grindelia root distribution at 180 cm

roots/cm²



Elymus root distribution at 30 cm

roots/cm²

1.0

0.8

0.6

0.4

0.2

0.0

Fall rain: 11/1

New shoots

105

140

Seed

2/7/06

11/1/06



Elymus root distribution at 180 cm

roots/cm²

1.0

0.8

0.6

0.4

0.2

0.0

2/7/06

11/1/06

Seed

34

49

65

105

140

New shoots

11/1/06

Centaurea peak roots at 4 depths

Data	30 cm	60 cm	120 cm	180 cm
	Rosette (4/27)	Bolting (5/24)	Bolting (5/24)	Spiney (6/14)
Roots (#/cm ²)	0.75	0.72	0.66	0.54
Water (%)				
CO ₂ (μg C)				

Grindelia peak roots at 4 depths

Data	30 cm	60 cm	120 cm	180 cm
	Flowering	Flowering	Flowering	Flowering
	(6/14*)	(6/14*)	(6/14*)	(6/14*)
Roots (#/cm ²)	0.41	0.47	0.87	0.25
Water (%)				
CO ₂ (μg C)				

*transplanted on 2/20/06

Elymus peak roots at 4 depths

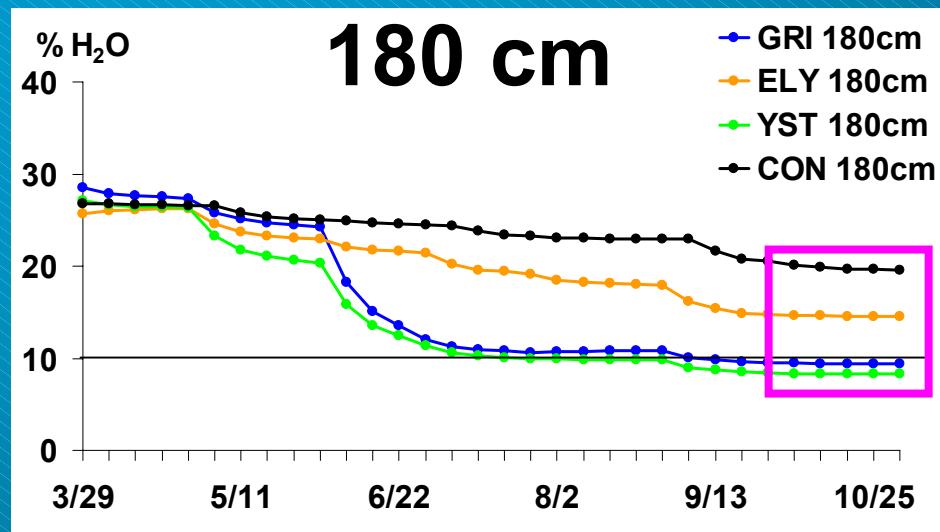
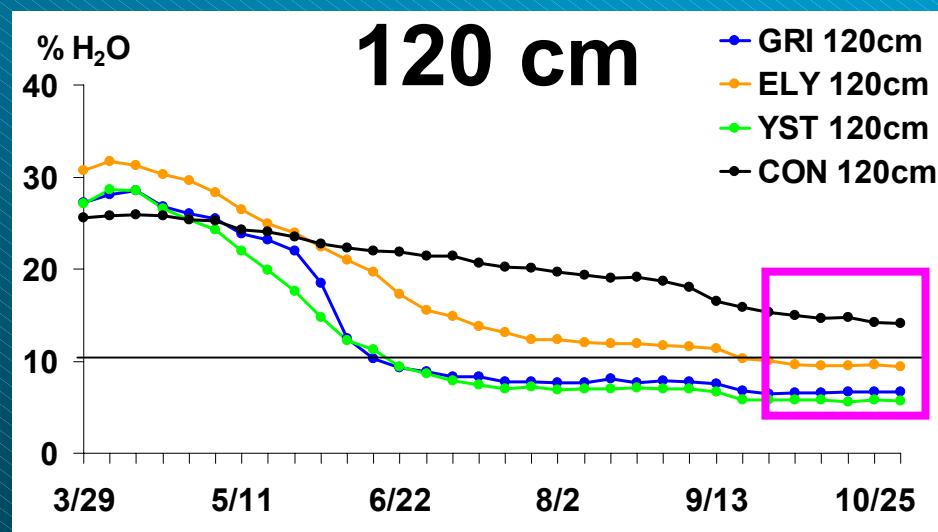
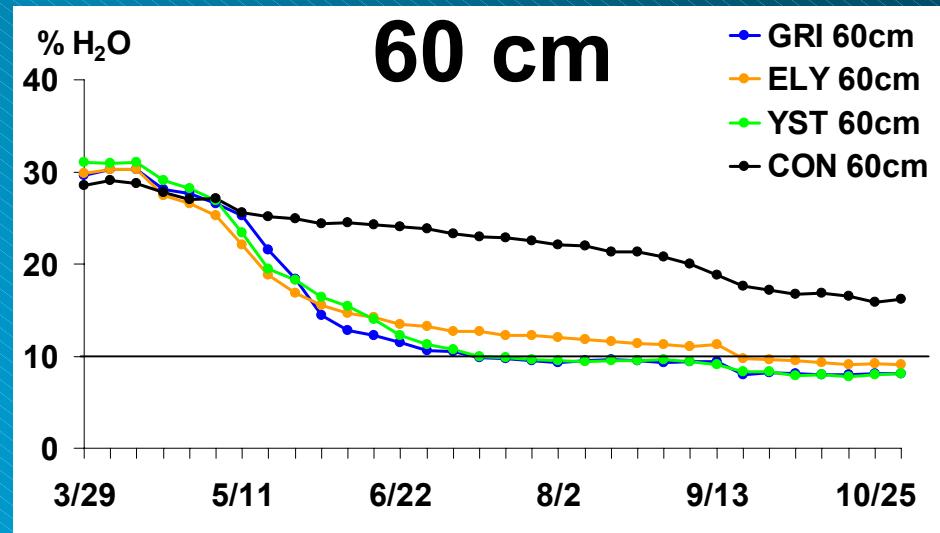
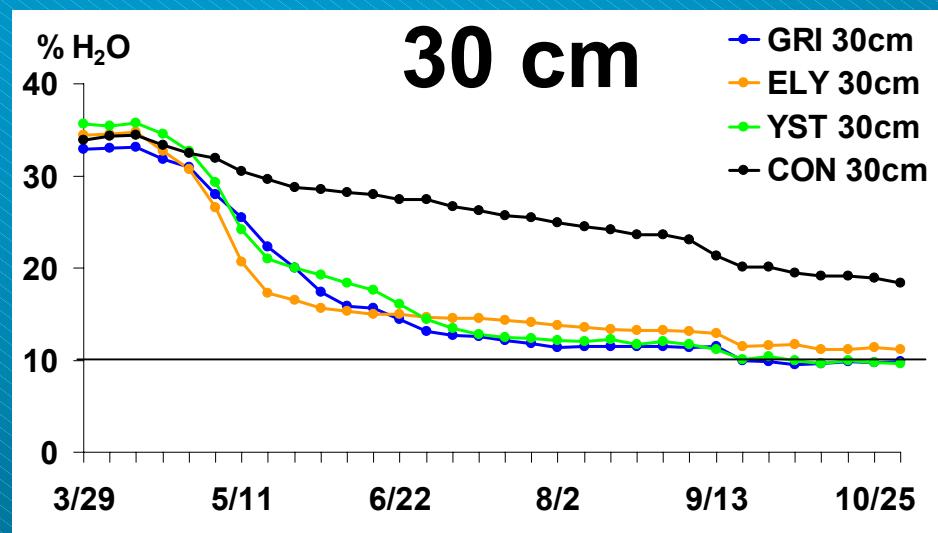
Data	30 cm	60 cm	120 cm	180 cm
	Vegetative (4/19)	Vegetative (5/3)	Seeding (5/24)	Seeding (8/30)
Roots (#/cm ²)	0.89	0.64	0.38	0.40
Water (%)				
CO ₂ (μg C)				

Root activity - methods

- **Soil moisture**
 - Frequency: weekly
 - Method: Neutron probe at 30, 60, 120, 180 cm
- **Soil [CO₂]**
 - Frequency: weekly
 - Method: Soil atmosphere probes at 30, 60, 120 cm*
- **Soil temperature**
 - Frequency: bi-hourly
 - Method: HOBO™ data loggers at 30, 60, 120 cm

*Anderson, J.P.E. 1982. Soil respiration. *In Methods of Soil Analysis, Part 2*

Soil water in 2006



Centaurea peak roots at 4 depths

Data	30 cm	60 cm	120 cm	180 cm
	Rosette (4/27)	Bolting (5/24)	Bolting (5/24)	Spiney (6/14)
Roots (#/cm ²)	0.75	0.72	0.66	0.54
Water (%)	33	16	18	14
CO ₂ (μg C)	33	25	24	25

Grindelia peak roots at 4 depths

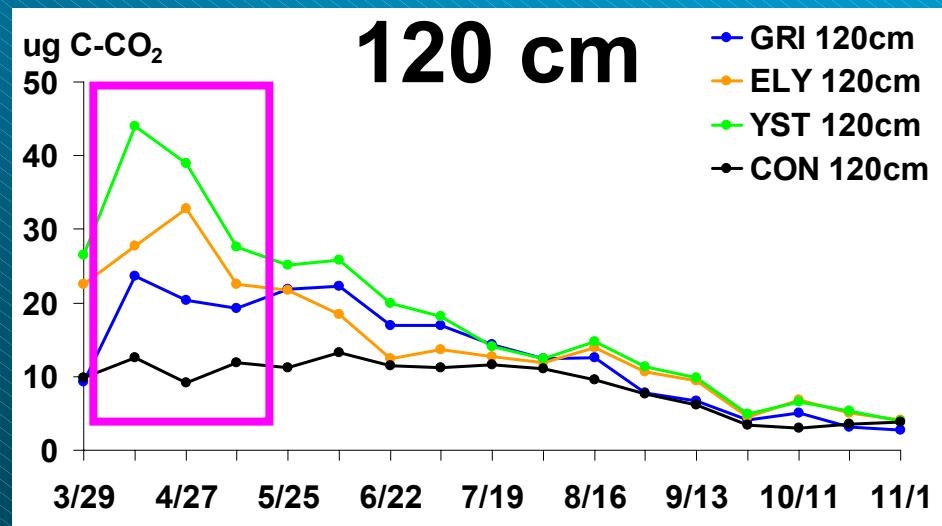
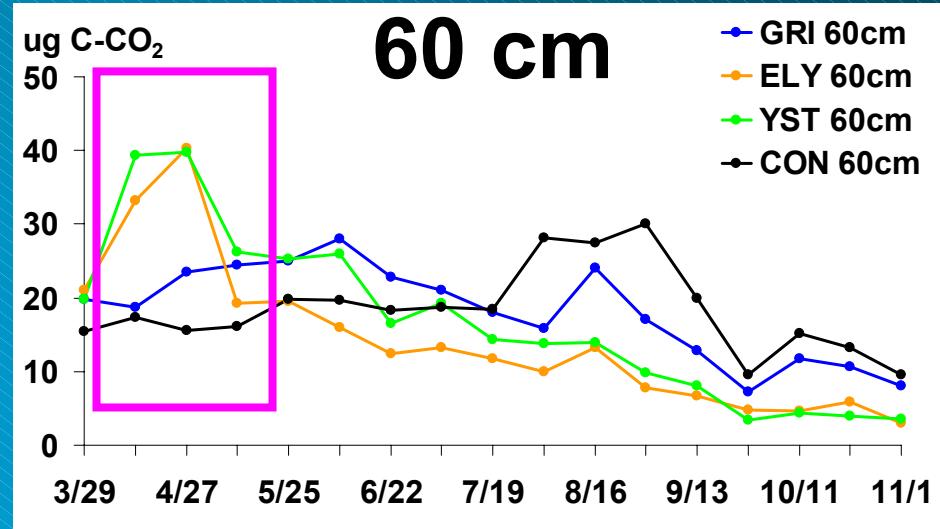
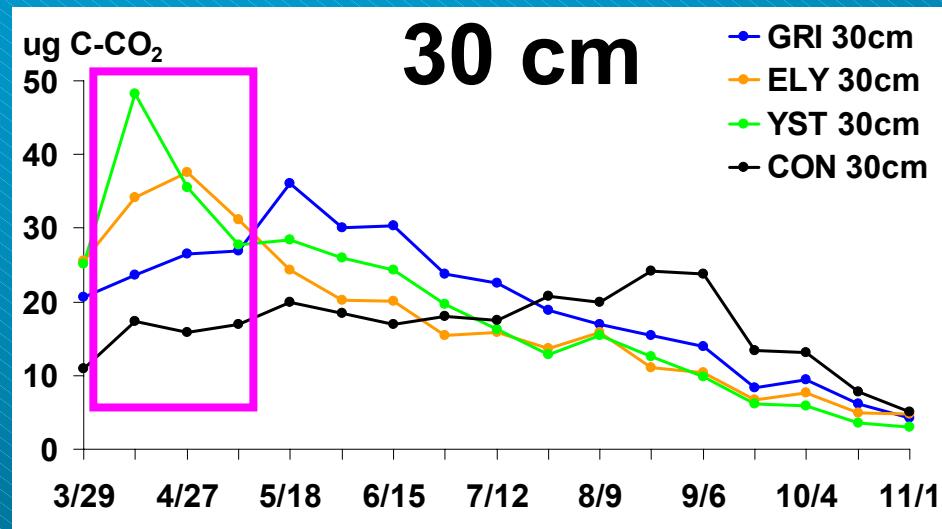
Data	30 cm	60 cm	120 cm	180 cm
	Flowering (6/14*)	Flowering (6/14*)	Flowering (6/14*)	Flowering (6/14*)
Roots (#/cm ²)	0.41	0.47	0.87	0.25
Water (%)	16 28	12 24	10 22	16 25
CO ₂ (μg C)				

*transplanted on 2/20/06

Elymus peak roots at 4 depths

Data	30 cm Vegetative (4/19)	60 cm Vegetative (5/3)	120 cm Seeding (5/24)	180 cm Seeding (8/30)
Roots (#/cm ²)	0.89	0.64	0.38	0.40
Water (%)	33	25	24	18
CO ₂ (μg C)	33	27	24	23

Soil [CO₂] in 2006



Centaurea peak roots at 4 depths

Data	30 cm	60 cm	120 cm	180 cm
	Rosette (4/27)	Bolting (5/24)	Bolting (5/24)	Spiney (6/14)
Roots (#/cm ²)	0.75	0.72	0.66	0.54
Water (%)	33	16	18	14
CO ₂ (μg C)	36	22	24	N/A
	16	20	11	

Grindelia peak roots at 4 depths

Data	30 cm	60 cm	120 cm	180 cm
	Flowering	Flowering	Flowering	Flowering
	(6/14*)	(6/14*)	(6/14*)	(6/14*)
Roots (#/cm ²)	0.41	0.47	0.87	0.25
Water (%)	16	12	10	18
CO ₂ (μg C)	30	29	22	N/A
	17	20	11	

*transplanted on 2/20/06

Elymus peak roots at 4 depths

Data	30 cm Vegetative (4/19)	60 cm Vegetative (5/3)	120 cm Seeding (5/24)	180 cm Seeding (8/30)
Roots (#/cm ²)	0.89	0.64	0.38	0.40
Water (%)	33	25	24	18
CO ₂ (μg C)	35	24	22	N/A
	16	15	11	

Summary - root growth

- *Centaurea*
 - Peak coincided with earlier phenological development.
 - Decline from flowering to seeding.
- *Grindelia*
 - Peak at all depths occurred early summer.
 - Growth continued at deep depths.
- *Elymus*
 - Peak occurred later at deeper depths with decline only at shallow depths.



Summary - root activity

- Peak soil moisture depletion

- *Centaurea*

- shallow: rosette to bolt (31% loss)
 - deep: bolt to bud (24-27% loss)

- *Grindelia*

- Similar to *Centaurea*

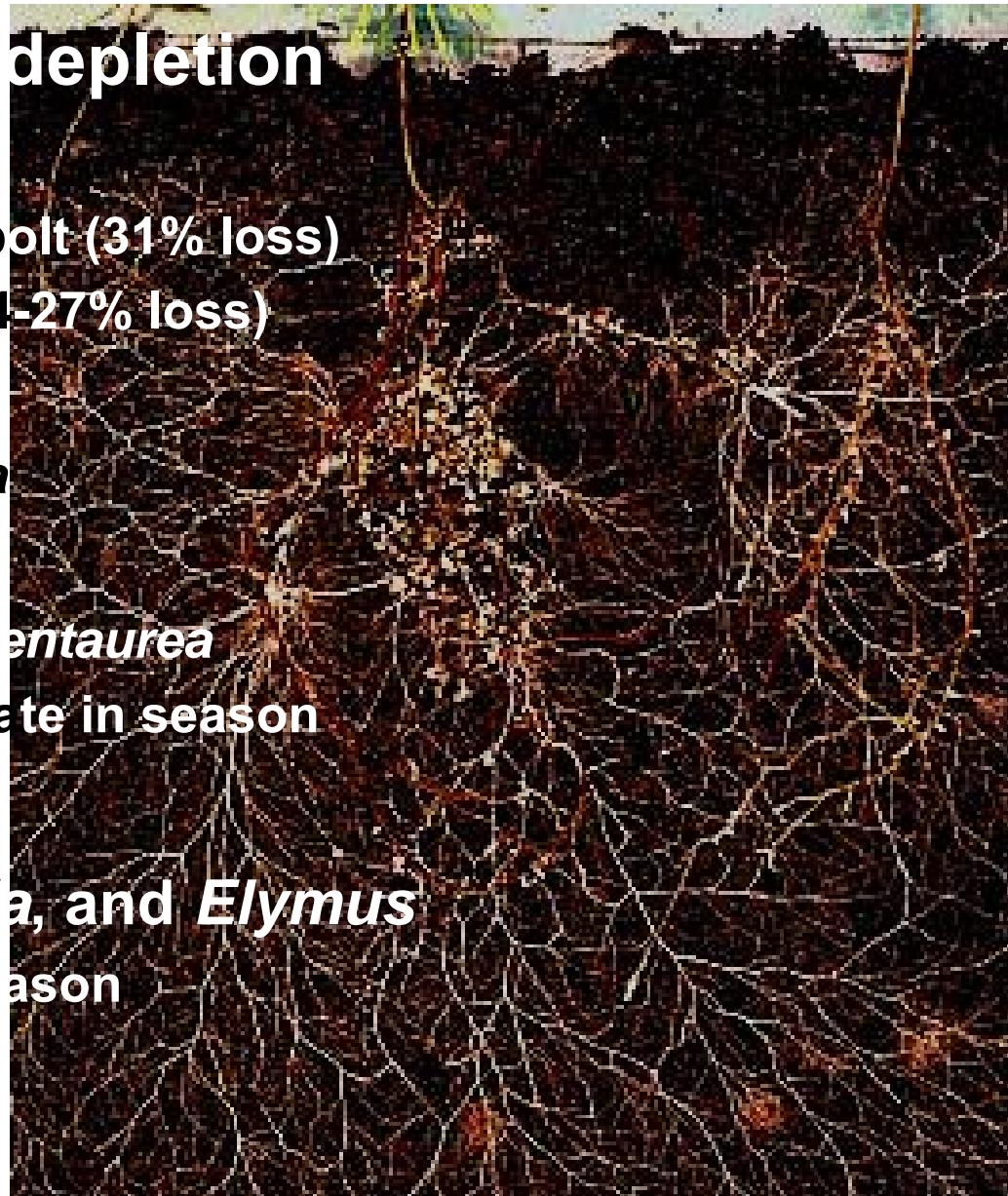
- *Elymus*

- Shallow similar to *Centaurea*
 - Deep > 10% (SWC) late in season

- Peak soil [CO₂]

- *Centaurea, Grindelia, and Elymus*

- Occurred early in season



Root conclusions

Belowground life cycle

Phases	CEN		GRI*		ELY	
	<u>deep</u>	<u>shallow</u>	<u>deep</u>	<u>shallow</u>	<u>deep</u>	<u>shallow</u>
Construction (peak [CO ₂])	Ros	Ros	Veg	Veg	Veg	Veg
Resource acquisition (↓% SWC)	Bol	Bud	Veg	Bud	Veg	Seed
Termination (↑% dead roots)	Bud	Flower	?	?	?	?

*2007 data

Root implications

- *Centaurea* control
 - Control early (before loss in SWC)
 - Reduce impact on desirable species
- *Grindelia* and *Elymus* establishment
 - Adequate soil water content
 - Location (slope, aspect, root depth)
 - Soil conditions (texture, structure, nutrients)
 - Precipitation patterns ('dry' vs 'wet' years)
 - Planting date
 - Weed control (see above)

Questions?



