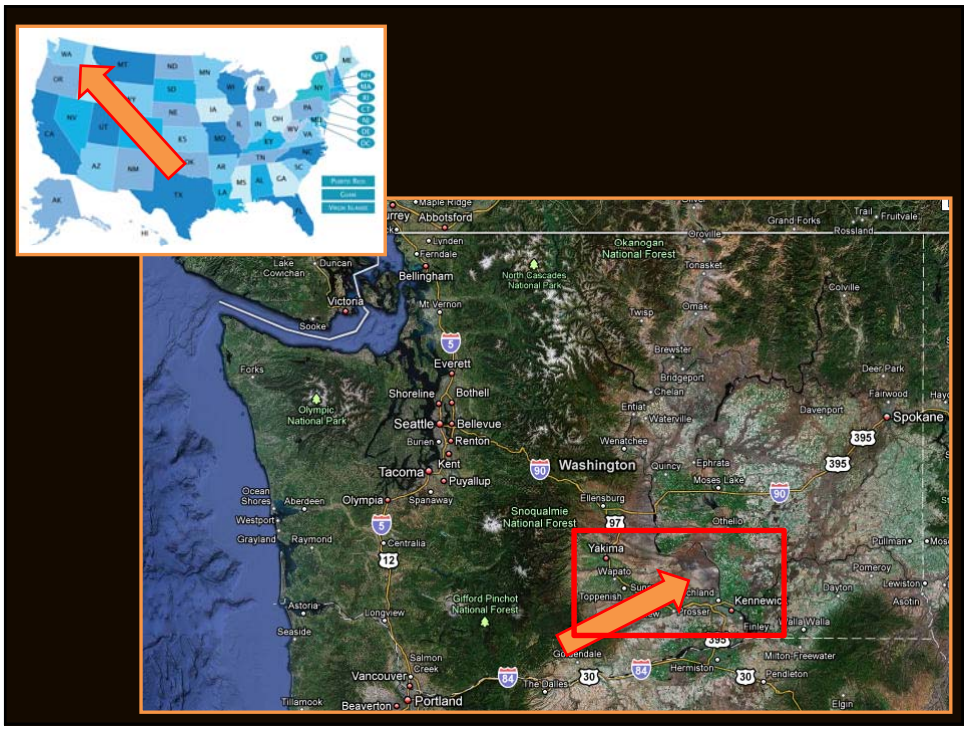
The impact of multiple wildfires on trajectories of change and stable states in sagebrush-steppe ecosystems

G.M. Davies, E. Dettweiler-Robinson, J. Bakker, P. Dunwiddie, J. Evans, S. Hall & J. Downs

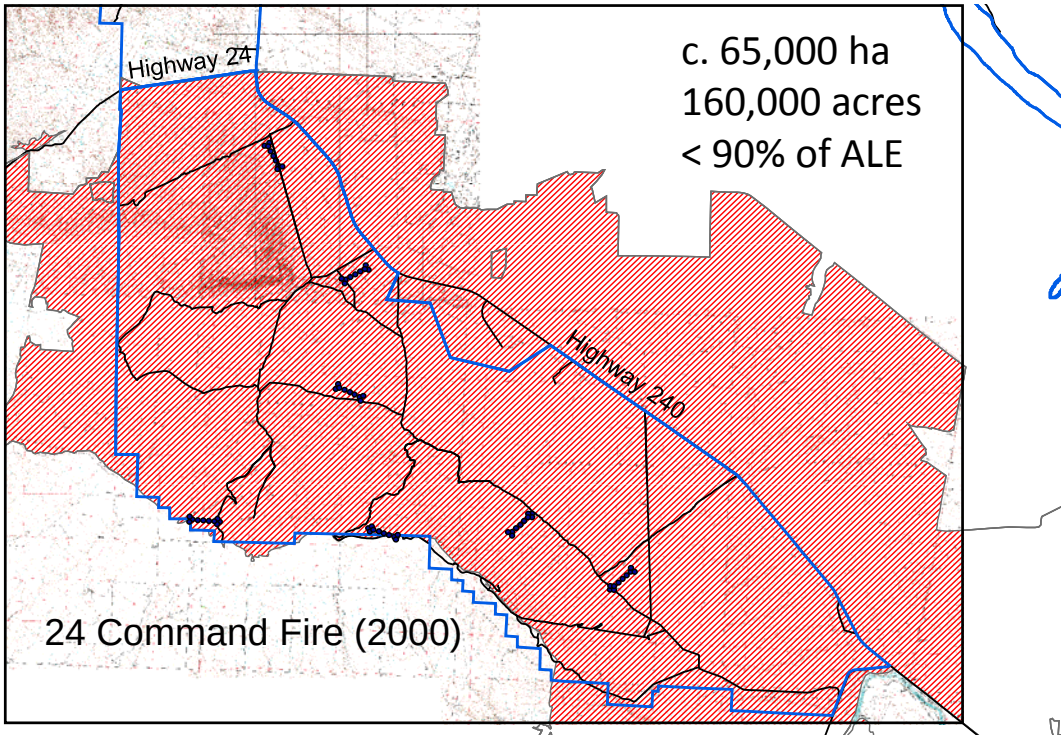


Fitzner-Eberhart Arid Lands Ecology Reserve

31,000 ha
77,000 acres

24 Command Fire (2000)

Heidi Newsome (USFWS)

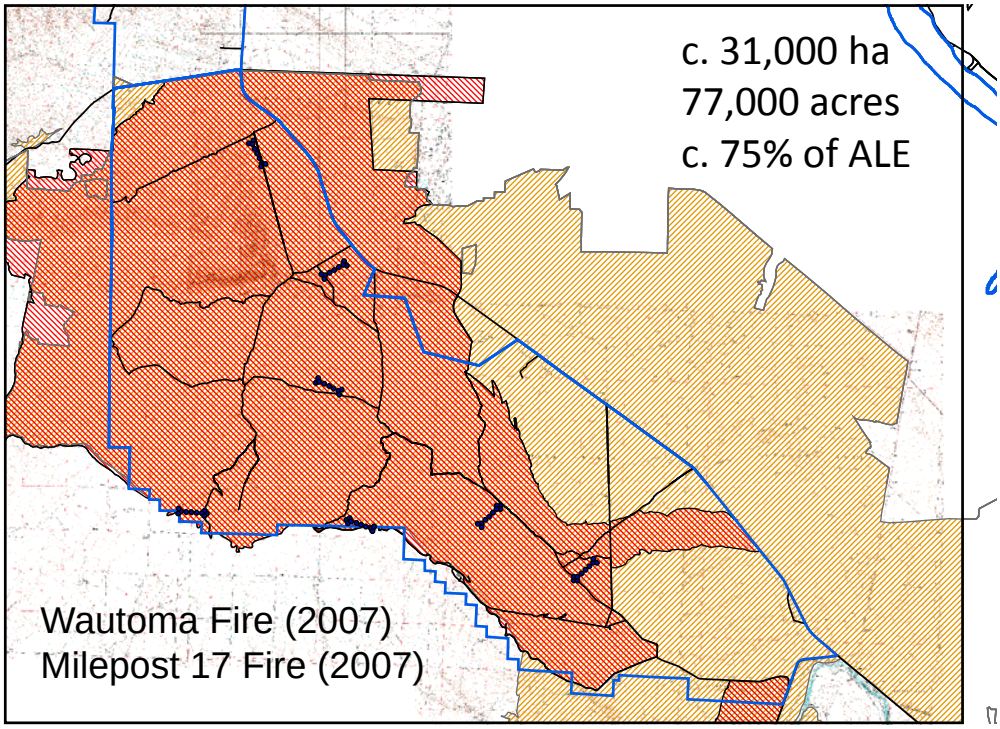


24 Command Fire 2000

Photos :
Heidi Newsome, USFWS (right)
Rajah Bose, Tri-City Herald (above)

24 Command Fire aftermath
Heidi Newsome (USFWS)
6 29'00

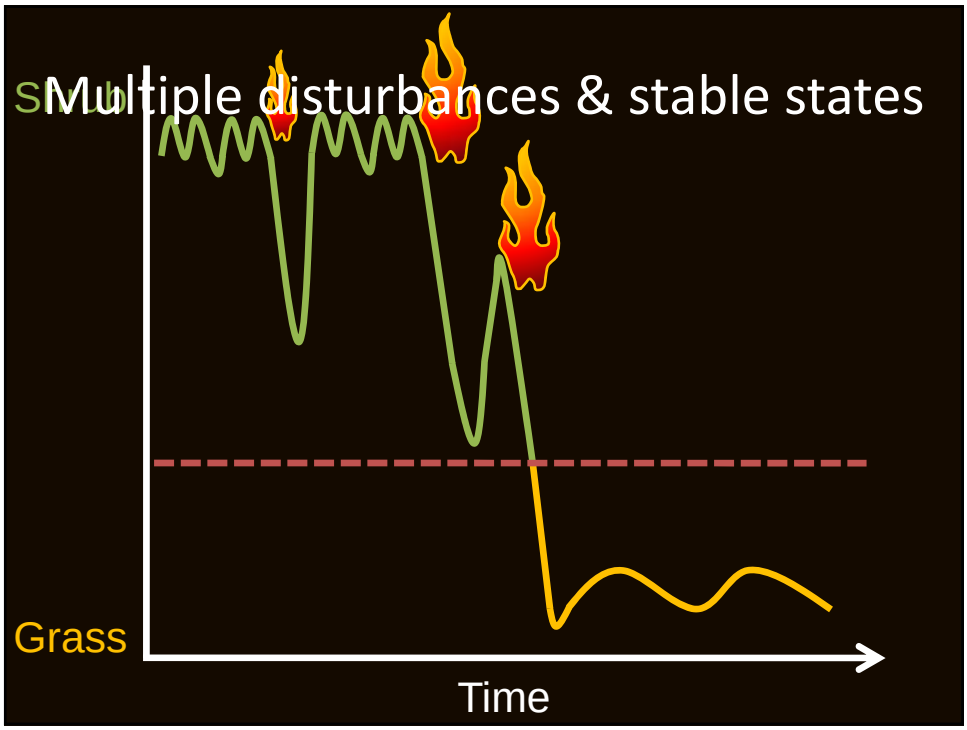
NATIONAL WILDLIFE REFUGE
AREA
CLOSED
Wautoma Fire (2007)
Milepost 17 Fire (2007)
Photo by Kevin Goldie (USFWS)


c. 31,000 ha
77,000 acres
c. 75% of ALE
Wautoma Fire (2007)
Milepost 17 Fire (2007)

Wautoma Fire aftermath
Photo by Kevin Goldie (USFWS)

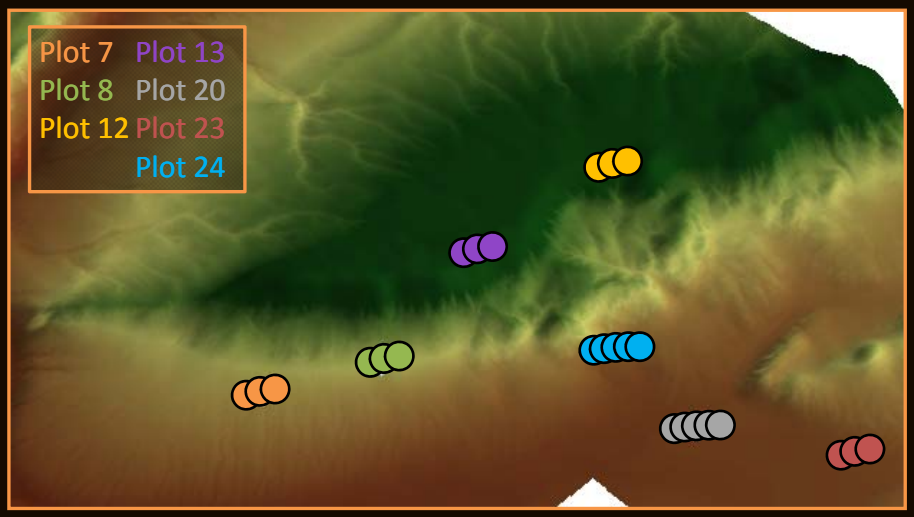
Wautoma Fire aftermath

Photo by Kevin Goldie (USFWS)



Objectives

- Examine effect of multiple disturbances
- Understand changes in vegetation communities
- Examine “trajectories” of change
- Discuss evidence for changes in stable states



- Plots = 3 or 5 100 m transects (200-400m apart)
- 20, 20 x 50 cm quadrats per transect
- Species % cover: 1996, 2001 through 2004, 2009

Data analysis 1

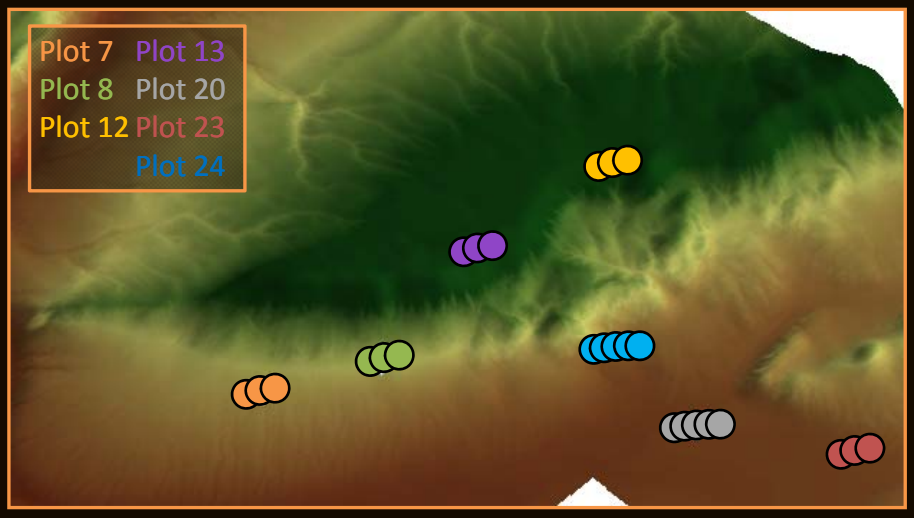
- 1996, 2002 and 2009 examined in detail
  (NB fires in 2000 and 2007)

1. Mantel tests (spatial autocorrelation)
2. Cluster analysis (broad community groups)
3. PERMANOVA (significance of differences)

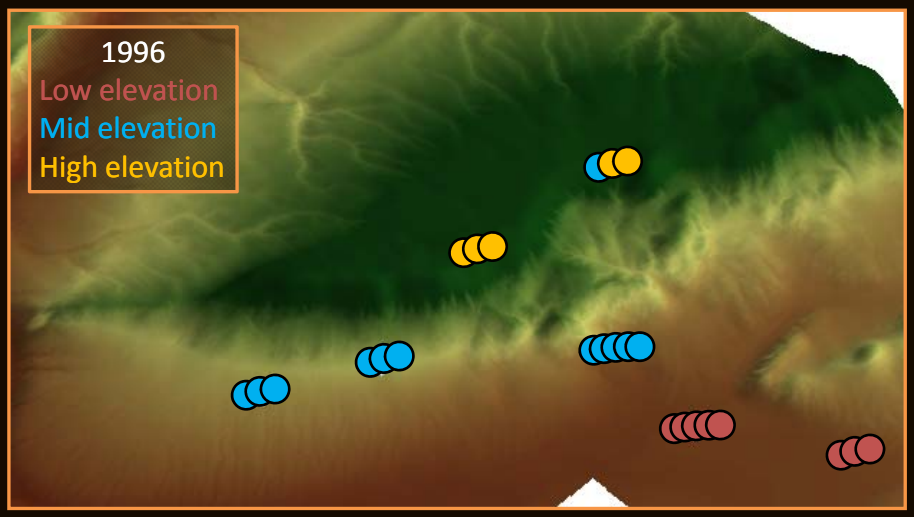
Data analysis 2

4. Non-metric Multidimensional Scaling (NMDS)
   - Confirm community groups (within years)
   - Developmental trajectories
   - Community change

- Analysis completed in R (vegan, labdsv)



- Significant spatial autocorrelation between transects
- Partial Mantel test: $P < 0.001$, $r = 0.49$
  (controlling for elevation)

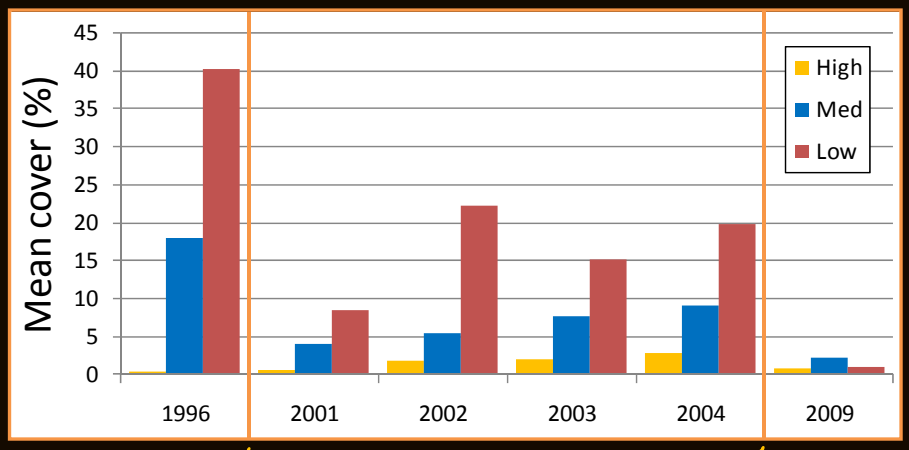


- Cluster analysis identifies 3 community types
- 1996 significant difference in communities ($P < 0.001$)
- 2009 significant difference in communities ($P < 0.001$)

- Cluster analysis identifies 2 community types
- Significant difference in communities ($P < 0.001$)

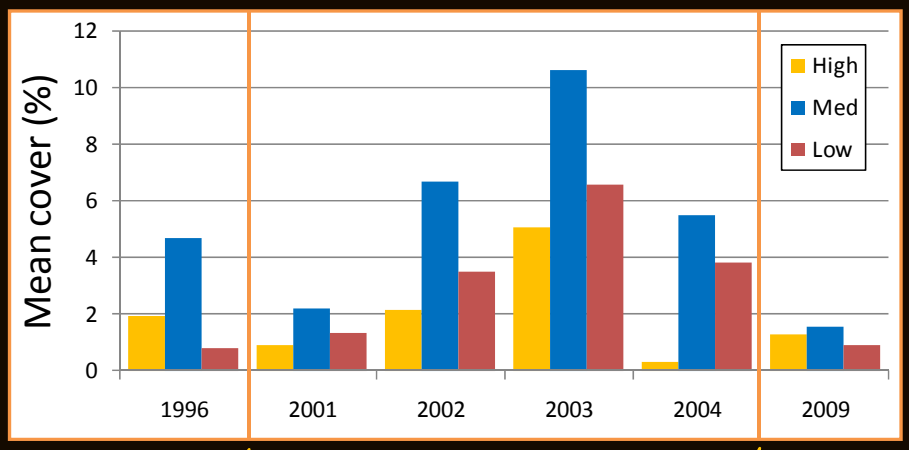
Trends in functional groups

Trends in functional groups 1



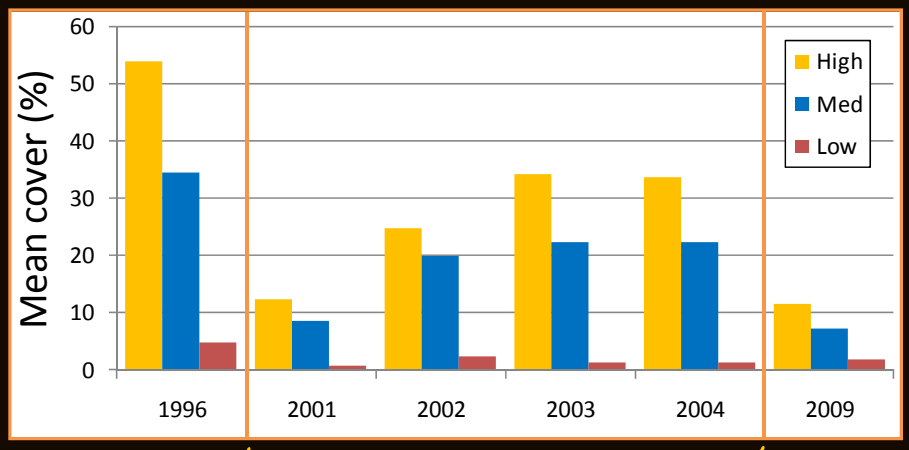
Invasive annual grass (*Bromus tectorum*)

Trends in functional groups 2



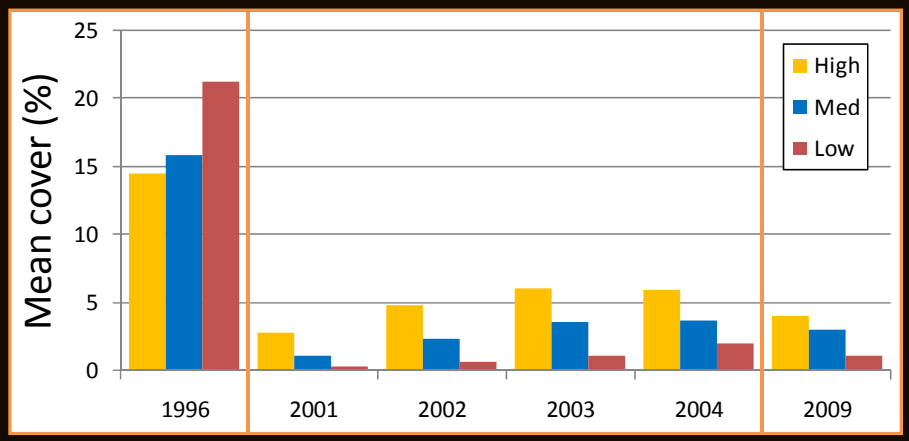
Invasive annual herbs

Trends in functional groups 3



Native perennial grasses

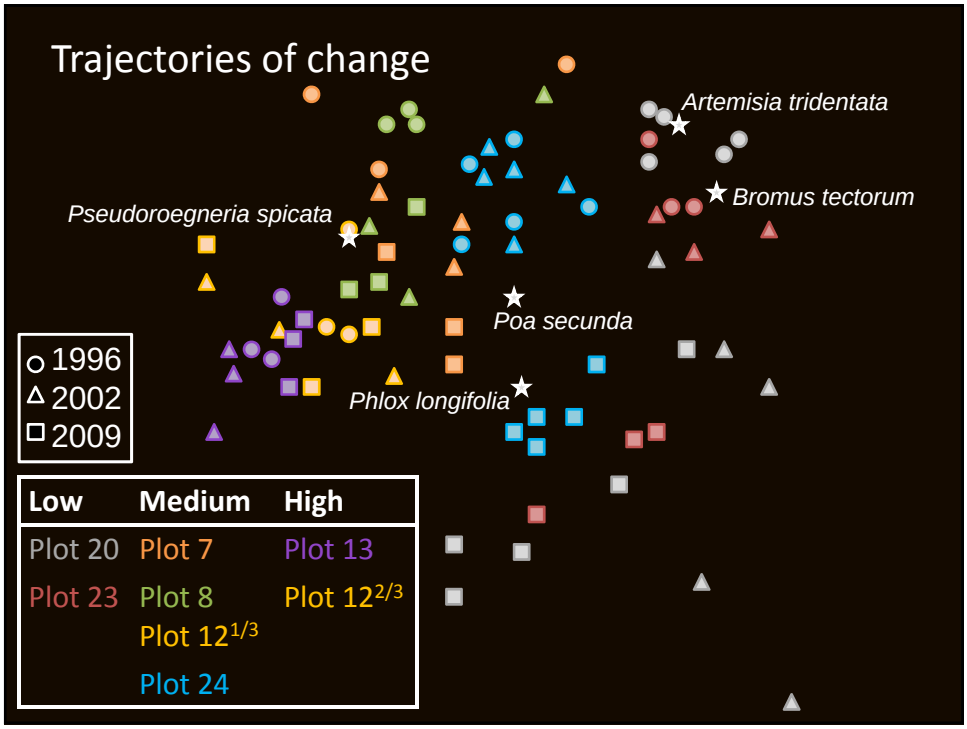
Trends in functional groups 4

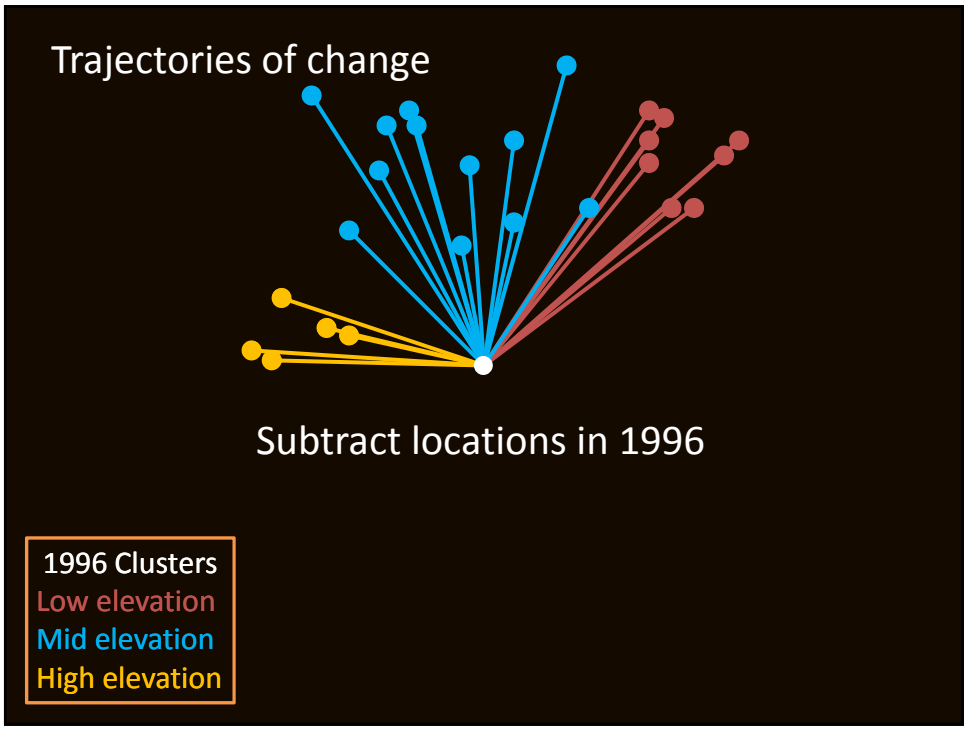


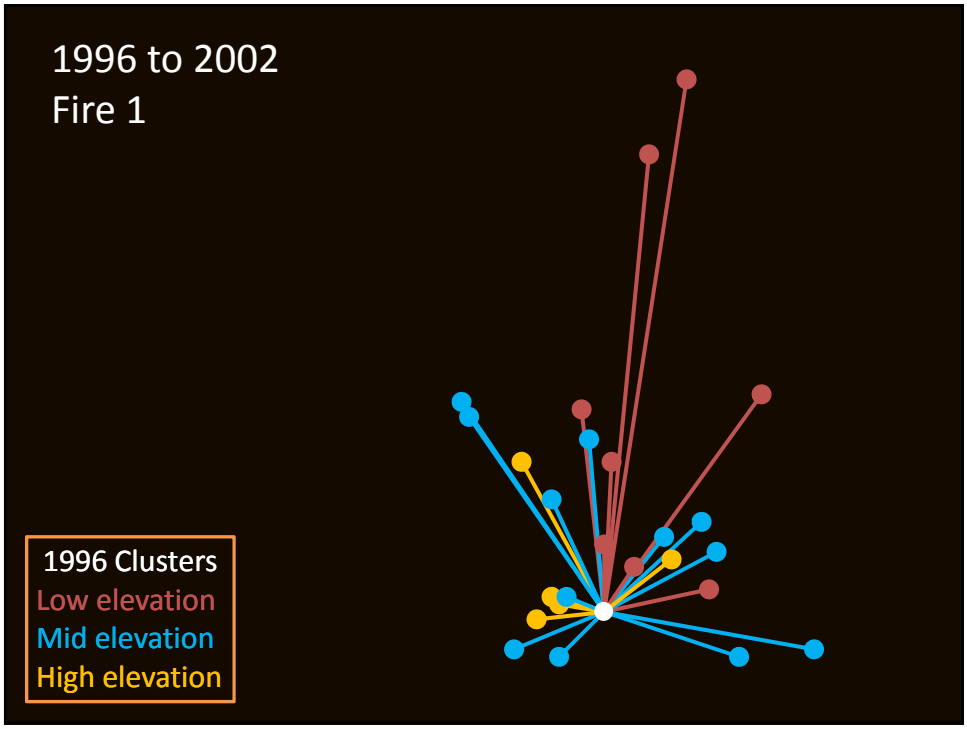
Native perennial shrubs

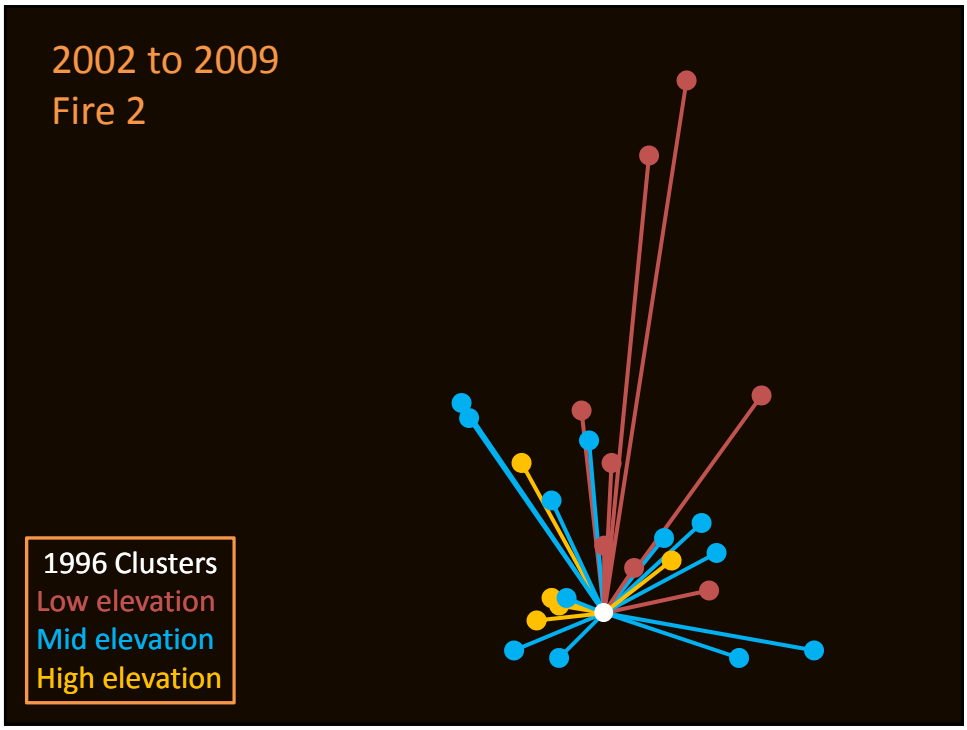
Trajectories of change

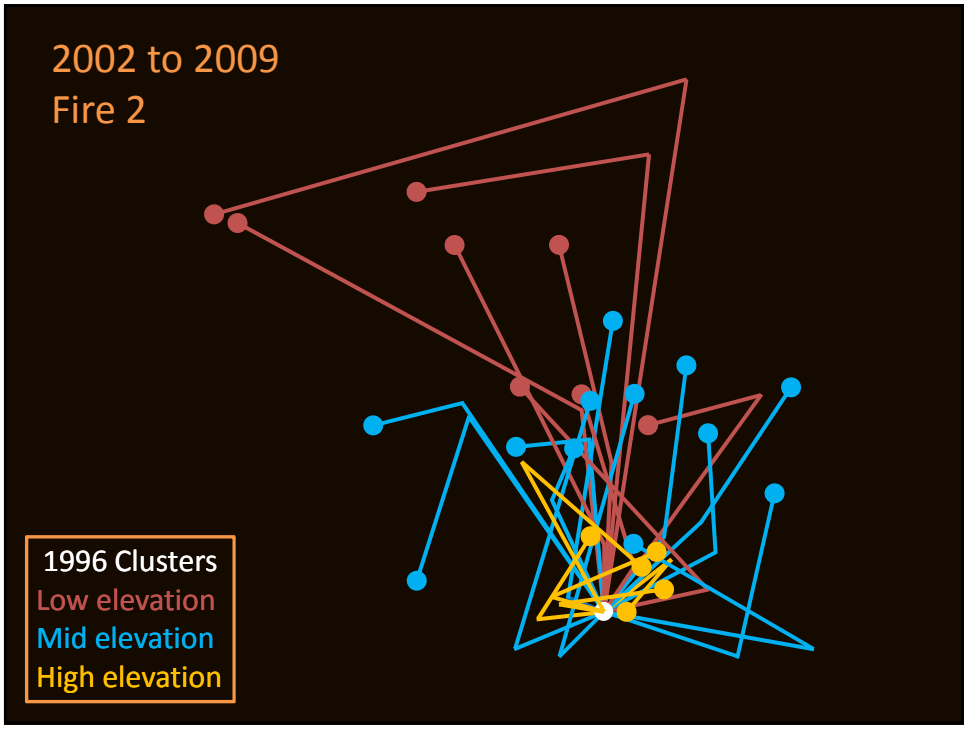
NMDS for all years and all transects

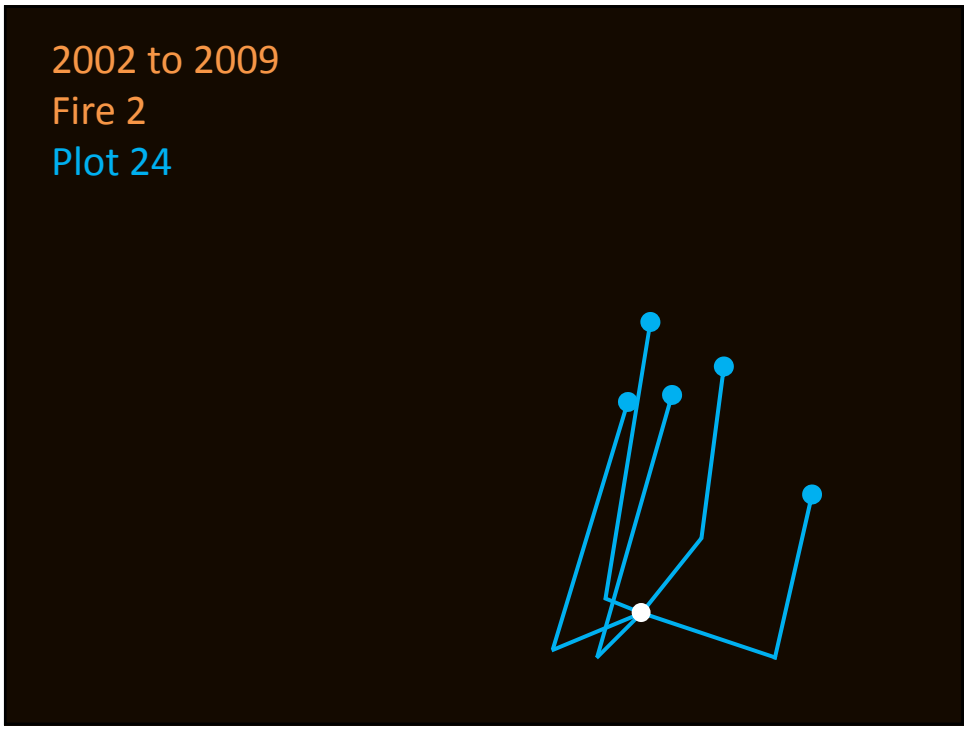

Trajectories of change
Artemisia tridentata
Bromus tectorum
Pseudoroegneria spicata
Poa secunda
Phlox longifolia
1996
2002
2009
Low
Medium
High
Plot 20
Plot 7
Plot 13
Plot 23
Plot 8
Plot 12^2/3
Plot 12^1/3
Plot 24


Trajectories of change
Subtract locations in 1996
1996 Clusters
Low elevation
Mid elevation
High elevation

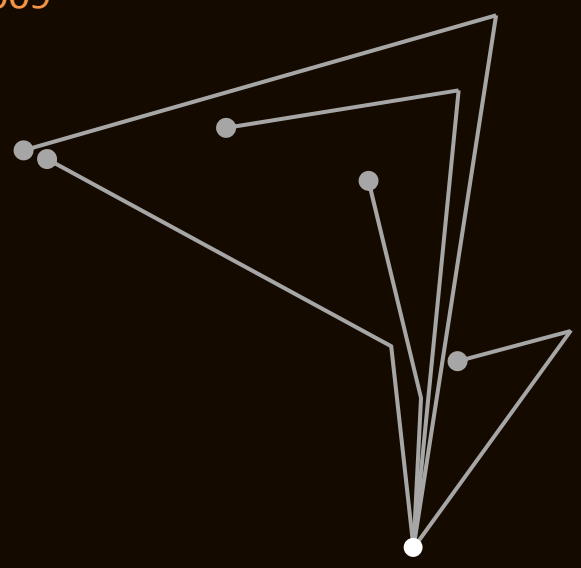

1996 to 2002
Fire 1
1996 Clusters
Low elevation
Mid elevation
High elevation


2002 to 2009
Fire 2
1996 Clusters
Low elevation
Mid elevation
High elevation

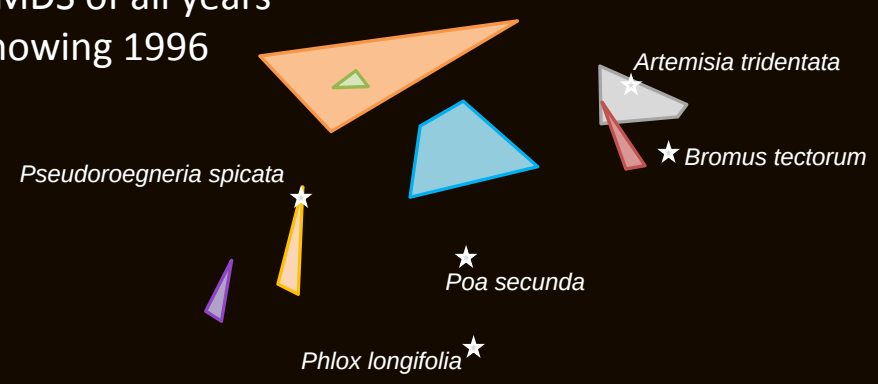

2002 to 2009
Fire 2
1996 Clusters
Low elevation
Mid elevation
High elevation


2002 to 2009
Fire 2
Plot 24

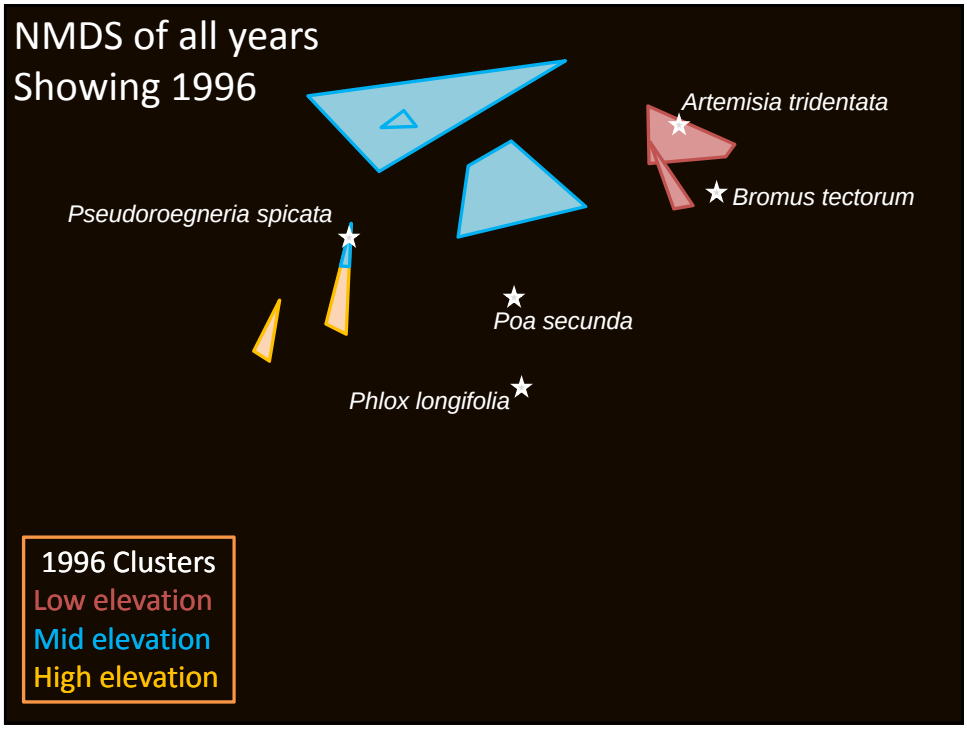
2002 to 2009
Fire 2
Plot 20

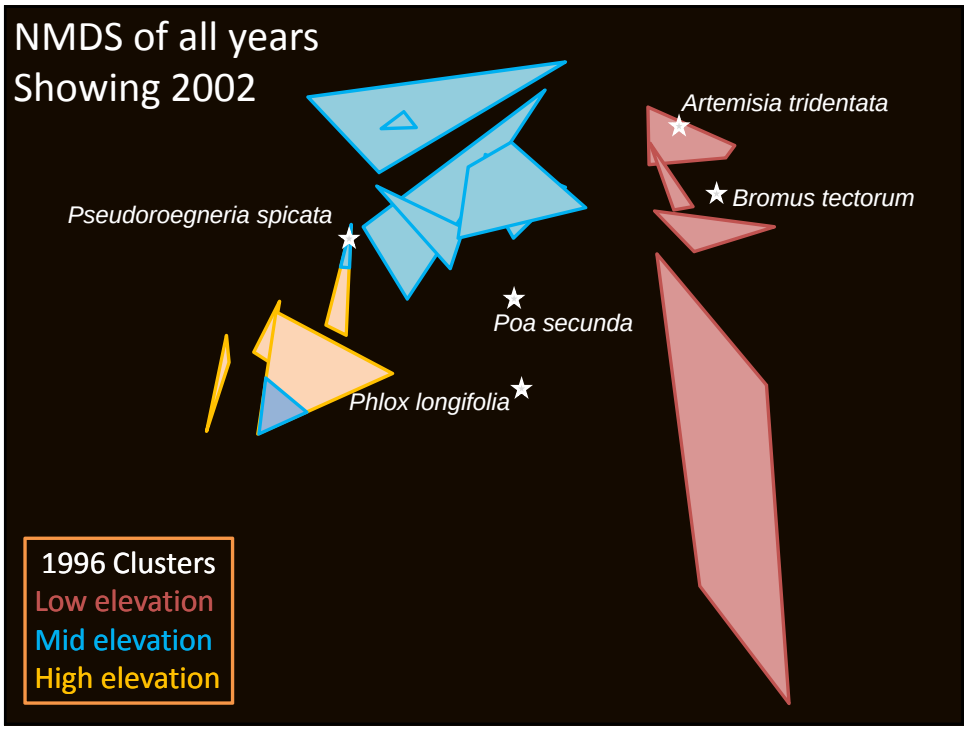


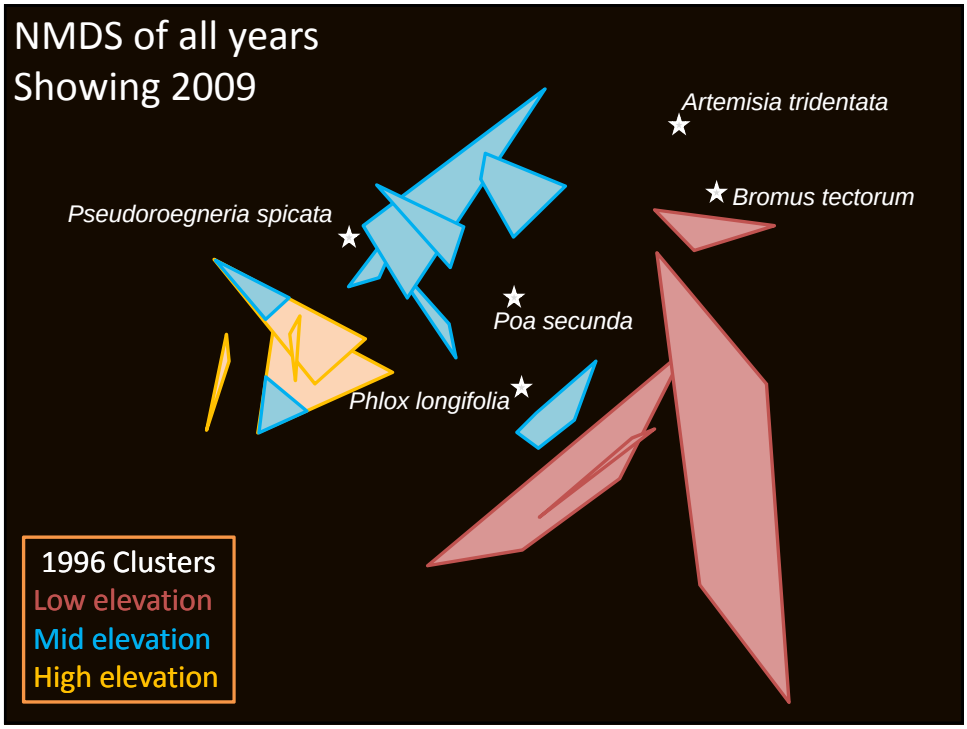
NMDS of all years
Showing 1996

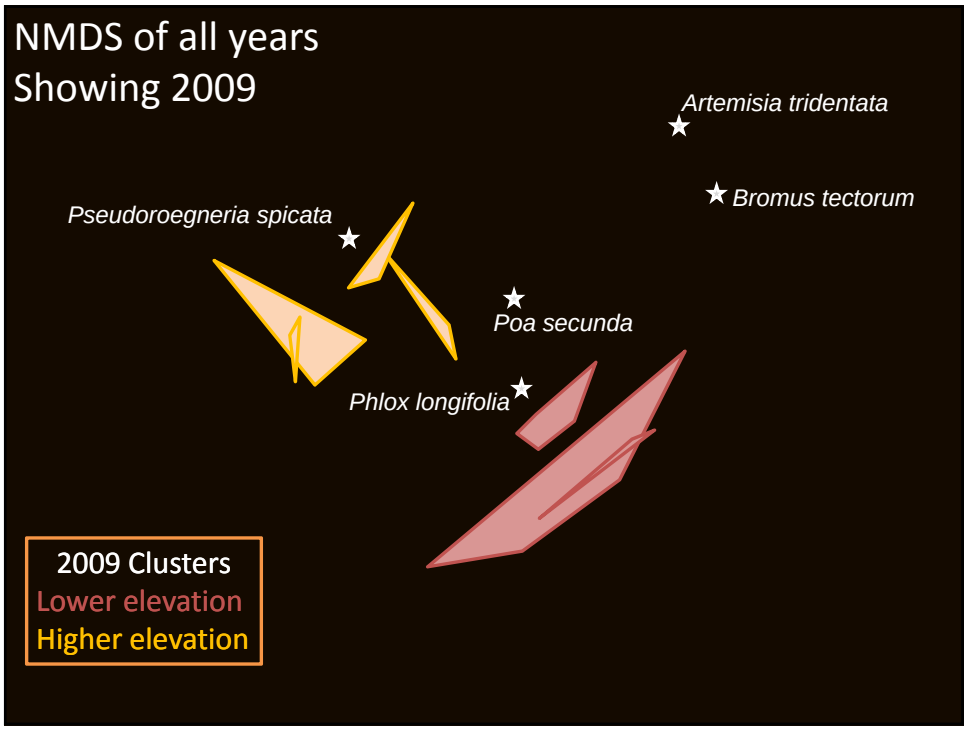


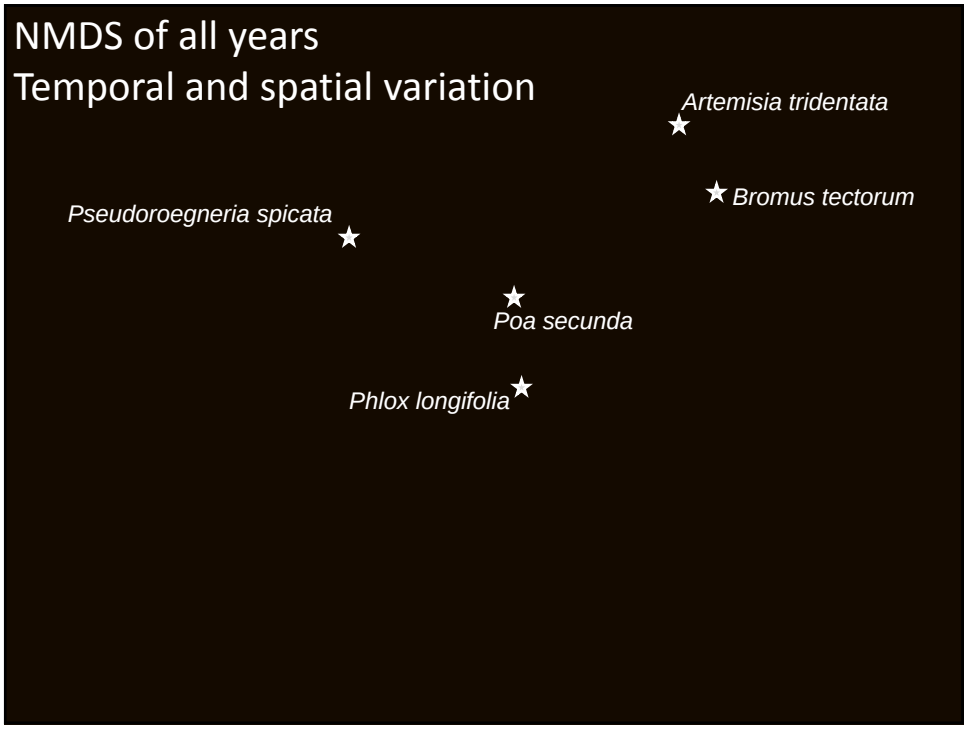
Low	Medium	High
Plot 20	Plot 7	Plot 13
Plot 23	Plot 8	Plot $12^{2/3}$
	Plot $12^{1/3}$	
	Plot 24	

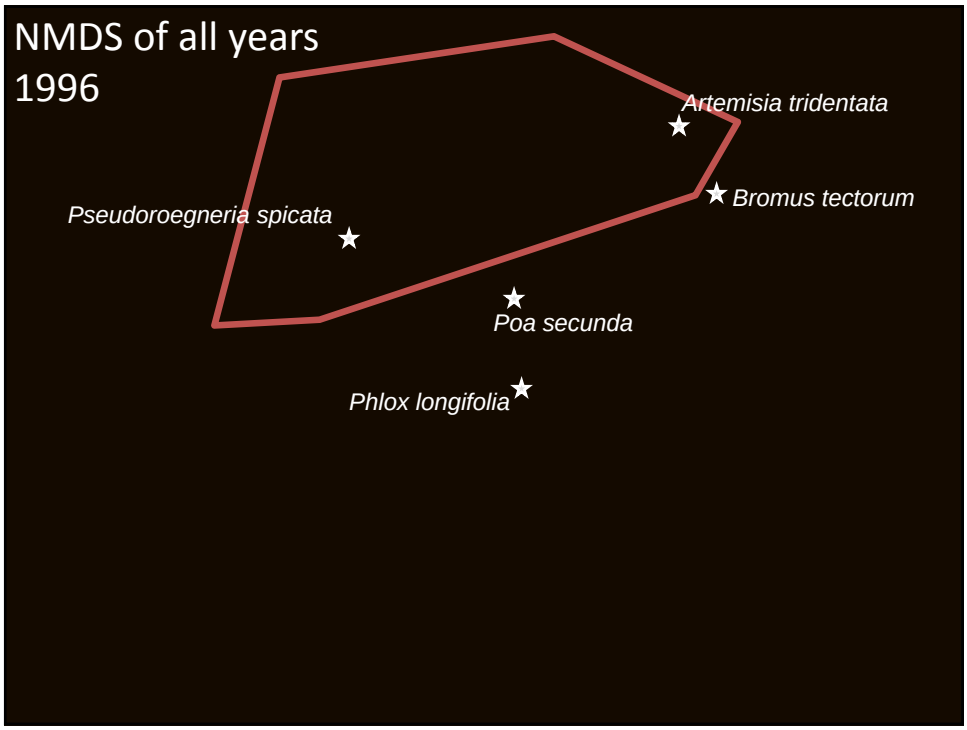

NMDS of all years
Showing 1996
Artemisia tridentata
Bromus tectorum
Pseudoroegneria spicata
Poa secunda
Phlox longifolia
1996 Clusters
Low elevation
Mid elevation
High elevation

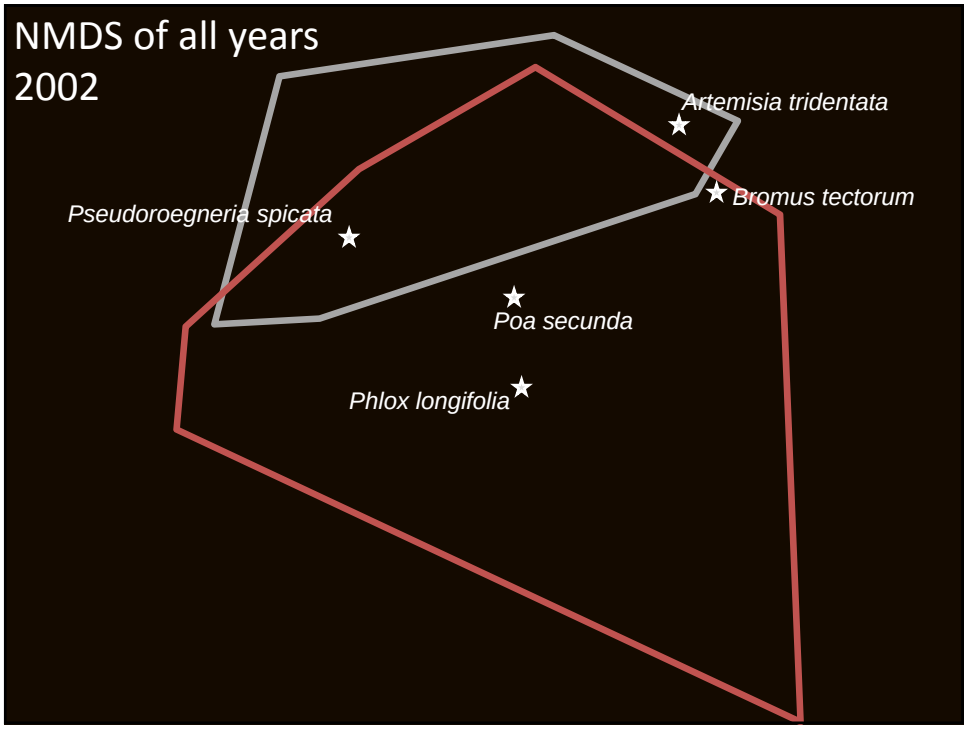

NMDS of all years
Showing 2002
Artemisia tridentata
Bromus tectorum
Pseudoroegneria spicata
Poa secunda
Phlox longifolia
1996 Clusters
Low elevation
Mid elevation
High elevation

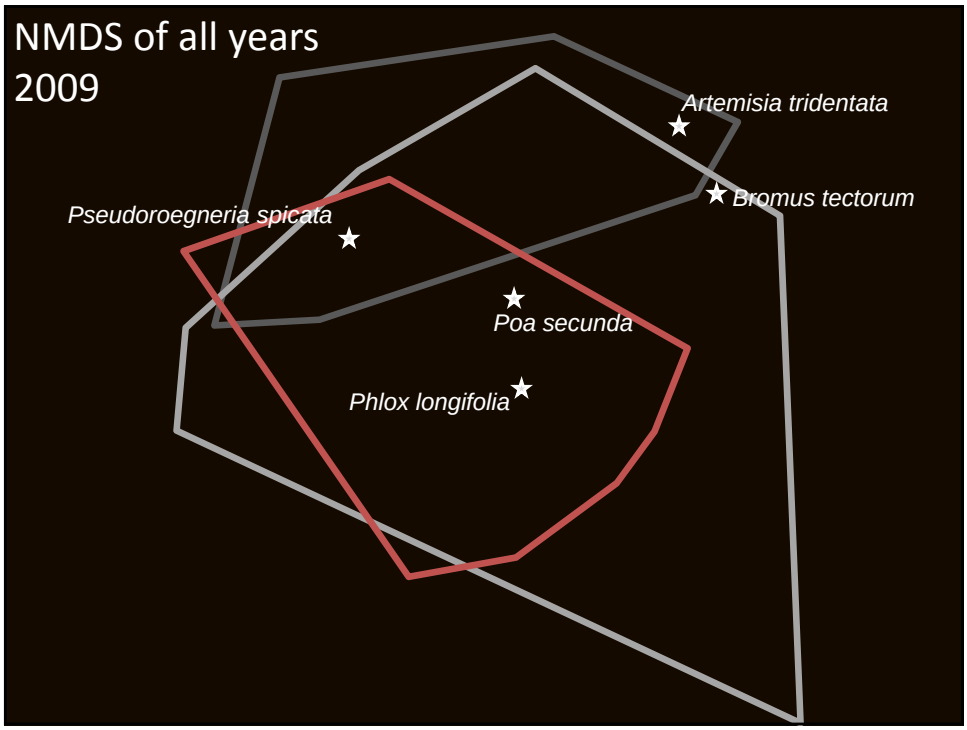

NMDS of all years
Showing 2009
Artemisia tridentata
Bromus tectorum
Pseudoroegneria spicata
Poa secunda
Phlox longifolia
1996 Clusters
Low elevation
Mid elevation
High elevation


NMDS of all years
Showing 2009
Artemisia tridentata
Bromus tectorum
Pseudoroegneria spicata
Poa secunda
Phlox longifolia
2009 Clusters
Lower elevation
Higher elevation


NMDS of all years
Temporal and spatial variation
Artemisia tridentata
Bromus tectorum
Pseudoroegneria spicata
Poa secunda
Phlox longifolia


NMDS of all years
1996
Artemisia tridentata
Bromus tectorum
Pseudoroegneria spicata
Poa secunda
Phlox longifolia


NMDS of all years
2002
Artemisia tridentata
Bromus tectorum
Pseudoroegneria spicata
Poa secunda
Phlox longifolia


NMDS of all years
2009
Artemisia tridentata
Bromus tectorum
Pseudoroegneria spicata
Poa secunda
Phlox longifolia

Importance Values

- Calculated for each species on each transect

$$IV = (C + O)/200$$

C = mean cover (%)

O = proportion of quadrats with species (%)

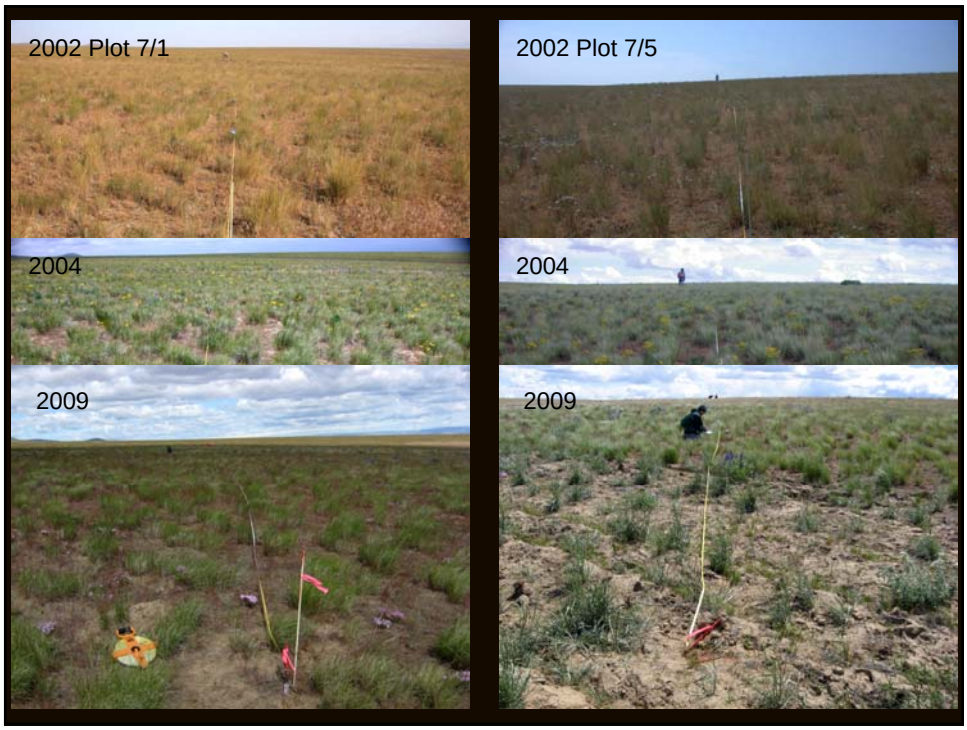
- Dominants = 3 species with highest IV excluding those where IV < mean IV

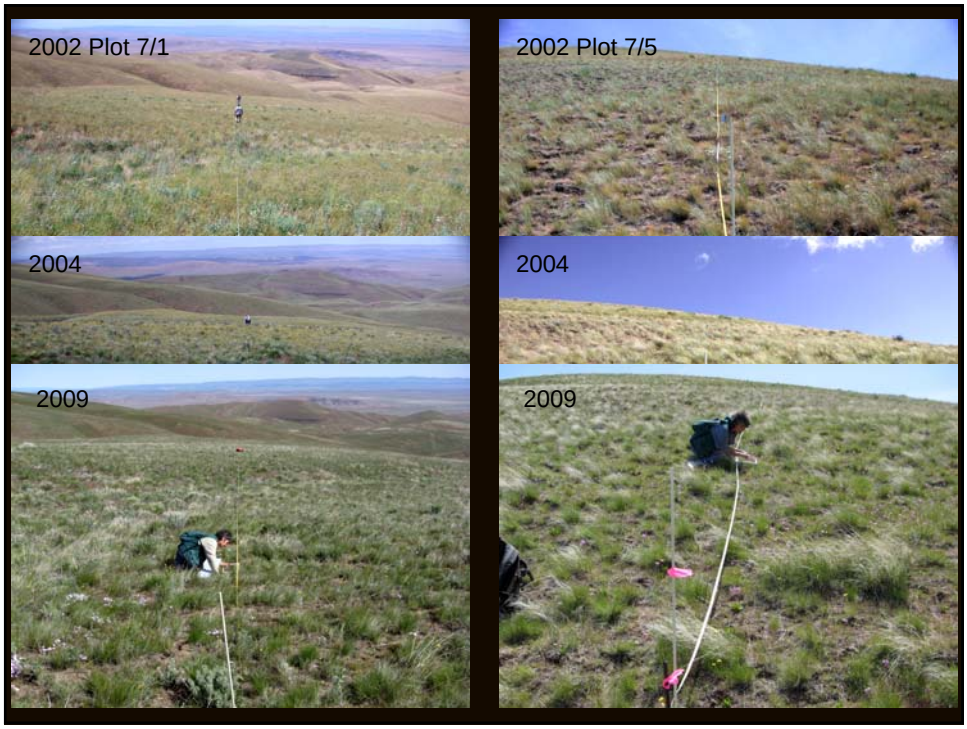
24

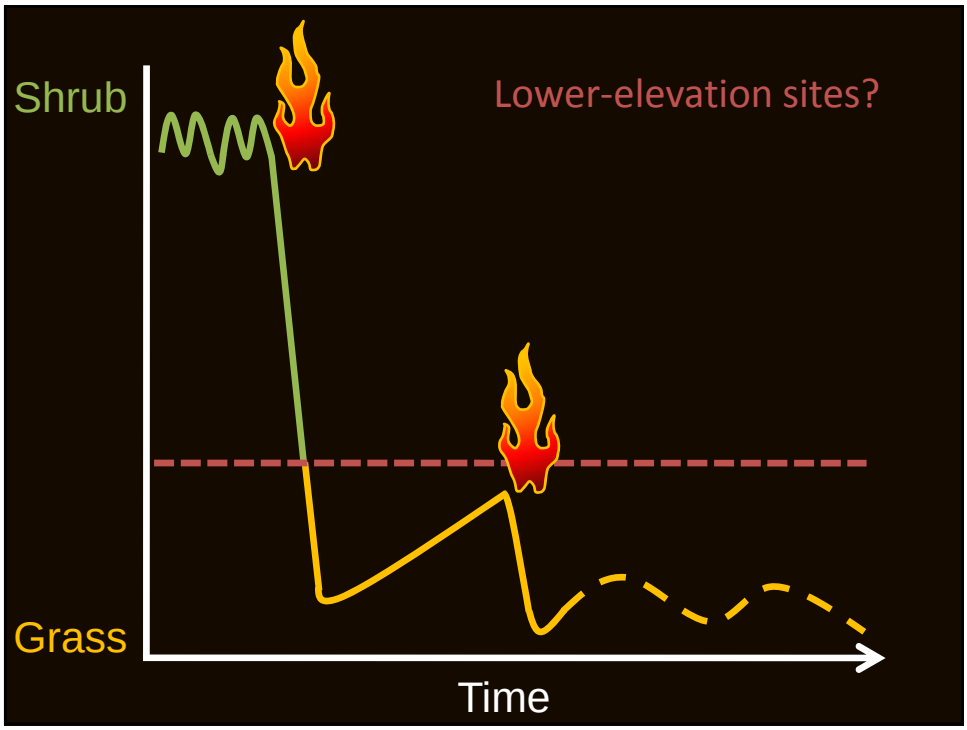
	1996	2002	2009
T1	MACA2 POSE ARTR4	POSE DEPI DRVE2	POSE BRTE SAKA
T2	POSE ARTR2 PHHO	DRVE2 DEPI SIAL2	POSE PHLO2 BRTE
T3	POSE HOUM ARTR2	SIAL2 DRVE2 PHLO2	BRTE SAKA POSE
T4	POSE ARTR2 BACA3	DRVE2 POSE DEPI	POSE SAKA BRTE
T5	ARTR2 POSE PHLO2	DEPI SIAL2 DRVE2	PHLO2 POSE BRTE

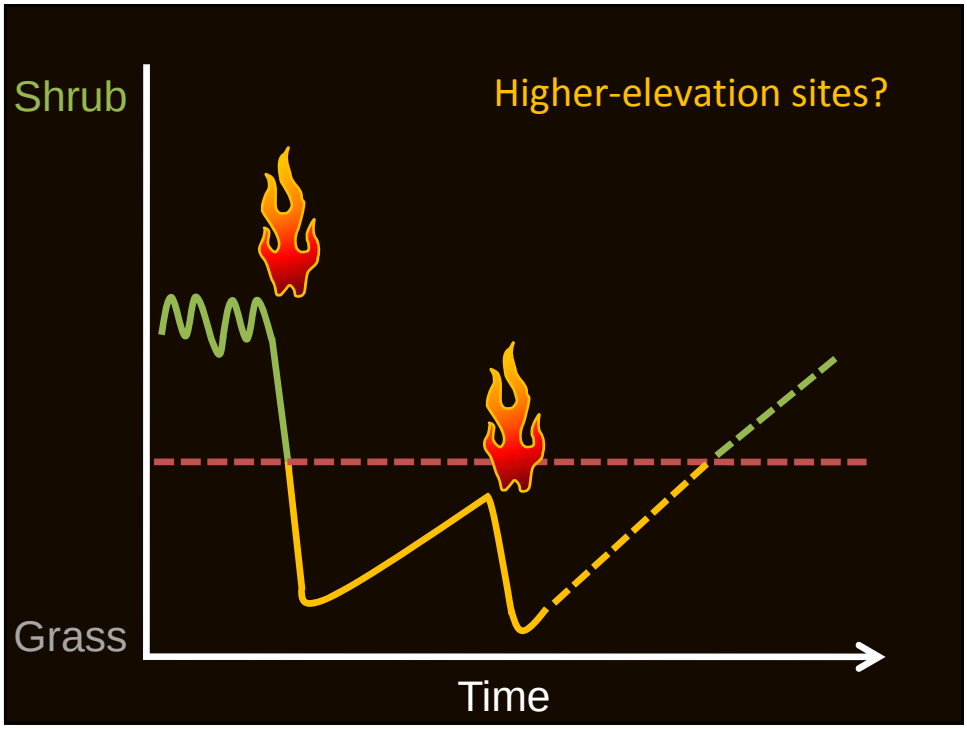
12

	1996	2002	2009
T1	PSSP6 POSE HOUM	POSE DRVE2 PSSP6	POSE AGGR DRVE2
T2	CRAT HOUM PSSP6	POSE PSSP6 DRVE2	POSE PSSP6 CRAT
T3	PHLO2 HOUM POSE	POSE PSSP6 HOUM	POSE PSSP6 BRTE




2002 Plot 7/1
2002 Plot 7/5
2004
2004
2009
2009


Shrub
Lower-elevation sites?
Grass
Time



Conclusions

- Communities differ in response to multiple disturbances
- Lower elevation sites invasive dominated
- Higher elevation sites may recover
- Plant traits may partially explain differences
- Iconic, community/habitat dominant lost

More information: http://depts.washington.edu/firesale
firesale@u.washington.edu