

# Gopher-mound and casting disturbances contribute to plant community structure in a Cascade Range meadow complex

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## Background

Pocket gophers (Geomysidae) are major agents of disturbance in grasslands throughout North America. By depositing soil on the ground surface, they bury plants and reinitiate succession at a local scale. Gopher disturbances increase habitat heterogeneity and potentially influence community structure and diversity by allowing less competitive species to persist. Plant burial by mounds often gives forbs an advantage over graminoids and provides annuals with germination sites [1].

Although gopher effects on vegetation are well-studied in lowland prairies, studies of higher-elevation systems are limited. Here, plant communities face shorter growing seasons and are dominated by perennial (often clonal) species, which can affect gopher disturbances are re-vegetated [2]. In addition, in mountain grasslands that experience deep and persistent snow, gopher disturbances can take the form of winter castings, as well as mounds.

**Mounds.** Mounds are piles of excavated soil that gophers deposit on the ground surface during summer or fall. Mounds vary in size and can persist for one or more years.

**Castings.** Castings are created in winter, when gophers fill snow tunnels with excavated soil that settles onto the ground surface after snow melt. Effects of castings on plant community structure have not been studied before.



## Objectives and Hypotheses

We investigated the effects of gopher disturbance on plant community structure in montane meadows at Bunchgrass Ridge, a high-elevation (4,300 ft.) plateau in the Oregon Cascade Range. We had two primary goals:

- To explore relationships between gopher disturbances and vegetation at larger spatial scales than previously studied in this system [2].** Based on relationships at the scale of individual mounds, we expected that increasing disturbance (greater cover of mounds plus castings) would lead to:
  - lower plant cover
  - reduced dominance by graminoids
  - reduced species richness (or alternatively a hump-shaped pattern)
  - no change in evenness
  - increased heterogeneity of species composition
- To assess the contributions of the two main forms of disturbance—mounds and castings—to these relationships.** We hypothesized that both mounds and castings would contribute significantly to these relationships, but less often for castings due to their smaller volume and more transient nature.

## Methods

### Sampling design

- Four 5 × 20 m plots in three separate meadows with differing community types
- Each plot contained moderate but variable gopher disturbance
- Plots with 20, 5-m transects, each with 25 contiguous 20 × 20 cm quadrats
- Estimated cover of disturbance: mounds (≥1 yr old) and castings
- Several weeks later, estimated cover of forb and graminoid species

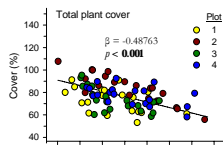
### Analysis

Mixed-effects models to assess relationships between disturbance (cover of mounds, castings, and all gopher disturbance combined) and

- **Plant cover:** total, forbs, graminoids, and ratio of forbs/graminoids
- **Diversity:** species richness (number of species/transect) and evenness
- **Heterogeneity:** mean Bray-Curtis dissimilarity between pairs of quadrats.

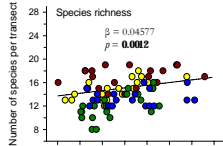


## Results



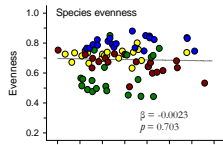
### Total plant cover

- negatively correlated with total disturbance, a trend driven by both mounds and castings



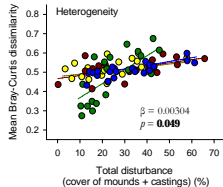
### Species richness

- positively correlated with total disturbance, a trend driven by castings



### Species evenness

- no relationship with disturbance



### Heterogeneity

- positively correlated with total disturbance, a trend driven by mounds

### Frequency and cover of disturbance across plots

- 60-70% of quadrats contained some form of disturbance
- mound cover averaged 12-21%, castings 9-14%, and total disturbance 25-33%



### Disturbance - growth form relationships

#### Total disturbance

- no consistent effect on forb or graminoid cover

#### Mounds

- reduced cover of graminoids
- increased forb/graminoid ratio

#### Castings

- no consistent effects on forbs or graminoids: trends varied among plots

Response variable	Mounds		Castings	
	Effect	P	Effect	P
Total plant cover	↓	<0.001	↓	<0.001
Forb cover	ns	0.99	ns	0.87
Graminoid cover	↓	<0.001	ns	0.34
Forb/graminoid ratio	↑	0.003	ns	0.67
Species richness	ns	0.098	↑	0.002
Heterogeneity	↑	0.012	ns	0.16

## Conclusions

**Castings reduce total plant cover, but effects are transient and non-selective compared to mounds, which are larger, denser, and more persistent.**

- Mounds are larger and last for several growing seasons, while castings are assimilated into the meadow matrix relatively quickly.
- Castings can indiscriminately reduce plant cover during the current growing season, but may not be deep or dense enough to differentially affect growth form survival or emergence.

Depth of burial matters because re-emergence from burial is the primary mechanism by which gopher mounds are re-vegetated in high elevation meadows. This individual of *Lupinus latifolius*, excavated from a gopher mound at Bunchgrass Ridge, illustrates how a new shoot and root system can develop following burial.



**Relationships between disturbance and growth form cover were not consistent among plots, which may be due to differences in species composition.**

- Species within a growth form differ in their susceptibility to burial and rates of regrowth [3]. Thus the nature of growth-form response can vary with the regenerative traits of the local species pool.

**Gopher disturbances reduce species richness locally, but enhance diversity and heterogeneity at larger spatial scales.**

- A previous study in this system [2] found increasing richness on mounds as they age [2], implying a negative relationship between disturbance and diversity at small spatial scales.
- The current study illustrates how diversity-disturbance relationships can vary with scale. Small disturbed patches have fewer species on average than do undisturbed patches, but they are more heterogeneous—more likely to contain species that are unique to a patch [2]. Although local (quadrat-scale) richness was reduced by disturbance, the potential for rarer species to establish on a transect increased, resulting in a positive correlation at this larger scale.

## References

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