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Quantifying changes in density and spatial extent of multiple *Centaurea maculosa* Lam (spotted knapweed) populations.

Exotic species vary in their rate of establishment, spread and impact at both the local and landscape scale. Changes in exotic species' density and spatial extent over time are often used as surrogate measures of impact; hence, it is important to quantify these rates across a range of environments. We studied the spatial and temporal growth of *Centaurea maculosa* populations across four different natural plant communities. At each site we measured changes in *C. maculosa* presence/absence and density in 33 0.25 m^2 plots (132 plots total). Temporal population growth rate was measured as the change in population density (*N*) over the change in time (*t*) or $\delta N/\delta t$, where $\delta N = N_t / N_{t-1}$ or λ. Spatial growth of populations was measured in two ways: (1) proportional change in spatial extent over time, and (2) local colonization and extinction rates. The probability of colonization was measured as the number of plots unoccupied in *t* that became occupied in *t +* 1 divided by the number of plots observed. The probability of extinction was measured as the number of occupied plots in *t* that became unoccupied in *t* + 1, divided by the number of plots occupied in time *t*. We also examined the relationships between temporal growth, spatial growth and habitat suitability for *C. maculosa* (generated from a logistic model of presence/absence data and environmental variables). We hypothesized that not all populations of *C. maculosa* would increase in density and spatial extent. We also hypothesized a positive relationship between the population growth rate (λ) and habitat suitability. Of the 132 plots, 7 unoccupied in *t* became occupied in *t* +1, and 7 occupied in *t* became unoccupied in *t* +1, meaning the probability of extinction equals the probability of colonization for these populations. Twenty-one percent of populations had a λ <1, 61 percent had a λ > 1, and 18 percent were stable. Populations with λ >1 were typically increasing in spatial extent as well. We found a significant positive relationship between λ and habitat suitability. Of the 13 patches studied, 8 decreased in spatial extent and 5 increased in spatial extent. These results highlight the fact that not all exotic species consistently increase in density and spatial extent in all habitats. The positive relationship between population growth rates and habitat suitability predictions suggest these predictions could be used for exotic plant management prioritization.

Quantifying changes in density and spatial extent of multiple *Centaurea maculosa* Lam. (spotted knapweed) populations

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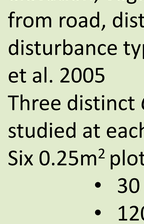

Introduction

- Not all non-native plant (NIS) populations increase in density and/or spatial extent across all environments.
- Knowing which populations are increasing in number of individuals and spatial extent can aid in prioritization of management.
- Establishing a relationship between NIS habitat suitability and invasiveness can make population prioritization and management more efficient.

Definitions

- **Invasiveness** : the degree to which a plant population or meta-population can be characterized as consistently increasing in density and/or spatial extent
- **Monitoring for Invasiveness**: measuring populations or meta-populations across a range of environments to determine change in density and spatial extent over time.
- ***Centaurea maculosa***: non-native biennial to short-lived perennial; often found in open, disturbed areas; considered a serious problem in the rangelands of the northwestern United States.

Objectives

1. Quantify change in density of *C. maculosa* populations across a range of environments
2. Quantify change in spatial extent of *C. maculosa* populations across a range of environments
3. Determine relationship between invasiveness (increasing in density and/or spatial extent) and habitat suitability

Methods

- Four sites across a range of habitat suitability- a function of slope, aspect , elevation, vegetation type, distance from road, distance from trail, and disturbance type, as determined by *Rew* et al. 2005
- Three distinct *C. maculosa* populations studied at each site
- Six 0.25m^2 plots per population
  - 30 plots/site
  - 120 plots total
- Spatial extent measured in three replications with Trimble Geo XT
- Density measured by counting the number of individuals per 0.0625 m^2
- Density analyzed per 0.25 m^2
- Temporal population growth rate calculated as the change in population density (N) over the change in time (t) or $\delta N/\delta t$, where $\delta N = N_t / N_{t-1}$ or λ.
- Spatial population growth was calculated as a proportion: area m^2_t / area m$^2_{t-1}$

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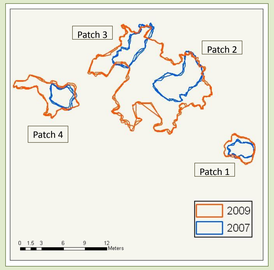
C. maculosa habitat suitability

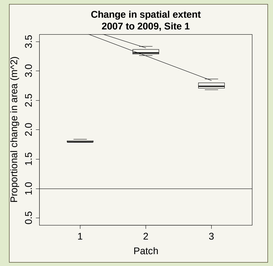
Site Specific Results

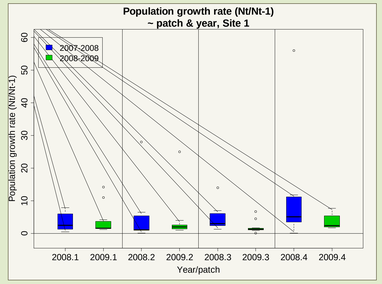
Site 1

Slope: 12-15%
Aspect: 220 W
Elevation: 1540-1560m

Pseudoroegneria spicata
Festuca idahoensis
Koeleria cristata
Artemisia frigida



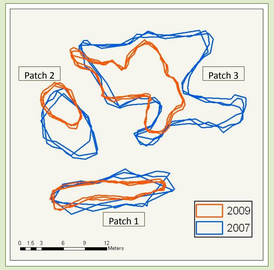


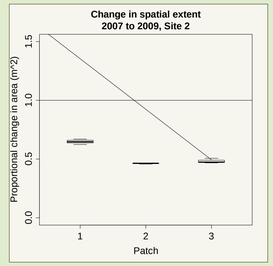


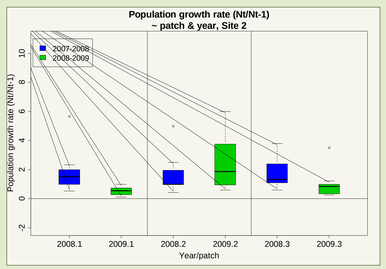
Site 2

Slope: 0-10%
Aspect: 0 N
Elevation: 1670m

Pseudotsuga menziesii
Symphoricarpos albus
Phleum pratense
Poa pratensis



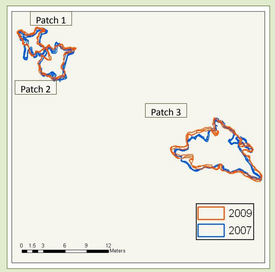


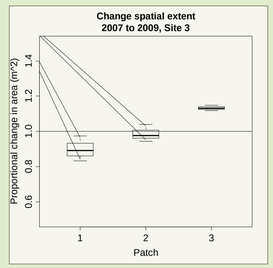


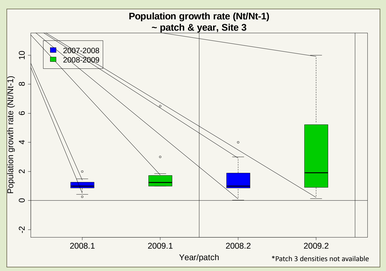
Site 3

Slope: 0%
Aspect: 90 E
Elevation: 1515m

Pseudoroegneria spicata
Festuca idahoensis
Bouteloua gracilis
Hesperostipa comata



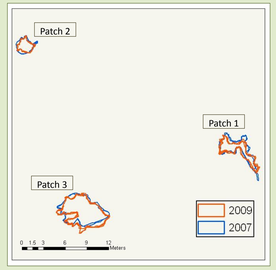


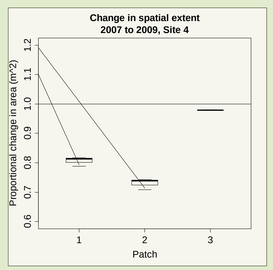


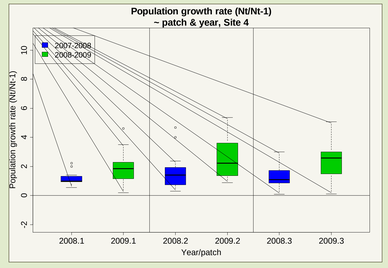
Site 4

Slope: 35-40%
Aspect: 90 E
Elevation: 1720-1780m

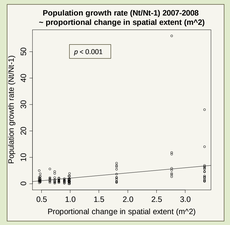
Artemesia tridentata
Pseudoroegneria spicatum
Festuca idahoensis
Balsamorhiza sagittata

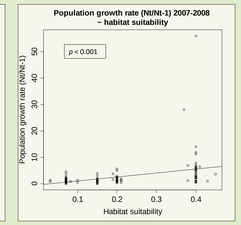


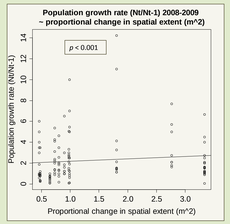


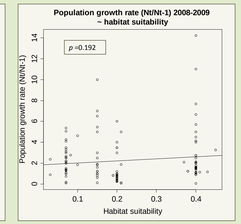


Combined Results









Conclusions

- Not all *C. maculosa* populations consistently increase in density and spatial extent across different environments.
- There is a significant relationship between population growth rate and habitat suitability, suggesting habitat suitability predictions can serve as a useful management prioritization tool.
- There is a significant relationship between spatial and temporal growth rates of *C. maculosa*, indicating that the most invasive populations will consistently increase in both density and spatial extent.

Literature Cited

Rew, LJ; Maxwell BD; Aspinall, R (2005) Predicting the occurrence of non-indigenous species using environmental and remotely sensed data. *Weed Research* 53,236-241

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