Geophysical Research Abstracts
Vol. 19, EGU2017-1789-4, 2017
EGU General Assembly 2017

Transitions and coexistence along a grazing gradient in the Eurasian steppe

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Ecological resilience theory has often been applied to explain species coexistence and range condition assessment of various community states and to explicate the dynamics of ecosystems. Grazing is a primary disturbance that can alter rangeland resilience by causing hard-to-reverse transitions in grasslands. Yet, how grazing affects the coexistence of plant functional group (PFG) and transition remains unclear. We conducted a six-year grazing experiment in a typical steppe of Inner Mongolia, using seven grazing intensities (0, 1.5, 3.0, 4.5, 6.0, 7.5 and 9.0 sheep/ hectare) and two grazing systems (i.e. a continuous annual grazing as in the traditional grazing system, and a mixed grazing system combining grazing and haymaking), to examine grazing effects on plant functional group shifts and species coexistence in the semi-arid grassland system.

Our results indicate that the relative richness of dominant bunchgrasses and forbs had a compensatory coexistence at all grazing intensities, and the richness of rhizomatous grasses fluctuated but was persistent. The relative productivity of dominant bunchgrasses and rhizomatous grasses had compensatory interactions with grazing intensity and grazing system. Dominant bunchgrasses and rhizomatous grasses resist grazing effects by using their dominant species functional traits: high specific leaf area and low leaf nitrogen content. Our results suggest that:

1. Stabilizing mechanisms beyond grazing management are more important in determining plant functional group coexistence and ecological resilience.

2. Plant functional group composition is more important in influencing ecosystem functioning than diversity.

3. Ecosystem resilience at a given level is related to the biomass of dominant PFG, which is determined by a balanced shift between dominant species biomass. The relatively even ecosystem resilience along the grazing gradient is attributed to the compensatory interactions of dominant species in their biomass variations. Community stability may rely on constantly regulating internal PFGs composition to maintain functional stability in grassland ecosystems.

In the semi-arid grassland system, environmental factors mediate grazing effects on PFG transition, leading to homogeneous grassland dominated by bunchgrass.