Species Loss and Ecosystem Functioning: Effects of Species Identity and Community Composition

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Losing a single species from an ecosystem may have large effects on community and ecosystem properties, but this may depend on characteristics of the species and the ecosystem. We examined the effect of losing a single species on productivity and nitrogen retention in experimental grassland communities, concentrating on how these effects varied with the functional identity of the species lost and the diversity and composition of the community from which it was lost. In one experiment, we constructed random plant assemblages that varied in species richness to measure the effect of diversity alone on productivity and nitrogen retention. In another experiment, we constructed plant assemblages to assess the effects of deleting an individual plant species from assemblages differing in their functional and species richness and composition. On average, as species richness declined, productivity decreased but nitrogen retention was unaffected. However, the magnitude and direction of change in ecosystem functioning with declining diversity depended on the identity of the species deleted and the composition of the community from which it was deleted. The functional identity of a species predicted the type of impact its loss had on productivity, but not on nitrogen retention.

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Several recent studies have shown a positive correlation between plant species richness and ecosystem productivity, stability, and sustainability (Naeem et al. 1994, 1995, 1996, Tilman and Downing 1994, Tilman 1996, Tilman et al. 1996). Because all species presumably have some impact on the ecosystem in which they live, it is not clear how much of this relationship is caused by species number per se versus the effects of individual species. The abundance of a single species may affect community and ecosystem properties such as the abundance of other species (e.g., Paine 1966, 1974, Power et al. 1985), nutrient cycling (Vitousek and Walker 1989), and susceptibility to disturbance (D'Antonio and Vi- those with keystone effects (sensu Paine 1969, Power et al. 1996) to those whose loss either has a negligible effect or is compensated for by other species in its functional group (Walker 1992, 1995, Lawton and Brown 1993, Frost et al. 1995).

Here we systematically investigate all of the species in an experimental community to determine individual species' impacts on ecosystem processes and how these impacts are related to species and community characteristics. Using a series of greenhouse grassland plant communities, we determined the effect of losing a single species on two ecosystem processes and investigated how these effects varied with the functional identity of

tousek 1992). The magnitude of these impacts, however, seems to vary enormously among species, from the species and the diversity and composition of the community from which it was lost.

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Abstract:

Losing a single species from an ecosystem may have large effects on community and ecosystem properties, but this may depend on characteristics of the species and the ecosystem. We examined the effect of losing a single species on productivity and nitrogen retention in experimental grassland communities, concentrating on how these effects varied with the functional identity of the species lost and the diversity and composition of the community from which it was lost. In one experiment, we constructed random plant assemblages that varied in species richness to measure the effect of diversity alone on productivity and nitrogen retention. In another experiment, we constructed plant assemblages to assess the effects of deleting an individual plant species from assemblages differing in their functional and species richness and composition. On average, as species richness declined, productivity decreased but nitrogen retention was unaffected. However, the magnitude and direction of change in ecosystem functioning with declining diversity depended on the identity of the species deleted and the composition of the community from which it was deleted. The functional identity of a species predicted the type of impact its loss had on productivity, but not on nitrogen retention.