Kentucky bluegrass invasion alters soil carbon and vegetation structure

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Increases of invasive grasses, such as smooth brome or Kentucky bluegrass, is a concern on rangelands in the northern Great Plains because these invasions can impact the important functions and therefore services rangeland ecosystems provide the public. For example dense stands of sod-forming grasses, such as Kentucky bluegrass, may alter hydrological attributes by reducing water infiltration into the soil and increasing surface water runoff. Kentucky bluegrass also has a different photosynthetic pathway (C3) which can result in higher nitrogen (N) concentrations and less recalcitrant carbon (C) than native C4 grasses. The changes in N and C concentrations can contribute to faster decomposition rates and accelerated nutrient cycling. Kentucky bluegrass also has greater litter buildup which may impact soil biology. Long-term data (>100 years) from a grazing experiment near Mandan revealed the invasion of native prairie by Kentucky bluegrass, an exotic grass. Preventing or managing this invasion has been difficult because of climate variability and some management practices. The Mandan, ND ARS location is unique in that it has several long-term pastures to use as a case study of long-term invasion of native rangeland by exotic grasses.

One way to estimate the impact non-native grass invasions can have on nutrient cycling is to look at the stable isotope ratios in the soil. Differences in stable C isotope ratios between C3 and C4 plants can be used to estimate changes in the composition of soil organic C. Because of differences in photosynthetic pathways, C4 plants discriminate less against the 13C isotope than 12C, resulting in a less negative δ 13C ratio (approx. −9‰ to −15‰) than C3 plants (approx. −25‰ to −30 ‰).

The Northern Great Plains Research Laboratory has pastures that have been grazed similarly since 1916. The original vegetation at these long-term sites was primarily blue grama and needle-and-thread grass. Increased abundance of Kentucky bluegrass was noted at the long-term grazing site in the 1990s, and its abundance has increased steadily. In 2014, soil samples were collected to depths of 0 to 3 inches and 3 to 6 inches in pastures grazed similarly since

		Relative foliar cover[a]				Canopy cover[b]		
Stocking rate	Species	1964	1984	1994	1998	2004	2014	2014
		AUM ha^{-1}		%				
No grazing	Blue grama			0	0			0
	Kentucky bluegrass			56	62			14
	Smooth brome							30
1.0	Blue grama	64	23	16	3	3	14	2
	Kentucky bluegrass	0	0	29	44	64	63	41
2.4	Blue grama	100	79	86	72	40	16	5
	Kentucky bluegrass	0	0	0	0	30	74	40

[a] Data for 1964, 1984, and 1994 are from Frank et al. (1995). Relative foliar cover data for 1998, 2004, and 2014 are based on point-frame analysis of vegetation: one hundred 10-pin frames per sampling date in late summer or autumn.

[b] Canopy cover data from 2014 are averages of visual observations in 20 1-m^2 quadrats in the pastures and six quadrats in the exclosure.

1916. Samples were analyzed for total carbon (C) and nitrogen (N) and 13C and 15N isotopes and compared against archived samples from 1991.

Vegetation change from native to exotic grasses changed the isotopic composition of soil C. The soil 13C at the 0- to 3 inch depth became more negative between 1991 and 2014. Soil 13C became less negative with increasing stocking rate at both soil depths. Soil 15N values at the 0- to 2 inch depth decreased between 1991 and 2014. Soil 15N increased with increasing stocking rate at the 0- to 3 inch depth in 2014. Soil C and N concentrations at 0 to 3 inch increased by 35% and 27%, respectively, from 1991 to 2014; however, concentrations at the 3- to 6 inch depth did not change.

These data suggest that the shift from native C4 to invasive C3 grass did not reduce soil C storage in the long-term prairie pastures. A more negative impact of the invasion, however, may have been the buildup of dead biomass, which alters vegetation structure and may reduce native species' diversity and abundance.

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