

TITLE:

Data from: Soil disturbance and invasion magnify CO₂ effects on grassland productivity, reducing diversity

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ABSTRACT:

Climate change, disturbance, and plant invasion threaten grassland ecosystems, but their combined and interactive effects are poorly understood. Here, we examine how the combination of disturbance and plant invasion influences the sensitivity of mixedgrass prairie to elevated carbon dioxide (eCO₂) and warming. We established subplots of intact prairie and disturbed/invaded prairie within a free-air CO₂ enrichment (to 600 ppmv) by infrared warming (+1.5 °C day, 3 °C night) experiment and followed plant and soil responses for five years. Elevated CO₂ initially led to moderate increases in biomass and plant diversity in both intact and disturbed/invaded prairie, but these effects shifted due to strong eCO₂ responses of the invasive forb *Centaurea diffusa*. In the final three years, biomass responses to eCO₂ in disturbed/invaded prairie were 10 times as large as those in intact prairie (+186% vs. +18%), resulting in reduced rather than increased plant diversity (-17% vs. +10%). At the same time, warming interacted with disturbance/invasion and year, reducing the rate of topsoil carbon recovery following disturbance. The strength of these interactions demonstrates the need to incorporate disturbance into predictions of climate change effects. In contrast to expectations from studies in intact ecosystems, eCO₂ may threaten plant diversity in ecosystems subject to soil disturbance and invasion.

KEYWORDS:

aboveground net primary productivity, soil carbon, climate change, global change, invasive plants, *Centaurea diffusa*, plant diversity, mixedgrass prairie, soil disturbance, global warming

DATES OF DATA COLLECTION:

2009-2013

LOCATION:

Latitude 40.1083333, Longitude -104.71667

Wyoming, USA; Prairie Heating and CO₂ Enrichment (PHACE) experiment; northern mixedgrass prairie

FUNDING:

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USAGE NOTES:

Climate treatments included: (1) **ct**: ambient CO₂ and temperature, (2) **cT**: infrared warming to increase canopy temperature 1.5 °C during the day and 3 °C at night, (3) **Ct**: free-air CO₂ enrichment to 600 ppmv, and (4) **CT**: CO₂ enrichment plus warming.

Climate treatments were applied to “rings” (i.e. whole plots). Within rings, vegetation treatments (i.e. subplots) included (1) intact prairie, and (2) disturbed/invaded prairie. Within disturbed/invaded prairie subplots, we tilled two 20-cm × 100-cm strips, separated by a 15-cm x 100-cm strip of existing prairie vegetation in the center, and bordered by two 7.5-cm x 100-cm strips of prairie vegetation on the sides. For *Centaurea diffusa* biomass data in Table 2, strip types are coded as (1) tilled, and (2) vegetated. For both tables, the harvested area is indicated in the “area of harvested subplot” column.

For more details, please refer to Figures 1 and S1 in the associated manuscript.

DATA DESCRIPTION:

This dataset includes two data tables and a readme file.

Table_1	
COLUMN	DESCRIPTION
Year	Measurement year (2009-2013)
Ring	Alphanumeric identifier for each unique ring
Block	Alphanumeric identifier for each unique block
Climate Treatment	Climate treatment code: (1) ct: ambient CO ₂ and temperature, (2) cT: infrared warming to increase canopy temperature 1.5 °C during the day and 3 °C at night, (3) Ct: free-air CO ₂ enrichment to 600 ppmv, and (4) CT: CO ₂ enrichment plus warming.
Vegetation Treatment	Vegetation treatment: (1) intact prairie, (2) disturbed/invaded prairie
Area of Harvested Subplot_m2	Area of subplot harvested; units: square meters
Aboveground Biomass Total_g per m2	Aboveground biomass for all plant groups; units: grams per square meter
Aboveground CEDI Biomass_g per m2	Aboveground biomass for species <i>Centaurea diffusa</i> (CEDI) in disturbed/invaded subplots; units: grams per square meter
Aboveground Other Invasive Biomass_g per m2	Aboveground biomass for all seeded invasive species excluding <i>Centaurea diffusa</i> in disturbed/invaded subplots; units: grams per square meter
Aboveground Native Biomass_g per m2	Aboveground biomass for all native species in disturbed/invaded subplots; units: grams per square meter
Root Biomass_0-5cm_g per m2	Root biomass for all species at 0-5 cm soil depth, measured 2011; units: grams per square meter
Root Biomass_5-15cm_g per m2	Root biomass for all species at 5-15 cm soil depth, measured 2011; units: grams per square meter
Richness	Number of species in sampled subplot area
Evenness	Evenness of species in sampled subplot area
H'	Diversity (H') of species in sampled subplot area
Soil C_0-5cm_percent	Soil carbon percent at 0-5 cm soil depth
Soil C_5-15cm_percent	Soil carbon percent at 5-15 cm soil depth

NO3-N_micrograms N per 10 cm2	Soil nitrate (NO ₃ -) availability measured by resin strips inserted into the soil during the growing season; units: micrograms N per 10 cm ²
Light Penetration_proportion of ambient PAR	Proportion of ambient photosynthetically active radiation (PAR) reaching ground level in disturbed/invaded subplots, measured 2011-2013

Table_2	
COLUMN	DESCRIPTION
Year	Measurement year (2011-2013)
Ring	Alphanumeric identifier for each unique ring
Block	Alphanumeric identifier for each unique block
Climate Treatment	Climate treatment code: (1) ct: ambient CO ₂ and temperature, (2) cT: infrared warming to increase canopy temperature 1.5 °C during the day and 3 °C at night, (3) Ct: free-air CO ₂ enrichment to 600 ppmv, and (4) CT: CO ₂ enrichment plus warming.
Vegetation Treatment	Vegetation treatment: (1) intact prairie, (2) disturbed/invaded prairie
Disturbance Treatment	Disturbance treatment within disturbed/invaded prairie subplots: (1) tilled, (2) vegetated
Area of Harvested Subplot_m2	Area of disturbed/invaded subplot harvested; units: square meters
Aboveground CEDI Biomass_g per m2	Aboveground biomass for species <i>Centaurea diffusa</i> (CEDI) in tilled and vegetated areas within disturbed/invaded subplots, measured 2011-2013; units: grams per square meter

REFERENCE:

This dataset is supplement to: Blumenthal *et al.* 2022. Soil disturbance and invasion magnify CO₂ effects on grassland productivity, reducing diversity. Global Change Biology.