

Juniper Invasion Alters Ecosystem Services in the

Great Plains



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Background

The Great Plains' grasslands have been dominant for over 5,000 years because of the stabilizing interactions between people, fire, herbaceous fuels, and topography (1). Modern day uncoupling of historic interactions between people and fire (fire suppression) has led to the reorganization of vegetation communities under new conditions. This "reorganization" is recognized as juniper (*Juniperus spp.*) invasion in the Great Plains and directly alters the way people interact with and benefit from nature. Here, we conduct a meta-review of the literature to assess how ecosystem services change as grasslands are invaded by juniper.

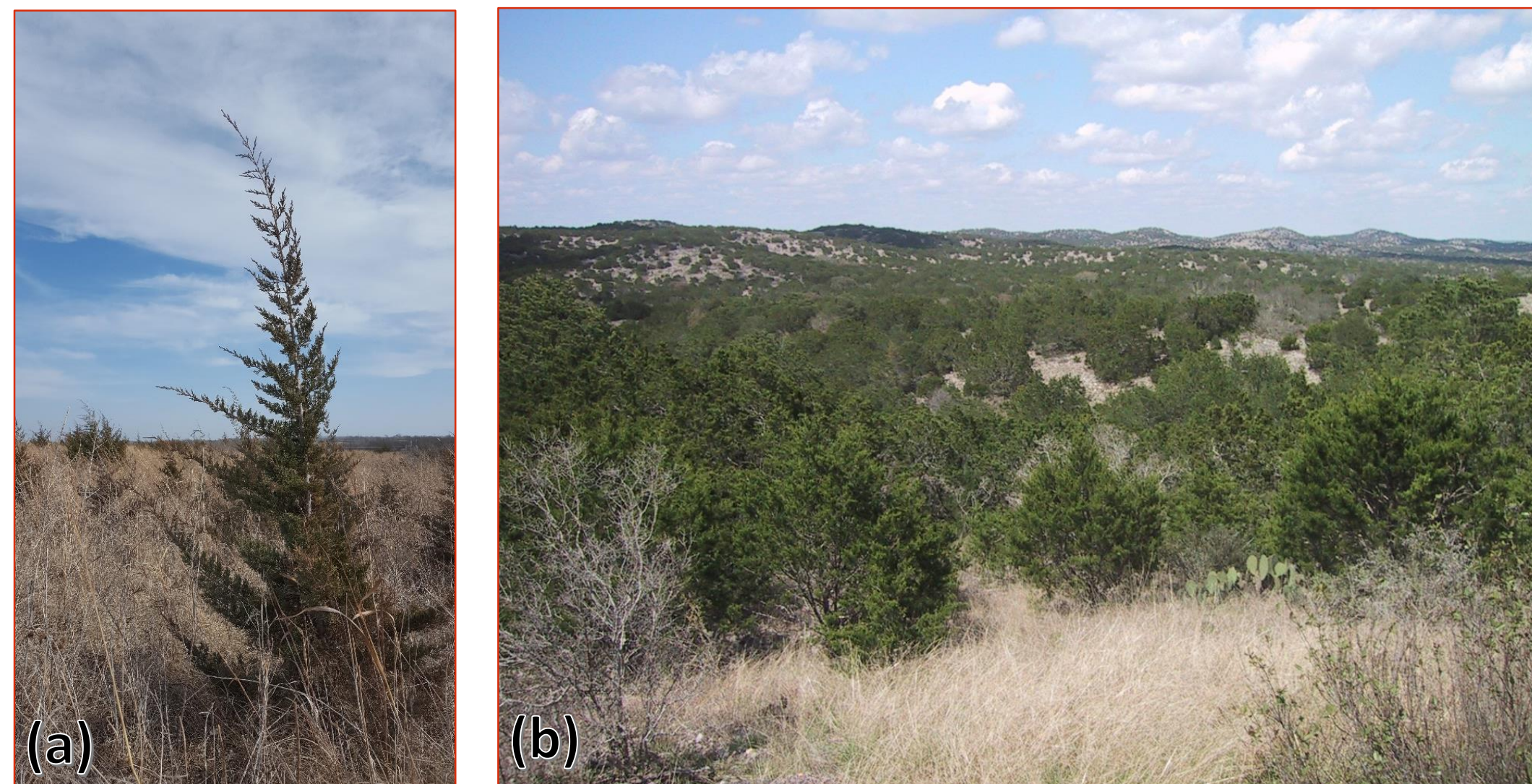


Figure 1. Eastern redcedar invasion can convert a diverse tallgrass prairie to a monoculture woodland in as little as 40 years (2). (a) early and (b) late stages of invasion.

Methods

Literature search and criteria

- We used a series of search phrases including terms associated with eastern redcedar (e.g., *juniperus virginiana*, juniper, cedar) and synonyms of the word impact on the Web of Science search engine.
- Articles included in the review had to meet the following criteria: (1) Published in a peer reviewed journal; (2) quantified an ecosystem service in a grassland and juniper dominated state; and (3) was conducted in the Great Plains.
- Non-relevant articles were removed based on title, abstract, or examination of full text.

Meta-analysis

- We used the log response ratio (RR) to quantify study effect size (Hedges et al. 1999)
 - $RR = \ln(X_{\text{juniper}}/X_{\text{grass}}) = \ln(X_{\text{juniper}}) - \ln(X_{\text{grass}})$
- Where X_{juniper} is the mean for a juniper state and X_{grass} is the mean for a grassland state.
- When multiple studies existed for an ecosystem service we calculated the mean log response ratio and standard errors.

Objective

- Quantify changes to ecosystem services when grasslands shift to juniper woodlands in the Great Plains

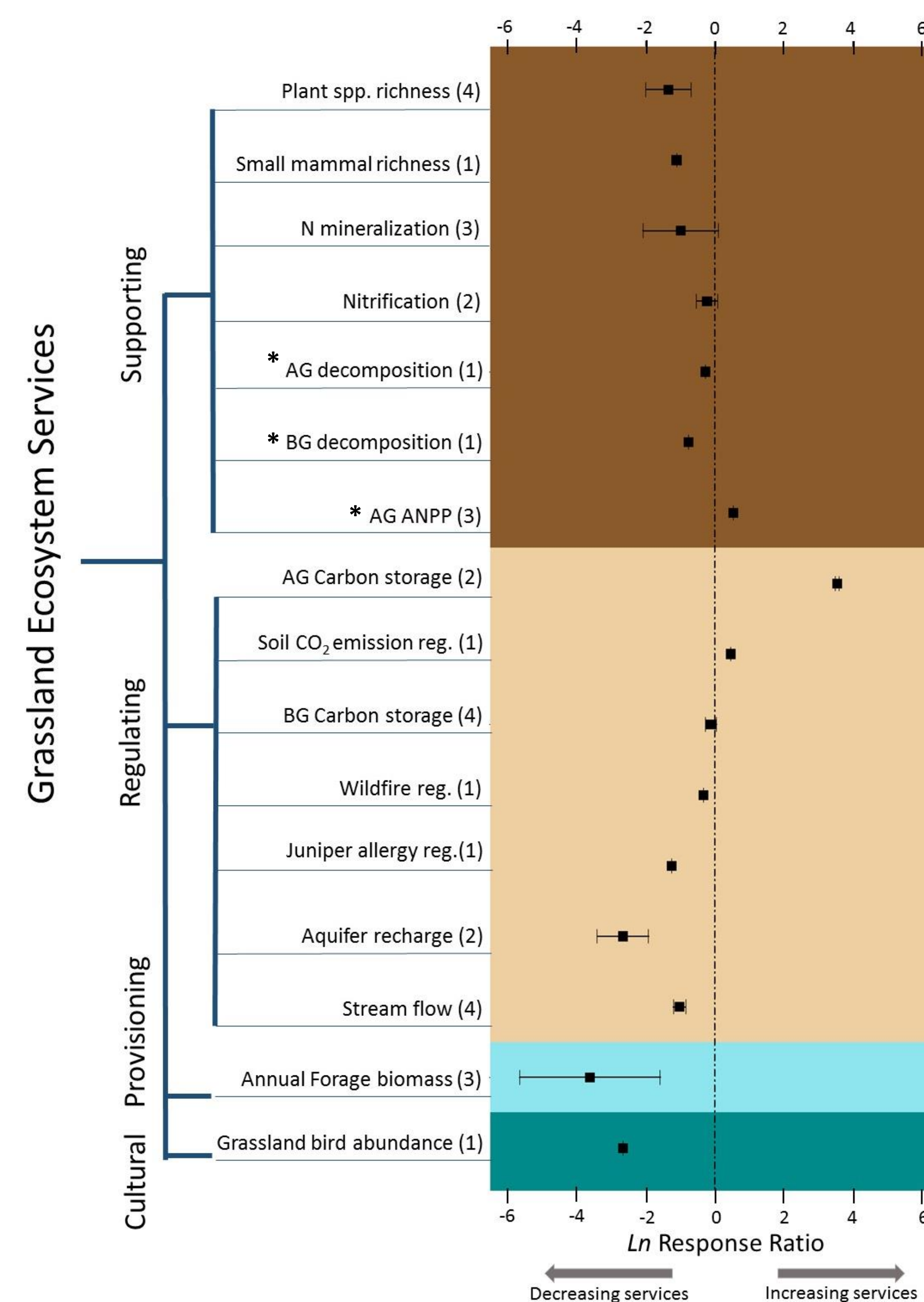


Figure 2. Mean response ratio (RR) ±SE for ecosystem services (# after service is the number of studies). Negative RR indicate a decrease in that service while positive values indicate an increase. Colors illustrate ecosystem service categories: **Supporting services** are those that are important for production of other services; **Regulating services** maintain and control important ecosystem functions; **Provisioning services** are material products obtained from ecosystems; and **Cultural services** are non-consumptive aspects of ecosystems that people receive.
*AB = aboveground; BG = belowground; ANPP = annual net primary production

Results

- We reviewed titles of 314 studies, of which 29 met all criteria
- Quantitative impacts were assessed for 16 ecosystem services
- Most ecosystem services declined with major exceptions for ecosystem services related to aboveground (AG) production of carbon

Summary

- Many of the services reviewed from the literature support other ecosystem services
- E.g., annual forage biomass supports:
 - livestock production
 - landowner Livelihoods
 - Public school funding
 - Wildlife forage
 - Wildlife habitat
 - Regulation of disturbance regimes
- Social and economic systems in the Plains are often organized to benefit from grassland associated ecosystem services like forage production and ground water supply.
- Observed ecosystem service changes are expected to alter current social and economic strategies
 - E.g., in eastern Nebraska land use has been seen to shift from grazing to recreation (e.g., hunting) after juniper invasion
- All ecosystem services shown to increase have low response diversity and resilience because they are primarily supported by a single species—redcedar
- Findings here indicate future alteration of ecosystem services in the Great Plains if appropriate fire regimes are not restored



Figure 3. Previously juniper invaded mixed-grass prairie that has been restored by a high intensity fire. Note the return of herbaceous biomass on steep slopes that were once covered by juniper—see juniper woody debris.

Acknowledgements

We thank Nebraska Game Fish and Parks Commission for funding this research. Craig Allen and the Eastern redcedar working group at UNL provided valuable feedback on this research for which we are grateful for.

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