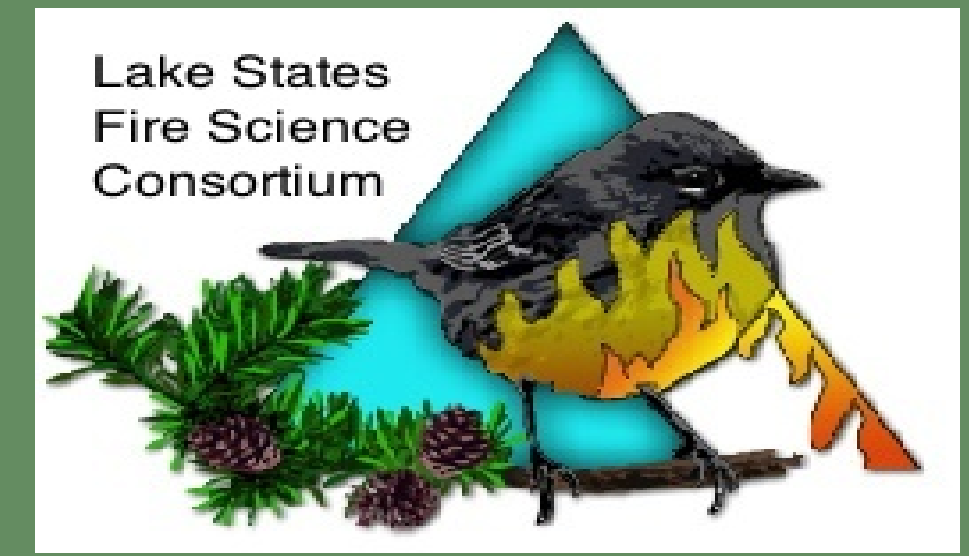


# Reviewing the Effects of Fire Frequency, Intensity, and Seasonal Timing on Invasive Plant Species in Great Lakes Prairies

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## Overview

- Fire is a form of disturbance that has been proven to produce vacancies in previously occupied niches of environments (Elton, 1958). However, fire in a prescribed setting is a proven restoration practice used to deter the prevalence of invasive plant species in a native ecosystem (Emery & Gross, 1995).
- The purpose of this study was to review the effects of fire's frequency, intensity, and seasonal timing in disturbance-dependent prairie ecosystems native to the Great Lakes region. Articles with primary focus on invasive species and reaction to fire frequency, intensity, or seasonal timing were collected for ecosystems relevant to the Lakes State Fire Science Consortium database.
- Articles were classified according to a treatment's decrease (positive response) or increase (negative response) in invasive plant species.
- Chi-square analysis was used to identify overall trends in positive or negative effects of fire.
- Fires of annual frequency conducted for a duration of three years at low intensities appear to be the best-documented method to control invasive plant species in grassland ecosystems in the Great Lakes focus region (Freq:  $\chi^2=5$ , timing:  $\chi^2=4$ ).
- Annual fires prove most effective when conducted in mid-summer. Mid-summer burns appear to be effective in decreasing invasive species prevalence while preserving native plant species seed banks. However, the effects of fire intensity were not statistically significant ( $\chi^2=2$ ).

## Introduction

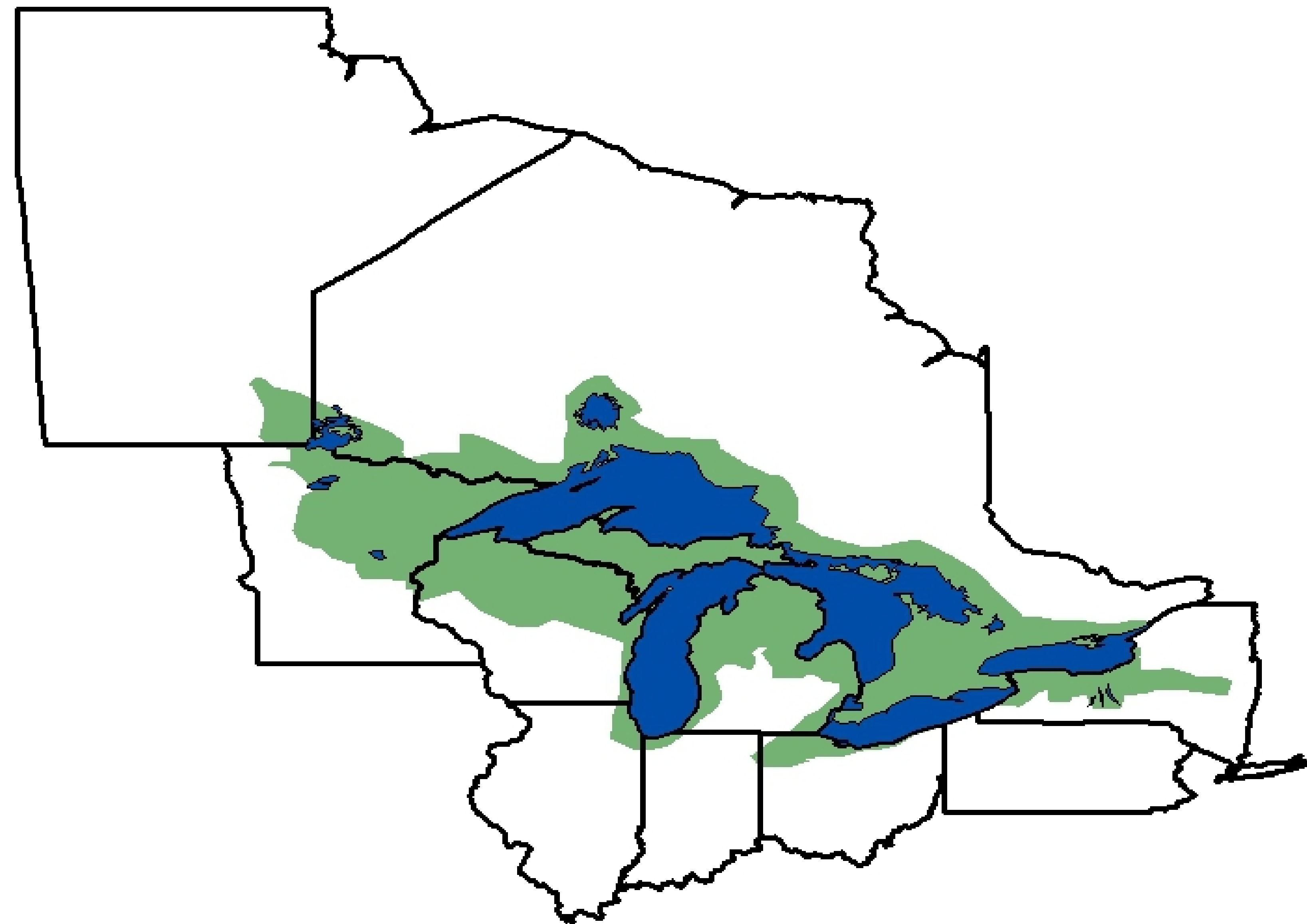
### Hypotheses

1. Fire regimes of high frequency ( $\geq$  one fire event per year for three years) decrease invasive plant species' post-fire prevalence.
2. Fires of high intensity ( $\geq$  300 degrees celcius) decrease invasive plant species' post-fire prevalence.
3. Fires that occur in mid-summer decrease invasive plant species' post-fire prevalence.

### Invasive Species: Risks of Fire

1. Natural disturbance regimes can produce vacant niches for which newly introduced invasive plant species can compete.
2. Suppression of natural fire regimes can allow less fire tolerant non-native species an opportunity to invade ecosystems.

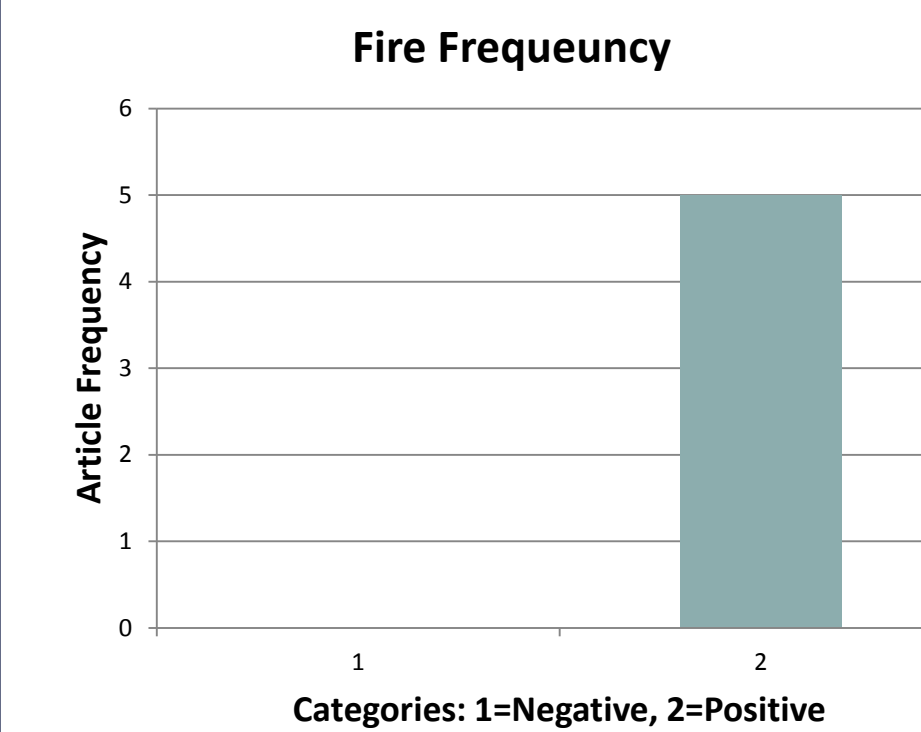
## The Lakes States Fire Science Consortium



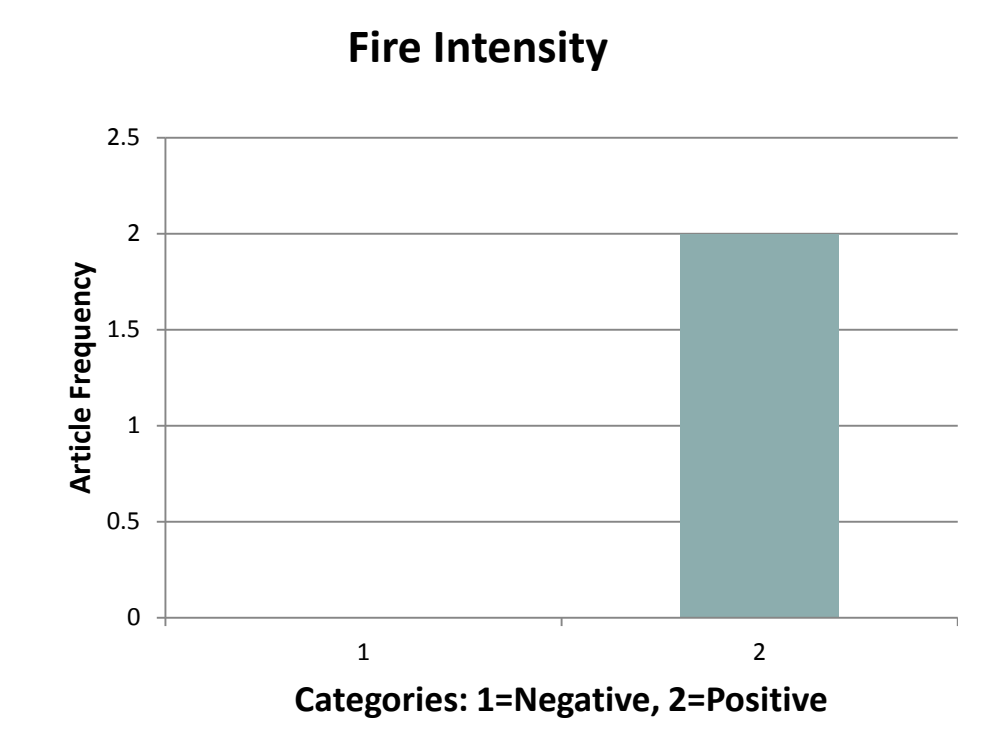
## Methods

Relevant Publications	Ecosystem	Topic	Location	Disturbance Type	Primary Invasive Specie(s)	Data Type
Bowles, M. et al. (2007)	Oak Savanna	Frequency	Morton Arboretum, DuPage Co, IL	Long-term prescribed burning (20 yr)	<i>Rhamnus Cathartica</i> , <i>Lonicera maackii</i>	Stem Density (#/0.25m <sup>2</sup> )
Bowles, et al. (2003)	Prairie	Frequency	Carrol, Henderson, IL	Long-term prescribed burning (20 yr)	<i>Bromus inermis</i> and <i>Poa pratensis</i>	Species Richness
Emery, S. M., & Gross, K. (2005)	Prairie/Savanna	Frequency	Fort Custer Training Center, Augusta, MI	Seasonal prescribed burning (3 yr)	<i>Centaurea maculosa</i>	Biomass and Individual Abundance
Heslinga, J. L., & Grese, R. E. (2010)	Tallgrass Prairie	Frequency	University of Michigan Nichols Arboretum, Ann Arbor, MI	Long-term prescribed burning (16 yr)	<i>Poa pratensis</i> and <i>Centaurea maculosa</i>	Species Richness
MacDonald, N. et al. (2007)	Prairie/Savanna	Frequency	Grand River, MI	Herbicide and prescribed burn (3 yr)	<i>Centaurea maculosa</i>	Biomass
Bowles, M. et al. (2007)	Oak Savanna	Intensity	Morton Arboretum, DuPage Co, IL	Long-term prescribed burning (20 yr)	<i>Rhamnus cathartica</i> , <i>Lonicera maackii</i>	Temperature
Emery, S., et al. (2011)	Eastern deciduous forest/Savanna	Intensity	Big Oaks National Wildlife Refuge in Madison, IN	Prescribed fires of ranging intensities	<i>Microstegium vimineum</i>	Temperature and Germination Rate (#seeds)
Emery, S. M., & Gross, K. (2005)	Prairie/Savanna	Seasonal Timing	Fort Custer Training Center, Augusta, MI	Seasonal prescribed burning (3 yr)	<i>Centaurea maculosa</i>	Biomass and Individual Abundance
Heslinga, J. L., & Grese, R. E. (2010)	Tallgrass Prairie	Seasonal Timing	University of Michigan Nichols Arboretum, Ann Arbor, MI	Long-term prescribed burning (16 yr)	<i>Poa pratensis</i> and <i>Centaurea maculosa</i>	Species Richness
Howe, H. F. (1994)	Grassland/Prairie	Seasonal Timing	Webster Township, SW WI	Seasonal prescribed burning and fire history	Not Specified	% Cover
MacDonald, et al. (2007)	Prairie/Savanna	Seasonal Timing	Grand River, MI	Herbicide and prescribed burn (3 yr)	<i>Centaurea maculosa</i>	Biomass
Romo, J. T., & Gross, D. V. (2011)	Fescue Prairie	Seasonal Timing	Kernen Prairie, Saskatoon, Sask.	Fire history and prescribed burn	<i>Poa compressa</i>	Species Richness and Diversity
Suding, K. N., & Gross, K. L. (2006)	Grassland/Savanna	Seasonal Timing	Fort Custer Training Center (FCTC), Augusta, MI	Prescribed Fire	<i>Centaurea maculosa</i> and <i>Poa pratensis</i>	Species Richness and Biomass

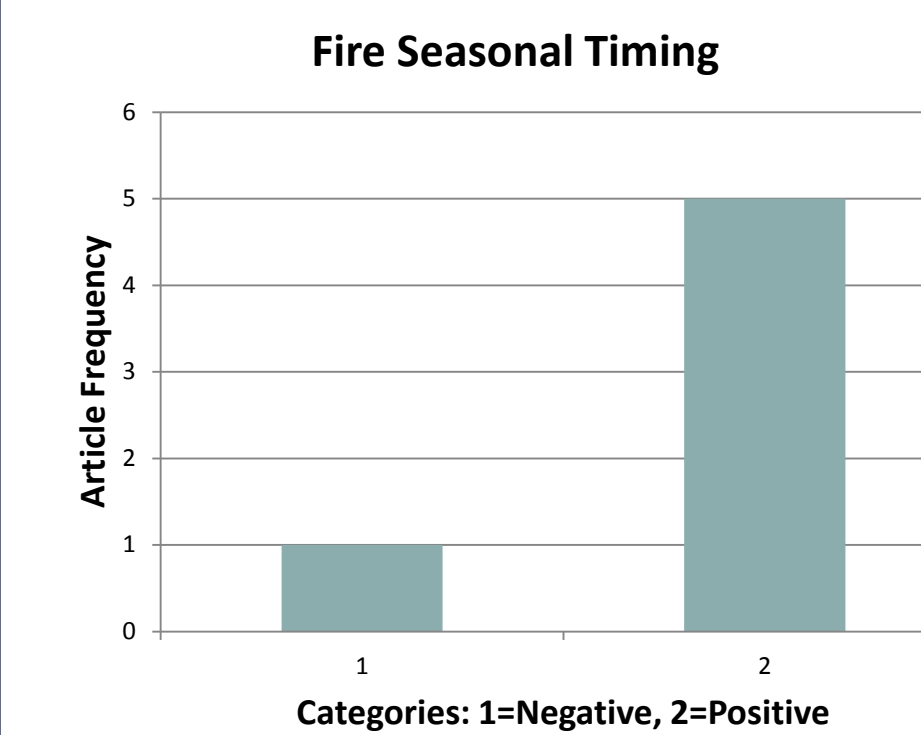
## Results



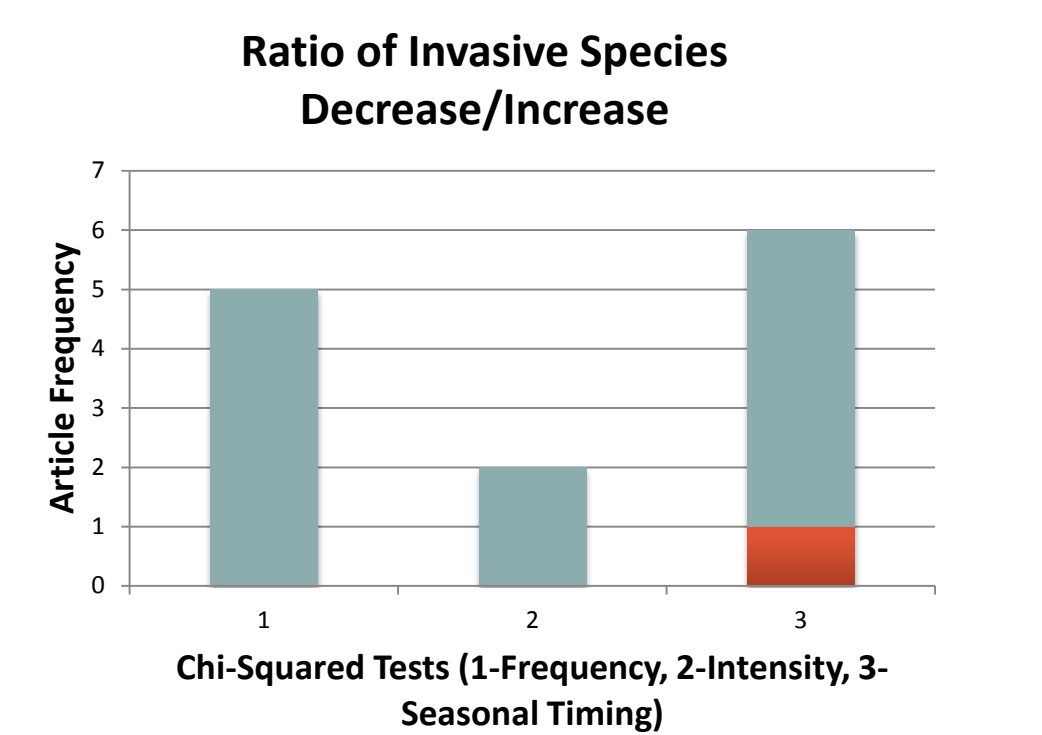
\*In the five articles pertaining to fire frequency, all five observed a decrease in invasive plant species and supported the alternative hypothesis ( $\chi^2=5$ ,  $c^2=3.84$ ).



\*Fires of higher intensity decreased seed germination for invasive plant species and theoretically would support the alternative hypothesis. However this result is statistically insignificant due to the low number of reviewed articles ( $\chi^2=2$ ,  $c^2=3.84$ ).



\*Mid-summer burning was effective in diminishing invasive species prevalence and thus supported the alternative hypothesis ( $\chi^2=4$ ,  $c^2=3.84$ ).



\*Only one of the twelve articles between the three tests concluded that fire in any form increased the prevalence of exotic invasive species (Red Portion).

## Discussion

1. Results suggest that fires of annual frequency conducted for a duration of three years decrease the number of invasive plant species in prairie ecosystems.
1. Results also suggest that annual fires prove effective when conducted in mid-summer months.
2. Although only two thirds of the hypotheses were supported according to the chi-squared test, low fire intensity has been found to be a successful practice to decrease invasive species abundance in ecosystems outside the Great Lake focus region (Hobbs & Huenneke, 2002).

## References

Elton, C. S. 1958. The ecology of invasions by animals and plants. *University of Chicago Press*, Chicago, Illinois, USA.

Emery, S. M., & Gross, K. L. 2005. Effects of timing of prescribed fire on the demography of an invasive plant, spotted knapweed *Centaurea maculosa*. *J. App. Eco.* 42(1): 60-69.

Hobbs, R., & Huenneke L. 2002. Disturbance, Diversity, and Invasion: Implications for Conservation. *Conservation Biology*. Vol. 6. 324-337.