

Knowledge gaps assessment of fire effects on reptiles and amphibians in the Lake States region

Samantha L. Lasko¹, Jessica R. Miesel^{2,3}, P. Charles Goebel^{2,3}, and David J. Mladenoff¹

¹Department of Forest and Wildlife Ecology, University of Wisconsin – Madison, ²Lake States Fire Science Consortium, and ³Ohio Agricultural Research and Development Center, The Ohio State University



Background

How does fire affect reptiles and amphibians in the Lake States region? What research has been done on this subject? Is fire disturbance problematic to species conservation and management in the Lake States Region?

- The important role of fire as a natural disturbance is becoming increasingly recognized in ecosystem management and species conservation.
- Most research on fire ecology has been focused in the western United States where the frequency of catastrophic fires has increased.
- The effects of fire (prescribed and wild) on ecosystems surrounding the Lake States region have not been thoroughly examined, even though fire is a natural disturbance in many of these ecosystems such as pine forests, prairies, and savannas.
- Some known effects of fire include (Smith 2000):
 - Setting back succession (may increase predation)
 - Increasing or decreasing food availability
 - Direct mortality
- Understanding fire's effect on wildlife is essential to effective management and conservation of species and ecosystems where fire is a naturally occurring disturbance.
- A number of herpetofauna are included in the Michigan Natural Features Inventory list of endangered species (16 total), including (MNFI, 2009):
 - Marbled salamander (*Ambystoma opacum*)
 - Eastern box turtle (*Terrapene carolina carolina*)
 - Eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*)
- Negative effects of fire on herpetofauna can cascade across trophic levels to predator species that depend on herpetofauna as prey (Keyser et al. 2004).
- Knowledge of fire effects on reptiles and amphibians could aid in more effective enforcement of the Endangered Species Act of Michigan and other states within the Lake States region.
- I performed a quantitative literature review to evaluate the state of information on the relationship between fire and herpetofauna in the Lake States region as part of an ongoing project by the Lake States Fire Science Consortium.
- A review of two species of interest, native to the Great Lakes region is intended to provide insight into knowledge on a species specific level.



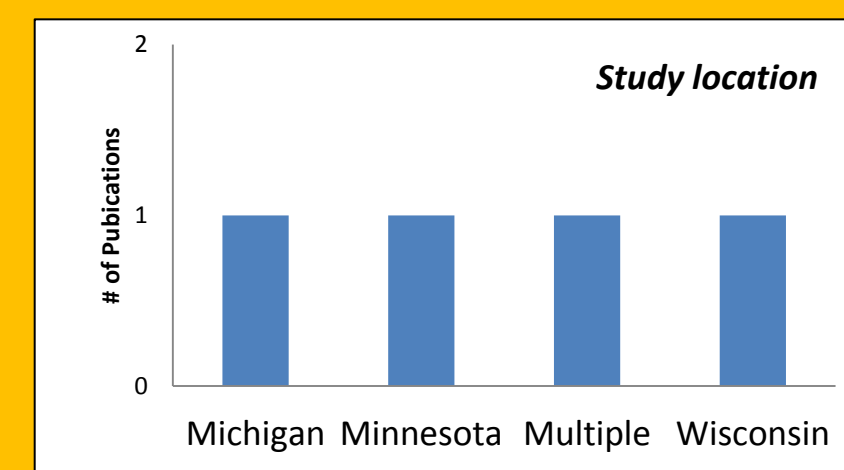
The Lake States Fire Science Consortium is one of 14 regional Consortia funded by the Joint Fire Science Program that promote the exchange of fire science information among ecologically relevant geographic regions.

Methods

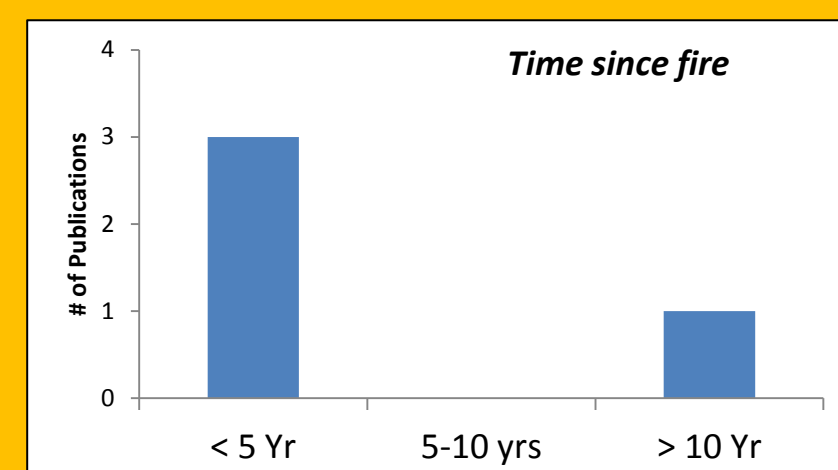
- Part 1: Articles within the LSFSC region:
 - Literature Search: Keywords describing reptiles and amphibians, refined by keywords describing fire (both wild and prescribed), refined by keywords describing the Lake States location.
- Part 2: Species Specific Articles
 - Red-backed salamander: Keywords describing the red-backed salamander, refined by keywords describing prescribed fire and wildfire.
 - Eastern massasauga rattlesnake: Keywords describing the eastern massasauga rattlesnake, refined by keywords describing prescribed and wildfire.
- Key information from each article was tabulated into an Excel spreadsheet. Categories included:
 - Location, citation, ecosystem type, wildfire or prescribed fire, duration of data collection, variables measured, species studied, and response type.
 - Response type was categorized as positive, negative, or neutral, depending on response reported by authors.

Results

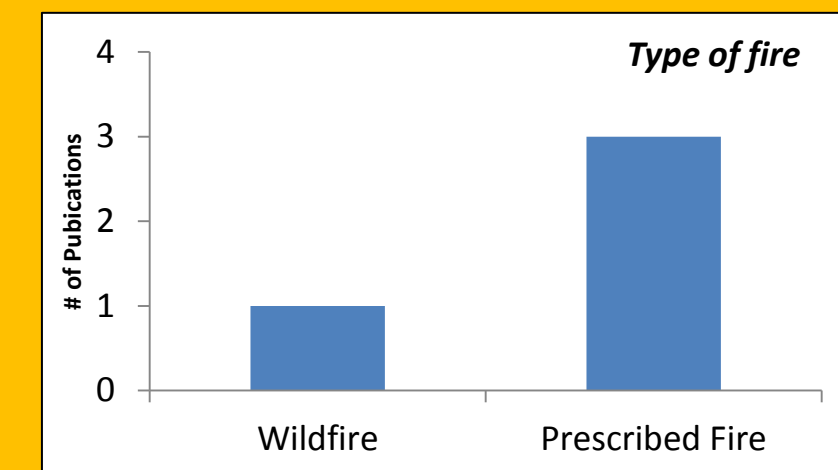
Four Publications within the Lake States Region Were Located:



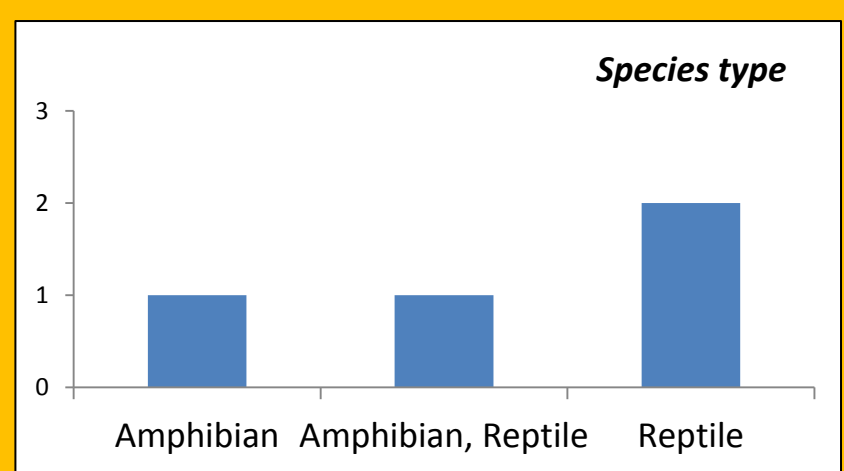
Studies are distributed evenly through the Lake States.



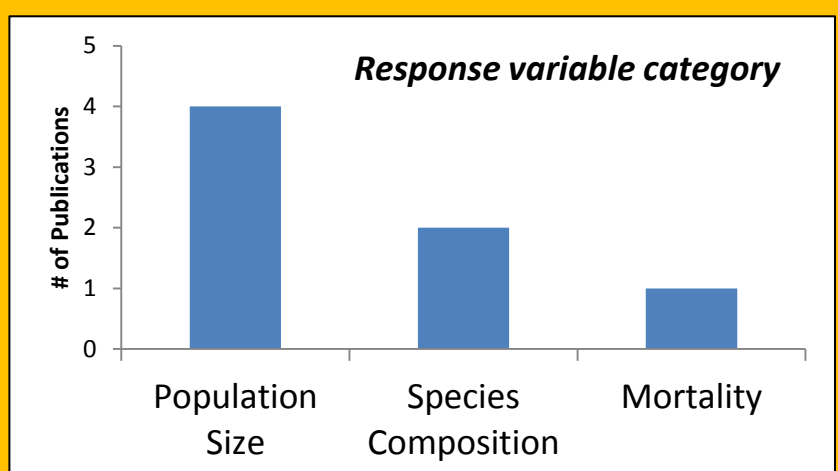
Majority of publications collect data for <5 years (only 1 long-term report).



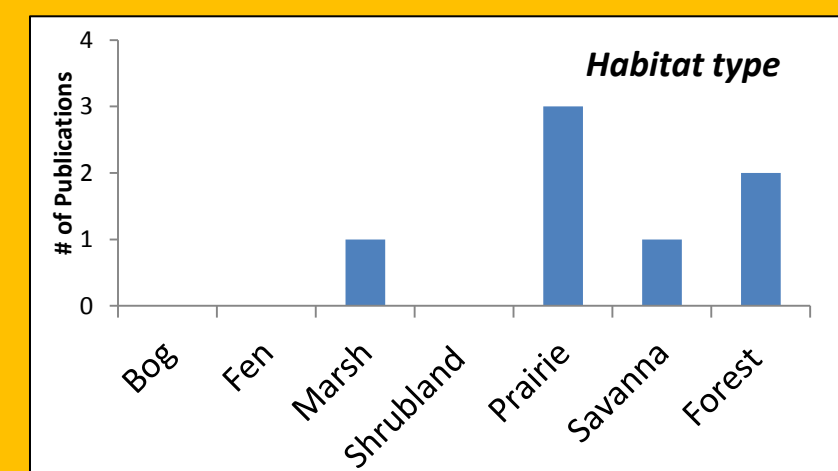
Prescribed fires are more frequently studied than wildfire.



Publications reporting on reptiles are more common than amphibians.



Population size is the most commonly measured variable.

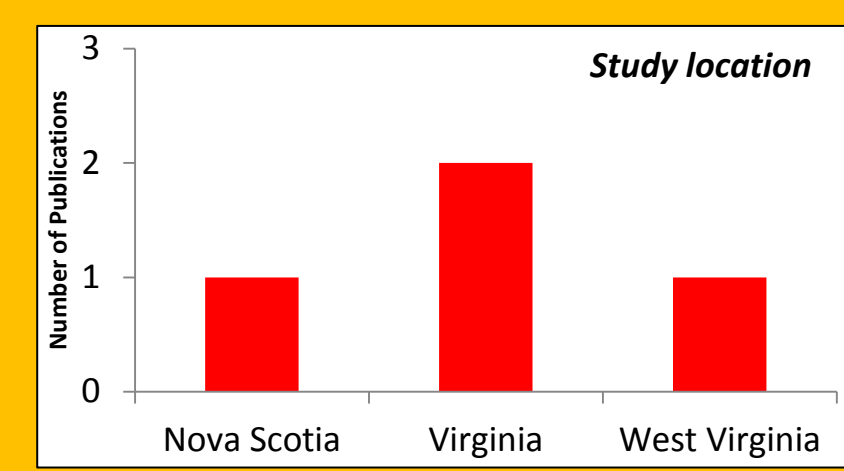


Prairie and forest habitats are most frequently studied.

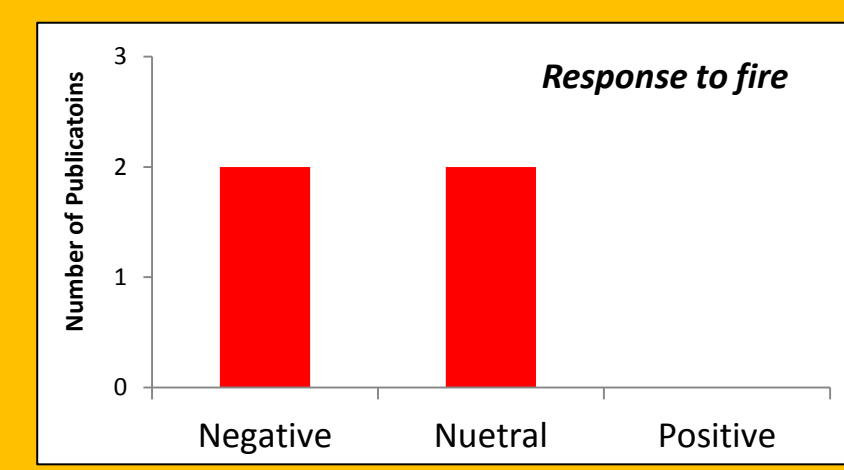
Species of interest:

Four red-backed salamander studies and one eastern massasauga rattlesnake study were located:

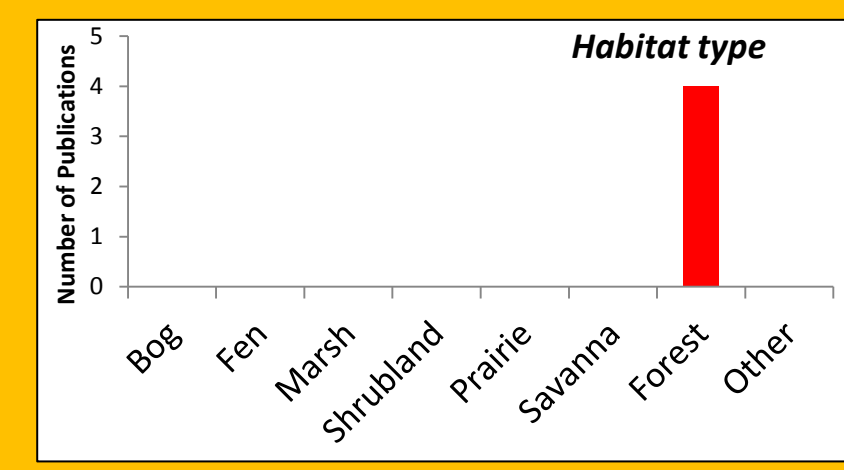
Red – backed salamander



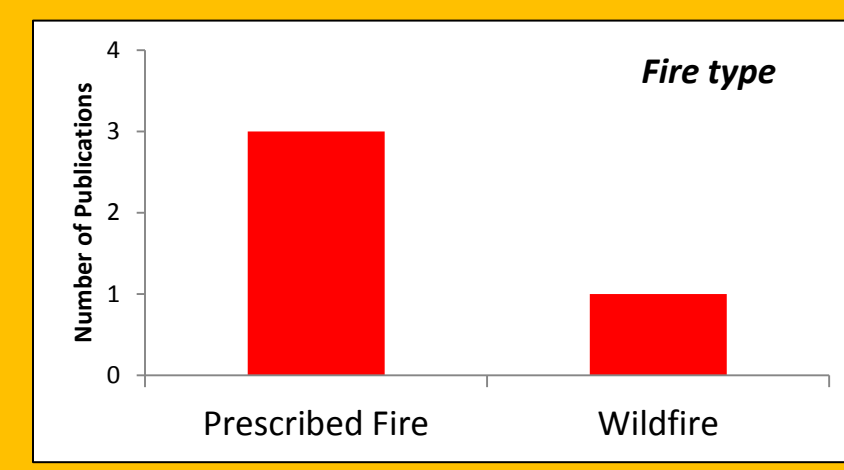
Most studies on the red-backed salamander are located in the Virginias.



Publications on the red-backed salamander report both negative and neutral response types with equal frequency. No positive responses are reported.

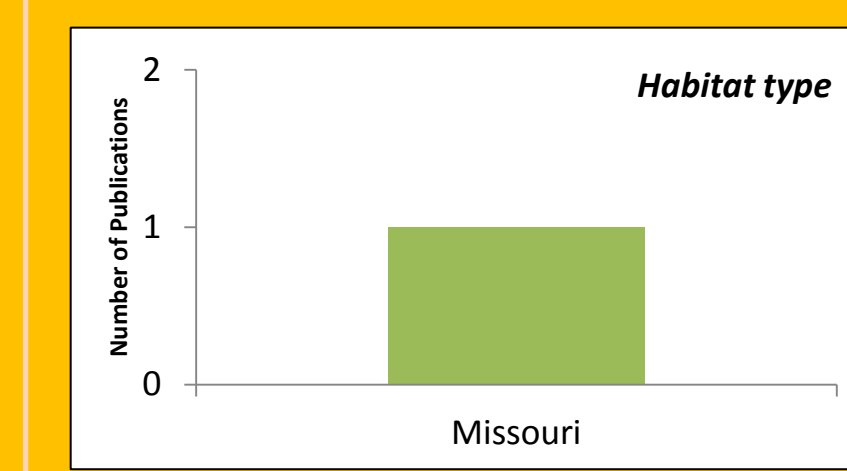


Forests are the only ecosystem type sampled by red-backed salamander studies.

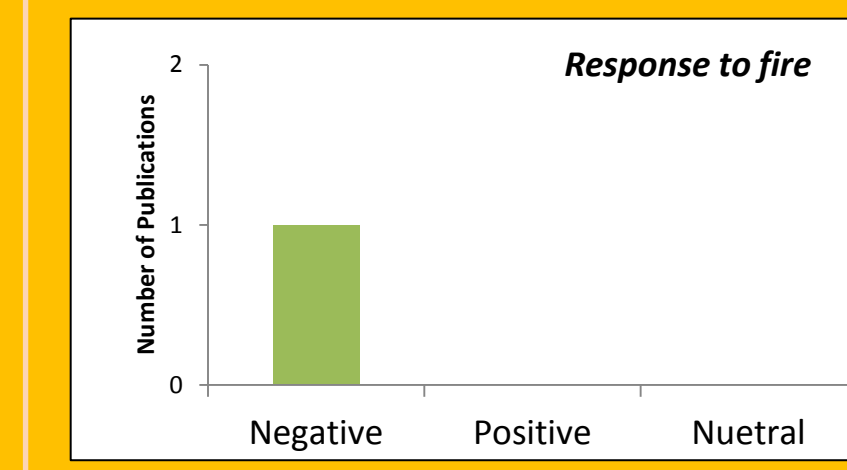


Prescribed fires are more frequently studied than wildfires in red-backed salamander studies.

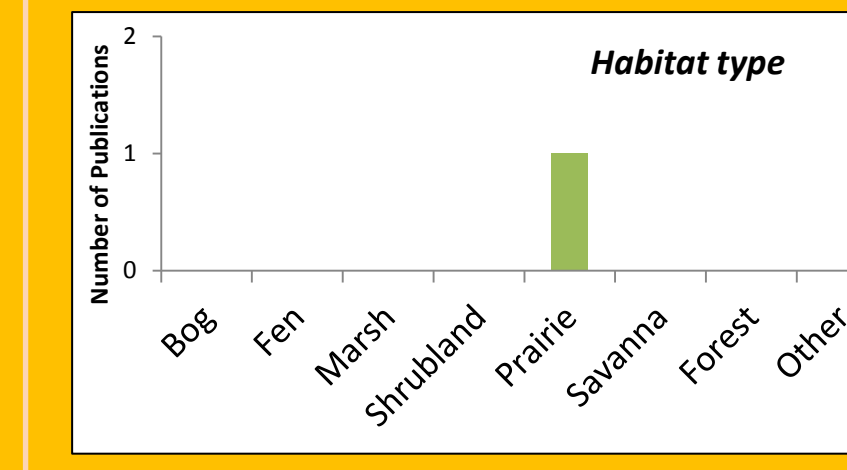
Eastern massasauga rattlesnake



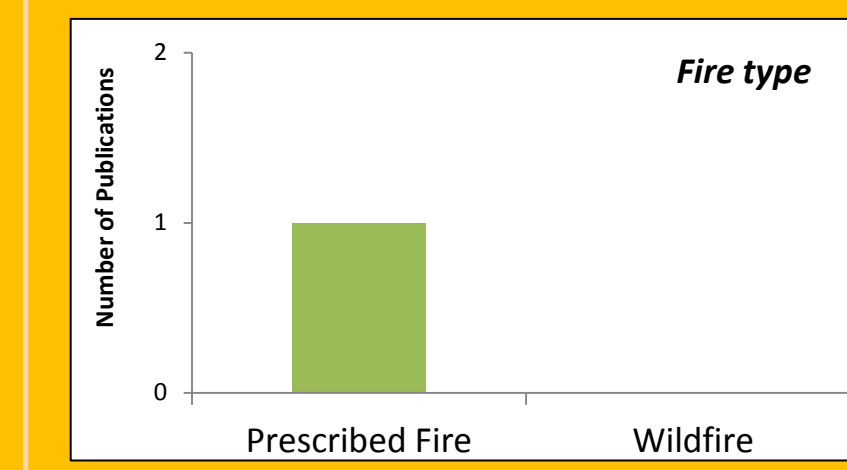
The eastern massasauga rattlesnake publication took place in Missouri.



The eastern massasauga rattlesnake publication reported a negative response to fire.



The eastern massasauga rattlesnake publication sampled a (wetland) prairie habitat.



The eastern massasauga rattlesnake publication studied prescribed fire effects.

Summary Table

Citation	Location	Ecosystem Type	Fire Type	Species Studied	Variables Measured	Response Type	Inside/Outside Consortium Region
Pitt (2001)	Minnesota	Old-Field Prairie Habitat	Prescribed	Northern prairie skink	Population size	Positive *confounded with field age*	Inside
Johnson & Leopold (1998)	New York	Shrub-dominated peatland	Prescribed	Eastern massasauga rattlesnake	Population size	Positive	Inside
Brodman (2010)	Multiple	Grasslands, savannah, forested upland, wetlands, open upland	Prescribed	Ten amphibian species studied.	Population size, species composition	Negative *Short-term (Immediate)* Positive *Long-term (2 years)*	Inside
Anderson (1982)	Michigan	Upland forest, swamp, shallow marsh, deep marsh, river bottom, deciduous forest.	Wildfire	Common garter snake, green frog.	Population size, species composition	Positive *young individuals only*	Inside
Carlisle et al. (2008)	Wisconsin	Prairie	Prescribed	Western fox snake	Population size, mortality	Negative *seasonally: spring, summer*	Inside
Durbian (2006)	Missouri	Wetland Prairie.	Prescribed	Massasauga	Mortality	Negative	Outside
Ford (2012)	West Virginia	Broadleaf woodland on mountain	Prescribed	Red-backed salamander	Population size, species composition	Neutral	Outside
Russel (2011)	Nova Scotia	Acadian Forests	Wildfire	Red-backed salamander	Population size.	Negative	Outside
Keyser et al. (2004)	Virginia	Oak-dominated Forest	Prescribed	Red-backed salamander	Population size, species composition	Neutral	Outside
Mitchell (2000)	Virginia	Upper coastal plain, mixed hardwood and pine forest	Prescribed	Red-backed salamander	Population size, species composition, mortality	Negative	Outside

Note: There were originally 2 eastern massasauga rattlesnake articles, but one of them only studied the effect of fire on massasauga habitat, rather than the snake directly, so we decided to eliminate it. This article is shown in the summary table because it is informative, but it was not included in the tallies of empirical studies of species response to fire.

Species of Interest



Red – backed salamander (*Plethodon cinereus*)
Red-backed salamanders are terrestrial salamanders that live in hardwood forested habitat. Their diet mostly consists of small insects (WI DNR web 2012). The red-backed salamander is an abundant species of least concern in the Lake States region but is still experiencing habitat loss nationally (Unknown 2009).



Eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*)
Massasauga's habitat consists of open prairies, preferable wetlands and early successional communities (Johnson 1998). The Massasauga is of special concern in Michigan and a candidate species for federal protection (MNFI 2012).

Discussion

Publications within the Great Lakes region:

- The small number of publications (4) found on fire effects on herpetofauna show that there is a lack of existing knowledge on this subject.
- So few publications made it unrealistic to perform statistical analysis on the quantity of different types of information presented in the body of information.
- The majority of the publications report on fire effects on reptiles. This reveals a gap in knowledge on fire effects on amphibians. This may be due to the terrestrial-bound habitat of reptiles (rather than salamanders, who can retreat to aquatic environments), making them easier to observe.
- The majority of studies reporting on prescribed fire effects make sense, as wildfires are unpredictable and prescribed fires can easily be implemented and controlled. Still, this reveals a gap in knowledge on wildfire effects.
- So few studies reporting long-term data collection reveal a gap in knowledge on long-term effects of fire.

Publications on species of interest:

- More studies reported effects on the red-backed salamander than on the massasauga, contrary to a majority of reptiles studied in the Lake States region.
- No publications occur within the Lake States region on the massasauga, even though the massasauga is in need of effective conservation efforts (MNFI 2012).

Management implications:

- Prescribed burns in the spring and summer should be withheld until snakes emerging from hibernation recover from "grogginess" (Carlisle et al. 2008).
- The study on the massasauga rattlesnake advises managers to avoid mowing (before burning) as a means of controlling woody vegetation, as it causes direct mortality to snakes (Durbian 2006).

Future research:

- The variety of reported response types suggest a complex relationship between fire and herps, requiring further study on variables such as time since fire, fire intensity, age of individuals, wildfire effects, season of fire, ecosystem type, and species within the habitat.
- Further research on the massasauga's response to fire in the Lake States region should be a priority, for conservation purposes.

References

- Anderson, S. H. 1982. Effects of the 1976 Seney National Wildlife Refuge Wildfire on Wildlife and Wildlife Habitat. (D. of Interior, Ed.) Resource Publication, USDI Fish and Wildlife Service, U.S. Fish and Wildlife Service, Resource Publication 146; pp.1-28.
- Brodman, R. 2010. The Importance of Natural History, Landscape Factors, and Management Practices in Conserving Pond-Breeding Salamander Diversity. *Herpetological Conservation and Biology*, 5(3): pp. 501–514.
- Carlisle, et al. 2008. Pantherophis vulpina vulpina (Western Fox Snake) Mortality. *Herpetologica* Review, 39(1): Pp. 98-99.
- Durbian, F. E. 2006. Effects of Mowing and Summer Burning on the Massasauga (*Sistrurus catenatus*). *American Midland Naturalist*, 155(2), Pp. 329-334.
- Ford, W. M., et al. 2010. Woodland salamander response to two prescribed fires in the central Appalachians. *Forest Ecology & Management*, Pp. 1003–1009.
- Johnson G., Leopold D. 1998. Habitat management for the eastern massasauga in a central New York peatland. *Journal of Wildlife Management*, Vol. 62, Pp. 84-97.
- Keyser P. D., et al. 2004. Prescribed Fire Impacts to Amphibians and Reptiles in Shelterwood-harvested, Oak-dominated Forests. *Virginia Journal of Science*, Vol. 55, Pp. 159-168.
- Lake States Fire Science Consortium. About Us [Online] <http://www.lakestatesfire.org/about_us.htm> Nov. 19, 2012.
- Michigan Natural Features Inventory (MNFI). Michigan Species List [Online] <<http://www.mnfi.org/data/specieslist.html>> Nov. 19, 2012.
- Mitchell, J.C. 2000. Observations on Amphibians and Reptiles in Burned and Unburned Forests on the Upper Coastal Plain of Virginia. *Virginia Journal of Science*, Vol.51, Pp. 199-203.
- Pitt, W. C. 2001. Density of prairie skinks (*Eumeces septentrionalis*) in old-field habitats. *American Midland Naturalist*, Vol. 146, Pp. 86-93.
- Russel, R. W. 2011. Plethodon cinereus (Eastern Red-Backed Salamander) Wildfire Survival. *Herpetological Review*, 42(2), Pp. 253-259.
- Unknown, Salamanders in Niagara [Online] http://salamandersinniagara.com/eastern_red_back/eastern_red_back_conservation_status.htm Dec. 2, 2012.

