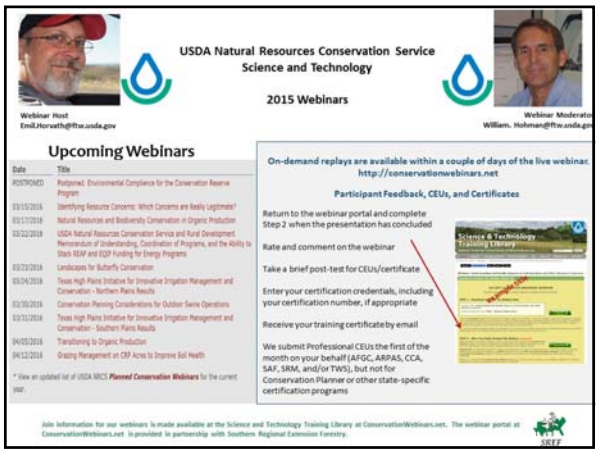


LANDSCAPES FOR BUTTERFLY CONSERVATION

Diane Debinski
Iowa State University

Leslie Ries
Georgetown University

2

WHY BUTTERFLIES?

- The public loves them
- They are ecosystem service providers
- They are sensitive to climate
- They are important habitat indicators
- Their biology is well known

Graphic from www.butterfliesandmoths.org

BUTTERFLIES ARE MOSTLY ASSOCIATED WITH OPEN HABITAT IN TEMPERATE REGIONS

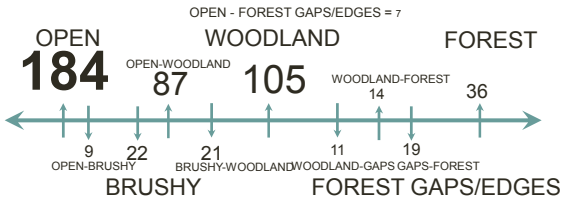
Butterflies have a range of habitat associations along several axes of consideration

- **Canopy**: Forest to woodland to open (*but most butterfly species in temperate regions are associated with open habitat!!*)
- **Disturbance**: From highly disturbed to pristine, different butterfly species are reliant on different levels of disturbance and this is largely a function of their required resources (hostplant, nectar plants, roosting sites).
- **Resource specialization**: From highly specialized (in terms of host and nectar flowers) to extreme generalists, the degree of specificity can be (but isn't necessarily) relate to their level of habitat specificity
- EXAMPLE: MONARCH 

4

MOST TEMPERATE BUTTERFLIES PREFER OPEN HABITAT!

Of the 515 most common US species, their canopy associations are:



5

THREE KEY CONCEPTS FOR THIS WEBINAR

Habitat fragmentation
- Fragmentation can be caused by "natural" landscape mosaics or by disturbance or habitat loss (often human-caused)

Succession and disturbance-dependent habitats
- Succession is the natural process that habitats go through after disturbance and many ecotypes are dependent on disturbance

Multi-species management
- Considering multiple species in management decisions is challenging, but traits can help make this goal tractable

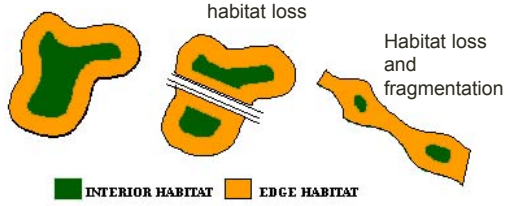
6

1. Habitat Fragmentation

FRAGMENTATION IS USUALLY ASSOCIATED WITH HABITAT LOSS, BUT NOT ALWAYS

Fragmentation with minimal habitat loss

Habitat loss and fragmentation



7

1. Habitat Fragmentation

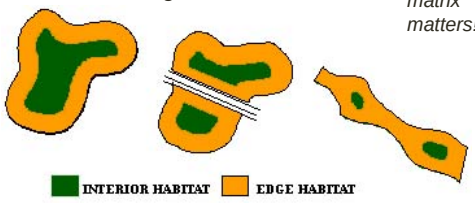
THREE COMPONENTS TO FRAGMENTATION (SEPARATE FROM HABITAT LOSS)

Area effects (of individual patches)

Isolation

Edge effects**

NOTE: the matrix matters!!!

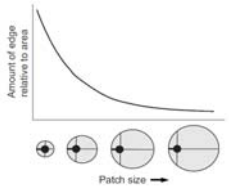


8

1. Habitat Fragmentation

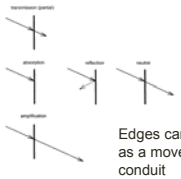
EDGE EFFECTS ARE UBIQUITOUS AND ARE A KEY FACTOR IN BOTH AREA AND ISOLATION EFFECTS

1. Most area effects are scaled-up edge effects



Fletcher et al. 2007

2. One of the major factors for isolation is movement behavior near habitat edges



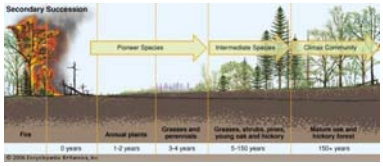
Edges can also act as a movement conduit

Strayer et al. 2003

NOTE: Basic edge effects (positive, negative, neutral) are predictable based on habitat associations (Ries et al. 2004, Ries and Sisk 2008) and species traits (Ries and Sisk 2010).

2. Disturbance

DISTURBANCE IS OFTEN NECESSARY TO KEEP DOMINANT ECOTYPES IN THEIR PREFERRED STATES



2. Disturbance

OTHER IMPORTANT DISTURBANCES THAT CAN MAINTAIN OPEN HABITAT

Grazing

Mowing

But the key to maintaining diverse, open environments is often timing, rotation and intensity

11

2. Disturbance

TODAY'S FOCUS WILL BE ON PRAIRIES, BUT DISTURBANCE TO MAINTAIN HABITAT QUALITY IS IMPORTANT IN MANY ECOTYPES

Oak savannah

Long-leaf pine

NOTE: In areas dominated by forest, small-scale disturbances are often great places for butterflies!

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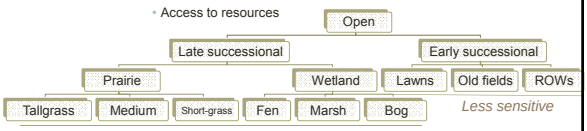
3. Multi-species management

MULTIPLE-SPECIES MANAGEMENT: HABITAT RULES!

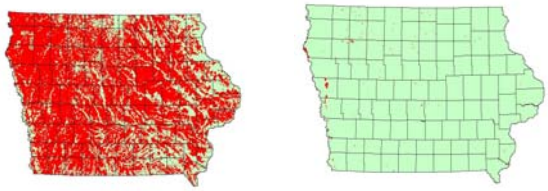
- Habitat associations are the most important single thing you can know about all the species in the butterfly community.
  - What drives habitat associations would be the second:
    - Hostplant
    - Cover
    - Access to resources



Species primarily associated with these habitats are more sensitive

Another key traits: mobile vs. sedentary

IOWA AS AN IDEAL SYSTEM TO UNDERSTAND LANDSCAPE-LEVEL CONSERVATION IN THE FACE OF HABITAT LOSS AND FRAGMENTATION



Historic Prairie (shown in red) **Current Prairie**

Map was created by Rob Fletcher, Robin McNeely, and the Iowa Gap Analysis Program at the Department of Animal Ecology, Iowa State University, Ames, Iowa. Data sources included the Iowa Department of Natural Resources, Iowa Gap Analysis Program, The Nature Conservancy, and the Iowa Natural Heritage Foundation.

14

OVERALL QUESTION: HOW DO BUTTERFLIES PERCEIVE AND USE HABITAT IN A HIGHLY FRAGMENTED SYSTEM?

- How does management of linear habitats affect butterflies?
- How do butterflies respond to habitat edges and are there differences in response based upon the type of edge?
- Are there differences in butterfly communities in integrated vs. isolated restorations?
- To what extent does landscape context influence community composition at a local level?

16

GENERAL METHODS

- Butterflies were surveyed in transects or blocks with standardized time and effort
- Abundance for each species was summed across replicates within a season
- A minimum species abundance level was required for inclusion in community analysis
- Vegetation structure and nectar resources were also quantified

17

ASSESSING COMMUNITY RESPONSES VIA BUTTERFLY GUILDS

- Habitat-Sensitive (prairie obligates) species found primarily in grasslands with relatively low anthropogenic disturbance (i.e., fragmentation); host plants are prairie grasses and forbs

R. VanNimwegen

- Disturbance-Tolerant (generalists) are common in many habitats regardless of disturbance level

18

VIGNETTES

- Linear habitats
- Responses to habitat structure
- Isolated vs. integrated restorations
- Local vs. landscape effects
- Managing for multiple species
- Data Resources – Monitoring Plug

19

LINEAR HABITATS

20

Linear Habitats: Roadsides

Conservation Value of Roadside Prairie Restoration to Butterfly Communities

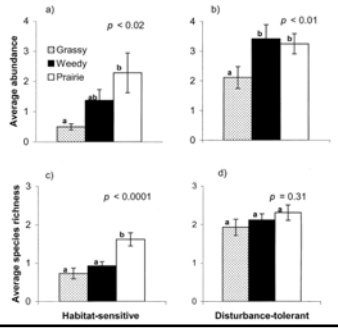
LESLIE RIES,* DIANE M. DEBINSKI, AND MICHELLE L. WIELAND

Department of Animal Ecology, 124 Science II, Iowa State University, Ames, IA 50011, U.S.A.

Roadsides can add habitat, connectivity but also can subject individuals to higher mortality

21

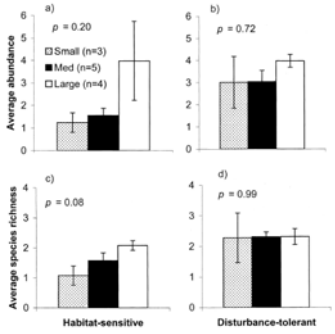
RESPONSE TO ROADSIDE TYPE



Management for flowers (whether weedy or prairie) boosted abundance of both habitat-sensitive and disturbance-tolerant species. But greatest benefits for habitat-sensitive species came from restoration to prairie

22

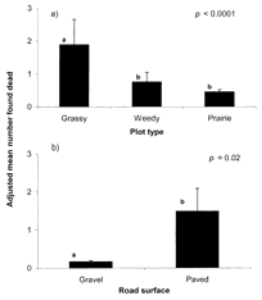
ROADSIDE PATCH SIZE EFFECT



Small <800 m, Medium 800-5000m, Large >5000 m

Size of the roadside restoration had no effect on disturbance-tolerant species. Habitat-sensitive butterflies showed a trend of higher abundances and diversity at larger restoration sites.

23



MORTALITY ON ROADSIDES

ALL SPECIES

The cost to benefit ration of roadside habitat is still unclear, but restorations away from large, busy roads are the least risky.

24

Linear Habitats – Filter Strips

ELSEVIER

Available online at www.sciencedirect.com
SCIENCE DIRECT®

Agriculture, Ecosystems and Environment 109 (2005) 40–47

Agriculture Ecosystems & Environment

www.elsevier.com/locate/agee

Factors affecting butterfly use of filter strips in Midwestern USA

Kathleen F. Reeder, Diane M. Debinski *, Brent J. Danielson

Interdepartmental Program in Ecology and Evolutionary Biology, 253 Bessey Hall, Iowa State University, Ames, IA 50011, USA

Received 30 August 2004; received in revised form 25 January 2005; accepted 15 February 2005

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Filter Strips – Study Design

Switchgrass

Non-native grass

Native grasses and forbs

26

Filter Strips - Responses to Vegetation

Composition: Butterfly abundance increased with increasing flowering plant cover and number of flowering ramets.

Width: Monarchs & Regal Fritillaries in particular had higher abundances in wider filter strips (range 18-167m)

Reeder, Debinski & Danielson (2005) *Ag. Ecosystem & Env.*

27

EDGE RESPONSES

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Edge Responses

Butterfly Responses to Habitat Edges in the Highly Fragmented Prairies of Central Iowa

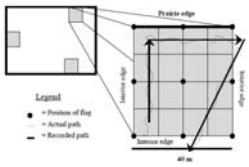
Leslie Ries; Diane M. Debinski

The Journal of Animal Ecology, Vol. 70, No. 5 (Sep., 2001), 840-852.

29

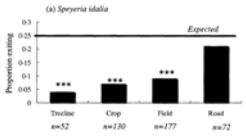
EDGES OF PRAIRIES

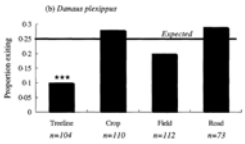
- Crossing an edge is the first step in dispersal or migration
- Prairie edges may include treeline, crops, roads, or grasslands
- Study system: monarchs (open generalists) and regal fritillaries (prairie specialists) at prairie edges



30

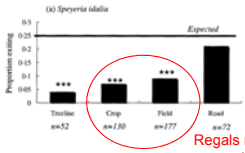
EDGE CROSSING BEHAVIOR



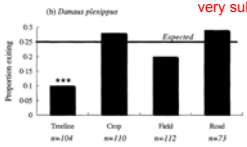


31

EDGE CROSSING BEHAVIOR

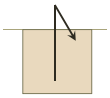


Regals respond to very subtle edges



32

RETURN AFTER CROSSING?



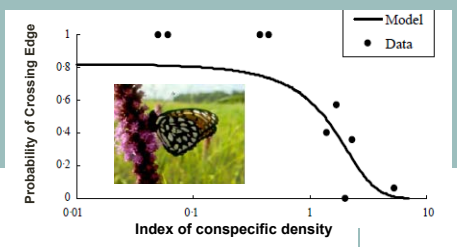
*The habitat specialist (*S. idalia*) was much more likely to return after "sampling" the adjacent habitat*

33

MONARCHS MORE LIKELY TO CROSS AS SUMMER PROGRESSED

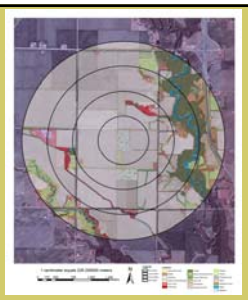
34

REGALS ARE MORE LIKELY TO CROSS EDGES (AND NOT RETURN) WHEN CONSPECIFIC DENSITY IS LOW



Many butterfly species respond to conspecific density and thus may not stick around when densities are low.
Which species? We don't know!

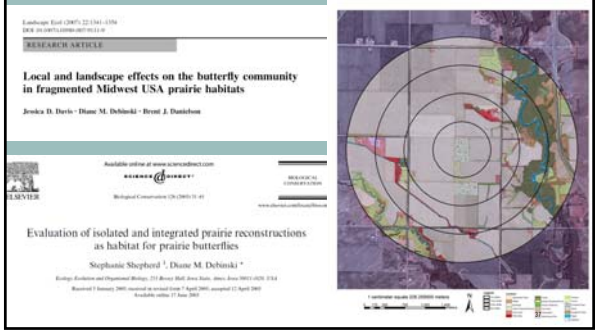
35



LANDSCAPE EFFECTS

36

SEPARATING LOCAL AND LANDSCAPE EFFECTS



RESEARCH ARTICLE

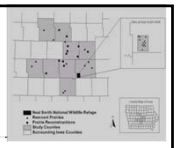
Local and landscape effects on the butterfly community in fragmented Midwest USA prairie habitats

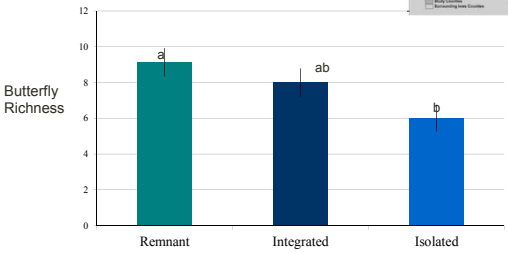
Jessica D. Davis · Diane M. Debinski · Brent J. Danielson

Evaluation of isolated and integrated prairie reconstructions as habitat for prairie butterflies

Stephanie Shepherd [1], Diane M. Debinski *

ISOLATED VS. INTEGRATED PRAIRIES





Note: this relationship was driven by habitat-sensitive species

Shepherd & Debinski (2005) *Biol. Conservation*

VEGETATIVE PREDICTOR VARIABLES

Butterfly Variables	N	C(p)	R^2	Variables in Best Model	B (slope)
Richness	36	2.00	0.31**	#Ramets	0.481
				% Litter	0.436
Abundance	36	0.76	0.13	#Ramets	0.274
				% Litter	0.324

Shepherd & Debinski (2005) *Biol. Conservation*

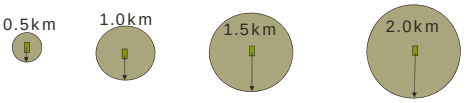
LOCAL VS. LANDSCAPE VARIABLES

Local Variables

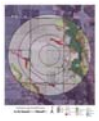
Acronym	*Description*
litter	% cover of litter
fabund	Floral abundance
size	Site size

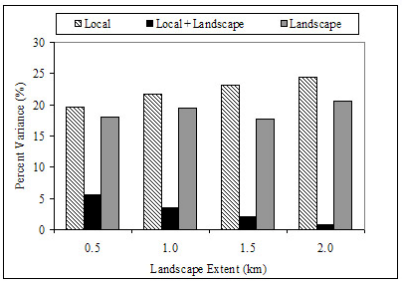
Landscape Variables

Acronym	*Description*
grass	Proportion of each buffer that is grassland
road	Proportion of each buffer that is road
fri	Proportion of each buffer with FRI ≥ 3
mindist	Distance to nearest polygon with FRI ≥ 3 within each buffer



VARIABLE IMPORTANCE RELATIVE TO DISTANCE





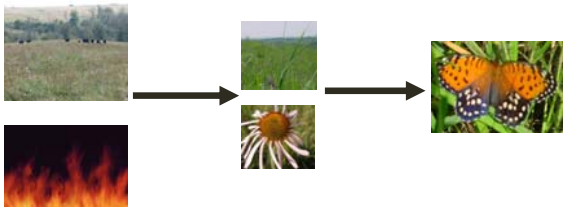
(Davis, Debinski & Danielson, 2007 *Landscape Ecology)*

FIRE AND BUTTERFLIES

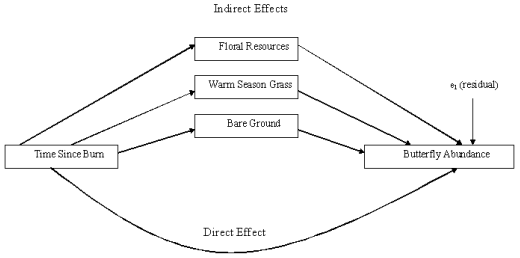
FIRE & BUTTERFLIES

- Primary burn season in the Midwest is early spring.
- Most of our resident butterflies are in larval or egg stages at this time.

DRILLING DOWN: DIRECT AND INDIRECT EFFECTS

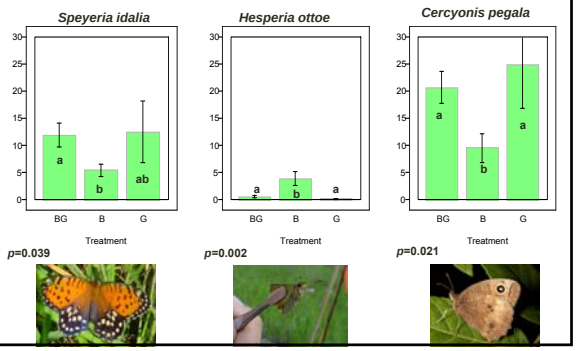


Vogel et al. 2010 *J. Insect Conservation*

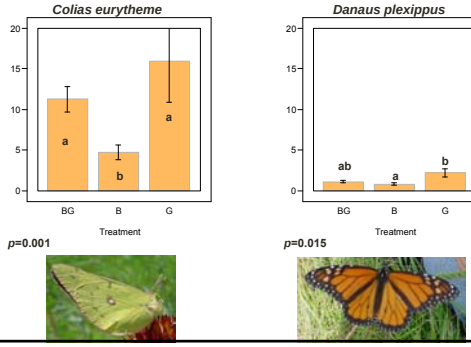


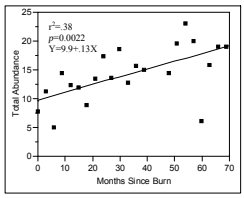
Vogel et al. 2010 *J. Insect Conservation*

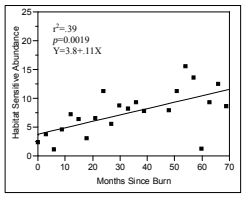
Habitat-sensitive Species Responses



Disturbance-tolerant Species Responses



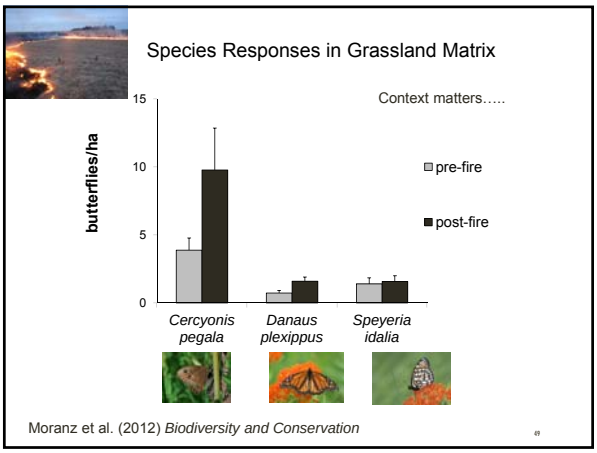


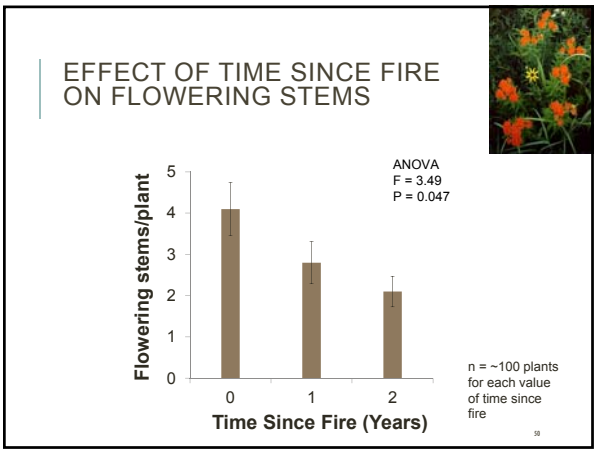


Time since burn effects – community

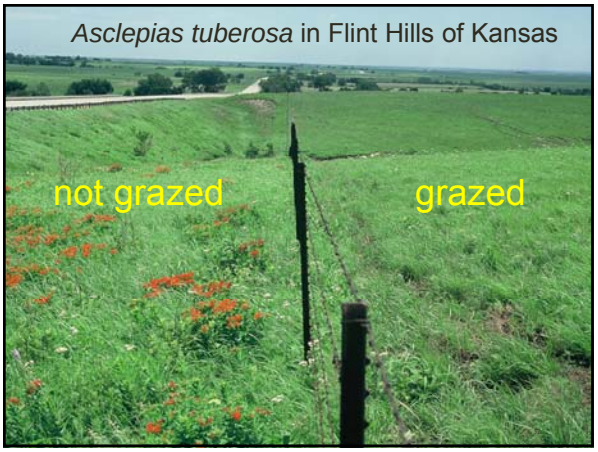
Photo by Justin Huisman

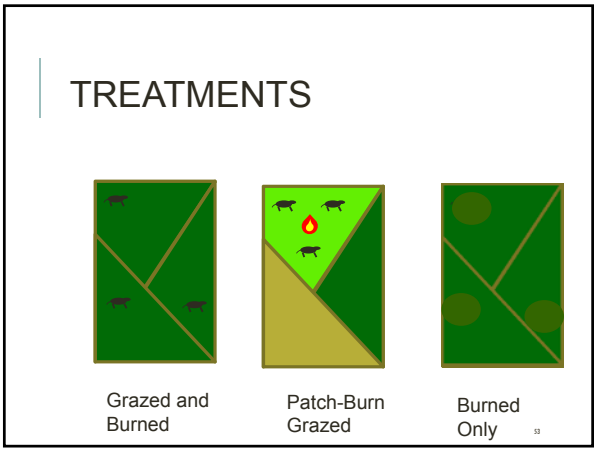
Vogel , Koford and Debinski 2010 *J. Insect Conservation*

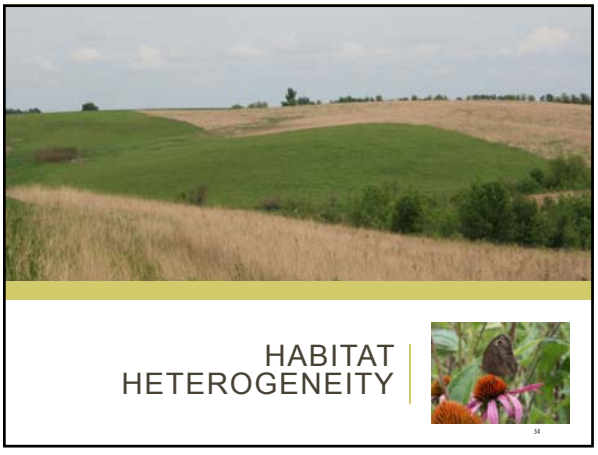

Species Responses in Grassland Matrix
Context matters…..
butterflies/ha
15
10
5
0
pre-fire
post-fire
Cercyonis pegala
Danaus plexippus
Speyeria idalia
Moranz et al. (2012) Biodiversity and Conservation


EFFECT OF TIME SINCE FIRE ON FLOWERING STEMS
ANOVA
F = 3.49
P = 0.047
Flowering stems/plant
5
4
3
2
1
0
0
1
2
Time Since Fire (Years)
n = ~100 plants for each value of time since fire

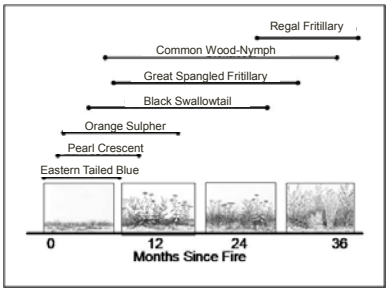

CONSERVATION GRAZING


Asclepias tuberosa in Flint Hills of Kansas
not grazed
grazed


TREATMENTS
Grazed and Burned
Patch-Burn Grazed
Burned Only


HABITAT HETEROGENEITY

HABITAT HETEROGENEITY RELATIVE TO BUTTERFLY SPECIES



Delaney modified from: Fuhlendorf et al. (2009) Pyric herbivory: Rewilding landscapes through the recoupling of fire and grazing

55

ADDITIONAL SGCN BUTTERFLIES OBSERVED OVER TIME

Zebra Swallowtail (*Eurytides marcellus*)
Edwards' Hairstreak (*Satyrium edwardsii*)
Two-spotted Skipper (*Euphyes bimacula*)
Wild Indigo Duskywing (*Erynnis baptisiae*)
Zabulon Skipper (*Poanes zabulon*)
Byssus Skipper (*Problema byssus*)

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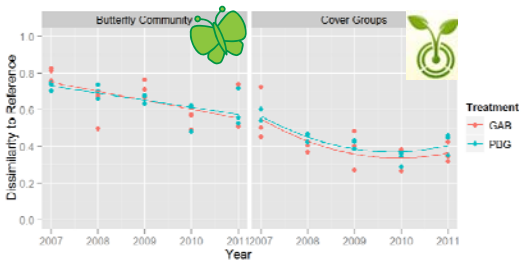
BUTTERFLY & PLANT SPECIES DIVERSITY RESPONSES OVER TIME



Delaney et al. (in revision)

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POLLINATOR FLORAL RESOURCES IN FOUR GRASSLAND TYPES

J. Delaney

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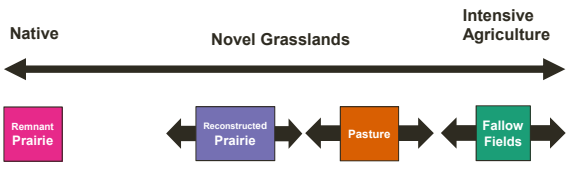
CAN WE MANAGE NOVEL GRASSLANDS TO MIMIC PRAIRIES?



Delaney et al. (2015)

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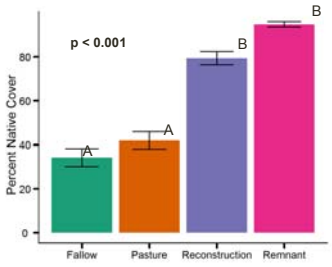
DIFFERENCES IN NATIVE VEGETATION COVER BY GRASSLAND TYPE



Delaney et al. (2015)

Note: Richness of flowering species follows a similar trend

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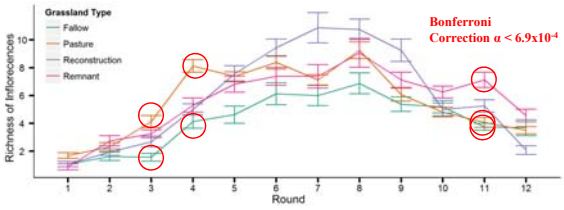
RICHNESS OF FLOWERING SPECIES

Delaney et al. (2015)



MAY JUN JUL AUG SEP OCT

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TAKE-HOME LESSONS

The best vegetative predictors of butterfly richness & abundance were often #flowering ramets and %cover of litter.

Vegetation composition and structure influence butterflies use of linear habitats.

Filter strip width is positively correlated with overall diversity and abundance of habitat sensitive butterflies.

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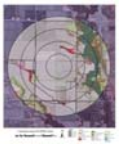
TAKE-HOME LESSONS

Integrated reconstructions support a more diverse butterfly assemblage than isolated ones.

The matrix matters - landscape effects were discernable out to 2 km from a prairie.



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TAKE-HOME LESSONS

Management matters – recovery from burns can vary based upon isolation of patch and characteristics of matrix.

Patch-burn grazing may provide increased habitat heterogeneity and refugia from burns.

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WHAT DOES ALL THIS MEAN FOR THE MONARCH?

- New conservation goal: send 6 ha of monarchs to Mexico every year! (see monarchjointventure.org)
  - Monarchs need milkweed
  - Monarch need nectar sources
- Maintain diverse open habitat for monarchs in their breeding grounds
- What about milkweed?

  Its still unclear exactly how milkweed is limiting for monarchs (amount?, distribution throughout landscape?). But, until research clarifies this issue, the push is to get as much ***locally-sourced*** *milkweed planted as possible*

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NINE DEMONSTRATION MILKWEEDS

Swamp milkweed
Butterfly milkweed
Tall Green milkweed

Showy milkweed
Prairie milkweed
Common milkweed

Poke milkweed
Whorled milkweed
Honeyvine milkweed

1-8 photos: Prairie Moon Nursery

THE DATA PRESENTED HERE WERE FROM ACADEMIC RESEARCH STUDIES

Monitoring from citizen scientists is another source of data – and is growing!!

Two sites are portals to programs collecting butterfly monitoring data:

www.nab-net.org

www.monarchnet.org

Both are part of the North American Butterfly Monitoring Network, led by Leslie Ries

Please check them out!

The North American Butterfly Monitoring Network
working together to advance knowledge on butterflies

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FINAL MESSAGES

1. Butterflies are a great indicator group for management
2. Habitat associations are great predictors of how butterflies will respond to landscapes – and most temperate butterflies prefer open habitat
3. Maintaining diverse butterfly communities in highly fragmented landscapes requires the use and consideration of "matrix" habitat
4. Maintaining diverse butterfly communities often relies on disturbance regimes
5. Traits can be a useful way to make sense of highly variable responses of different butterfly species to the same management actions or ecological changes

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Joint Fire Sciences Program
USDA - NRI

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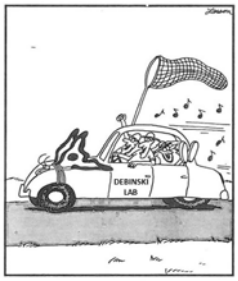
For more Information:

http://www.public.iastate.edu/~debinski/



And keep an eye out for Leslie's upcoming website for her new lab which will be posted at her faculty profile at Georgetown: biology.georgetown.edu

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REFERENCE LIST

Davis, J.D., D.M. Debinski, and B.J. Danielson. 2007. Local and landscape effects on the butterfly community in fragmented Midwest U.S.A. prairie habitats. *Landscape Ecology* 22:1341-1354.

Debinski D.M., R. A. Moranz, J.T. Delaney, J.R. Miller, D.M. Engle, L.B. Winkler, D.A. McGranahan, R.J. Barney, J.C. Trager, A.L. Stephenson, and M.K. Gillespie. 2011. A cross-taxonomic comparison of insect responses to grassland management and land-use legacies. *Ecosphere* 2(12): Article 131. [doi:http://dx.doi.org/10.1890/ES11-00226.1]

Delaney, J.T., K. Jokela and D.M. Debinski. 2015. Seasonal succession of pollinator floral resources in four grassland types in the tallgrass prairie ecoregion. *Ecosphere*. http://dx.doi.org/10.1890/ES15-00218.1

Fletcher Jr., R. J., L. Ries, J. Battin and A. D. Chalfoun. 2007. The role of habitat area and edge in fragmented landscapes: definitively distinct or inevitably intertwined? Canadian Journal of Zoology 85: 1017-1030.

Moranz, R. A., D.M Debinski, D.A. McGranahan, D.M. Engle, J.R. Miller. 2012. Untangling the effects of fire, grazing, and land-use legacies on grassland butterfly communities. *Biodiversity and Conservation*. 21(11):2719-2746. doi:10.1007/s10531-012-0330-2

Reeder, K.F., D.M. Debinski and B.J. Danielson. 2005. Factors affecting butterfly use of filter strips in Midwestern USA. *Agriculture, Ecosystems & Environment* 109(1-2):40-47.

Ries, L. and D.M. Debinski. 2001. Butterfly responses to habitat edges in the highly fragmented prairies of Central Iowa. *Journal of Animal Ecology* 70:840-852.

Ries, L., D.M. Debinski and M.L. Wieland. 2001. The conservation value of roadside prairie restoration to butterfly populations. *Conservation Biology* 15(2):401-411.

Ries, L., R. J. Fletcher, J. Battin, and T. D. Sisk. 2004. Ecological responses to habitat edges: mechanisms, models and variability explained. Annual Review of Ecology, Evolution and Systematics 35:491-522

Ries, L. and T. D. Sisk. 2004. A predictive model of edge effects. Ecology 85:2917-2926.

Ries, L. & T. D. Sisk. 2008. Butterfly responses to habitat edges are predicted by a simple model in a complex landscape. Oecologia 156:75-86.

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REFERENCE LIST (CONT.)

Ries, L. and T. D. Sisk. 2010. What is an 'edge species'? The implications of sensitivity to habitat edges. Oikos 119:1636-1642.

Shepherd, S. and D.M. Debinski. 2005. Evaluation of isolated and integrated prairie reconstructions as habitat for prairie butterflies. Biological Conservation 126:51-61.

Vogel, J., D.M. Debinski, R. Koford and J. Miller. 2007. Grassland butterfly responses to prairie restoration through fire and grazing. *Biological Conservation* 140:78-90.

Vogel, J., R. Koford and D.M. Debinski. 2010. Direct and indirect effects of time since burn on butterfly abundance in tallgrass prairie. *Journal of Insect Conservation*. 14:663-677.

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