

# The compatibility of prescribed burning and the conservation of insects in fragmented landscapes

**Karl Gnaedinger**

**Manager, Indian Boundary Prairies**

**The Nature Conservancy in IL**





Indian Boundary Prairies - a remnant





A close-up photograph of a moth with a brown body and several white spots, resting on a green leaf. The moth is positioned in the center of the frame, with its wings spread slightly. The background is a soft-focus green, suggesting a natural outdoor setting.

**Dr. Ron Panzer**  
**Northeastern IL University**

**Primary Researcher**

**I've been around... 17 years**



## research interests

- 1) The prevalence of conservatism among insects
- 2) The status of conservative species
- 3) The importance of site size
- 4) The levels of fire-sensitivity among insects
- 5) The value of restorations as sanctuaries for vulnerable species





actual managers of  
[ PRAIRIE ] natural areas

practical advice for  
natural area  
managers





# Prairies



*Dry to Wet including sedge meadow*





# Savannas





What are the effects of  
management activities  
on biodiversity,  
especially on non-  
plants?

*Cribrus shingii* (P) GMP, 7-26-04





## VERY SHORT RESULTS:

SMALL, HIGH QUALITY, NATURAL  
AREA REMNANTS HOLD MUCH OF THE  
IMPERILED BIODIVERSITY THAT  
REMAINS IN THE MIDWEST REGION.

PRAIRIES NEED SOME LEVEL OF  
FIRE, AND INSECT POPULATIONS  
CAN RECOVER FROM THE CAUTIOUS  
USE OF ROTATIONAL COOL SEASON  
PRESCRIBED FIRE





# FIRE ADVERSE ENTOMOLOGISTS



# FIRE LOVING BOTANISTS



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## Eg.- IBP protocol for invertebrate survivorship

1. We employ 2, 3 and 4 year burn rotations  
(50%-33%-25%) of the HIGH QUALITY habitats
2. Allow 3 years for recovery following “wildfires” that leave small and scarce refugia
3. Avoid infernos by sticking to conservative burn prescriptions [our window – may  $\Delta$  for you]
  - > 30% Relative Humidity
  - < 70° F
  - < 15 mph Winds







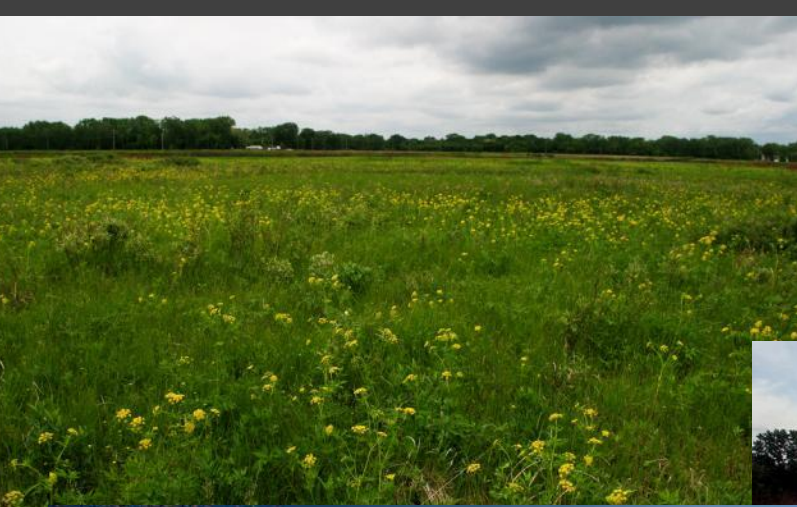
## Eg.- IBP protocol for invertebrate survivorship

4. Mow and/or burn “defensive” firebreaks to control for wildfires
5. Reduce fire intensity- for Eg; Begin burns earlier in the day in sensitive upland habitats
6. Maintain skips
7. Protect “special” patches for specific reasons
8. Mow select areas if there are reasons to avoid fire for some years





# *Fragmented Landscapes*





# Chicago Wilderness

REGION MAP



## NATIONAL CONNECTIONS. REGIONAL ALLIANCE. LOCAL ENGAGEMENT.

Chicago Wilderness is a regional alliance that connects people and nature. Our more than 235 member organizations work together to restore local nature and improve the quality of life for all living things by protecting the lands and waters on which we all depend.

Embedded in one of North America's largest metropolitan regions and stretching from southern Wisconsin, through northern Illinois, into northwestern Indiana and southwestern Michigan is a network of natural areas that includes nearly 340,000 acres of protected lands and waters. These natural areas are Chicago's wilderness, and are home to a wide diversity of life: thousands of native plant and animal species live here among the more than nine million people who also call the region home.



Clear distinction in our area  
between  
high quality remnants and large  
scale degraded landscapes

disruption and fragmentation  
everywhere; where is this not  
true?

Urban /Rural, East /West?

But the above distinction perhaps may  
be harder to make in some areas

# Floristic Quality Indices

Colorado

Florida

Illinois

Iowa

Michigan

USFWS

Missouri

Nebraska

Ohio

South Dakota

Wisconsin

USACE





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# The compatibility of prescribed burning and the conservation of insects in fragmented landscapes.



## Plants:

- Often Long-lived
- Roots below ground

## Insects:

- short-lived
- many (dormant) above ground
- many incapable of movement between sites



# Lots of species inhabit prairies

- Est.
- ~ 13000 insect spp.
  - ~ 1300 plant spp.
  - ~ 130 vertebrate spp.



# Conservationists

What species need our help to survive  
the next 100 (or 5000) years in our  
area??

What species are in danger of  
extinction??

or...

What species need our help to survive  
right NOW?



# Conservationists:

1<sup>st</sup> distinction-

Species Vulnerable now,  
or not??

[ $\Delta s$  w/time]





Conservationists:

2<sup>nd</sup> distinction- a subset of the above, but the most relevant to our fragmented area, **does the species depend on a remnant habitat to survive, or not ??**



# Remnant Dependent [ R-D ] Species

Obviously, *it is unrealistic to expect most conservative insects species to repopulate distant sites if their entire isolated population is wiped out*



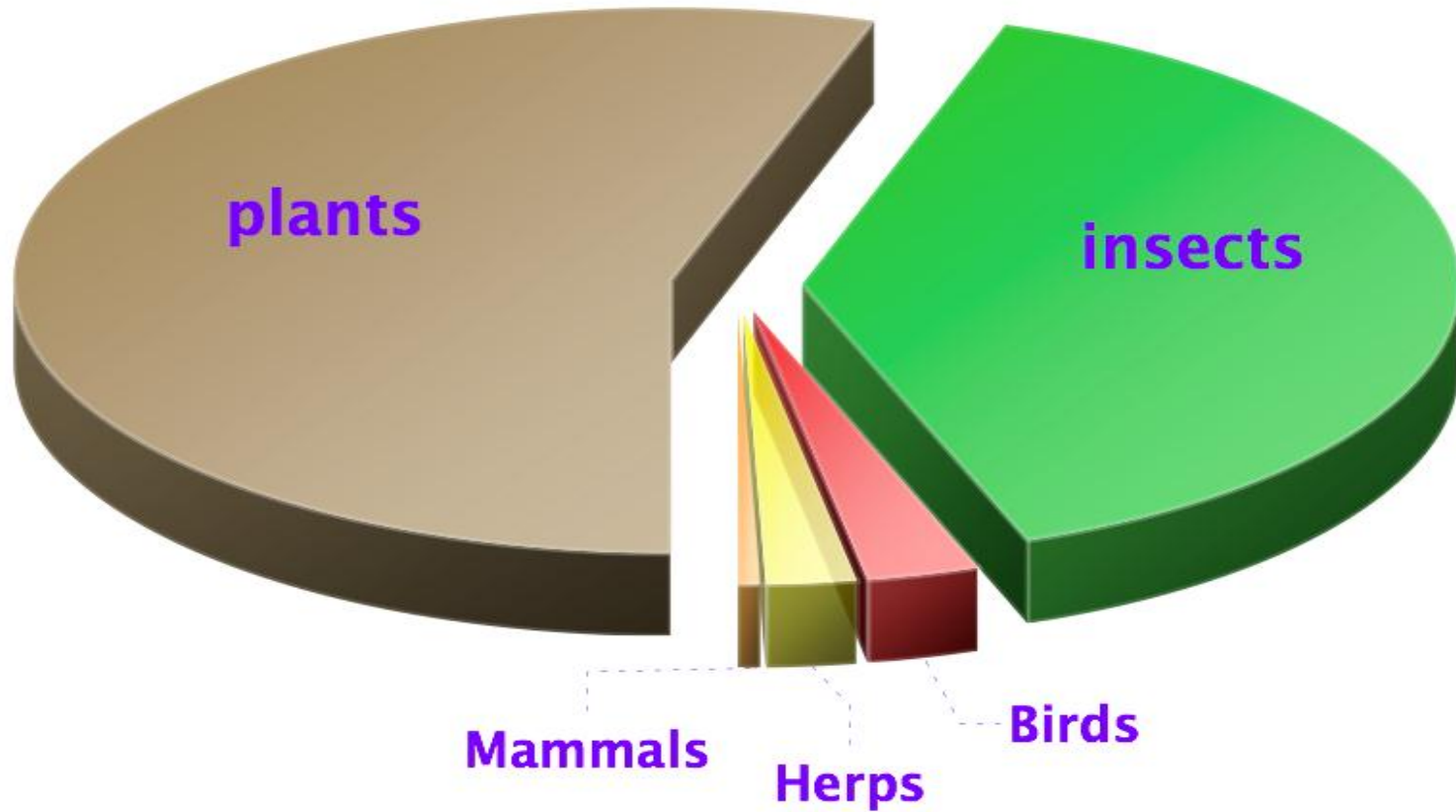




*Conservatives  
tend to be  
imperiled & R-D*



# Relative numbers of prairie-associated species of conservation concern



1090 species







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# *Sayapion segnipes*



*Sayapion segnipes* off *Tephrosia*, gmp Sep 06



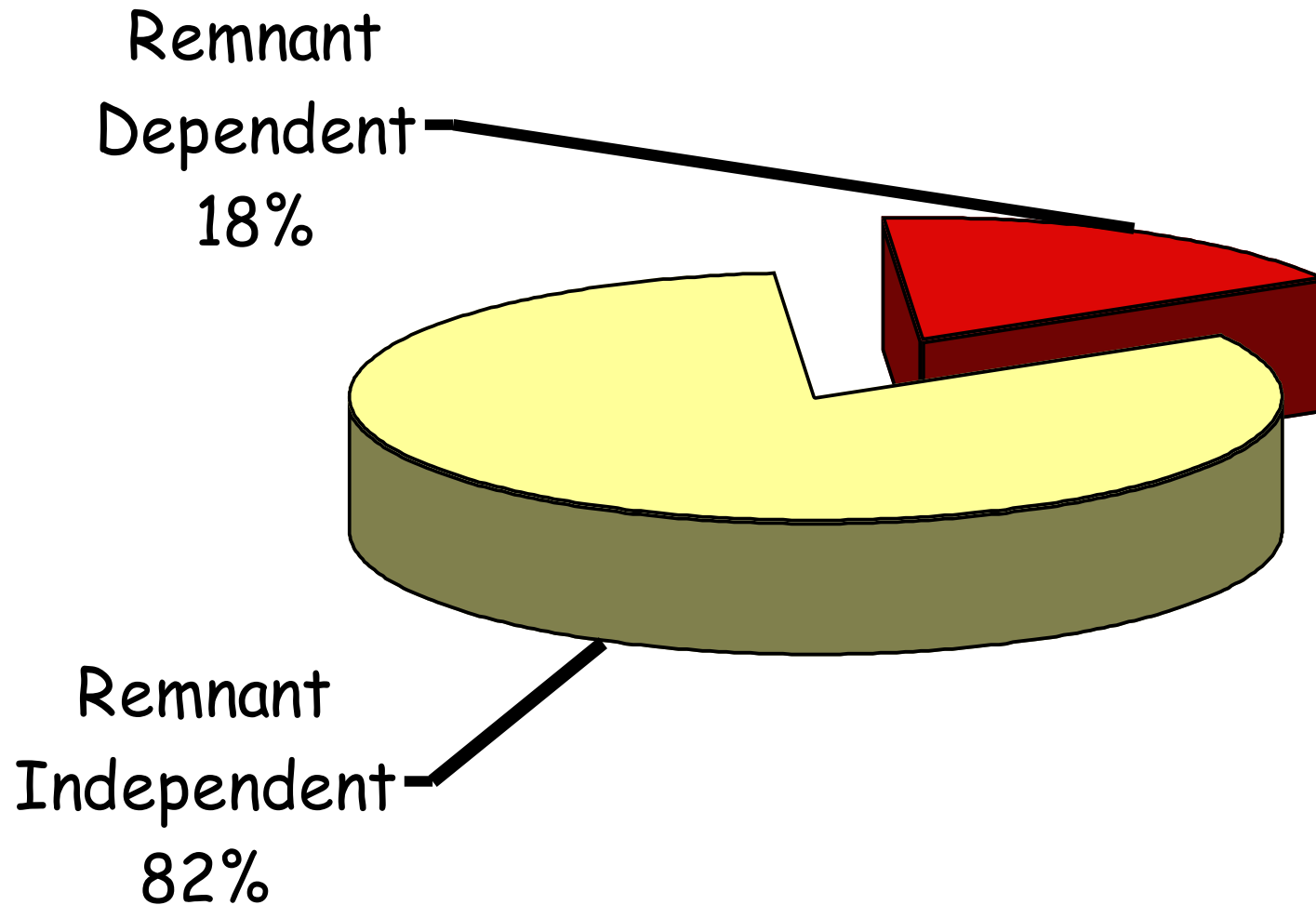
# Annual or less than annual Species



*Aflexia rubranura*





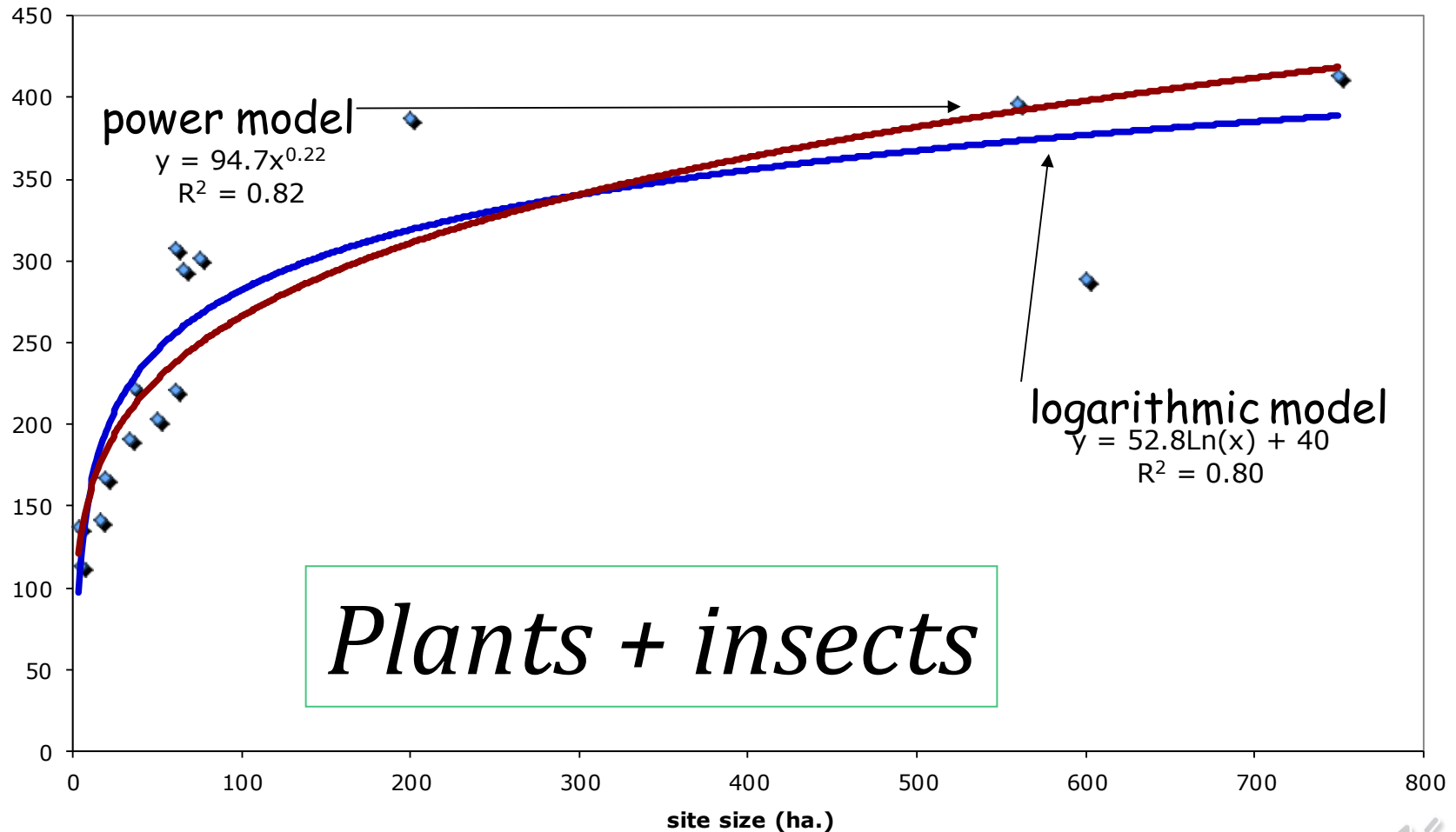


~ 18% of the insect species that inhabit prairie IN OUR REGION are conservative.



# Small sites are important size is overrated

Species Richness

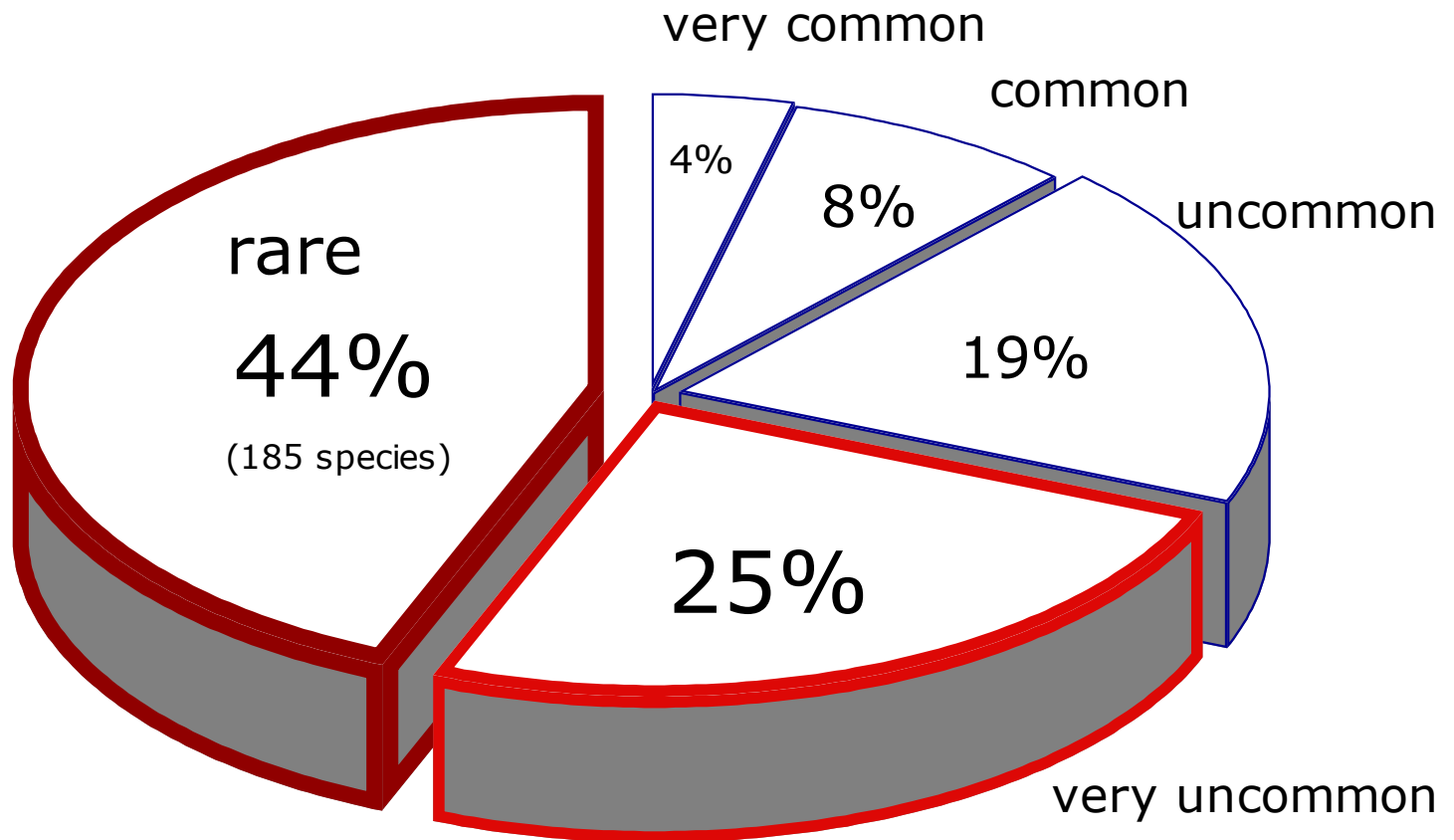


*Plants + insects*

Site Area

# Distribution of 'rarity' among R-D insect species

## Conservative insects: CW status









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# R-D SUMMARY SLIDE

There are hundreds of known conservative insect species inhabiting Midwestern prairies and sand savanna remnants of all sizes.

Probably a third or more are absent from most remnants, and should be considered to be rare.

Most are incapable of recolonization from distant locations.









# Panzer et al. 1992 – 2006 CB, BC, NAJ

- 46 sites, IL, IN, WI
- 55 burns (21 sites)
- 1 - 600 ha.
- Xeric - wet
- 154 insect spp.
- 73 are conservative

MUCH RESEARCH SUPPORTS A POSITION ON FIRE  
FREQUENCY SOMEWHERE IN THE MIDDLE OF **NONE** TO  
**YEARLY**

*Harper, Siemann et al; Tooker and Hanks., etc*

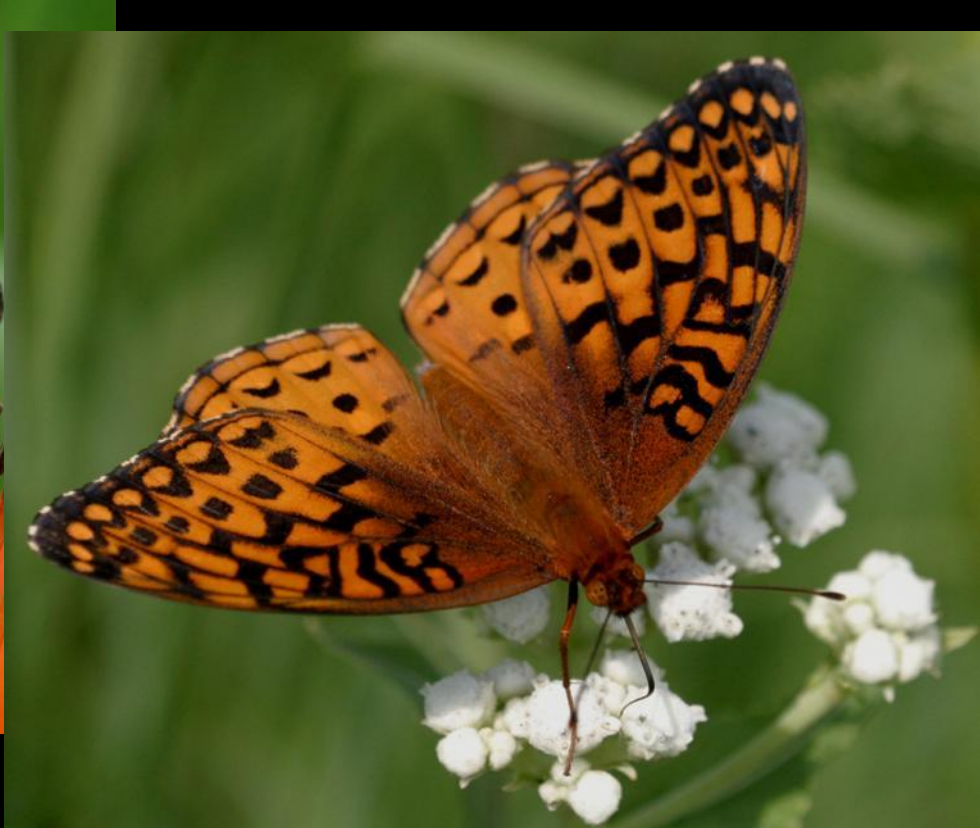


# life history attributes

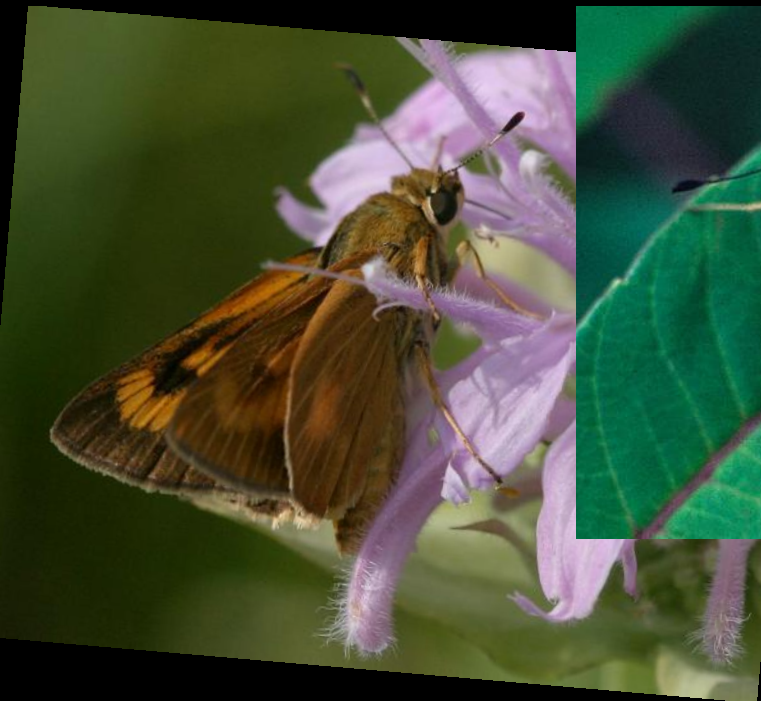
Conservative species 73; **RI 81**

- ~ 400 tests
- Duff 68 - soil 05
- Upland 45 - wet 28
- Univoltine 61- multivoltine 12
- Winged 58 - flightless 15
- Common 48 - uncommon/rare 23









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*Erimobina jocasta*, West Chicago Prairie, July 23, 2004

Ron Pinner











# hoppers



**1) Response** (initial impact) - 0 +

fire-sensitivity correlates [ecological or life history attributes (-)]

**2) recovery** (with refugia present)

mechanisms (recolonization versus in situ survival)

**3) Species composition & richness**

(are fire managed sites depauperate?)

**4) intense and complete burn case study**

(any survivors?)

**5) Consecutive fire test**





# Initial impact



Predictable?

Effect

direction?

Effect size? 



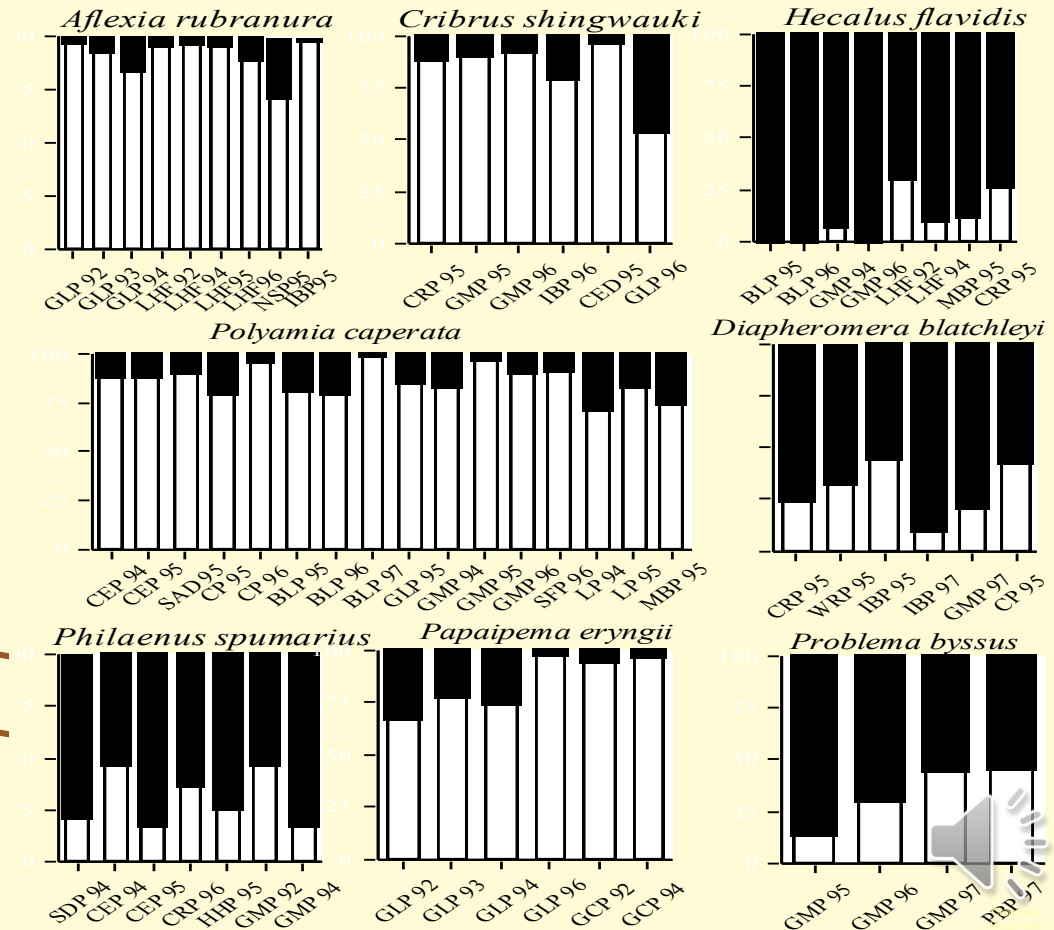
# Consistent species population responses to fire [with refugia] + , 0, or -.

9 R-D species , independent replications

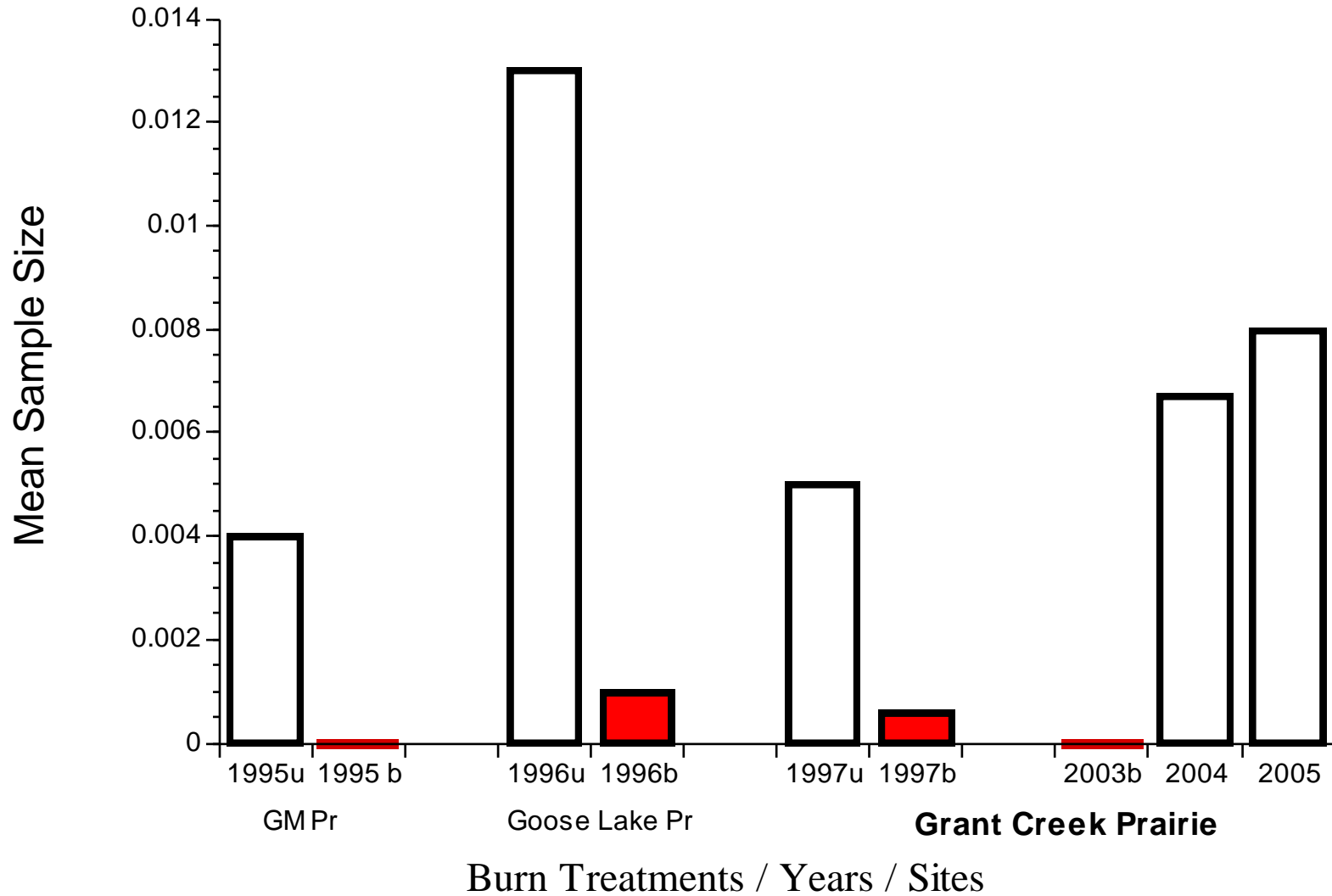
93% of  
all species  
responded  
consistently  
to fires

Burned vs. unburned relative

population densities



# *Papaipema beeriana* (-)



# Initial impact

- **80% of soil dwellers were fire positive or neutral.**
- **41% of all species were fire-negative**
- **42% of native species fire-sensitive.**
- **38% of exotic species fire-sensitive.**
- **59% of all r-d species were fire negative.**
- **Mean mortality for fire-sensitive r-ds about 70% .**
- **Significant associations between fire-sensitivity and upland inhabitation and non vagility.**





# Post Fire Recovery



How long?  
flightless species  
Univoltine species

How?  
In situ survival  
Recolonization

$b+1$





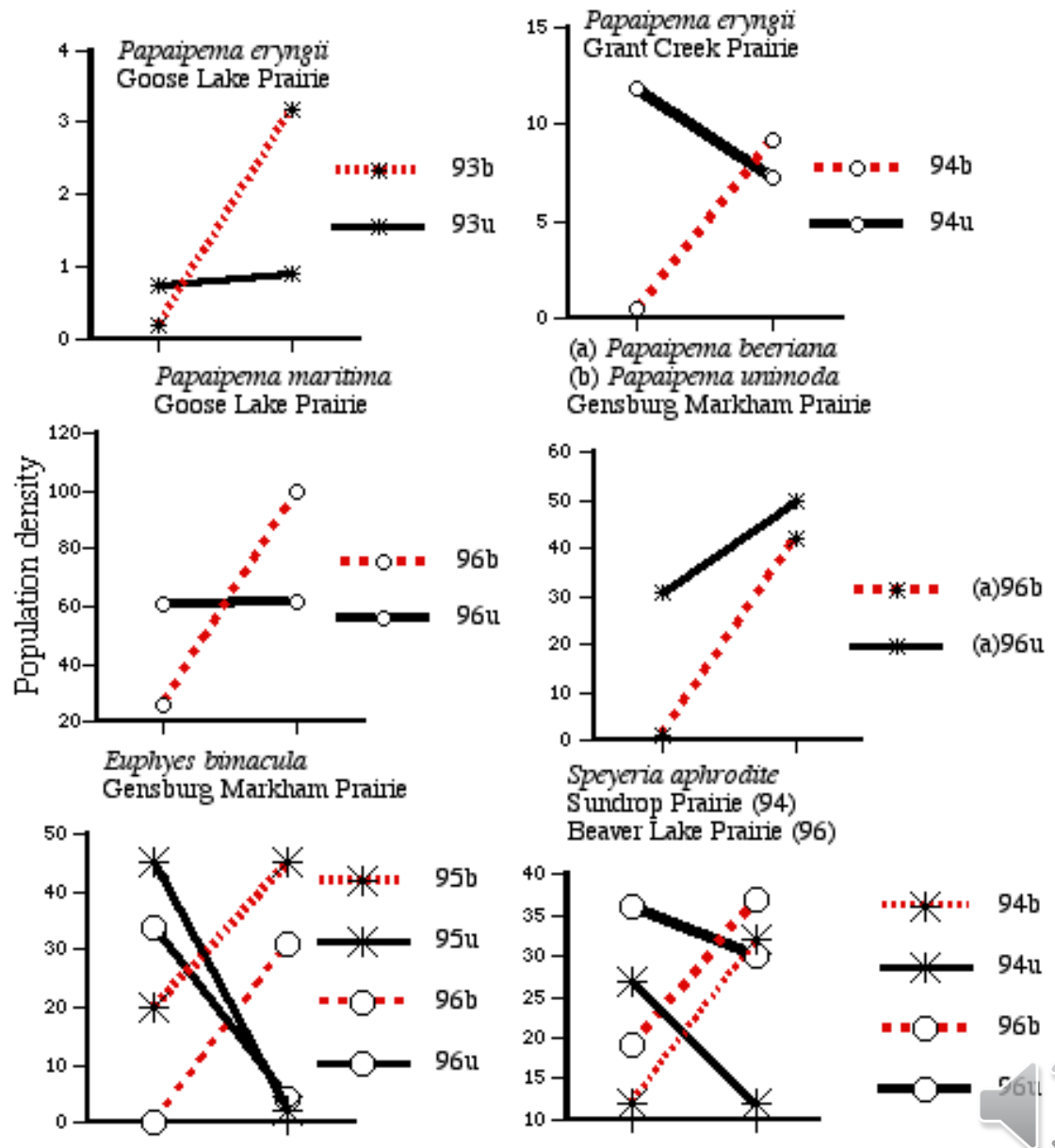
# Post fire population recovery

- Tracked 185 populations through one season.
- **Tracked 155 through two seasons.**
- 2/3rd of 61 species had mean recovery times  $\leq 1$  year.
- All 61 species had mean recovery times  $\leq 2$  years.



185  
populations  
tracked

68% of all  
species  
recovered in  
one year:



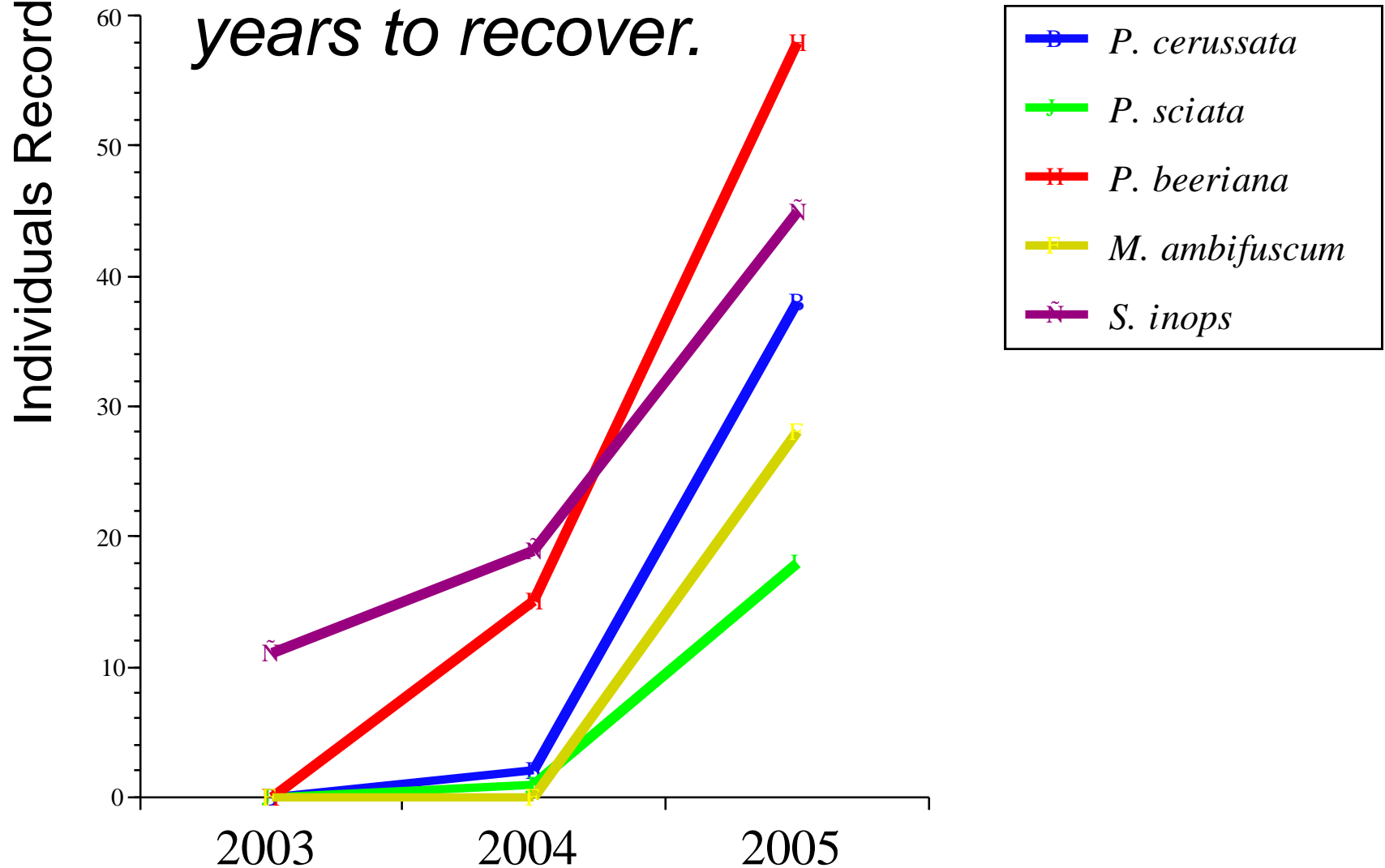


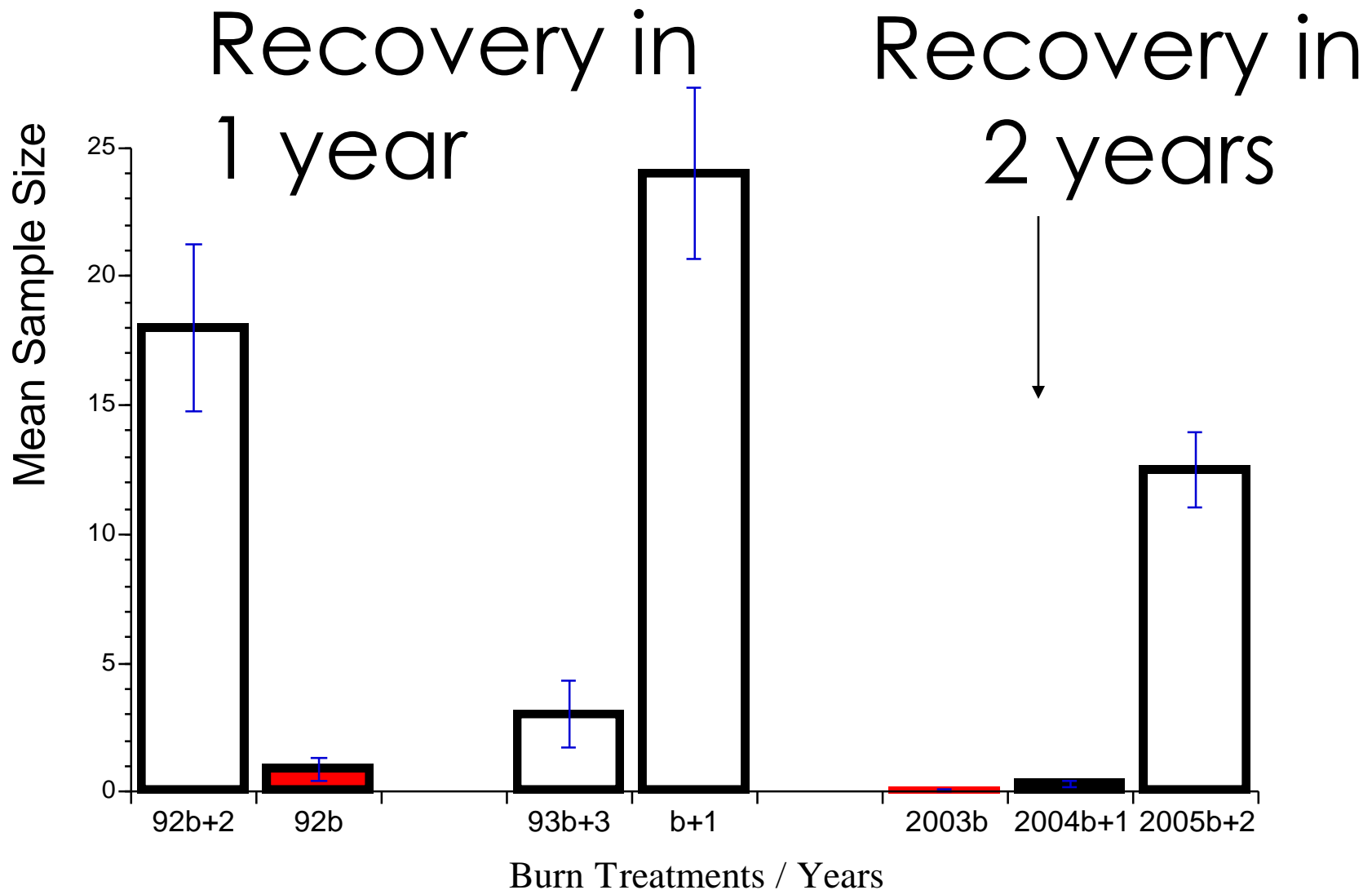
# Post fire recovery

- 3 populations each of a different species did not recover in two years. (however, 13 other pop. recovered in  $\leq 2$  yrs)
- 53 vagile species did not recover faster than 11 wingless species. (88% in situ survival).
- **Univoltine species** tended to recover more slowly than multivoltine species



*Many (univoltine) species require two years to recover.*





*Papaipema  
eryngii*





# Recovery Mechanisms

- Survival in place
  - *underground*
  - *small internal refugia*
  - *incomplete burn [in duff]*

- Recolonization





# IF AN ENTIRE SITE IS BURNED?

Some insect species may survive based on placement or intensity effects [survival]

However, many species will not.





# WHAT IF RECOLONIZATION IS NOT POSSIBLE?

We completely burned 40 isolated patches on 3 sites to do a small scale test of this for 6 species.

R-D; Duff Dwelling; Uni-voltine; Non-vagile  
[most wingless]









*Cribrus shingwauki* ♀ GMP, 7-26-04



Survivorship following complete burns;  
sampled before re-colonization could occur

Patches (40)	~ 4 m <sup>2</sup>	~ 8 m <sup>2</sup>	~ 16 m <sup>2</sup>	~ 32 m <sup>2</sup>
With survivors	3	11	12	11
Without survivors	1	2	0	0
Total tests	4	13	12	11

IN PLACE SURVIVAL CAN BE  
IMPORTANT: LEAVE SKIPS ALONE 





Evidence of recolonization?



# The maintenance of nearby refugia is essential

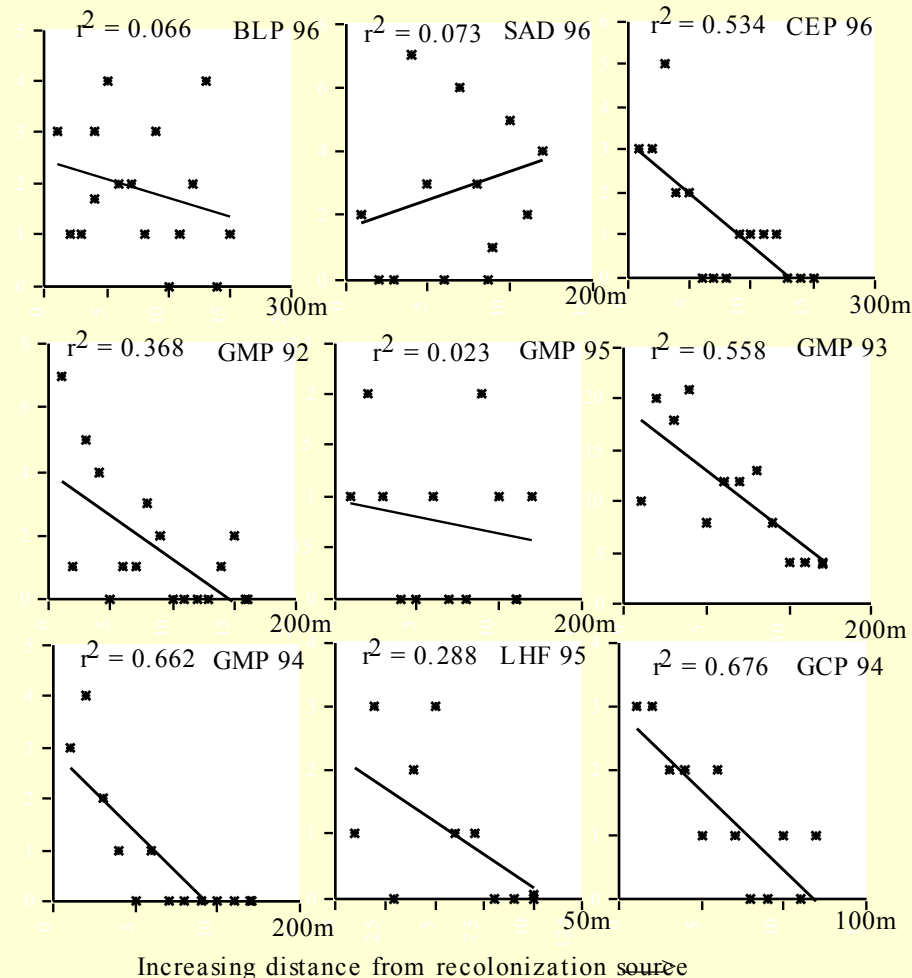
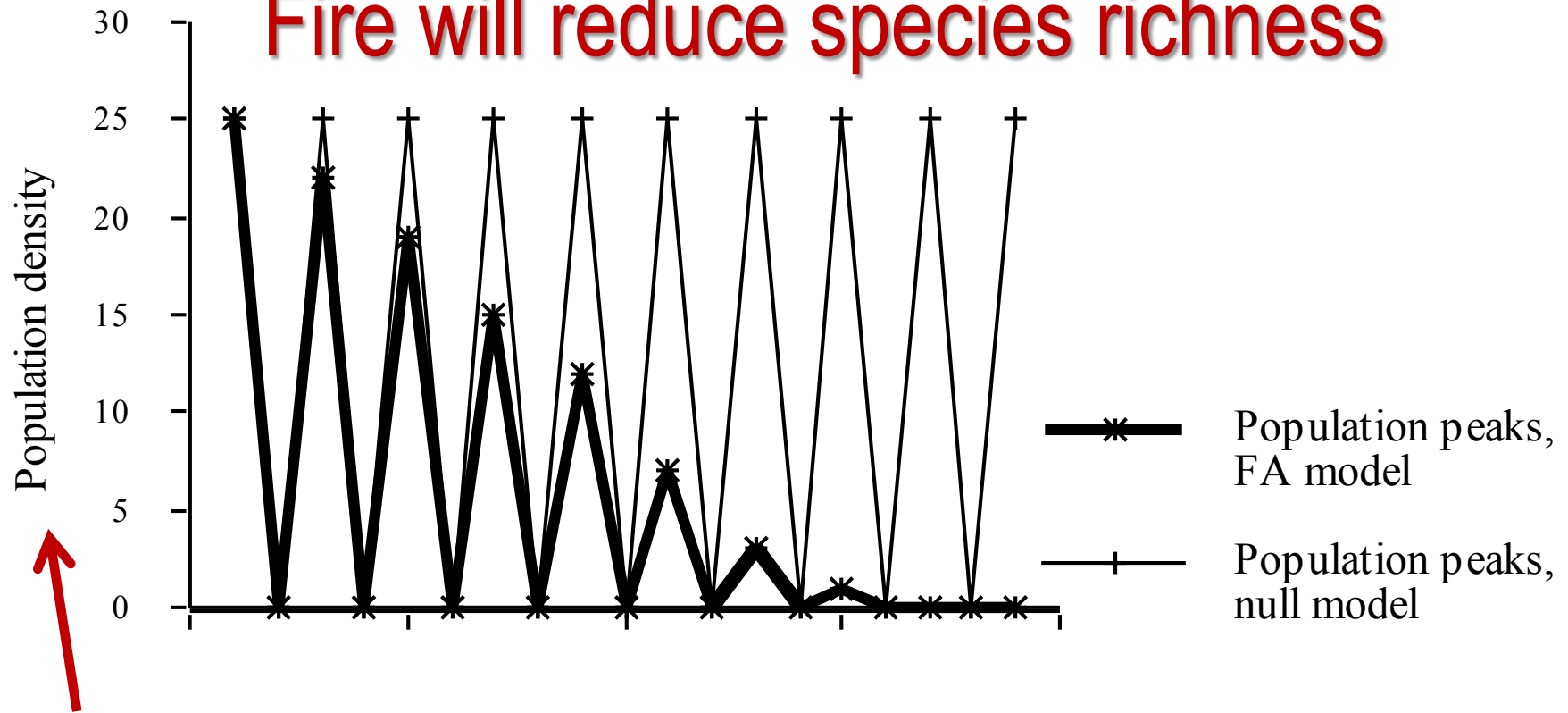


Figure 2. Distribution of postfire population density within recovering populations of *Laevicephalus unicoloratus* in recently-burned prairie. Spatial scale is shown in meters. Site acronyms are listed in Table 1.



# Fire attrition hypothesis-

## Fire will reduce species richness



or Species Richness

**Figure 1. Fire Attrition Model.** The fire attrition hypothesis predicts that short burn return intervals will result in increasingly smaller population sizes and will culminate in the extirpation of fire-sensitive species.

20 FM vrs 20 FE sites

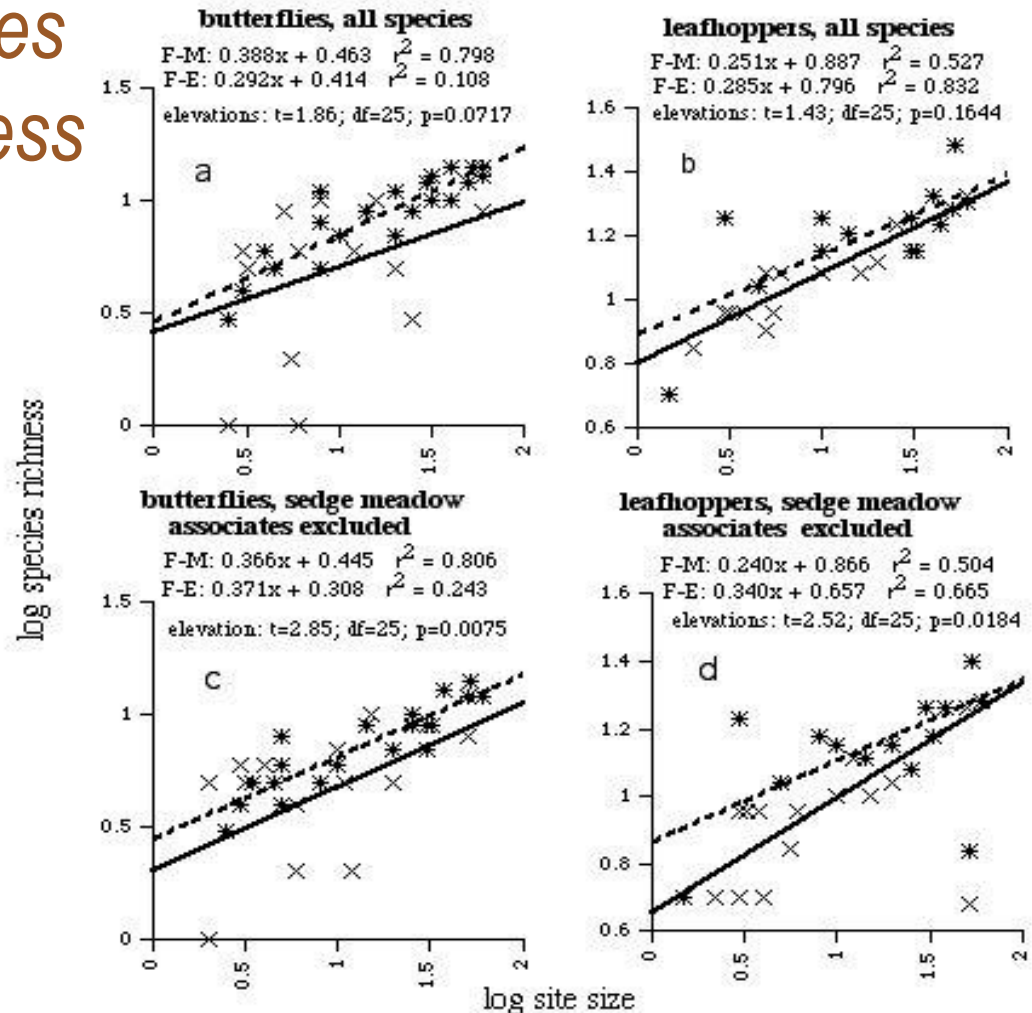




# ***Fire Managed sites did not loose species***

*Species  
Richness*

In fact, there  
were more R-D  
butterfly and  
leafhopper  
species in the  
FM systems



*Site Size*



Insect population densities within 7 paired fire-managed and fire-excluded sites. (64 populations; 36 spp.)

	no. populations
no sig. difference between sites	30/64*
greater densities in <b>fire managed sites</b>	28/64 (44%)
greater densities in <b>fire excluded sites</b>	6/64 (10%)



# Distribution of 24 exclusive spp. Among 46 CW sites

- Fire-managed sites
- 4/27 butterflies
- 15/64 leafhoppers
- Fire-excluded sites
- 0/27 butterflies
- 9/64 leafhoppers





# No support for the attrition of species by fire hypothesis

- FM sites supported equal or greater numbers of r-d species than FE sites.
- Population densities tended to be greater on FM sites. (44% vrs 06%)
- 19 of 28 (68%) exclusive species occurred solely on Fire Managed sites.

Published in Biol. Cons.



# Catastrophic wildfire



April 14, 2003  
80+ degrees  
Winds ~30mph  
Humidity low



# Post-fire insect study, Grant Creek Prairie (2003-2007)

Attributes*:	Univoltine (1 generation)	Above ground	Upland species	Flightless species	Species of CC
<b>28 moth species</b>	<b>28</b>	<b>25</b>	<b>13</b>	<b>0</b>	<b>18</b>
<b>2 leafhopper species.</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>1</b>

*\* Thought to contribute to fire-vulnerability*





# Initial impact

- Will surviving populations be smaller than expected?
- Will any species be lost?



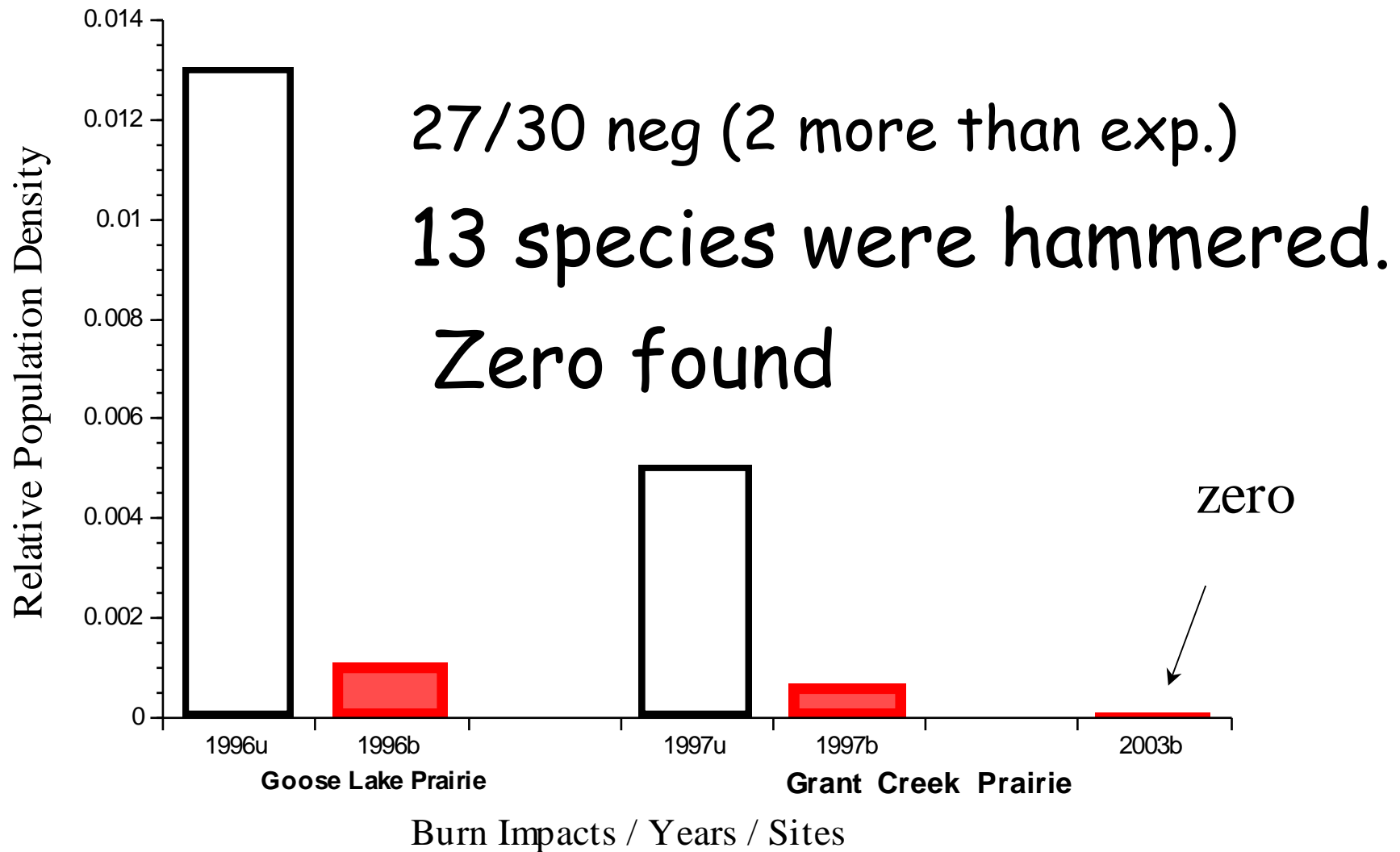
# Expected responses

• Fire positive	02
• Fire neutral	03
• Fire negative	09
• Unknown, presumed fire-sensitive	16

25/30 species known or  
presumed to be fire-sensitive.



# *Papaipema beeriana*, Impacts





# Characterization of relative population sizes for 30 insect species following a total burn of the Grant Creek Prairie in the spring of 2003.

*\*\* flightless leafhoppers recovered*

Relative population size classes		2003†	2004	2005
expected ("normal")		<b>11*</b>	15**	22
smaller than expected	↓	<b>6**</b>	5	7
undetectable	↓	<b>13</b>	10	1

† measure of fire intensity

\* 4 of 5 fire-neutral/positive species

**19/30 spp. Scarce or undetectable in year** 

# Post fire recovery

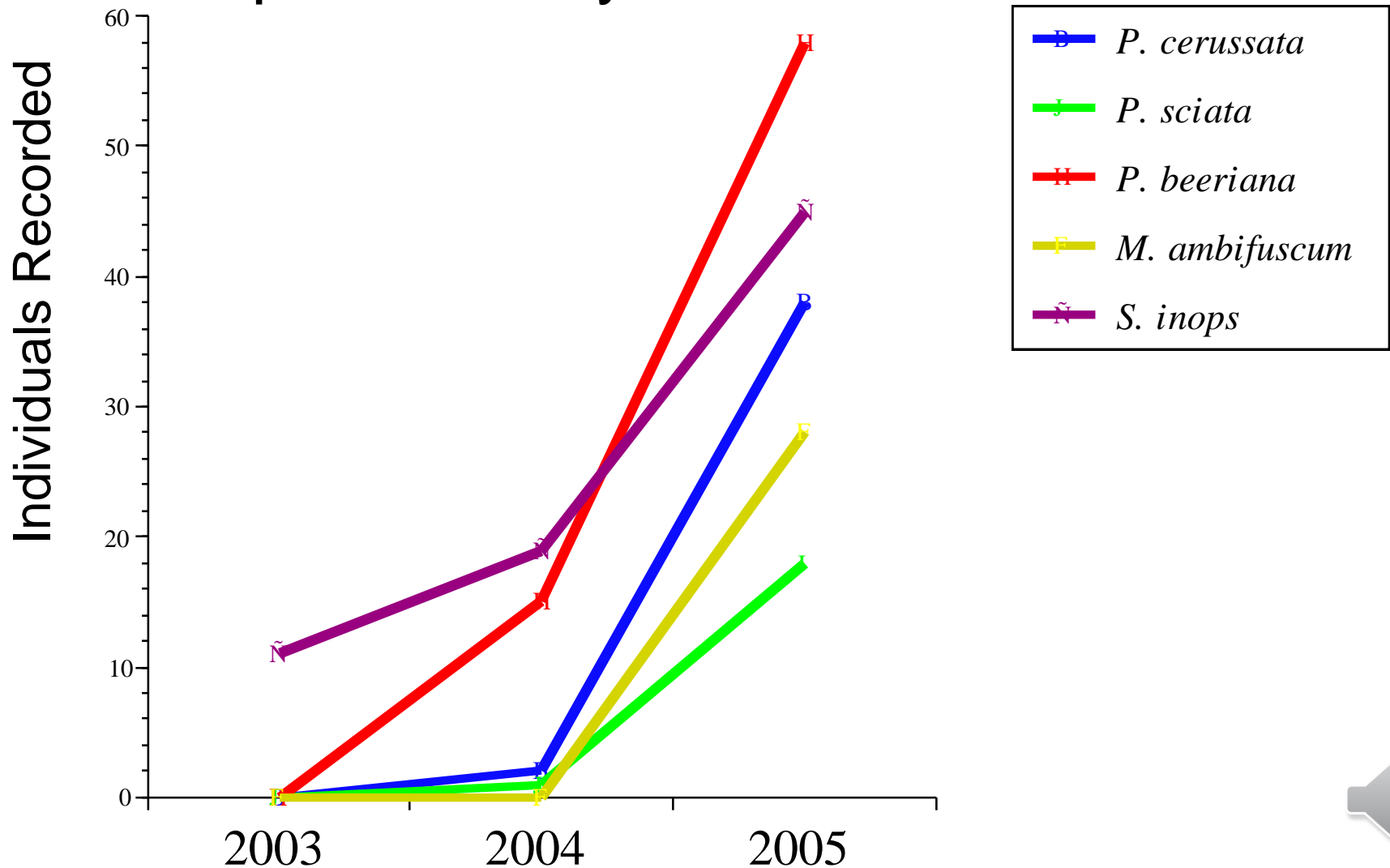
Will the lack of refugia lengthen historic and projected recovery intervals?

- Have any species been extirpated?



# 11 of 19 heavily impacted populations recovered in $\leq 2$ years

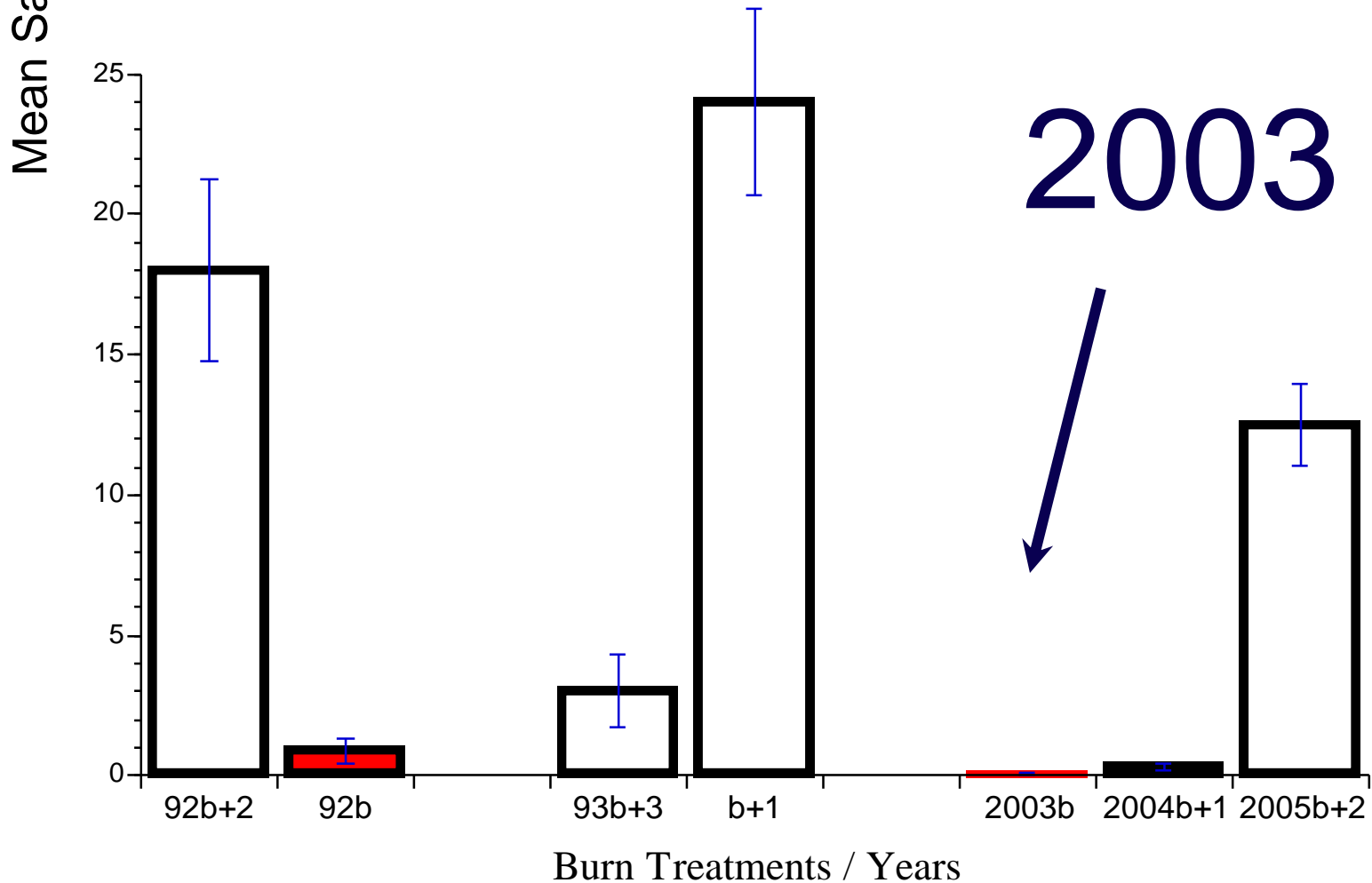
Expected = 1 year



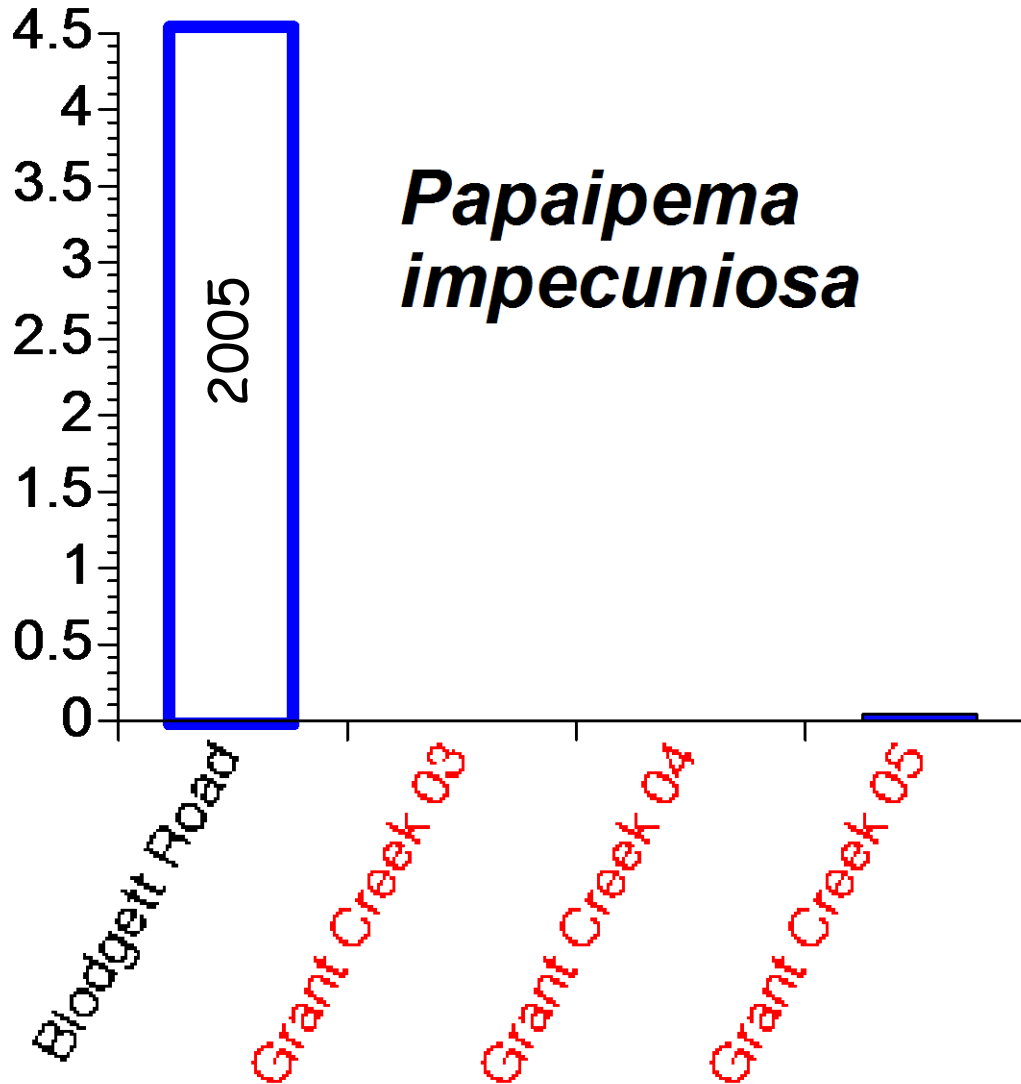


*P. Eryngii* requires an "extra" year  
Following intense fire.

*Papaipema eryngii*, larvae



7/17 species still scarce after 2 years



# Initial impact & recovery over 4 years

Population size classes	2003	2004	2005	2007
expected	11	15	22	25
smaller than expected <b>Not Recovered</b>	06	05	7	4
undetectable <b>Extirpated?</b>	13	10	1	1





# Intense and Entire Site burn summary

- **Response sizes for 19/30 species were more severe than expected. (fire intensity)**
- **11/19 species recovered in  $\leq 2$  years (“normal”)**
- **3 species required 3 or 4 years.**
- **5 species had not recovered after 4 years.**
- **One species has not been seen and may have been lost.**



*1 species apparently extirpated in  
this event*

*Has not recolonized from a site 1  
mile away*

*1. Intensity of fire*

*2. Everything [Entire Site] burned*

Burning everything may not be a  
good strategy for us to preserve  
conservative insects



# *Consecutive Burning*





# Consecutive Burning Issues

*Trade off in effects-*

- Increasing fuel load without fire  
[ ~ up to 5 years in prairie ] with  
subsequent increase in fire  
intensity when fire does occur

**Vs.**

- Not leaving time between fires for  
insect populations to recover



# Double-burn responses recorded for 32 species in 48 tests ( $b_1/u_1$ versus $b_2/u_2$ )

*12 paired sites*

Species groups	Species considered (populations)	<u>Double burn RESPONSES</u> (populations)		
		(less severe)	(non significant)	(more severe)
Fire positive	7 (8)	1	5	2
Fire neutral	7 (10)	0	8	2
Fire negative	18 (30)	2	19	9
Totals	32 (48)	3	32	13



*Conducted on 6 sites paired*

w/ Leafhoppers, 2 *Bruchomorpha*, 7  
Butterflies, & *C. saltans*

***Significant effects were usually  
negative, suggesting the  
consecutive burning is more likely to  
threaten than protect duff-inhabiting  
species.***





***Increasing fuel load without fire  
[ ~ up to 5 years in prairie ] with  
subsequent increase in fire intensity  
being significant to mortality***

## **UNCERTAIN HYPOTHESES**

***Not leaving enough time between  
fires for insect populations to  
recover***

**SHOWN BY OUR STUDIES TO BE TRUE**



# Summary

- Hundreds of conservative insect species persist solely on remnants.
- Roughly half are fire sensitive (FS).
- Fires often reduce FS populations to very small numbers. (80-100% killed)
- Species that inhabit dry and mesic habitats, and those with single generations are especially vulnerable.
- Most FS species require 1 or 2 years to recover following “normal” burns (with refugia present).
- Unburned refugia and skips play essential roles in the recovery of small populations.
- Complete burns should be avoided .



# *50% of R-Ds ( 8-10% of all insects) clearly vulnerable to fire*

Fire-negative species,  
slower recovery  
(  $\leq 2$  year)

Fire-negative  
species,  
slow recovery  
(  $\leq 3$  year)

Fire-negative  
species,  
rapid recovery  
(  $\leq 1$  year)

Fire-neutral  
species

Fire-positive  
species

Remnant-Dependent

Remnant-Independent

