o

# The effects of wildland fire on conservative insects in prairie and savanna remnant habitats

# The effects of wildland fire on conservative insects in prairie and savanna remnant habitats


## Karl Gnaedinger

Manager–

Indian Boundary Prairies

The Nature Conservancy

in IL

Indian Boundary Prairies - a remnant -

# Dr. Ron Panzer
# Northeastern IL University

## Primary Researcher, Photographer

Among our 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 true value of restorations as sanctuaries for vulnerable species

I

# 6) Conservation in Fragmented Landscapes---the importance and status of REMNANTS

# Ecological restoration goals

- To restore degraded ecosystems to their former condition (**Authenticity**)
- *To contribute appreciably to the protection of the numerous species associated with them* (**Conservation Value**).




Conservation Perspective

# Can humans restore an ecosystem?


F. albida

# *Fragmented habitat remnants as*

Biodiversity Reservoirs

# actual managers of [ PRAIRIE ] natural areas

# practical advice for natural area managers

**ECOSYSTEM-**

**A complex set of relationships of living organisms functioning as a unit and interacting with their physical environment.**

## TEMPERATE GRASSLANDS:

-Determined by $H_2O$ regime

-Grazing [mega- & micro-fauna]

-Determined by FIRE frequency

# *Saving high quality natural areas*

*Re-introduction of a natural disturbance*

# Naturalists–


We knew the uniqueness and rarity of plants

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

# What about animals?

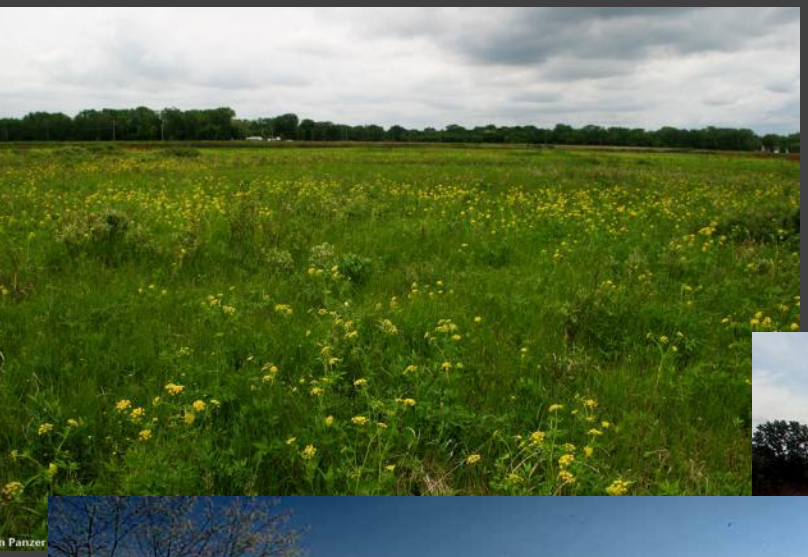
III

# Conservation in Fragmented Landscapes---the importance and status of REMNANTS

-backround

*Where we worked*

# Fragmented Landscapes



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

# Prairies


*Dry to Wet including sedge meadow*

# Savannas

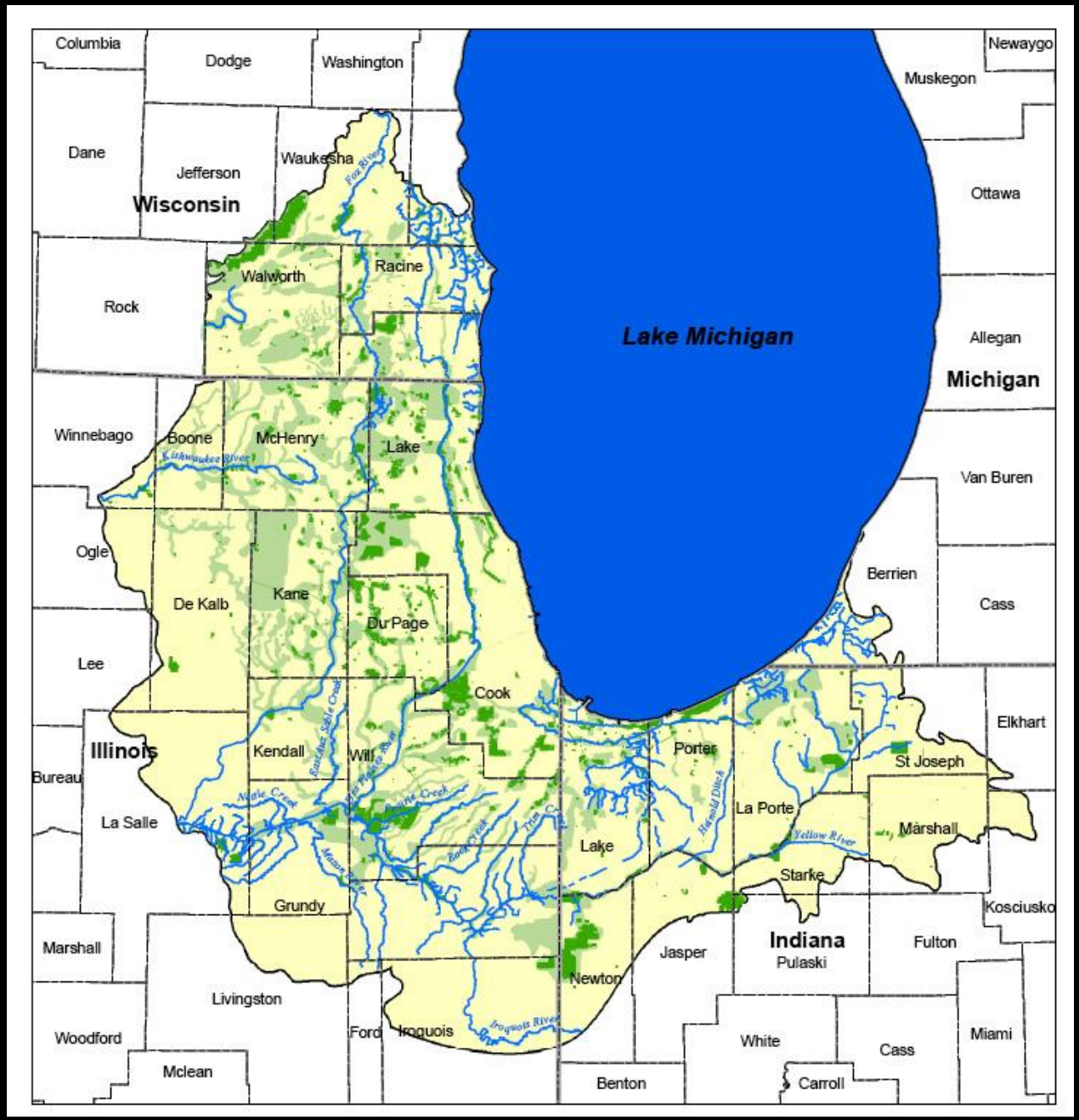
# Insect Inventory Sites

## 1982 - 2012

85 in Illinois
16 in Indiana
03 in Wisconsin

13 in WC Illinois
05 in NW Illinois
02 in NC Illinois


Δ's thru the seasons


Columbia
Dodge
Washington
Newaygo
Muskegon
Dane
Jefferson
Waukesha
Wisconsin
Ottawa
Rock
Walworth
Racine
Lake Michigan
Allegan
Michigan
Winnebago
Boone
McHenry
Lake
Van Buren
Ogle
De Kalb
Kane
Du Page
Berrien
Cass
Lee
Cook
Elkhart
Illinois
Kendall
Will
Porter
St Joseph
Bureau
La Salle
La Porte
Marshall
Lake
Starke
Grundy
Kosciusko
Marshall
Indiana
Pulaski
Fulton
Jasper
Newton
Livingston
Woodford
Ford
Iroquois
White
Cass
Miami
Mclean
Benton
Carroll

# Conservationists-Naturalists

What species need our help to survive the next 100 (or 500) years in our area??
What species are in danger of extinction??
or…
What species need our help to survive right NOW?

# Lots of species inhabit prairies

Est.

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


# Conservationists:

## 1st distinction-
## Species Vulnerable now, or not??
## [Δs w/time]

Δ
level of
Vulnerability

Smooth green

Conservationists:

2nd 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 ??**

# Conservative Species

The subset of species requiring authentic habitats; they do not survive in areas transformed by people into degraded habitats


Ron Panzer

# Conservatism in plants is well documented

## Floristic Quality Indices

| | |
|---|---|
| Colorado | Missouri |
| Florida | Nebraska |
| Illinois | Ohio |
| Iowa | South Dakota |
| Michigan | Wisconsin |
| USFWS | USACE |













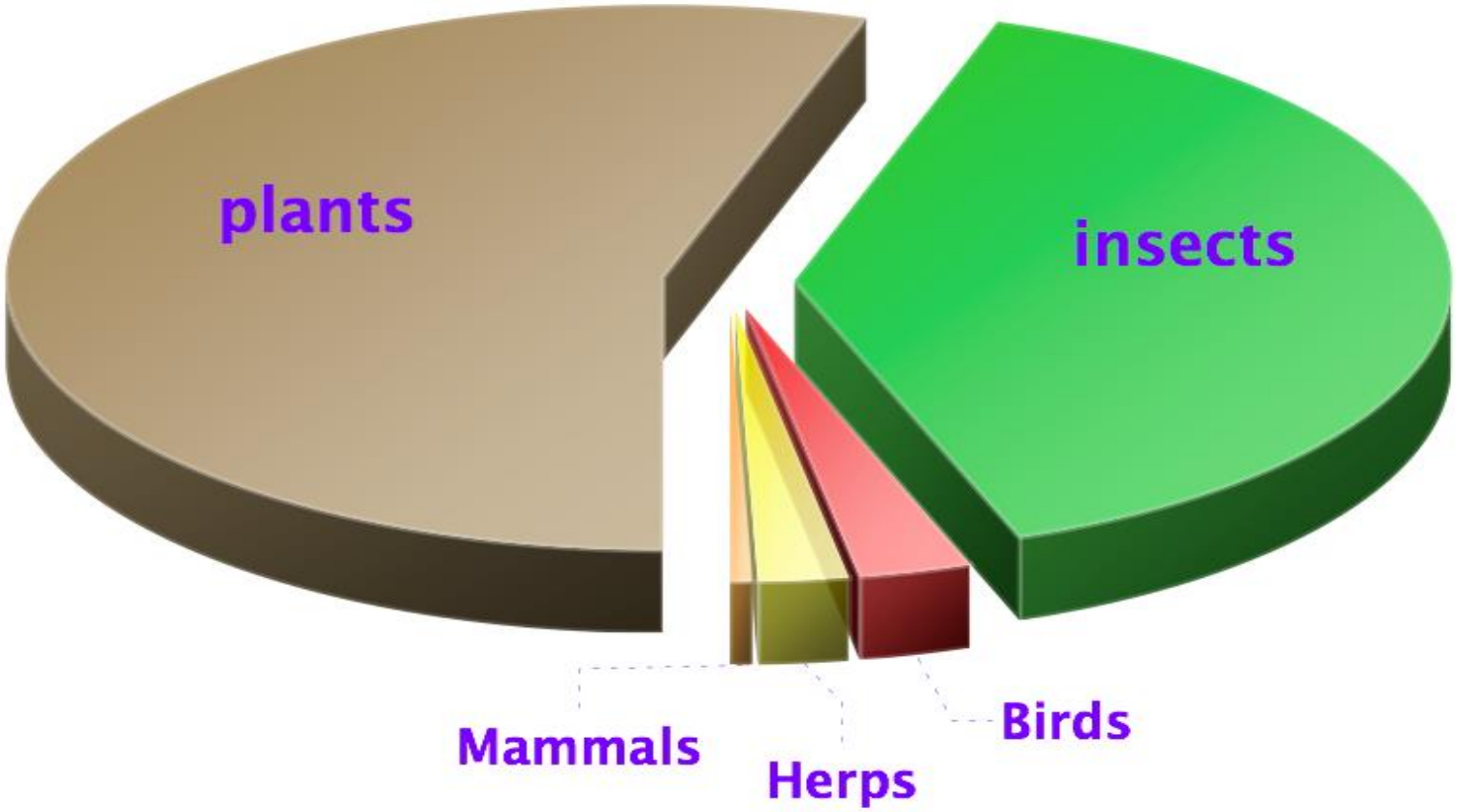

*Conservatives tend to be imperiled & R-D*

# How is conservative or remnant dependent status determined, for insects?

Searching in remnants, but then also searching [endlessly] in changed [degraded] habitats, such as

- Old Fields [Eurasian Meadow],
- roadsides,
- ditches,
- even cropped areas
- even lawns

# Relative numbers of prairie-associated species of conservation concern

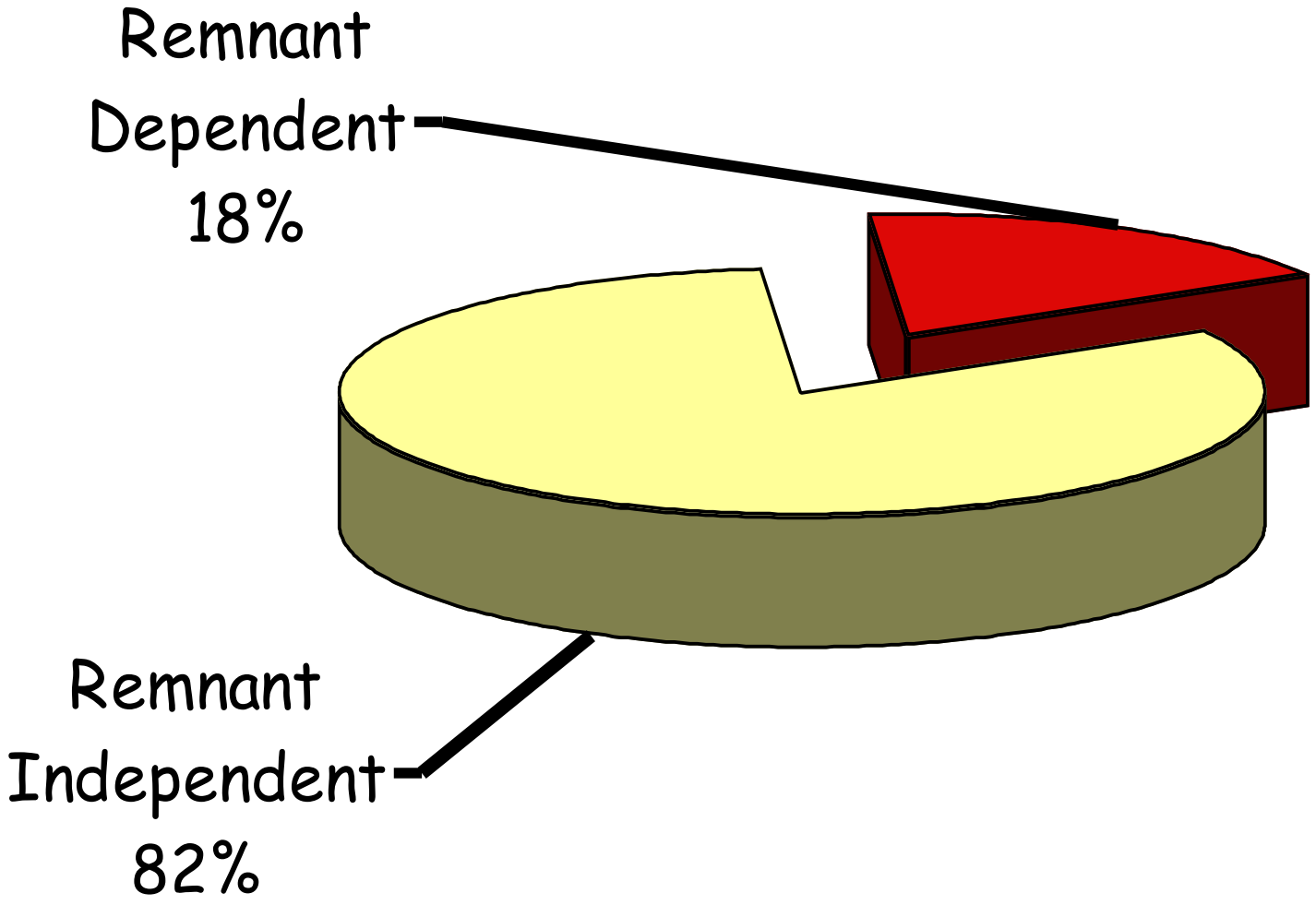



1090 species


Ron Panzer

# *Sayapion segnipes*

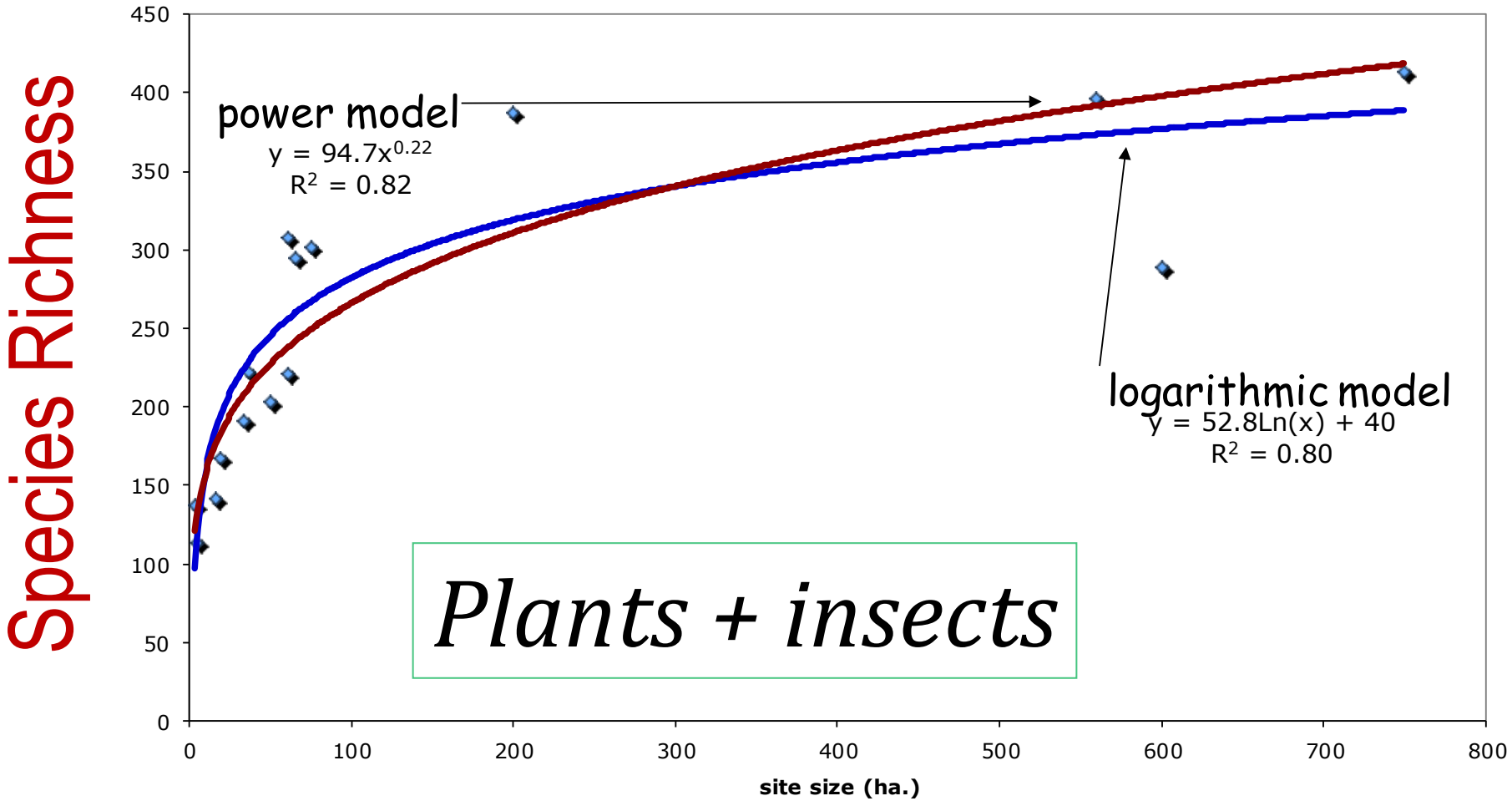
*Sayapion segnipes* off *Tephrosia*, gmp Sep 06




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

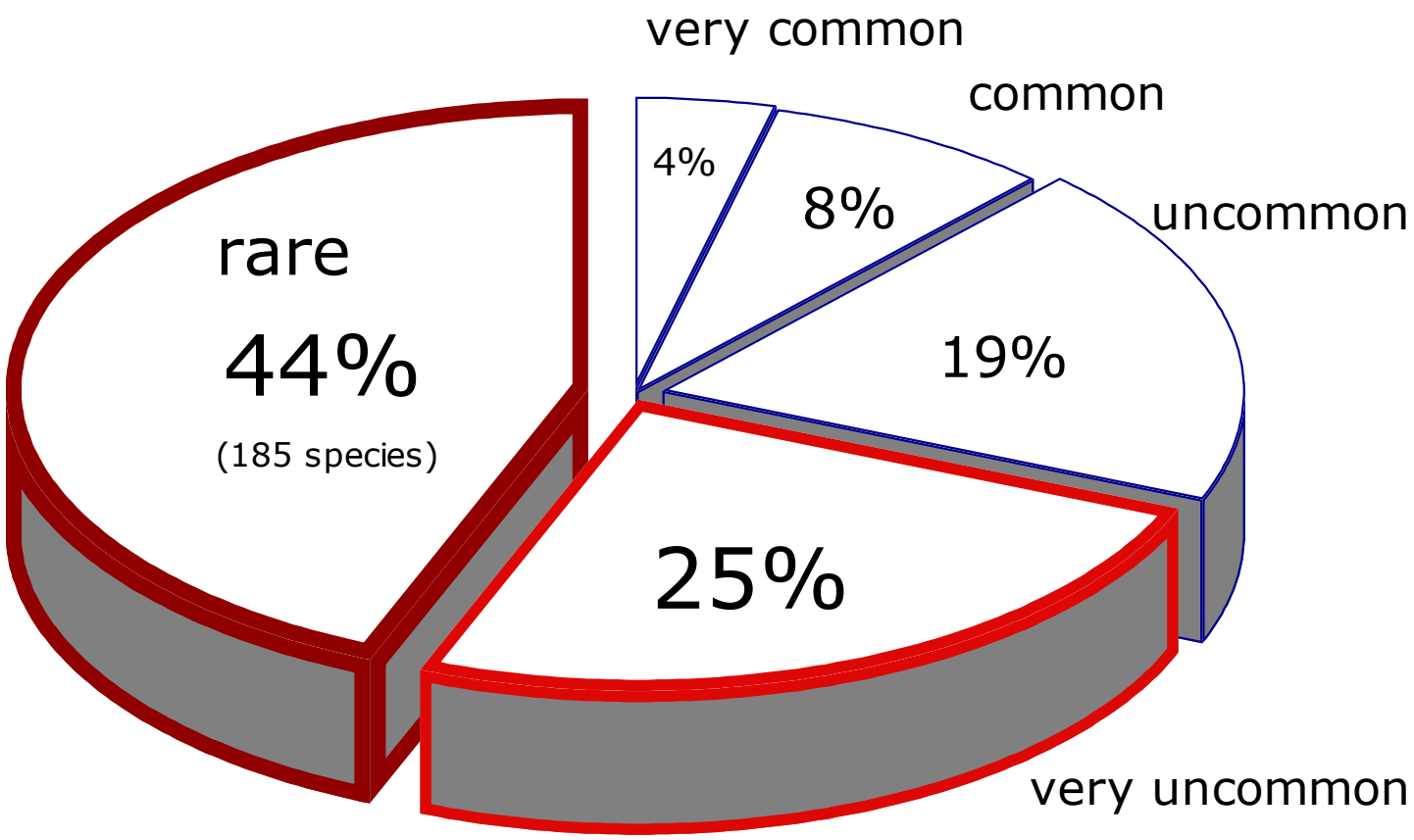
# Small sites are important

## [size is overrated]



# Distribution of ‘rarity’ among R-D insect species

**Conservative insects: CW status**



# Short Summary

- 15-20% of the prairie-inhabiting insects of the CW region are remnant-dependent.
- Every remnant supports some species.
- Roughly 1/3 are seemingly secure.
- Roughly 1/3 clearly are not.
- Insects represent a substantial proportion of the imperiled biodiversity in this region.

# R-D SUMMARY

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.

# Remnant Dependent [ R-D ] Species

**Obviously, in a fragmented landscape,** *it is unrealistic to expect most conservative insects species to re-populate* ***distant*** *sites* **if their entire isolated population is extirpated**

*which brings us to*

# FIRE

Fire is a natural periodic disturbance in terrestrial ecosystems

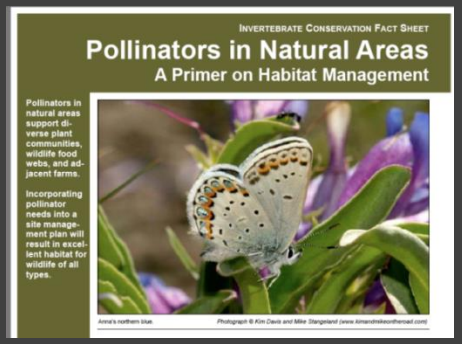
Deb trailing Fire

**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

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

-how often [frequency]

-how done [ringing?]

-what conditions

# 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 Δ for you]

   > 25% Relative Humidity

   < 75° F

   < 20 mph Winds

Fires can be of greatly varying intensity

*Avoid extreme conditions;… yet if there is fire,… it has reached the point of ignition*

# 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

## **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*

# 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

# Annual or less than annual Species

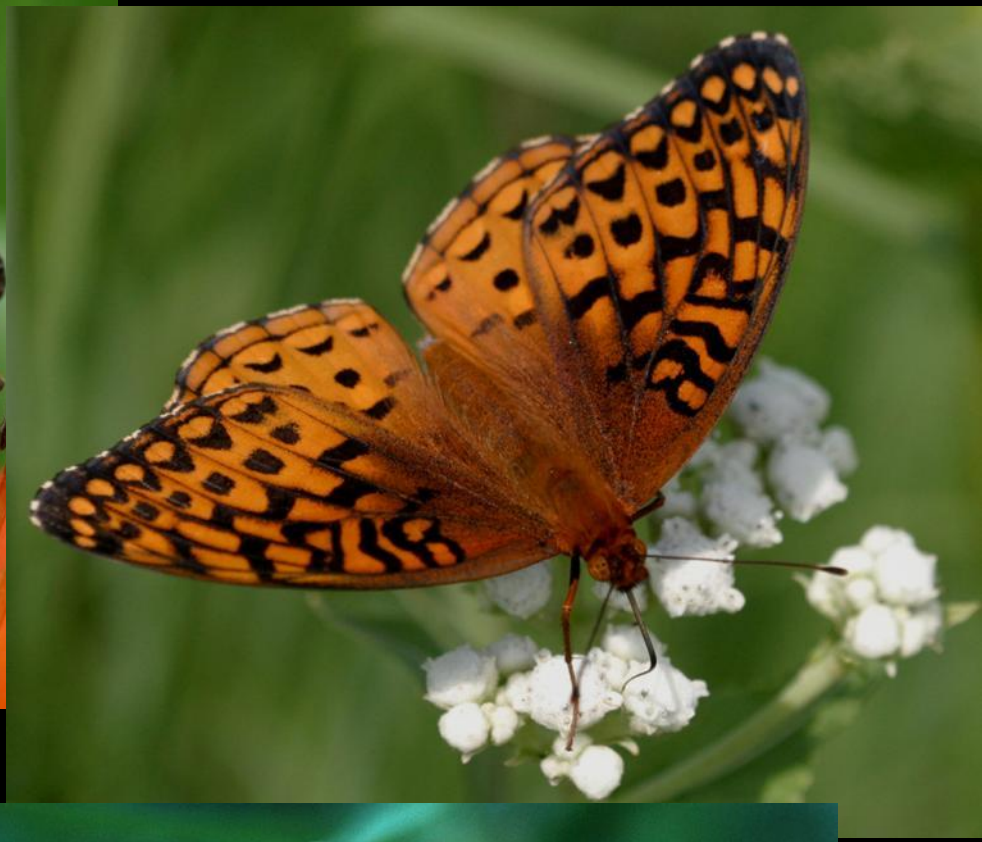

Aflexia rubranura

# life history attributes

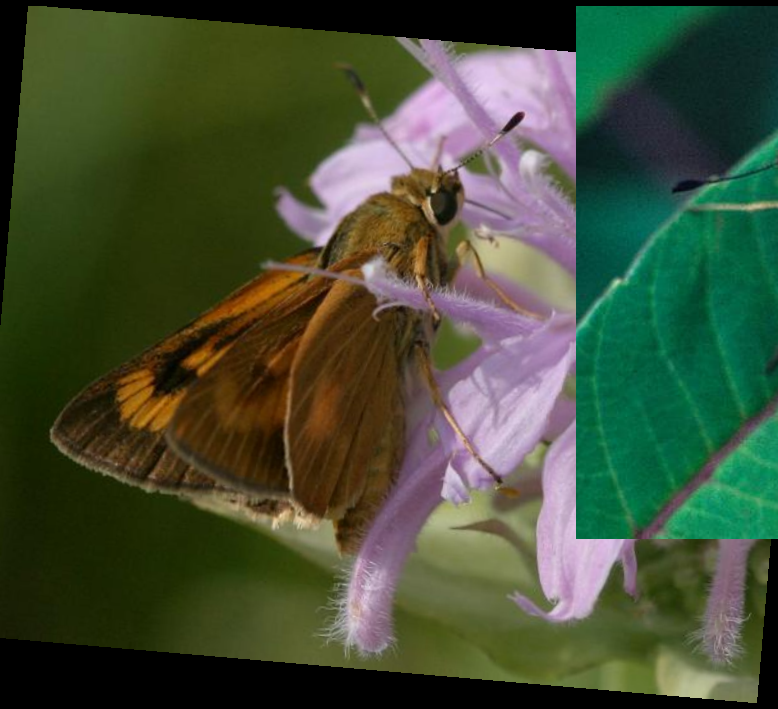
Conservative species 73; RI 81

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


Ron Panzer






Ron Panzer


Erimobina jocasta, West Chicago Prairie, July 23, 2004
Ron Panzer


D. blatchleyi


Mesamia straminea
Ron Panzer
Aphelonema rosa
Ron Panzer
Ron Panzer
Kansendria kansiensis
Limotettix truncatus
Scaphytopius vaccinium ♀ (brown-speckled face)
hoppers
Prairiana kansana angustans
Ron Panzer
Mesamia straminea nymph
Ron Panzer
Polyamia apicata (3 mm)
Ron Panzer
Polyamia rossi
Ron Panzer

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

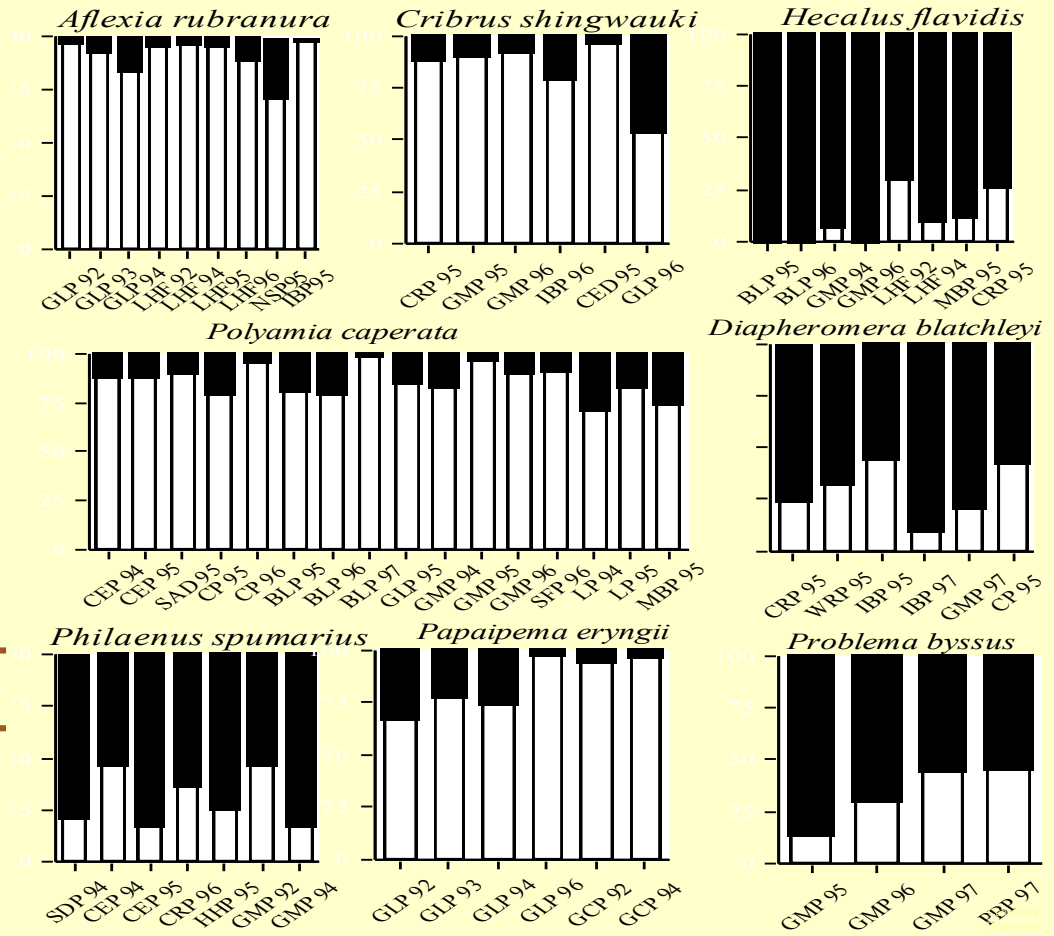

Predictable?
Effect direction?
Effect size?

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

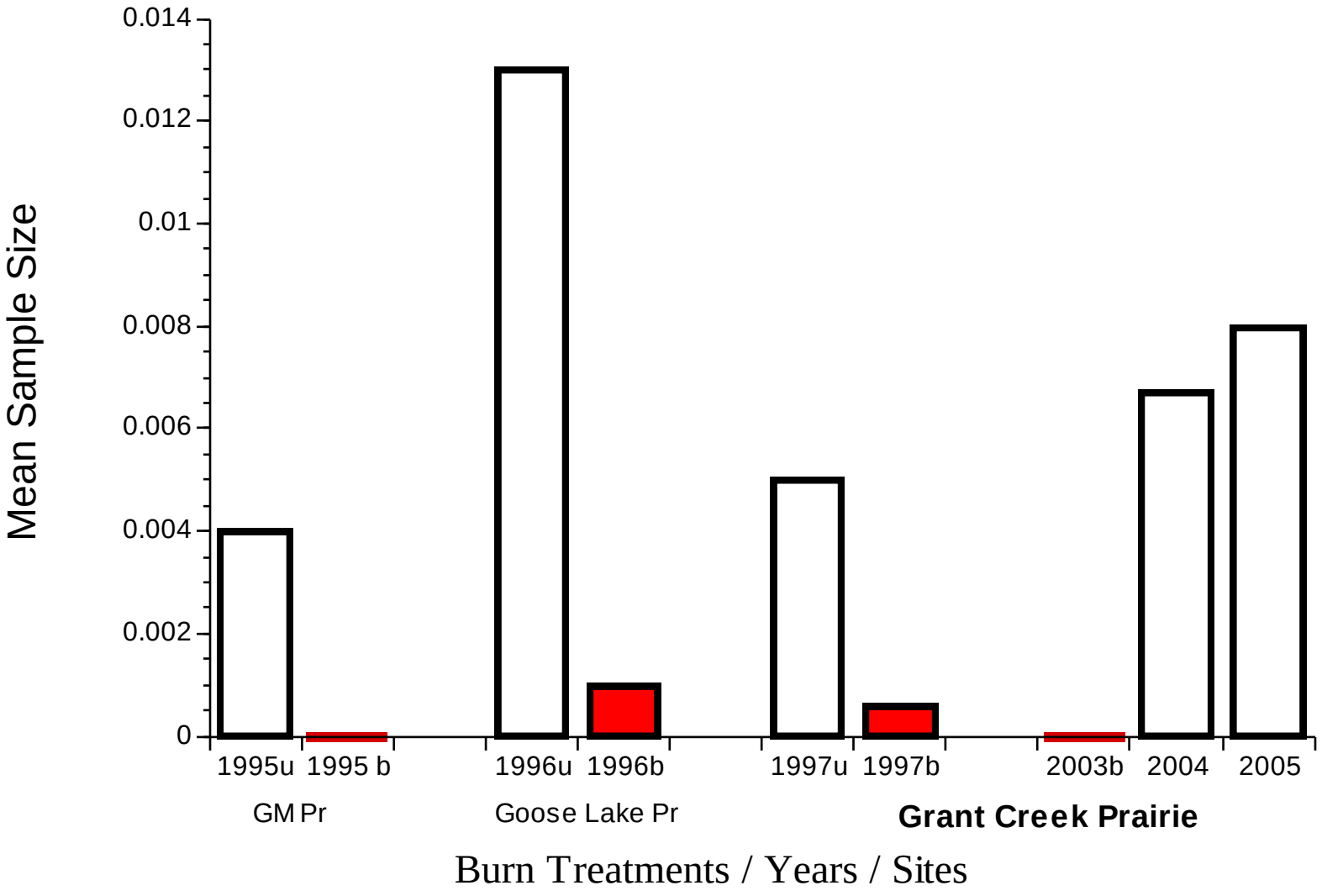
## 8 R-D species , independent replications

**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 inhabitance** and non vagility.

Published in Cons. Biol.

# Post Fire Recovery


## How long?

- flightless species
- Univoltine species

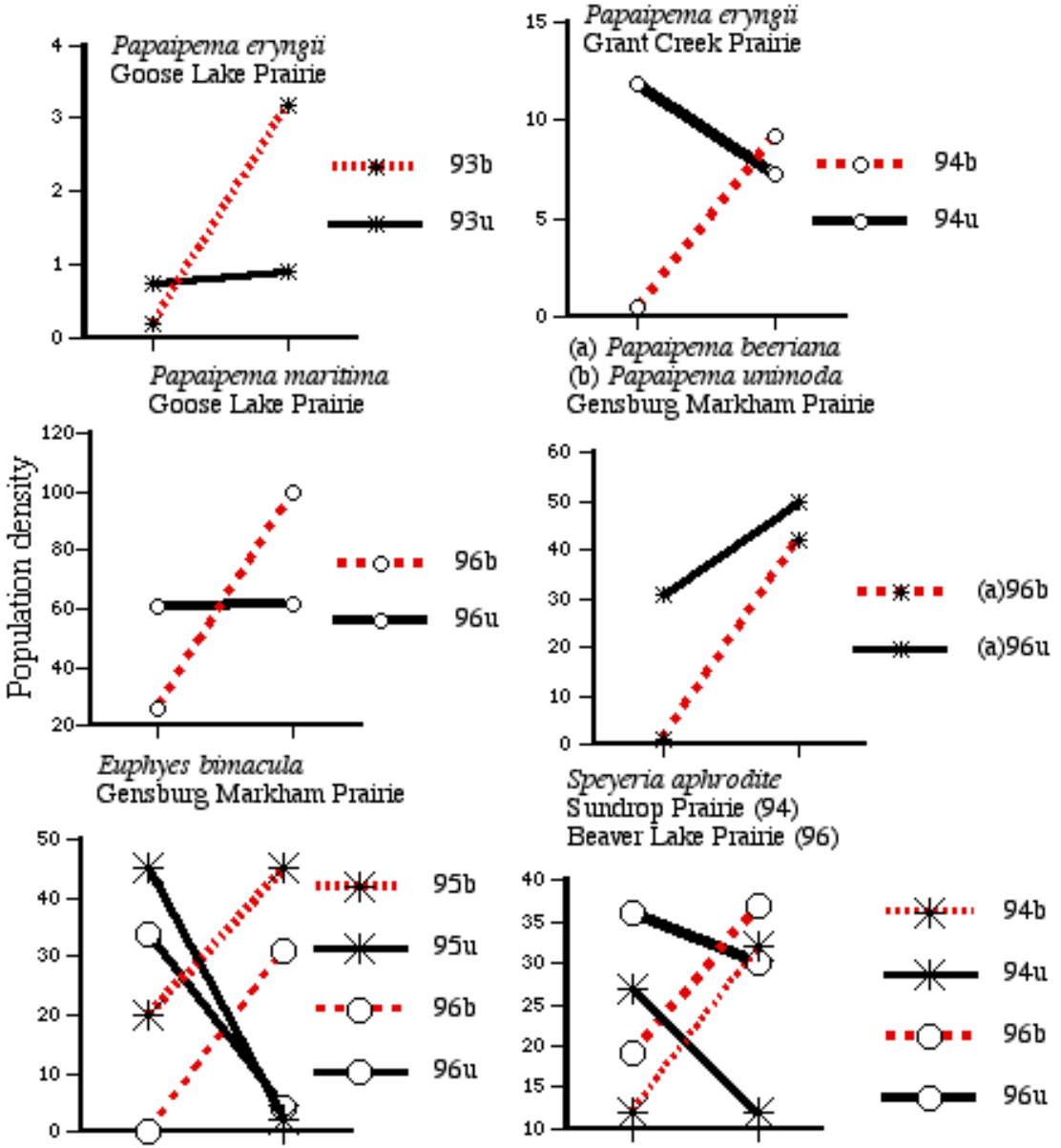
## How?

- In situ survival
- Recolonization

# Post fire population recovery

- Tracked 185 populations [61 species] through one season.
- **Tracked 55 populations through two seasons.**
- 2/3rd of 61 species had mean recovery times ≤ 1 year.
- All 61 species had mean recovery times ≤ 2 years.

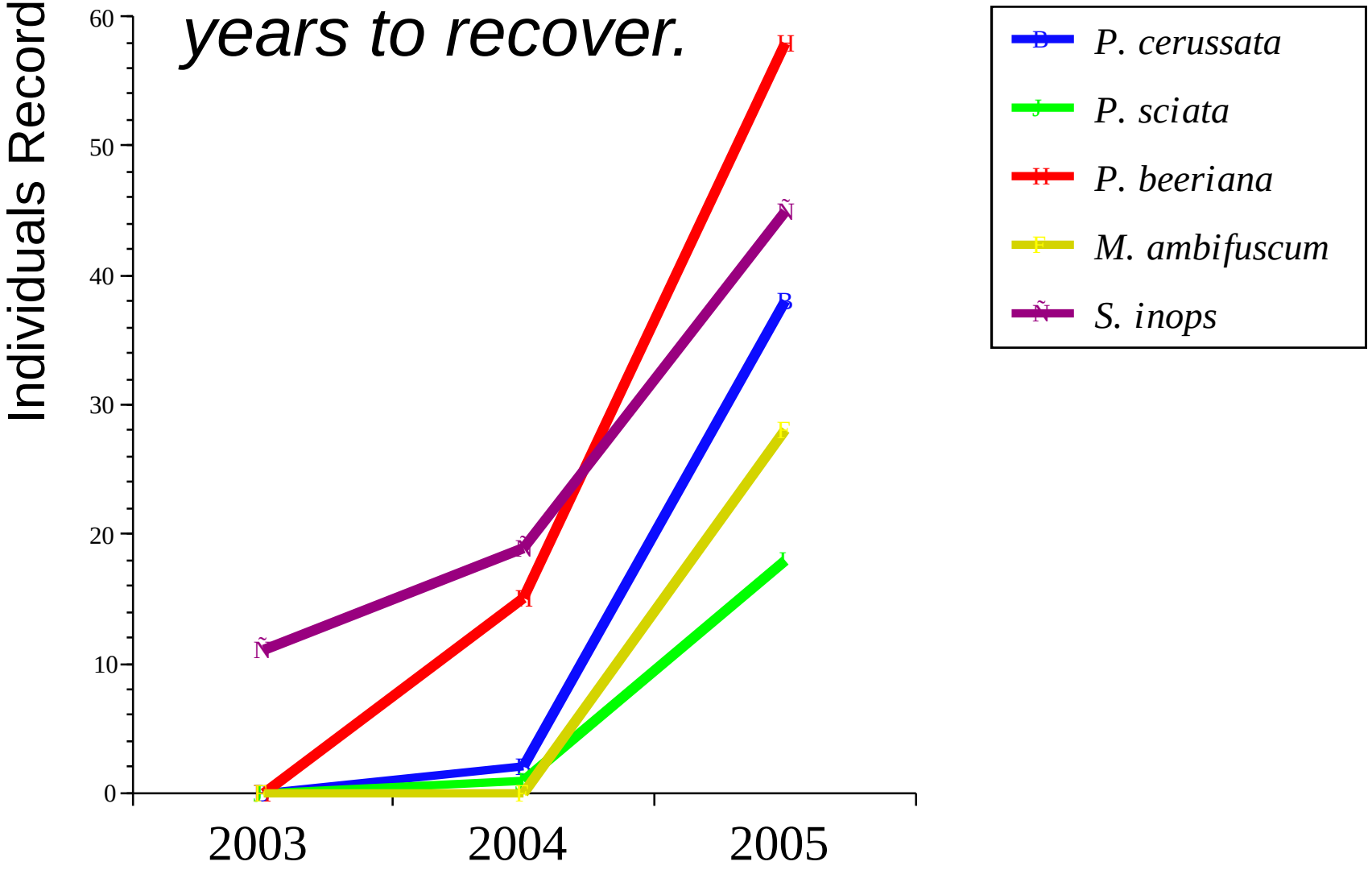
68% of all species recovered in one year:

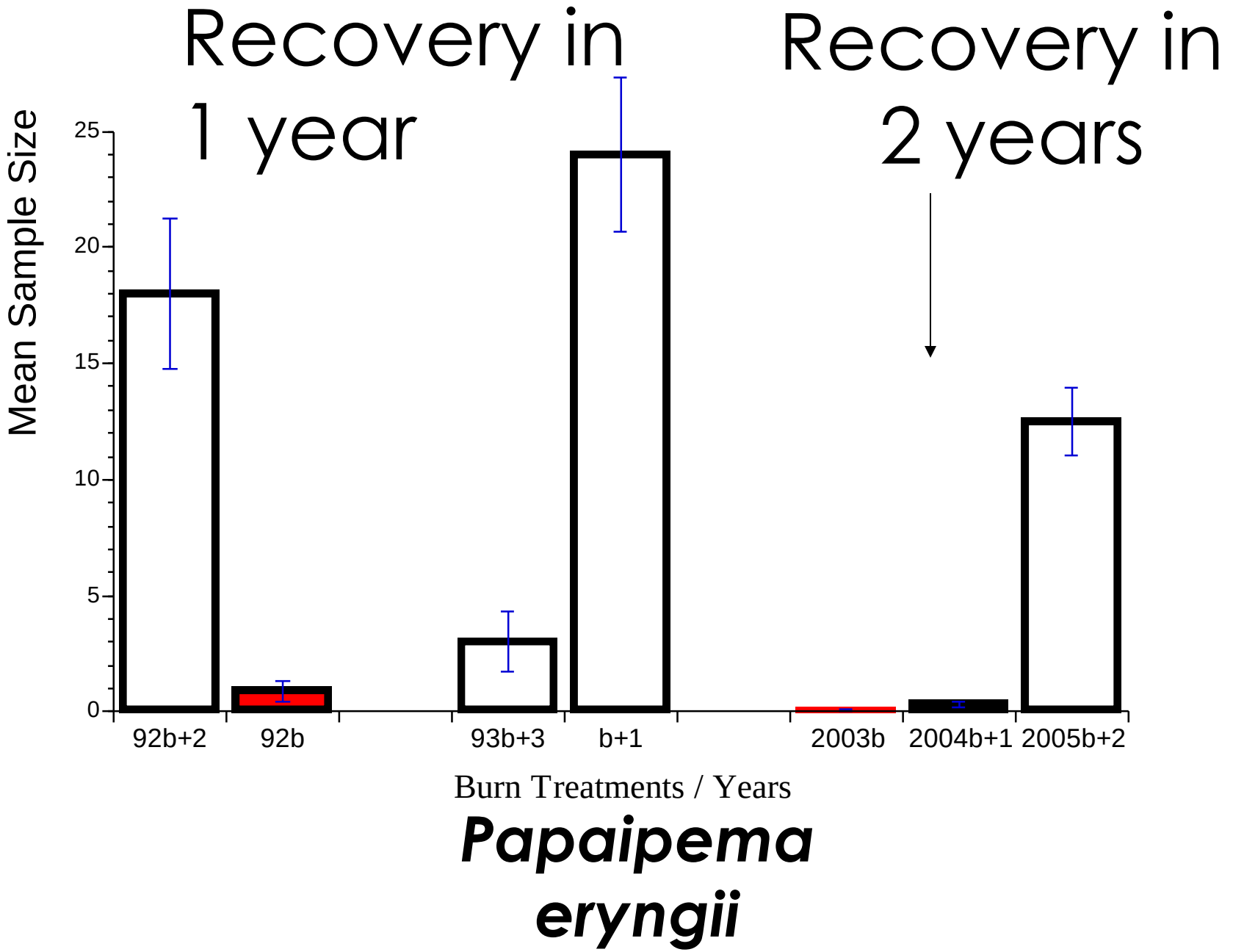


# Post fire recovery

- 3 populations each of a different species did not recover in two years. (however, 13 other pop. recovered in ≤ 2yrs)
- 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.*




Recovery in 1 year
Recovery in 2 years
Mean Sample Size
25
20
15
10
5
0
92b+2
92b
93b+3
b+1
2003b
2004b+1
2005b+2
Burn Treatments / Years
Papaipema eryngii

# Recovery Mechanisms

a. Survival in place

*-underground*

*-small internal refugia*

*-incomplete burn [in duff]*

b. Recolonization

# IF AN ENTIRE SITE IS BURNED?

Some insect species may survive based on placement or intensity effects [survival]
However, many species will not.

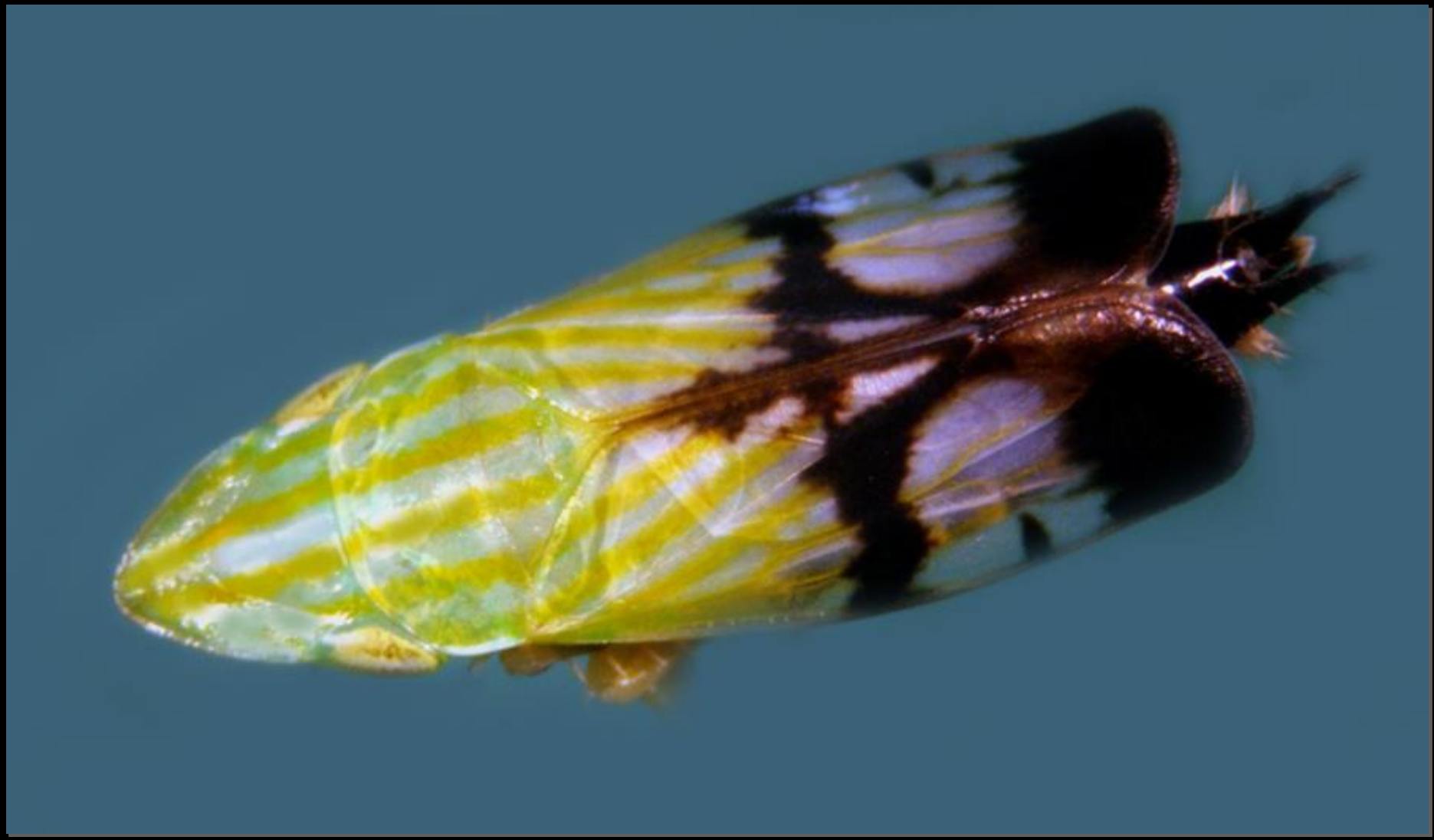
2a

# 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]; testing in-situ survival**

Eryngii larvae in carrot




Cribrus shingwauki ♀ GMP, 7-26-04

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

| Patches (40) | ~ 4 $m^2$ | ~ 8 $m^2$ | ~ 16 $m^2$ | ~ 32 $m^2$ |
|---|---|---|---|---|
| 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**

2b

# The maintenance of nearby refugia is essential

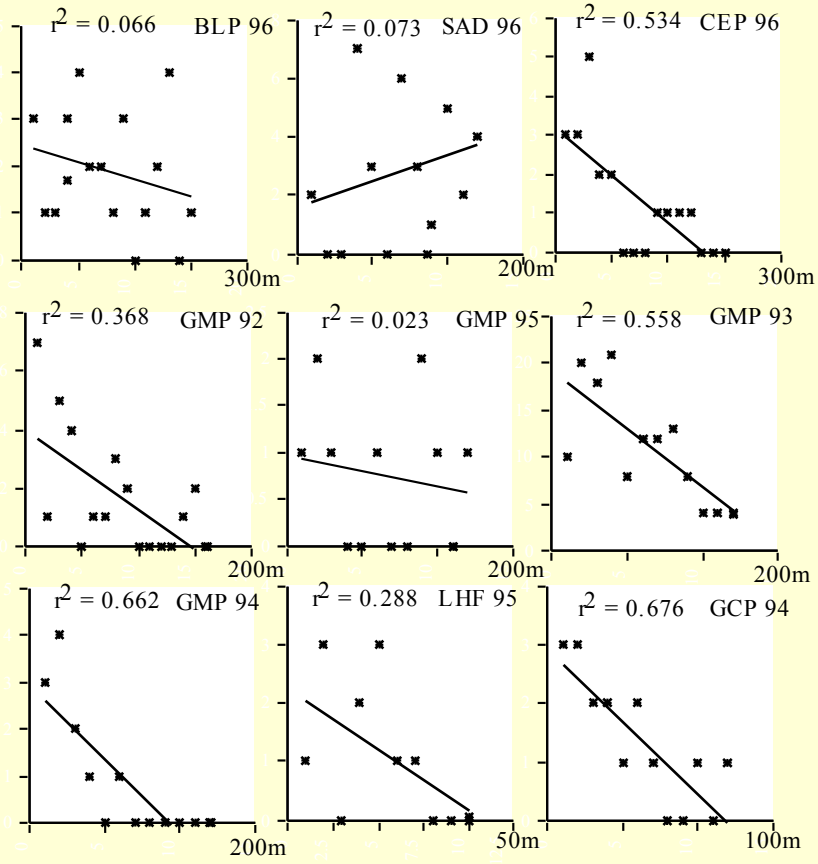



Figure 2. Distribution of postfire population density within recovering populations of *Laevicephalus unicolor* in recently-burned prairie. Spatial scale is shown in meters. Site acronyms are listed in Table 1.

**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**

# Fire attrition hypothesis-
# Fire will reduce species richness

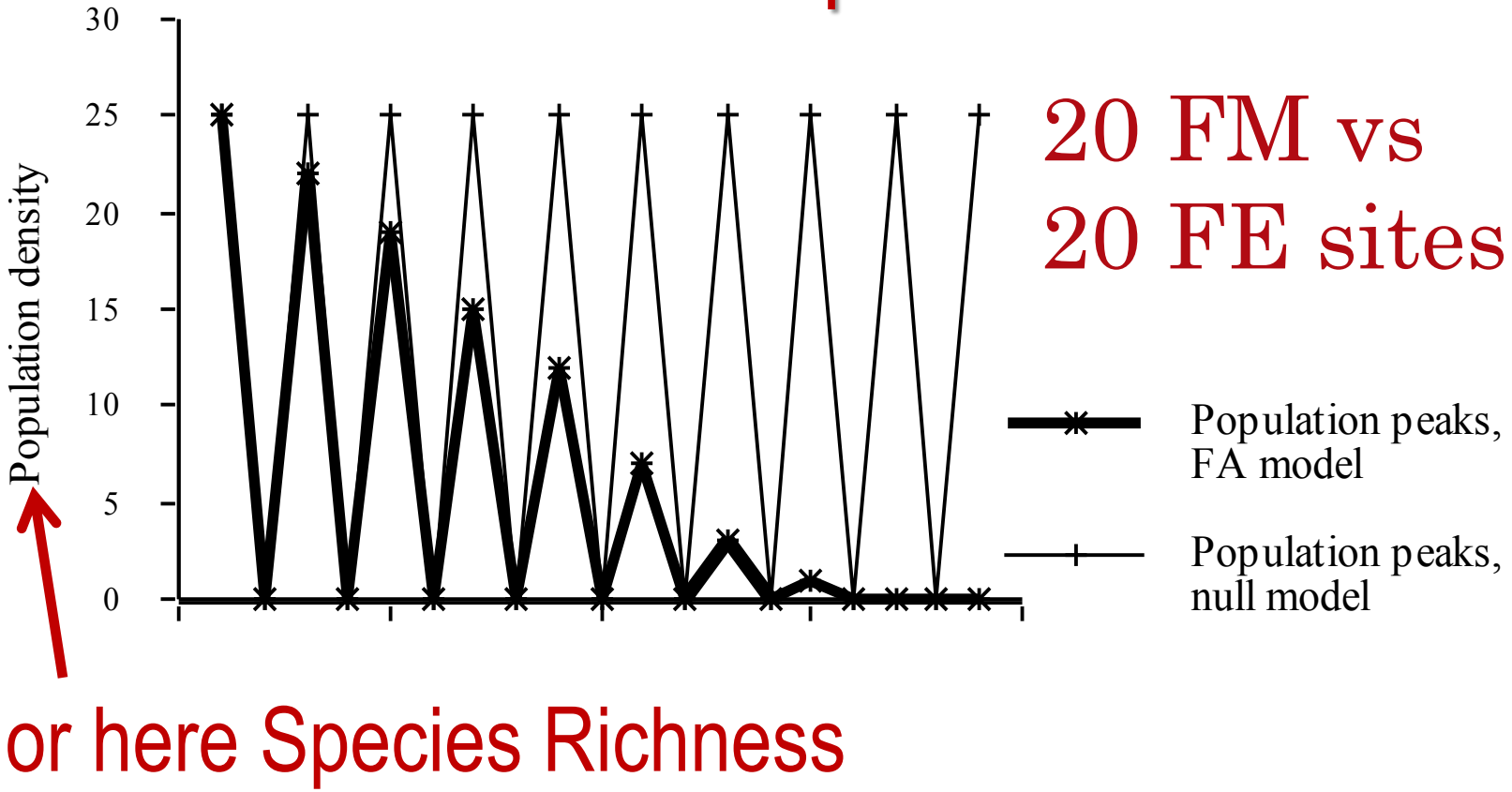
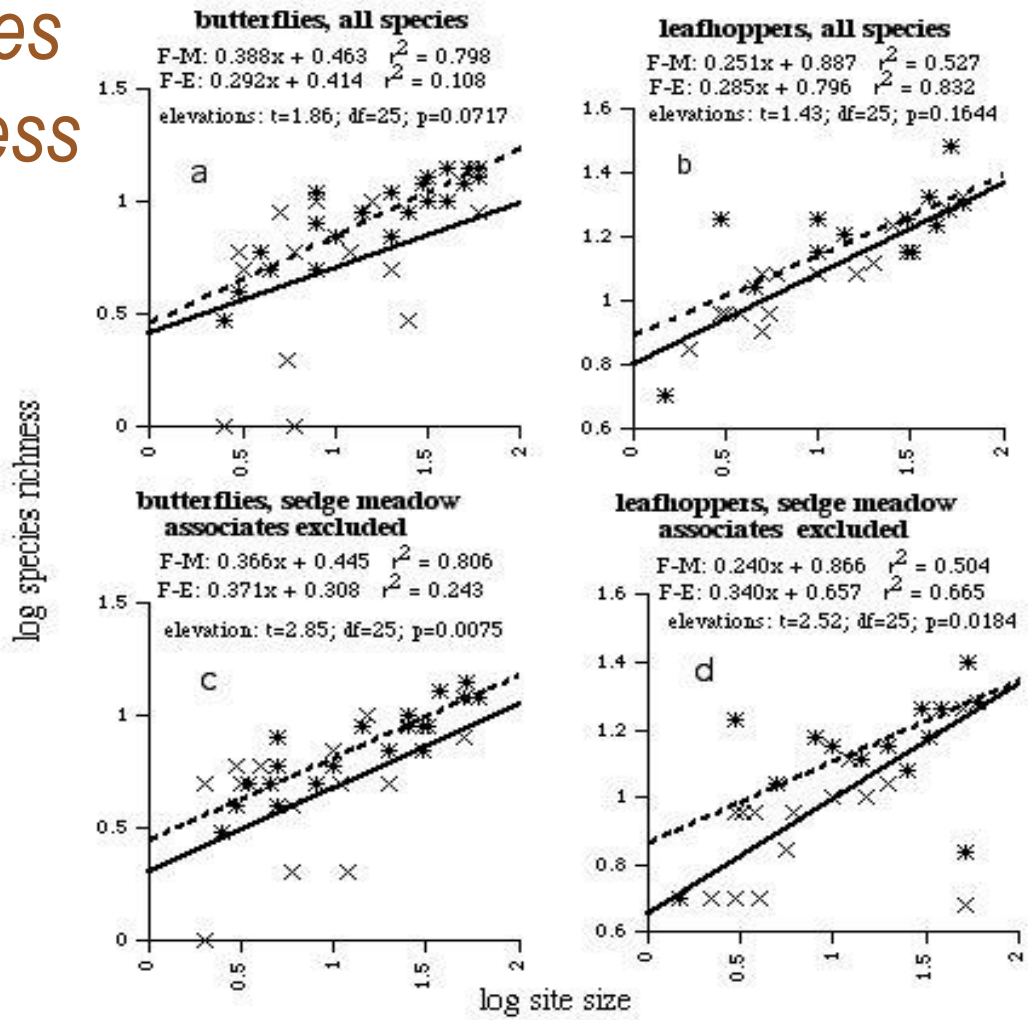



**Figure 1. Fire Attrition Model.** The fire attrition hypothesis predicts that short burn return intervals will result in increasingly smaller population sizes and will culminate in the extirpation of fire-sensitive species.

# *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 **fire managed sites** | 28/64 (44%) |
| greater densities in **fire excluded sites** | 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% vs 06%)
- 19 of 28 (68%) exclusive species occurred solely on Fire Managed sites.

Published in Biol. Cons.

**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**

# *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 |
|---|---|---|---|---|---|
| **28 moth species** | 28 | 25 | 13 | 0 | 18 |
| **2 leafhopper species**. | 2 | 2 | 1 | 2 | 1 |

** Thought to contribute to fire-vulnerability*

# Initial impact

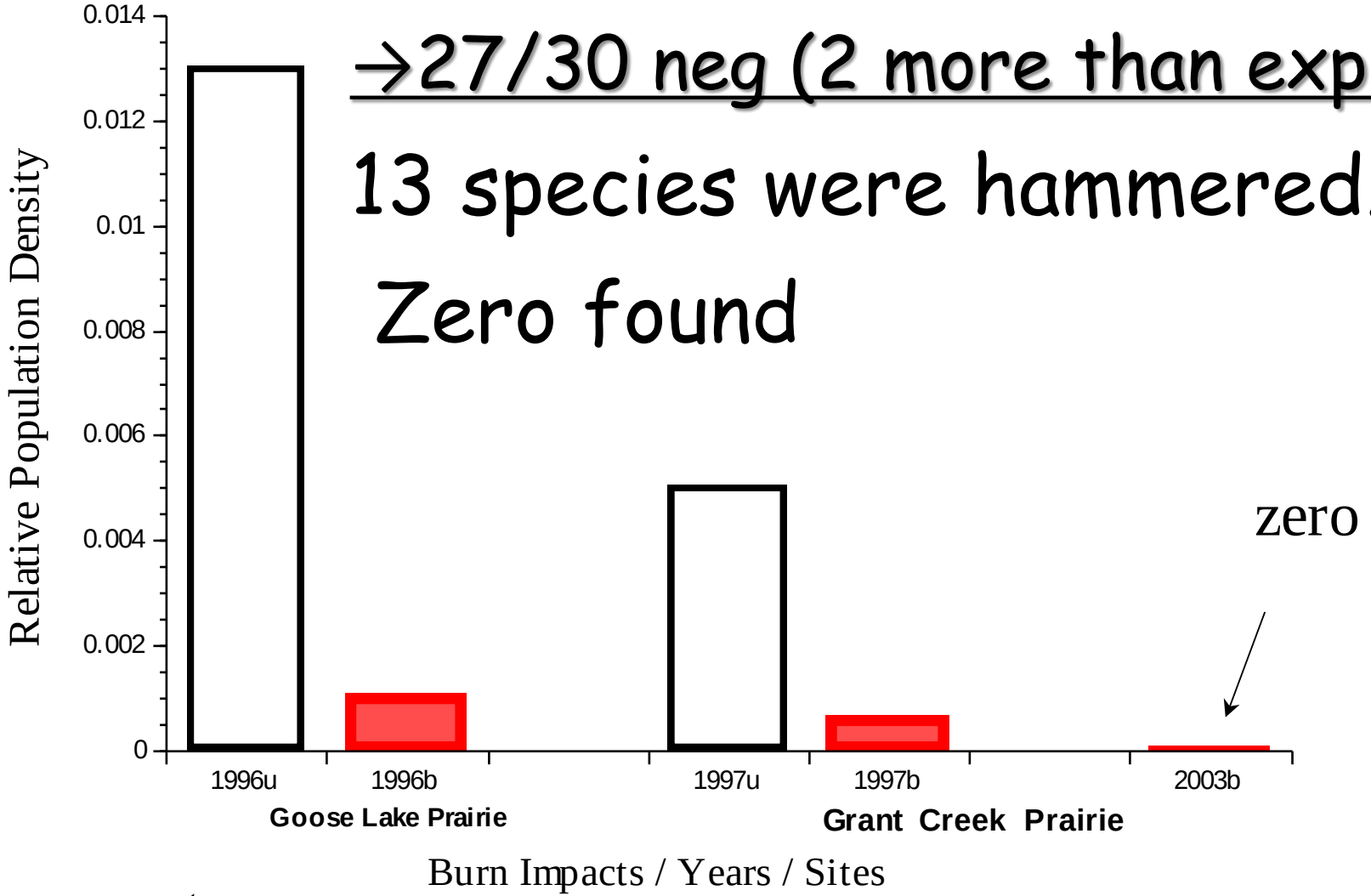
- Will surviving populations be smaller than expected?
- Will any species be lost?

# 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




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") | **11*** | 15** | 22 |
| smaller than expected ↓ | **6**** | 5 | 7 |
| undetectable ↓ | **13** | 10 | 1 |

† measure of fire intensity

* 4 of 5 fire-neutral/positive species

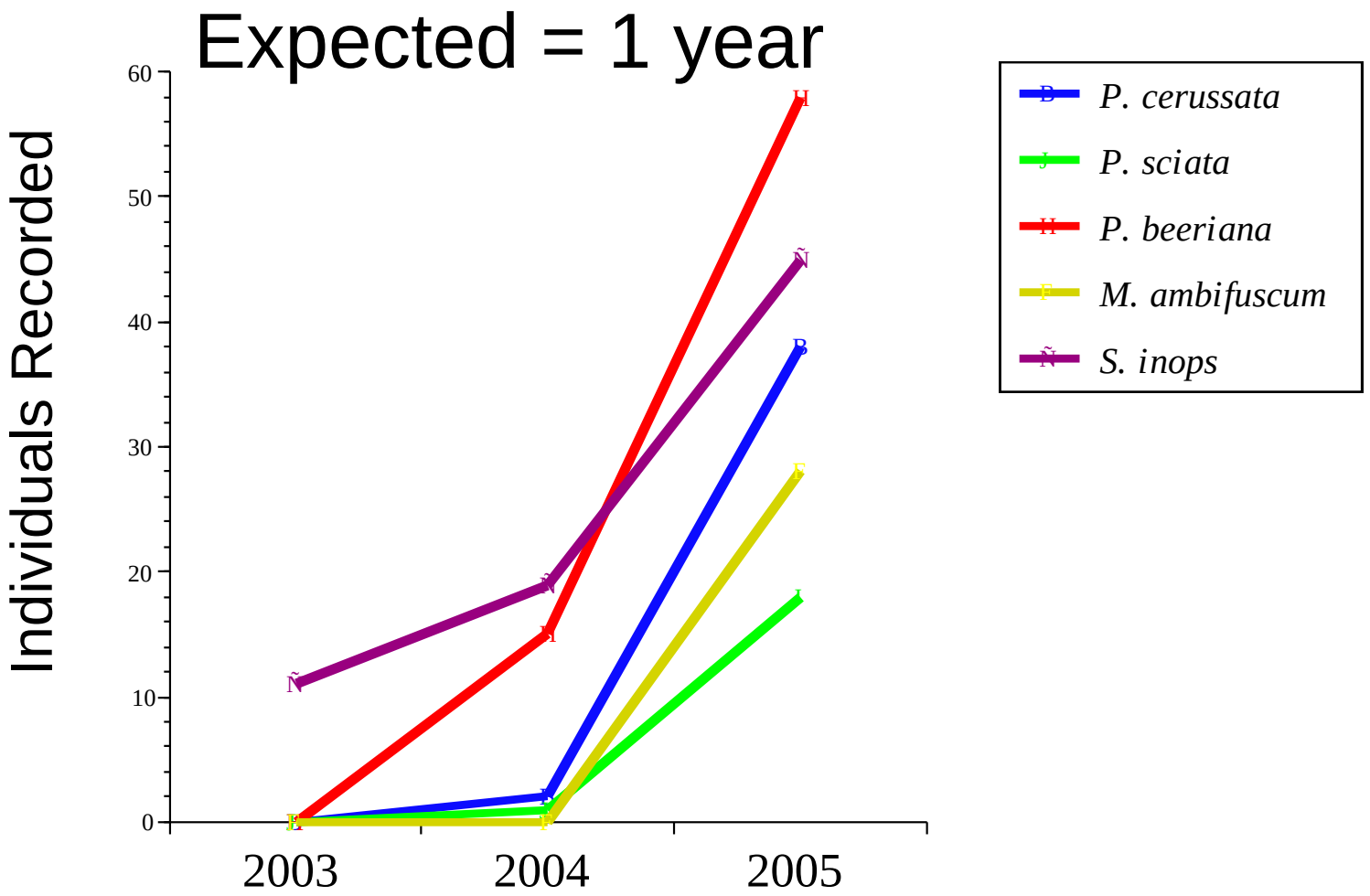
19/30 spp. Scarce or undetectable in year 1

# Post fire recovery

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

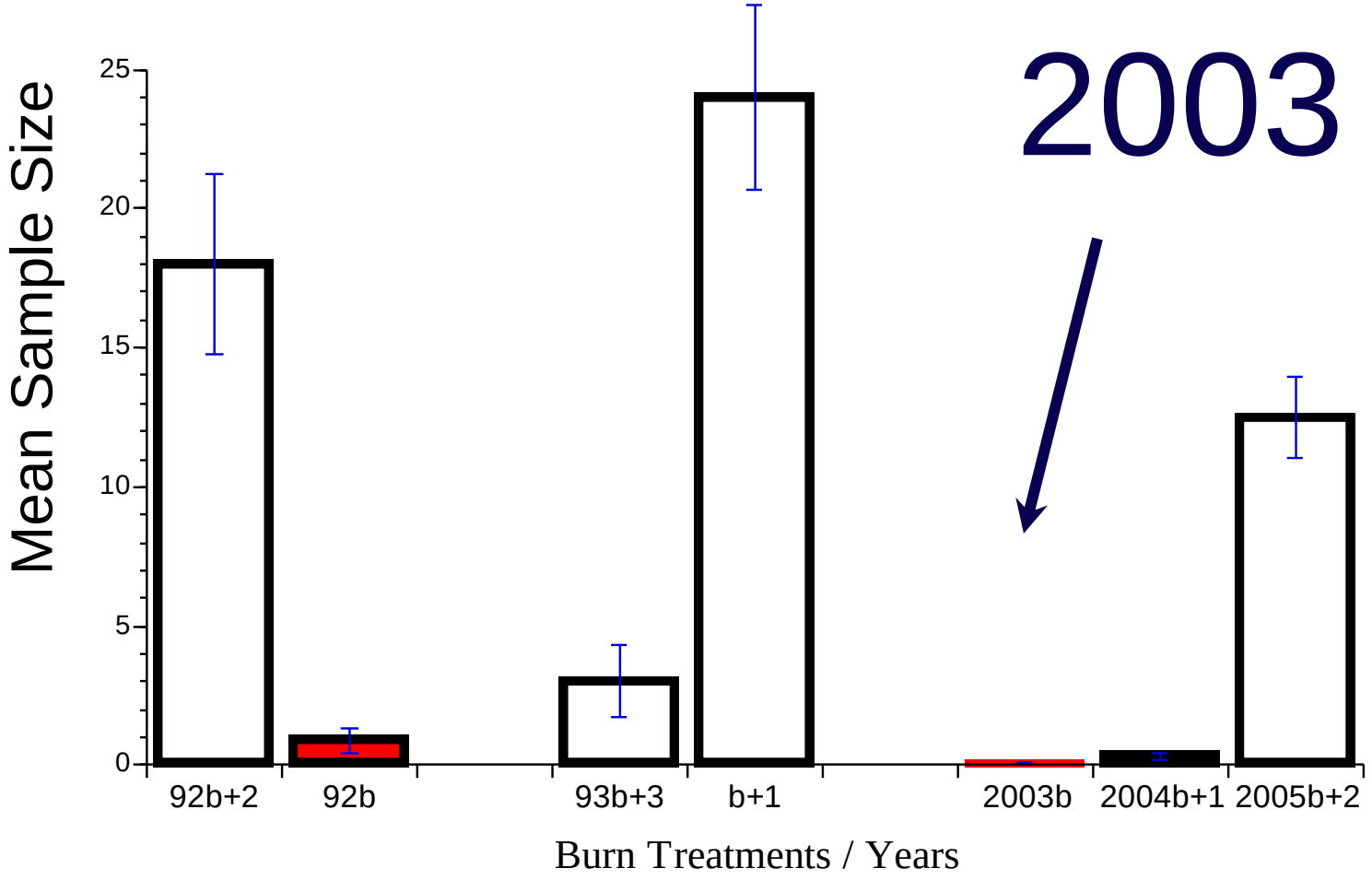
- Have any species been extirpated?

# 11 of 19 heavily impacted populations recovered in ≤ 2 years

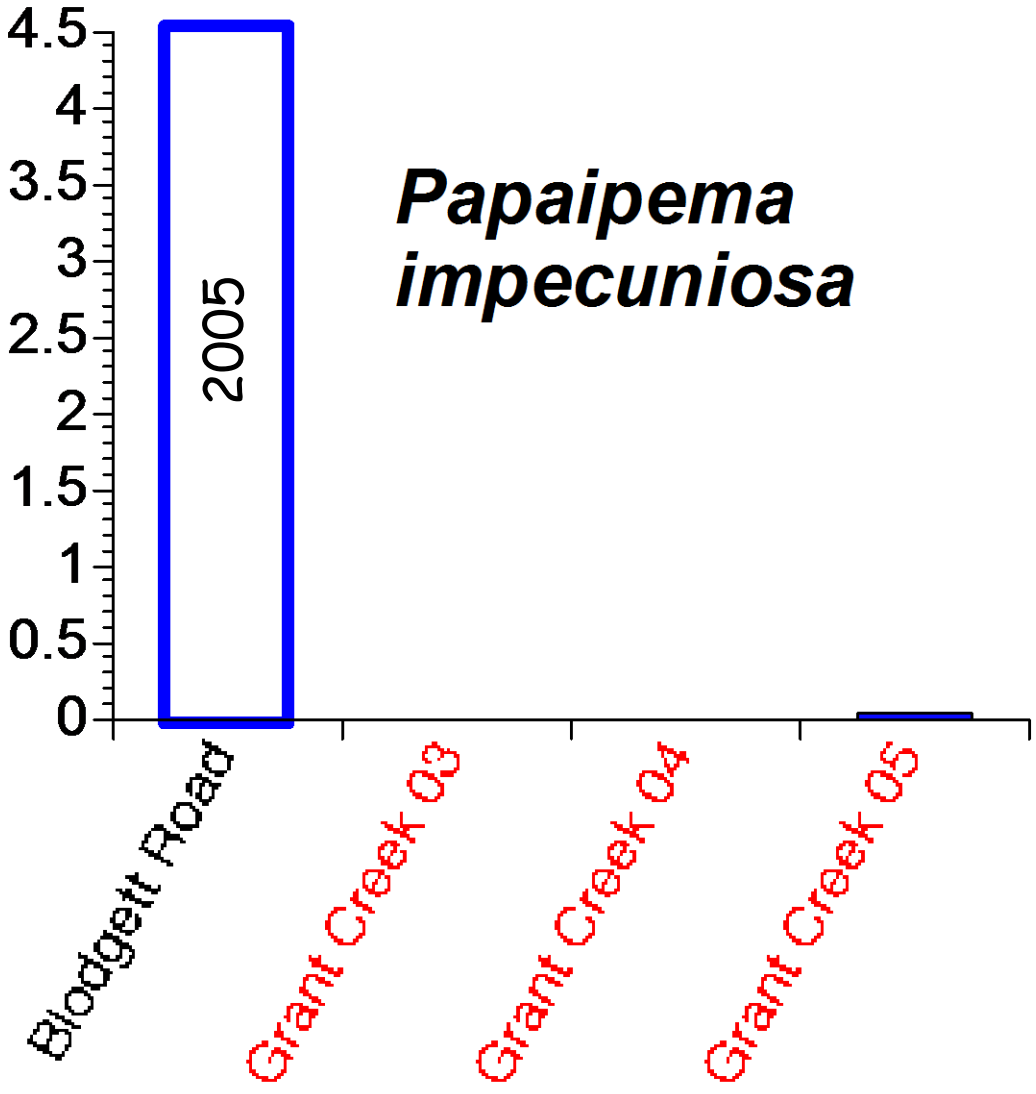


# *P. eryngii* requires an "extra" year Following intense fire.

*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<br>**Not Recovered** | **06** | 05 | 7 | 4 |
| undetectable<br>Extirpated? | **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 ≤ 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

**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

VII,5

# *Consecutive Burning*

# Consecutive Burning Issues

*Trade off in effects-*

- **Increasing fuel load <u>without fire</u> [ ~ 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 (pop-ulations) | Double burn RESPONSES (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*

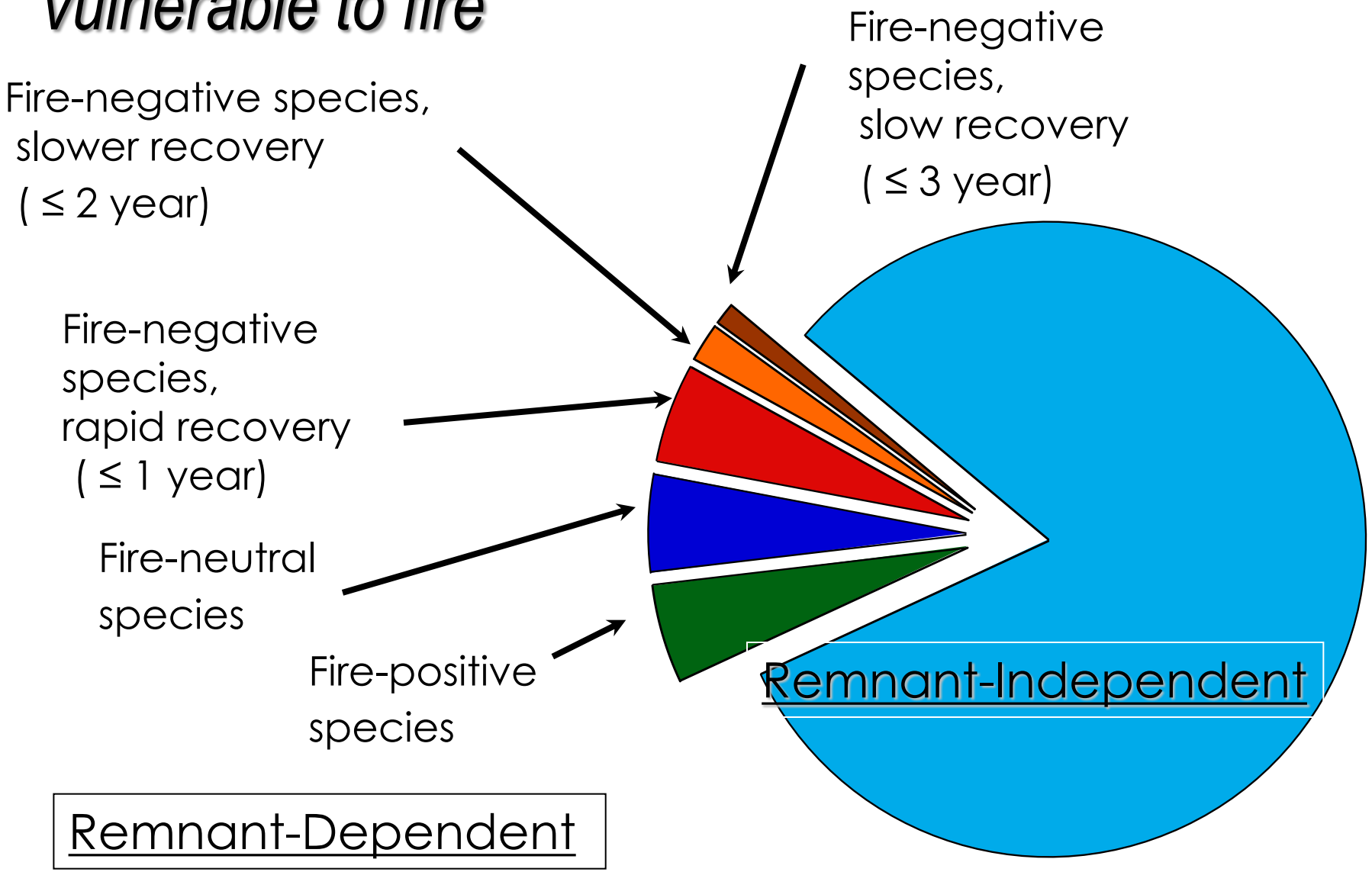
*[ ~ up to 5 years in prairie ] with subsequent increase in fire intensity being significant to mortality*

**UNCERTAIN HYPOTHESES**

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

**SHOWN BY OUR STUDIES TO BE TRUE**

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



# 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 .
- Use rotational burning

http://www.neiu.edu/~cwinsect/

# The End