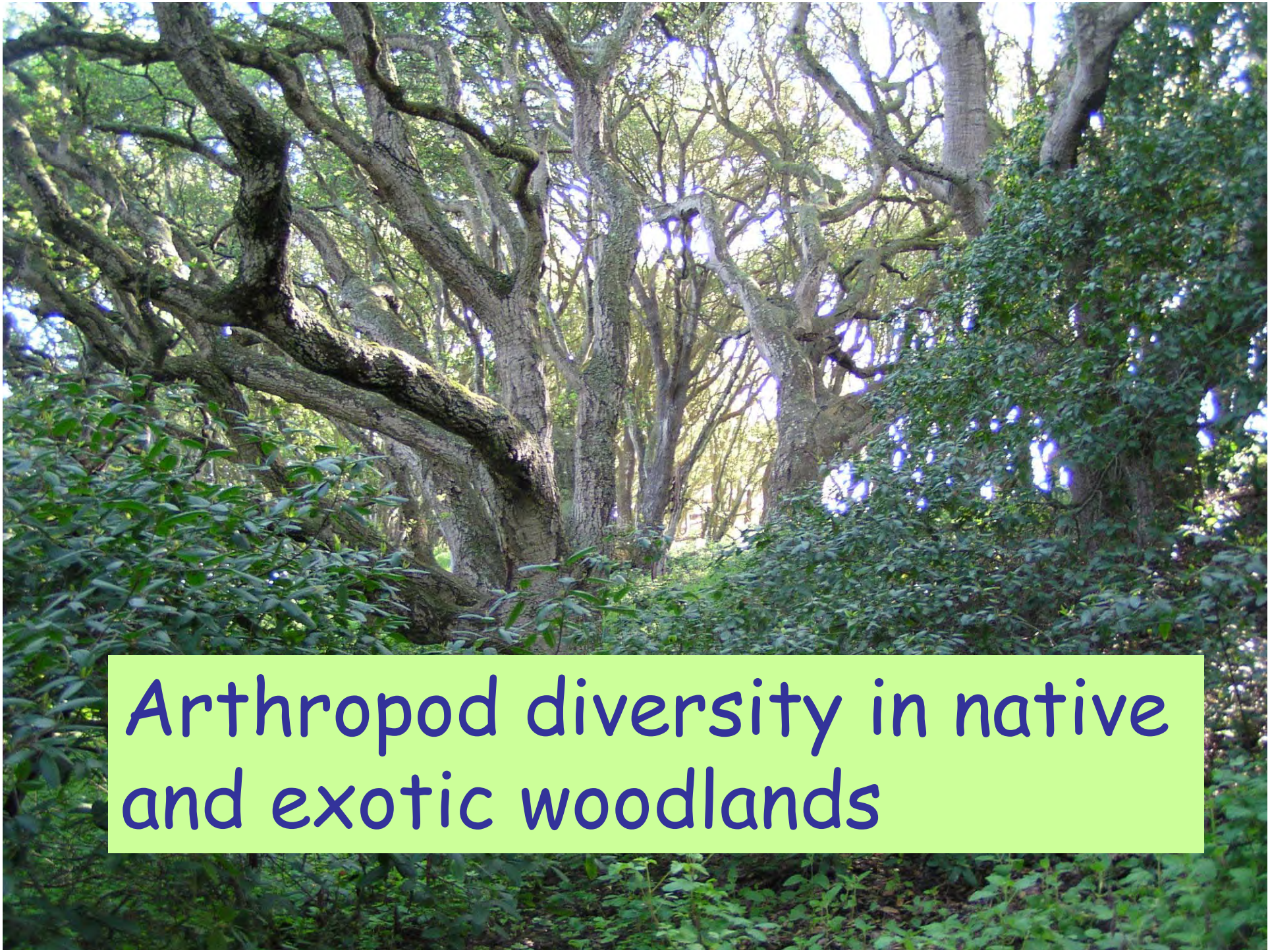


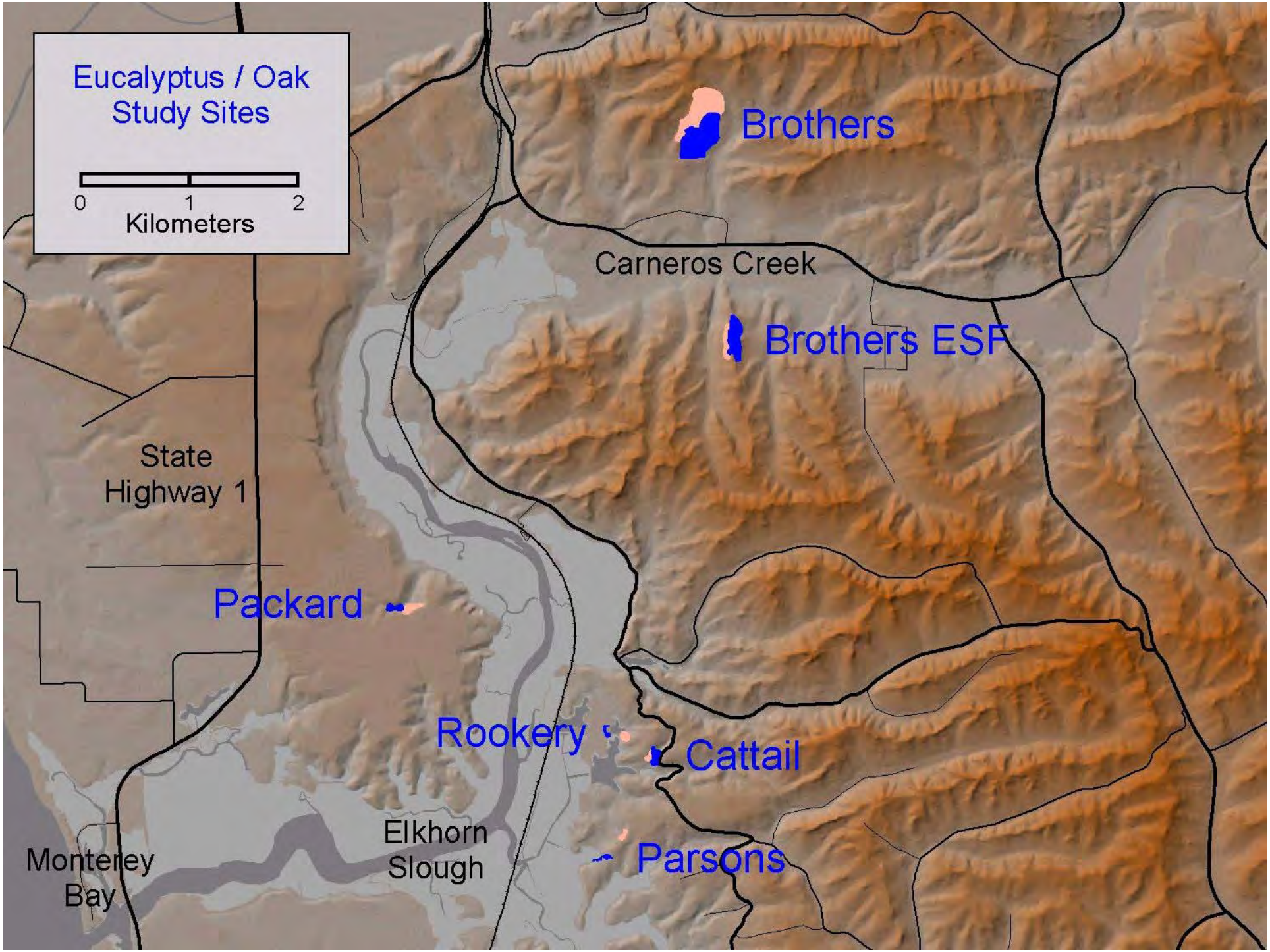
Arthropod diversity in native and exotic woodlands

What is an arthropod?

- Chitinous exoskeleton
- Paired jointed appendages
- Segmented body

Why use arthropods for assessing habitat value?

- Extremely abundant and diverse (75% of all animal species)
- Many taxa are well known
- Easy to sample
- Conspicuous in all trophic levels – e.g. herbivores, predators, decomposers.
- Sensitive to environmental disturbance


Eucalyptus / Oak
Study Sites
0
1
2
Kilometers
Brothers
Carneros Creek
Brothers ESF
State
Highway 1
Packard
Rookery
Cattail
Elkhorn
Slough
Monterey
Bay
Parsons

What part of habitat to sample?

Field methods - Pitfall traps

Captures surface-active, larger terrestrial arthropods (e.g. beetles, spiders, ants, isopods)

Field methods - Sticky traps

Samples aerial insects and those associated with foliage

Field methods –Trap placement

- One pitfall and sticky trap at center and edge of each site
- Traps deployed for one week

Field methods – Winkler (litter) traps

Captures slower-moving, arthropods hidden within litter layer (ants, springtails, mites), some of which are not caught in pitfall traps.

Sorting and identification

Arthropods keyed to level of order

Arthropods recovered in traps

- Arachnida
  - Acari (mites)
  - Araneae (spiders)
- Chilopoda (centipedes)
- Diplopoda (millipedes)
- Isopoda (sowbugs, etc.)
- Insecta
  - Collembola (springtails)
  - Coleoptera (beetles)
  - Diptera (flies)
  - Hymenoptera (ants, wasps, etc.)

Arachnids – Spiders and mites

Lycosid spider. Courtesy of Iziko Museums of Cape Town

Oribatid mite. Courtesy of Alan Hadley

Other arthropods- Myriapods and isopods

Centipede (Geophilimorpha) (left) and sowbug (Isopoda). Courtesy of Humboldt State Univ Natural History Museum

Insects – Springtails (Collembola)

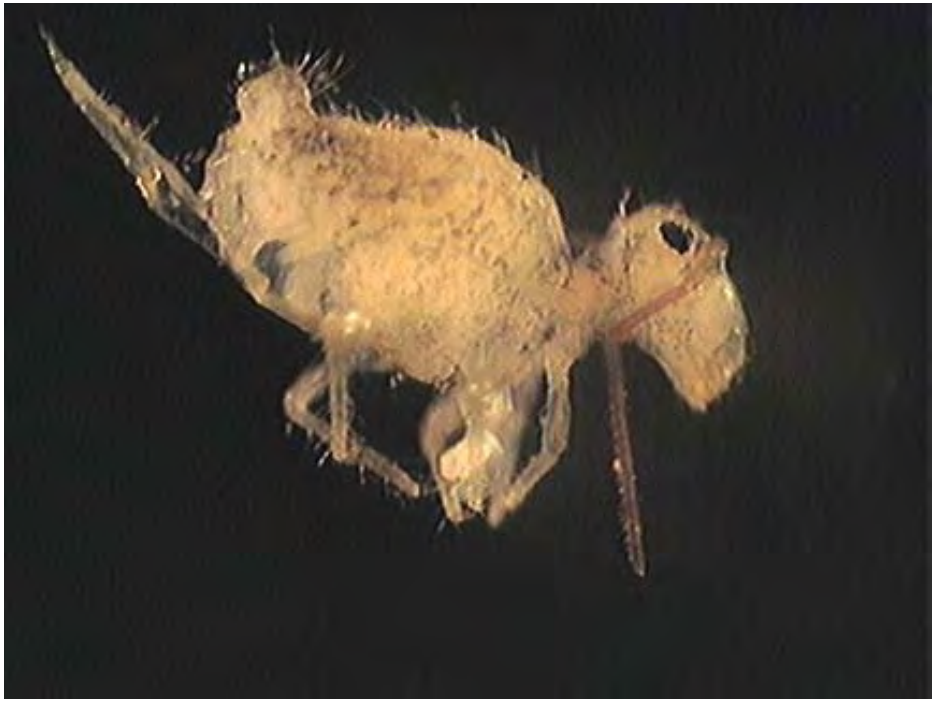


Image courtesy of John Van Dyk, Iowa State University Department of Entomology

Image courtesy of Alan Hadley

Insects – Flies (Diptera) and beetles (Coleoptera)

Leaf Miner Fly (Diptera). Courtesy of John Haarstad, Insects of Cedar Creek Insect Survey

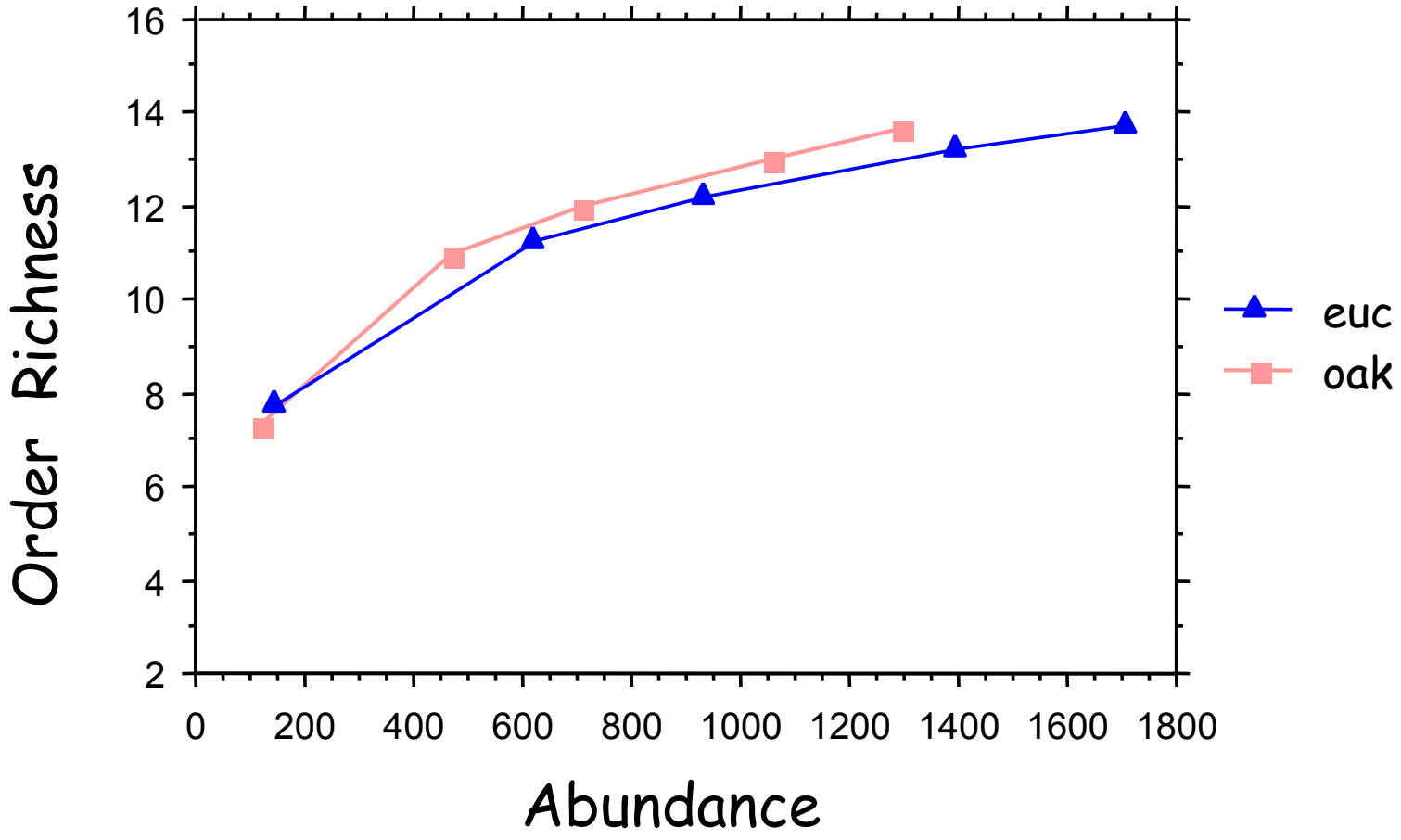
Courtesy of John Haarstad, Insects of Cedar Creek Insect Survey

Insects- Wasps and ants (Hymenoptera)

University of Missouri and
Sarah Heyman and Jan Weaver

Formicidae (Temnothorax sp.) Courtesy of
California Acad. Sciences

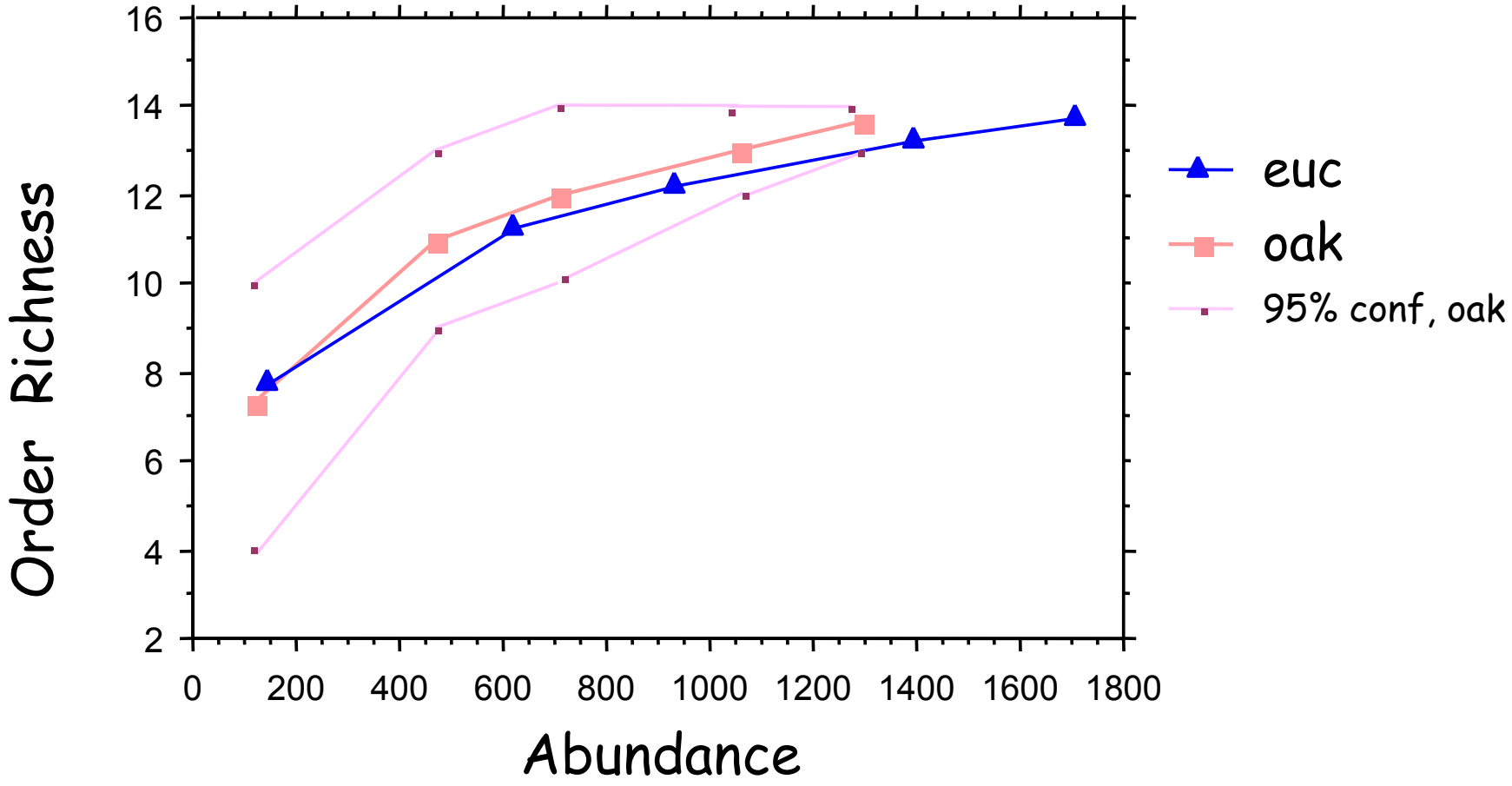
Rarefaction curve – Oak and eucalyptus



Still more taxa to be uncovered, slightly more so for oak

Ecosim 7.0 (Gotelli & Entsminger 2002)

Rarefaction curve – Oak and eucalyptus



Eucalyptus crossing below oak lower confidence limit

Ecosim 7.0 (Gotelli & Entsminger 2002)

Results - Pitfall and sticky traps Taxonomic summary

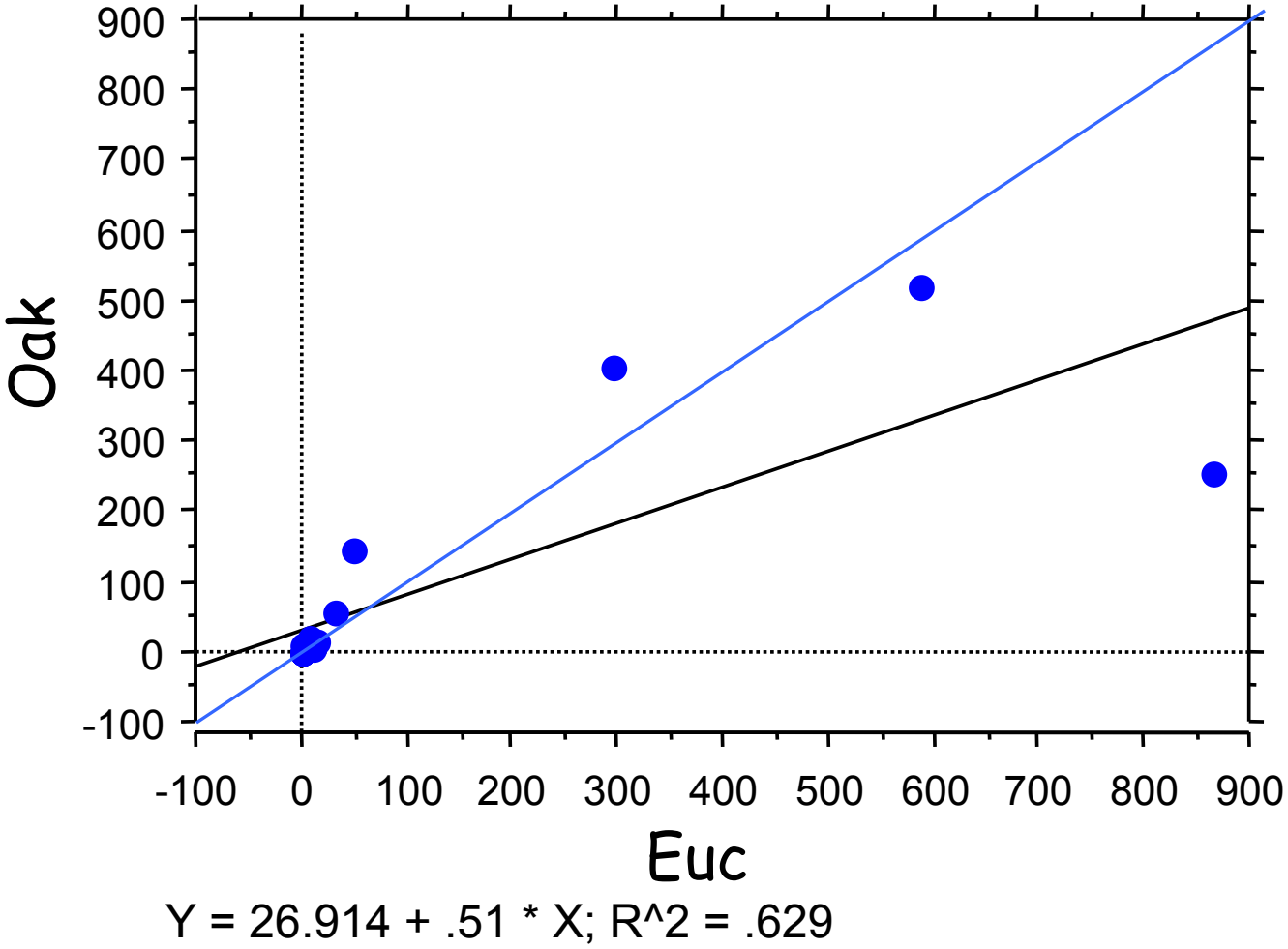
- Three orders account for majority of arthropods in oak and eucalyptus:
  - Collembola (springtails),
  - Acari (mites)
  - Diptera (flies)
- Less abundant orders:
  - Coleoptera (beetles) and Araneae (spiders) are less than 10% of total
  - many orders are rare (1% or less)
- 17 orders associated with oak and/or eucalyptus habitats

Order abundances – Oak and eucalyptus

Order	Oak	Euc
Collembola (springtails)	519	589
Thysanura (bristletails, etc.)	1	1
Orthoptera (crickets, etc.)	0	2
Homoptera (aphids, etc)	6	11
Psocoptera (barklice)	7	11
Diptera (flies)	255	864 **
Lepidoptera (moths, butterflies)	1	0
Thysanoptera (thrips)	4	7
Coleoptera (beetles)	146 *	48
Hymenoptera (ants, wasps, etc.)	16	13
Polyxenida (bristle millipedes)	0	2
Julida (common millipedes)	1	0
Lithobiomorpha (centipedes)	0	1
Acari (mites)	406	295
Araneae (spiders)	58	32
Pseudoscorpions	1	1
Isopoda (sowbugs, etc.)	7	0
Unknown	19	9

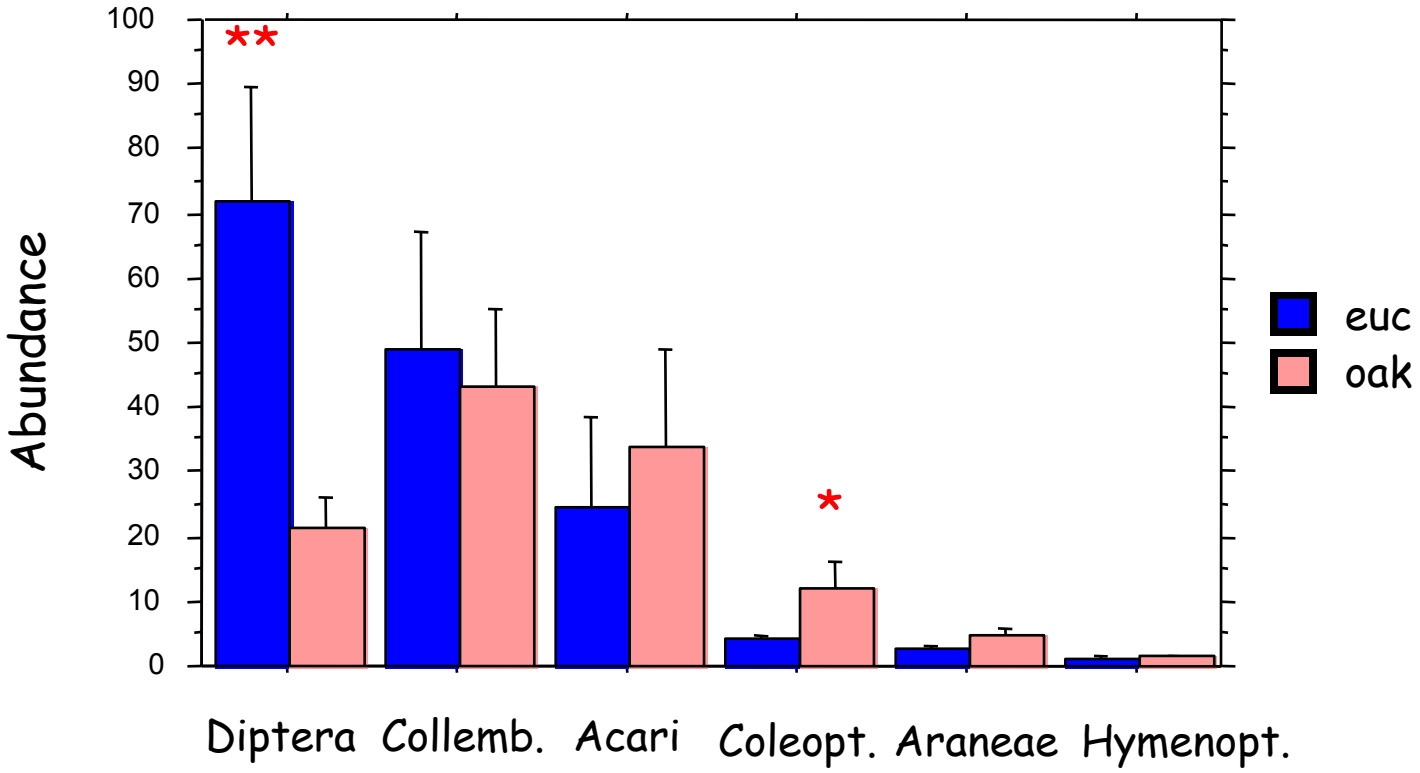
ANOVA, *P < .05; **P < .02)

Order abundances – Oak and eucalyptus



Total abundances (of orders) correlate fairly well in two habitats (i.e. rare in both euc and oak, or abundant in both).

Average abundance of top orders

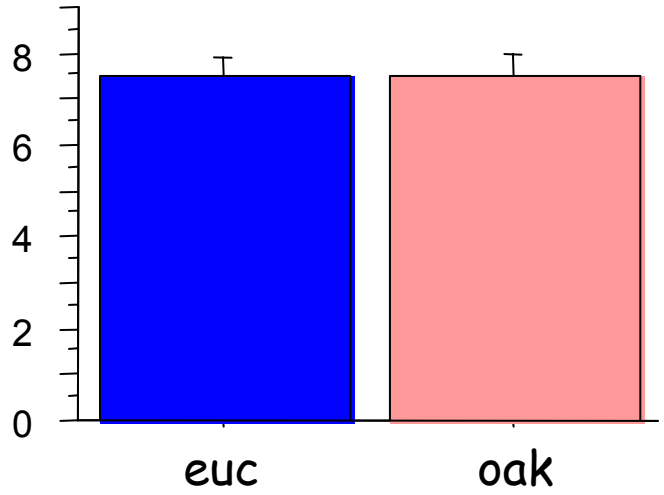


ANOVA, *P< .05; **P < .02)

Overall habitat comparisons

Order richness

average per sample

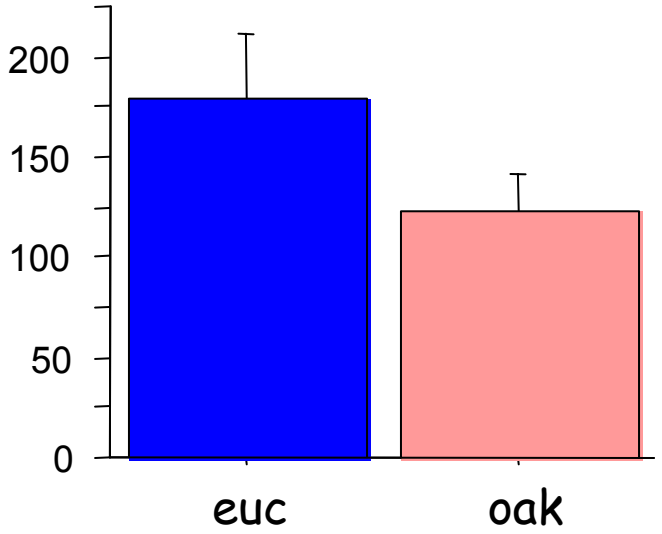


No significant different between woodland types (ANOVA, P>.05).

Overall habitat comparisons

Total abundance

average per sample

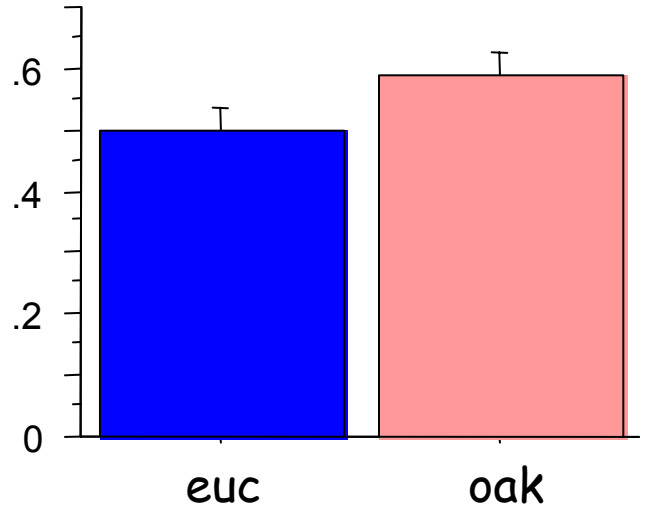


Abundance greater in eucalyptus groves than in oak woodlands (ANOVA, P>.05).

Overall habitat comparisons

Diversity (Shannon-Weaver)

average per sample



Diversity is greater in oaks- i.e. same number of orders but more evenly spread in oaks than eucs (ANOVA, P>.05).

Previous research on native and eucalyptus woodlands

- Sax (2002) surveyed arthropod diversity of native (oak and bay) and eucalyptus woodlands.
  - equal species richness (approximately 40 sp. in each habitat).
  - About half of species were shared by both woodland types.
  - Species composition was different between woodland types.
  - Eucs had higher invertebrate diversity than native woodlands (spring only).

Comparison of two studies

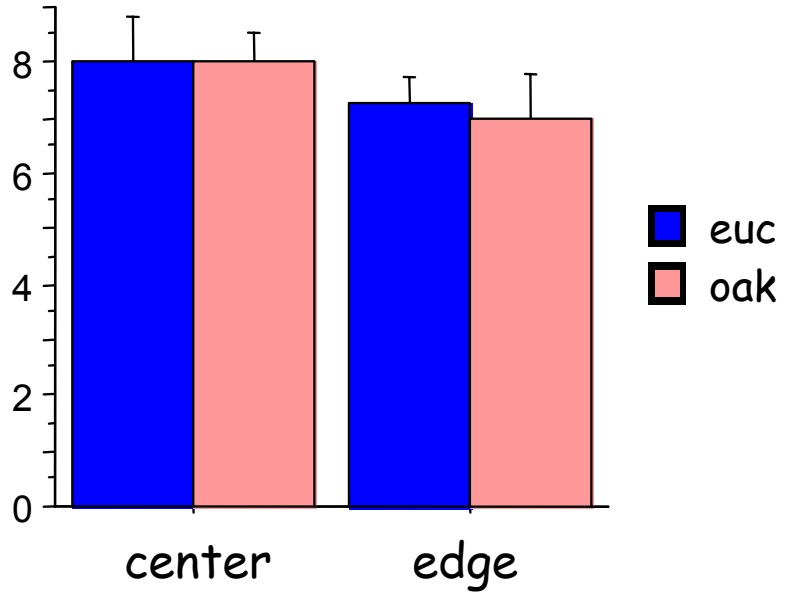
- Taxa richness equal in eucs and native woodlands
  - Order richness (present study) and species richness (Sax study)
- Diversity results differ
  - oaks have higher diversity than eucs (present study) while Sax detected higher diversity in eucs

Center vs edge habitats -Taking a closer look

Center vs edge

Order richness

average per sample

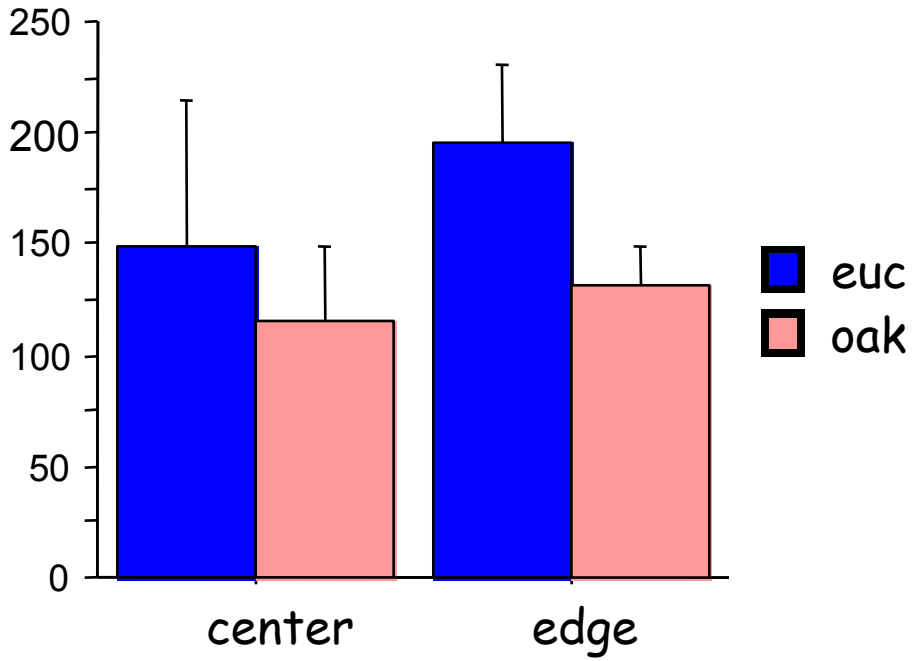


No significant difference between oak and eucalyptus for either center or edge (2-way ANOVA, P>.05).

Center vs edge

Total abundance

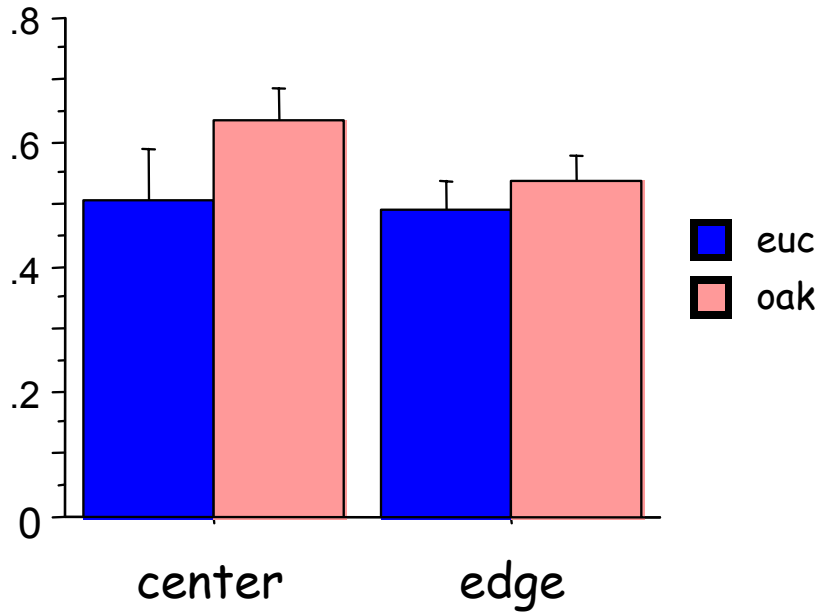
average per sample



Although not significant, eucs have higher arthropod abundance than oaks, particularly at edges (2-way ANOVA, P>.05).

Center vs edge

Diversity (Shannon-Weaver)
average per sample



Although not significant, oaks have higher arthropod diversity than eucs in center of woodlot (2-way ANOVA, P>.05).

Summary – Overall habitat comparisons

- Order richness is equal in oak and eucalyptus woodlands.
- Abundance greater in eucs, especially at edges.
- Diversity is higher in oaks, particularly in center.
- More samples might improve accuracy of estimation of diversity and abundance.

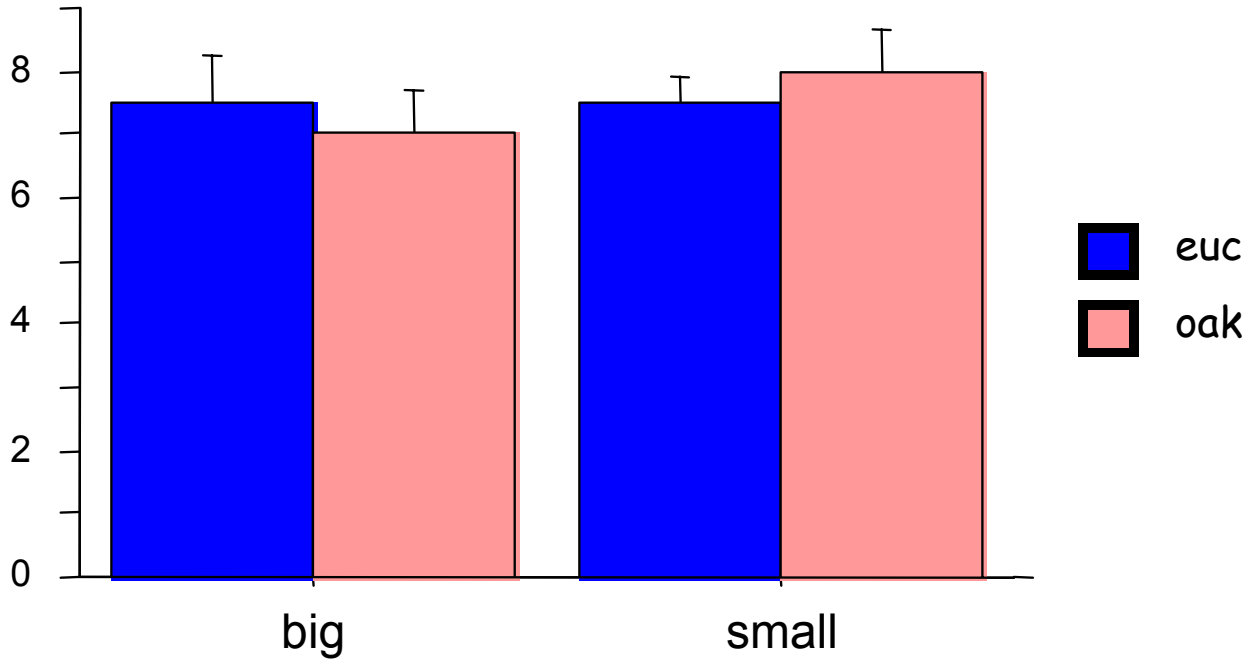
Future directions

- Focus on one or a few groups only (e.g. beetles, ants)
  - Orders abundant in all trophic levels
- More samples over several seasons
  - Limited sampling and early in season (need more replicates)
- Winkler trap data was not included in analysis
  - Captures a different suite of arthropods
- Keying to species is important in arthropod diversity studies
  - Morphospecies- surrogate for species

Acknowledgements

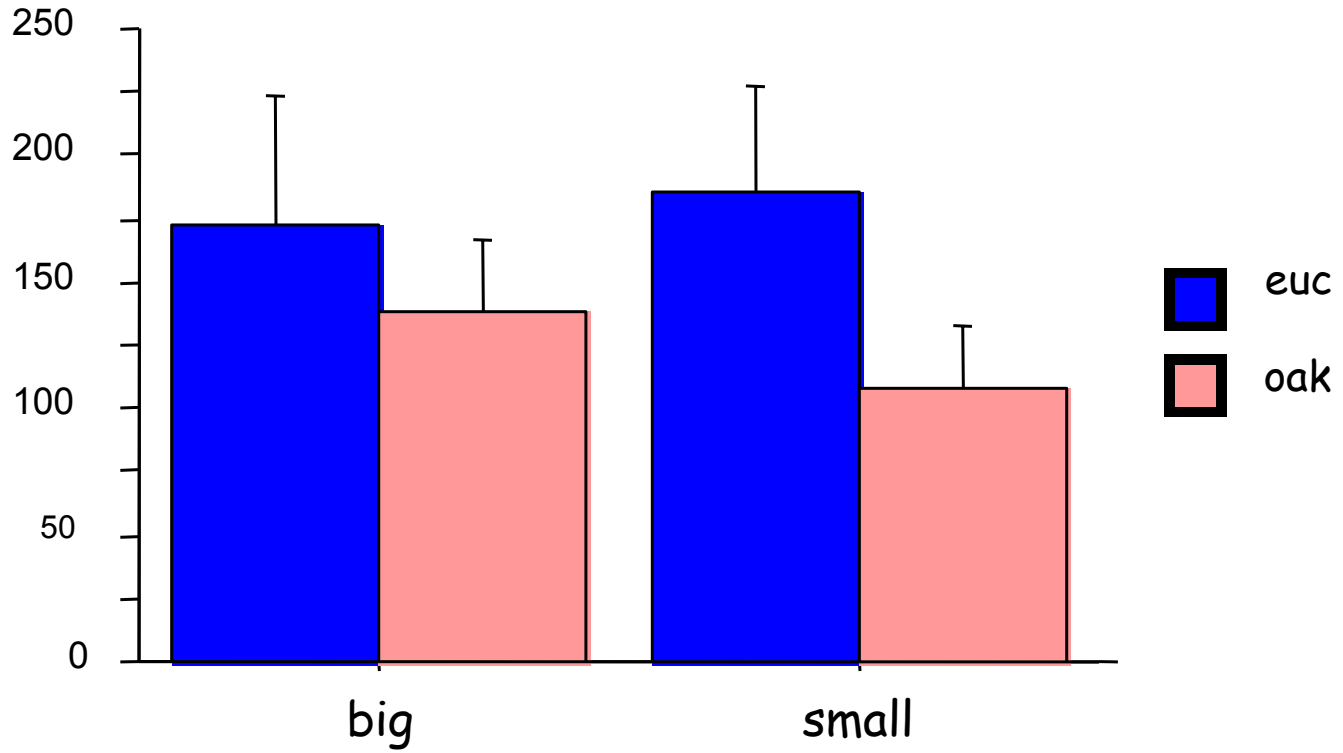
- Kerstin Wasson
- Eric Van Dyke
- Joshua Salisbury
- Sondra Schreibman
- Diana Wakimoto

Order richness split by woodlot size



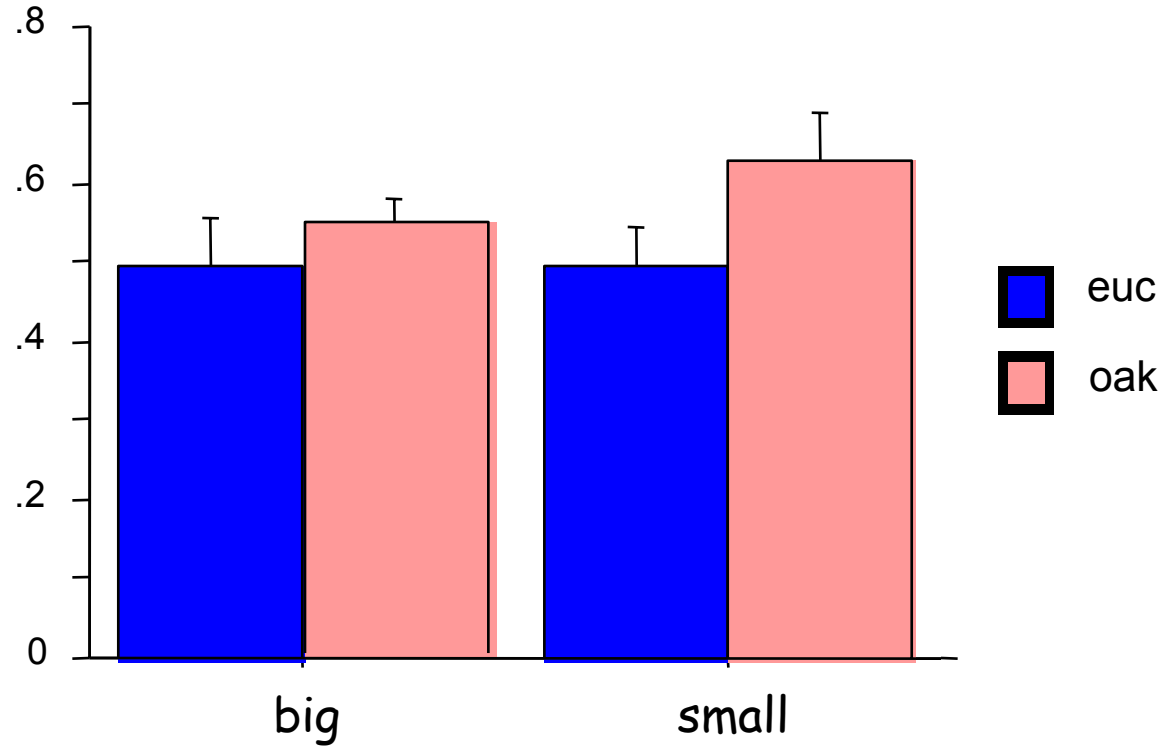
In big woodlots eucs have slightly higher order richness while in small woodlots, oaks have somewhat higher order counts (2-way ANOVA, P>.05).

Total abundance split by woodlot size



Euc groves have slightly higher arthropod abundance, regardless of woodlot size (2-way ANOVA, P>.05)

Diversity (Shannon-Weaver) split by woodlot size



Diversity in big and small euc groves similar, small oak groves have slightly higher diversity than big groves (2-way ANOVA, P>.05)