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
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

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

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

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).
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).
Although not significant, eucs have higher arthropod abundance than oaks, particularly at edges (2-way ANOVA, $P > .05$).
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 eucys, 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
In big woodlots eucs have slightly higher order richness while in small woodlots, oaks have somewhat higher order counts (2-way ANOVA, P>0.05).
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, \( P > .05 \))