Is retention harvesting the solution for sustaining biodiversity? Lessons from the EMEND experiment

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www.emend.ualberta.ca

Outline

Origins and Experimental Design

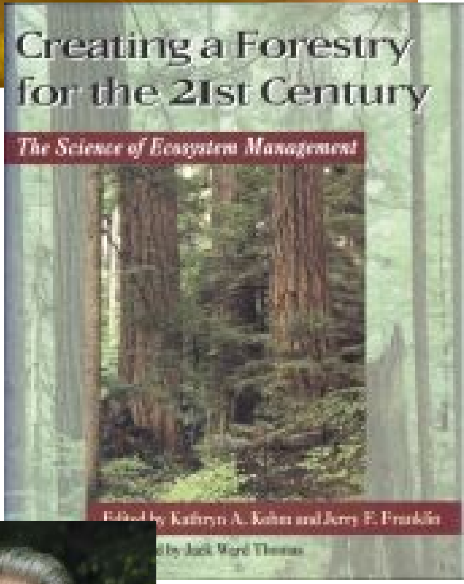
Biodiversity responses to dispersed retention

Values of aggregated retention

Informing placement of retention

Conclusions

When it began…… Challenge of managing for multiple values (biodiversity, ecological goods and services)



‘New Forestry’: managing for complexity of forest structure and function

- Mostly stand level
- Leaving live and dead trees
- Continuous cover, multi-cohort

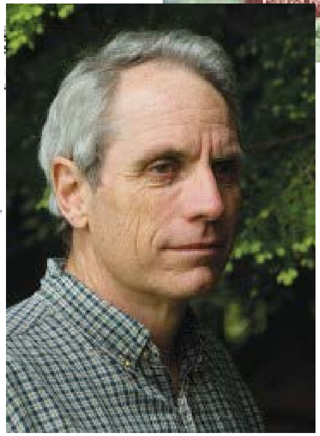
Natural disturbance-based management:

- “imitate” natural disturbance regimes
- Landscape level (age, patch size, shape)
- Biological legacies

Biological Conservation **65** (1993) 115–120

NATURAL FIRE REGIMES AS SPATIAL MODELS FOR MANAGING BOREAL FORESTS

Malcom L. Hunter Jr
Wildlife Department, College of Forest Resources, University of Maine, Orono, Maine 04469 USA



Research Update TRENDS in Ecology & Evolution Vol.16 No.11 November 2001

Research News

The new boreal forestry: adjusting timber management to accommodate biodiversity

John R. Spence

Forestry practices intended to ensure ecological sustainability have been developed rapidly during the past decade and now are widely deployed and promoted. In a recent special issue of the *Scandinavian Journal of Forest Research*, forest ecologists and biodiversity experts consider how this new management responds to Fennoscandian concerns about biodiversity. The authors conclude that the new forestry practices are largely untested scientific hypotheses, and explore a sound research framework aimed at improving management of boreal forests.

The papers deal principally with
(1) features lost from managed fores
(2) forest fragmentation; (3) designa
of reserves; (4) natural disturbance
model for forestry; (5) biodiversity
assessment and whether specific
management tactics preserve biodiv
and (6) linking researchers and mar
to develop effective research progra

trong requirements for
pes[5]. Those designated to
–3% of the Fennoscandian
veral issues must be

Retention Forestry to Maintain Multifunctional Forests: A World Perspective

July 2012 / Vol. 62 No. 7 • BioScience 633

LENA GUSTAFSSON, SUSAN C. BAKER, JÜRGEN BAUHUS, WILLIAM J. BEESE, ANGUS BRODIE, JARI KOUKI, DAVID B. LINDENMAYER, ASKO LÕHMUS, GUILLERMO MARTÍNEZ PASTUR, CHRISTIAN MESSIER, MARK NEYLAND, BRIAN PALIK, ANNE SVERDRUP-THYGESON, W. JAN A. VOLNEY, ADRIAN WAYNE, AND JERRY F. FRANKLIN

50 YEARS WITH IMPACT

Journal of Applied Ecology

1913 2013 British Ecological Society CELEBRATING 100 YEARS

Journal of Applied Ecology 2014, 51, 1669–1679 doi: 10.1111/1365-2664.12289

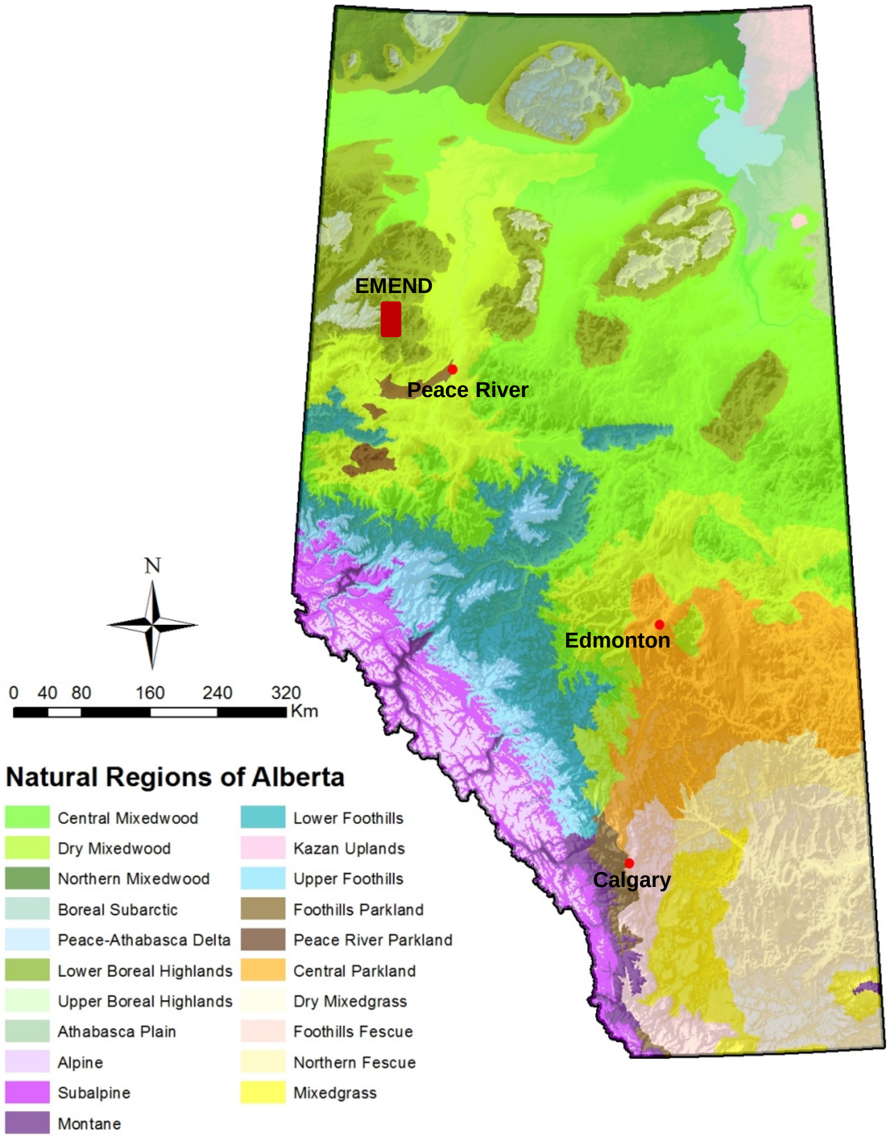
REVIEW

Can retention forestry help conserve biodiversity? A meta-analysis

Katja Fedrowitz[1], Julia Koricheva[2], Susan C. Baker[3], David B. Lindenmayer[4], Brian Palik[5], Raul Rosenvald[6], William Beese[7], Jerry F. Franklin[8], Jari Kouki[9], Ellen Macdonald[10], Christian Messier[11], Anne Sverdrup-Thygeson[12] and Lena Gustafsson[1]*

The EMEND Experiment (1997 – present)

(Ecosystem Management by Emulating Natural Disturbance)



Forest harvest and regenerative practices to maintain:

- biotic communities
- spatial patterns of forest structure
- ecosystem integrity

As in boreal mixed-wood landscapes originating through natural disturbances

Four boreal mixedwood forest cover types:

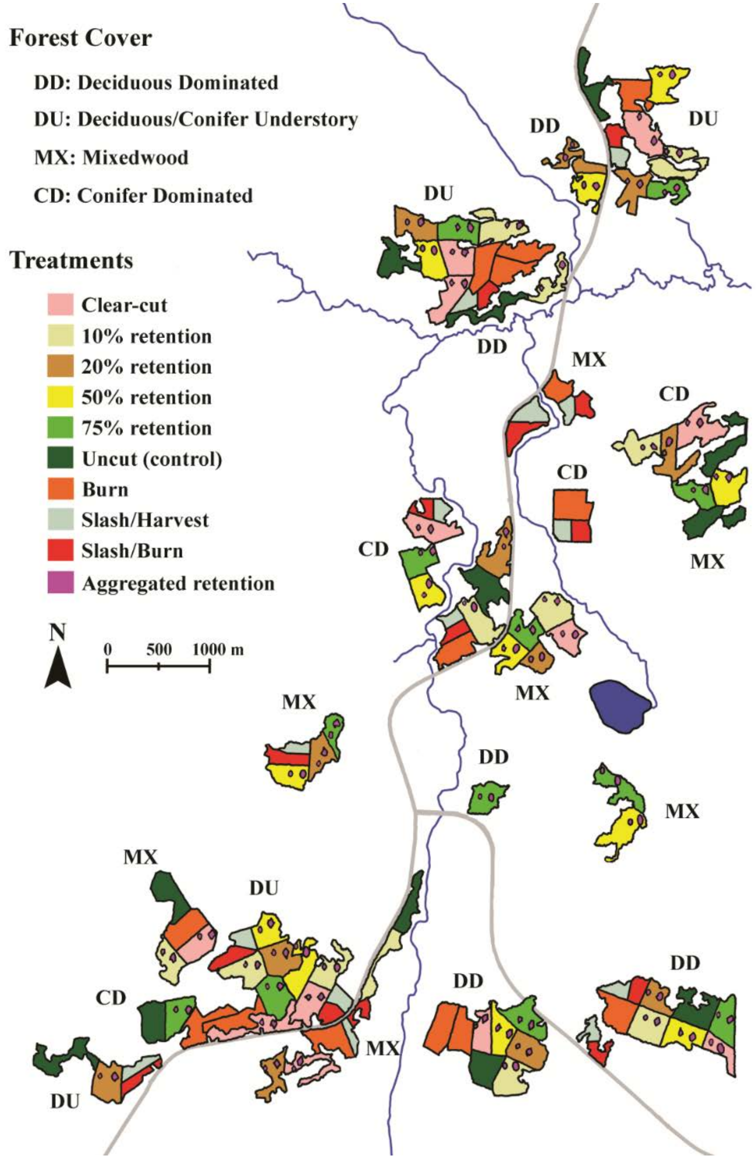
- **Broadleaf (aspen)-dominated (DDOM)**
- **Broadleaf with understory spruce (DDOMU)**
- **Mixed (MX)**
- **Conifer (white spruce) – dominated (CDOM)**

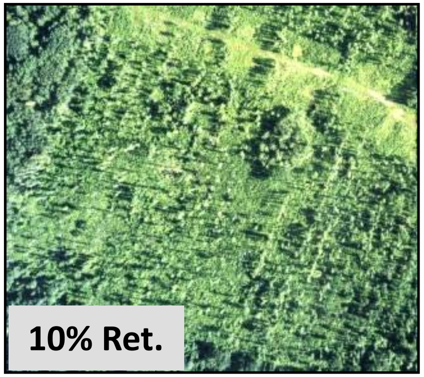
- **Clearcut (2 % retention)**
- **10 %**
- **20 %**
- **50 %**
- **75 %**
- **Unharvested control**
- **Standing timber burn**
- **10% retention + burn**

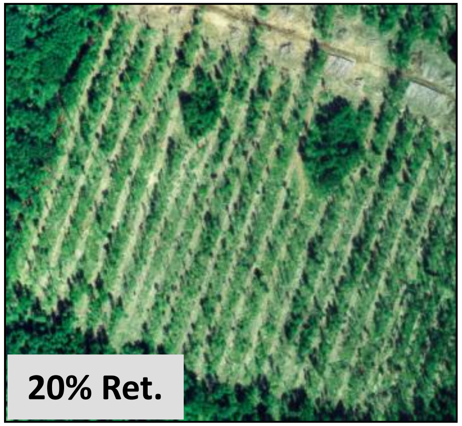
Dispersed green-tree retention
Aggregated retention: ¼ ha, 1/8 ha

10 ha compartments; 3 replicates
100 compartments/600 Permanent Sample Plots

100 compartments (~10 ha each)
7800 ha total area

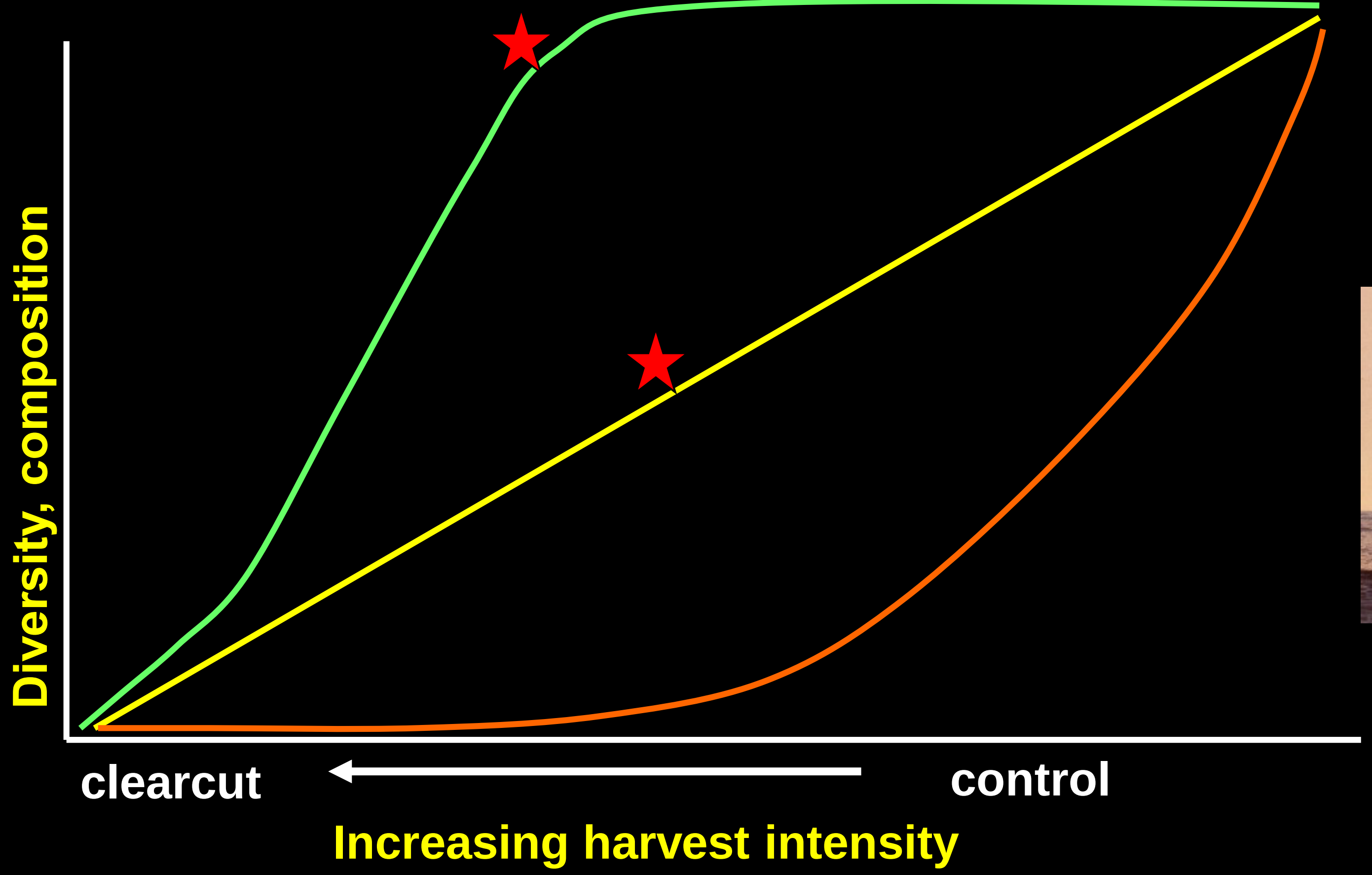






Pictures from www.emend.rr.ualberta.ca

Biodiversity responses to Retention harvesting: life-boat, faster recovery, specific habitat features







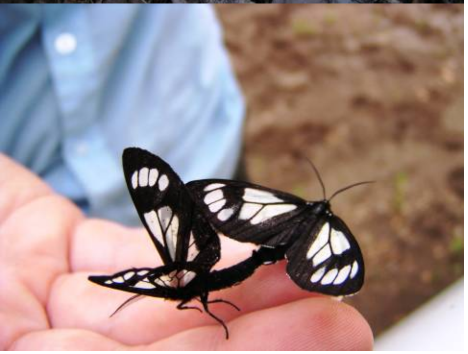
1996/97: project planning, plot selection, preliminary data collection

1998: pre-harvest data collection
Winter 1998/99: harvest

Ongoing core data collection:
1999, 2001, 2004, 2009/10, 2014-2017

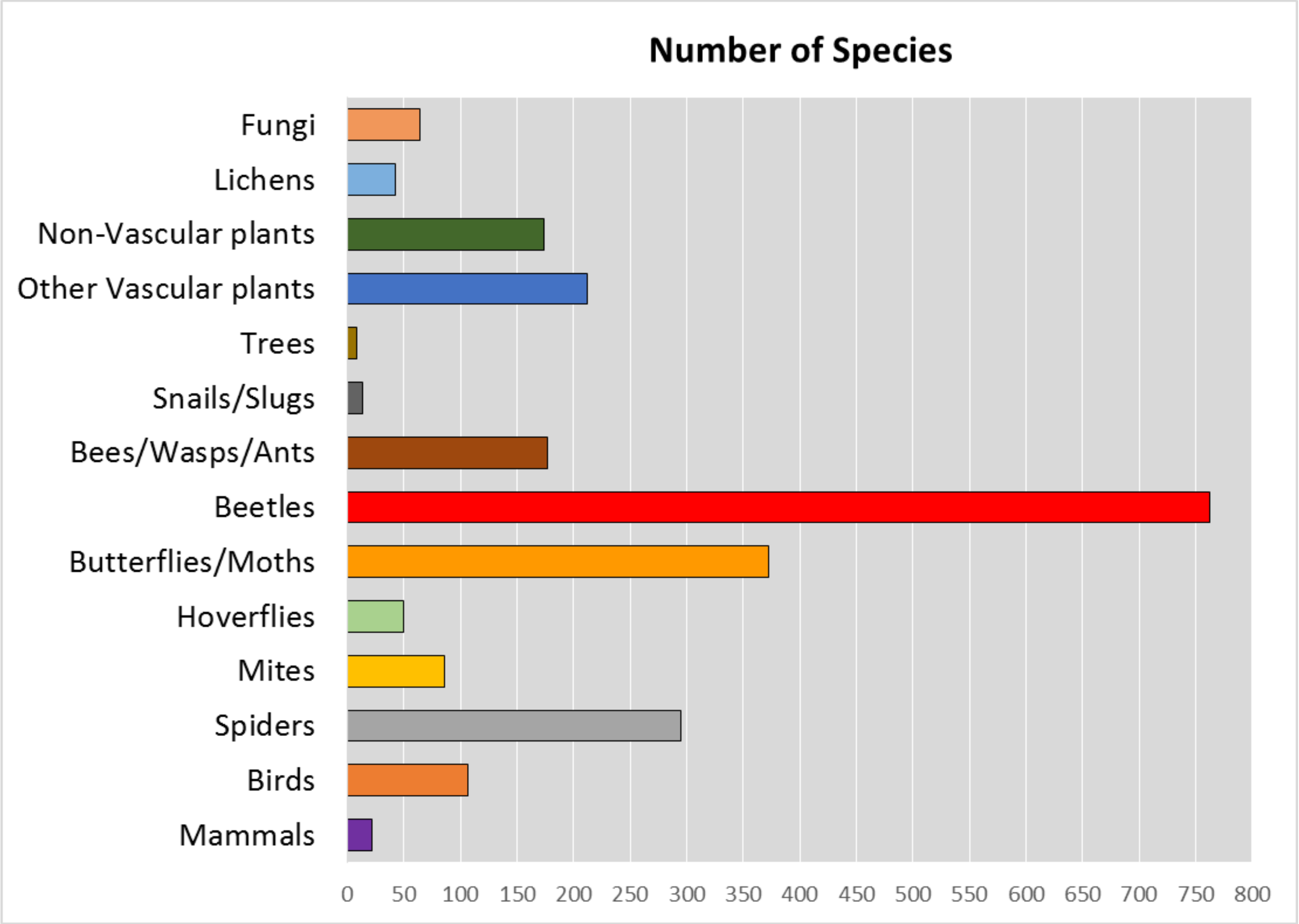
30+ researchers
45+ graduate students
100+ research assistants

So what have we learned?



BIODIVERSITY: 2388 species

world's largest geo-referenced boreal biodiversity database



10+ new species to science

Outline

Origins and Experimental Design

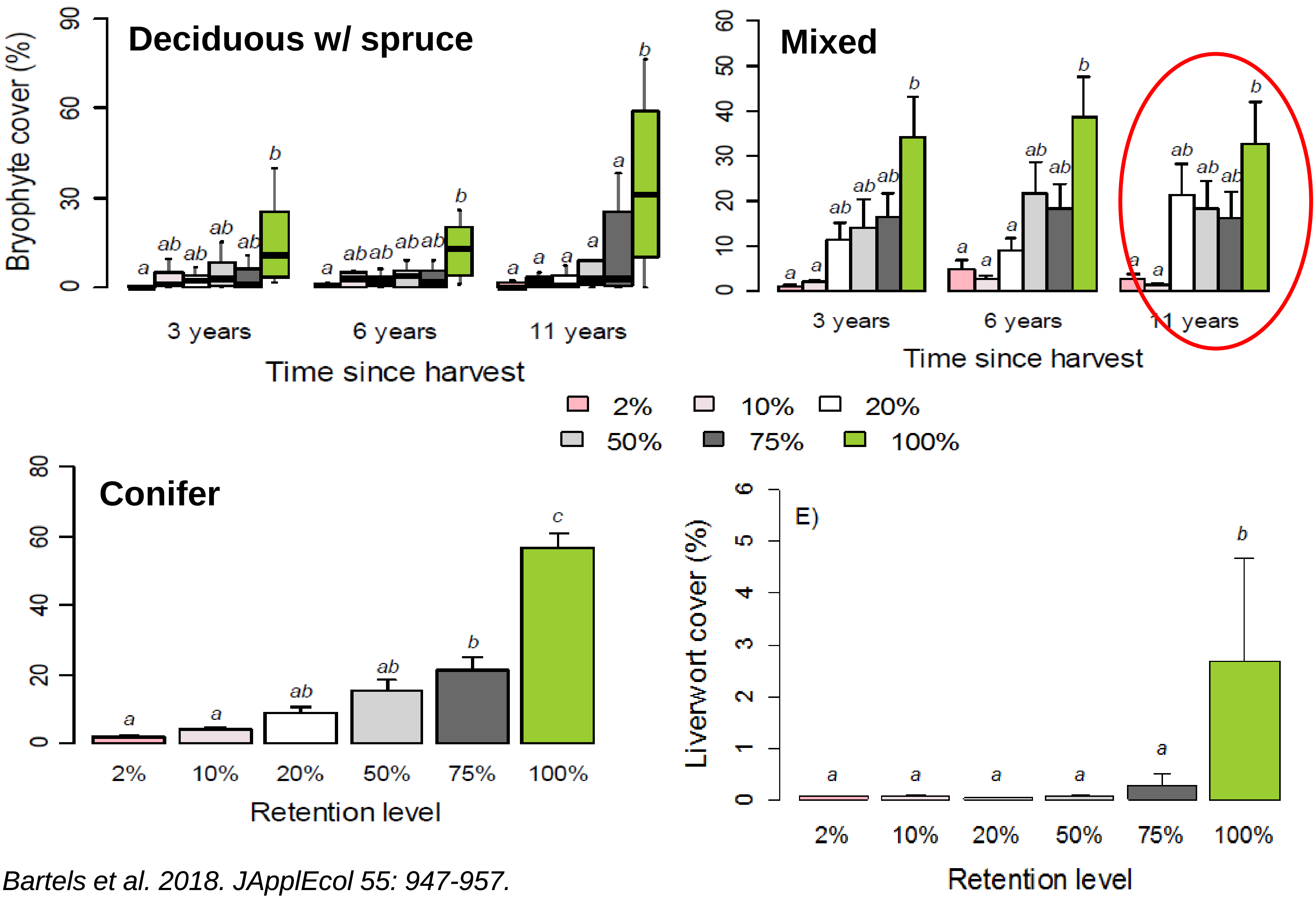
Biodiversity responses to dispersed retention:
- **Plants**
- **Invertebrates**
- **Songbirds**
- **Mammals**

Values of aggregated retention:
- Plants
- Invertebrates

Informing placement of retention

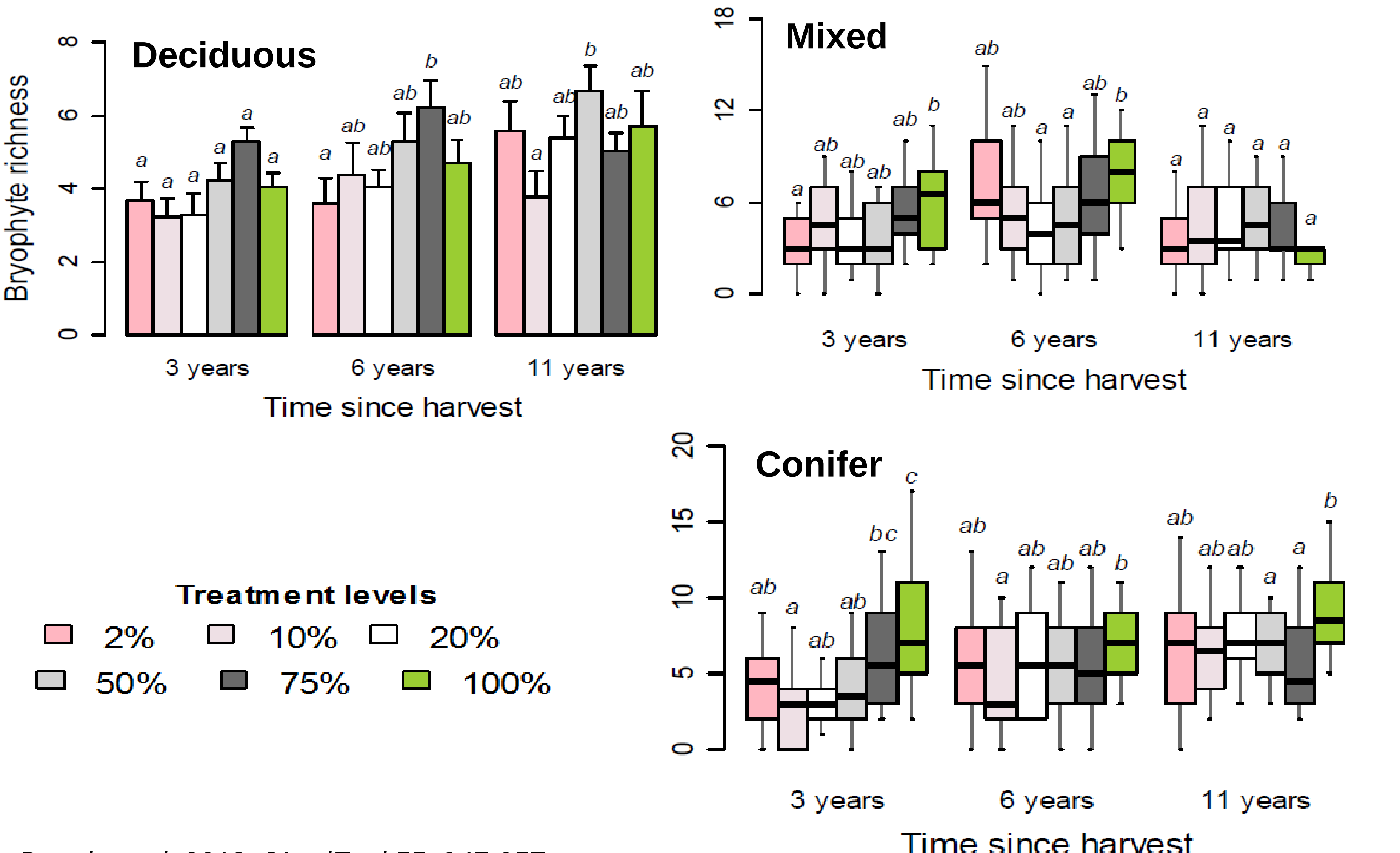
Conclusions

Bryophyte Cover: declined with harvest intensity



Bartels et al. 2018. JApplEcol 55: 947-957.

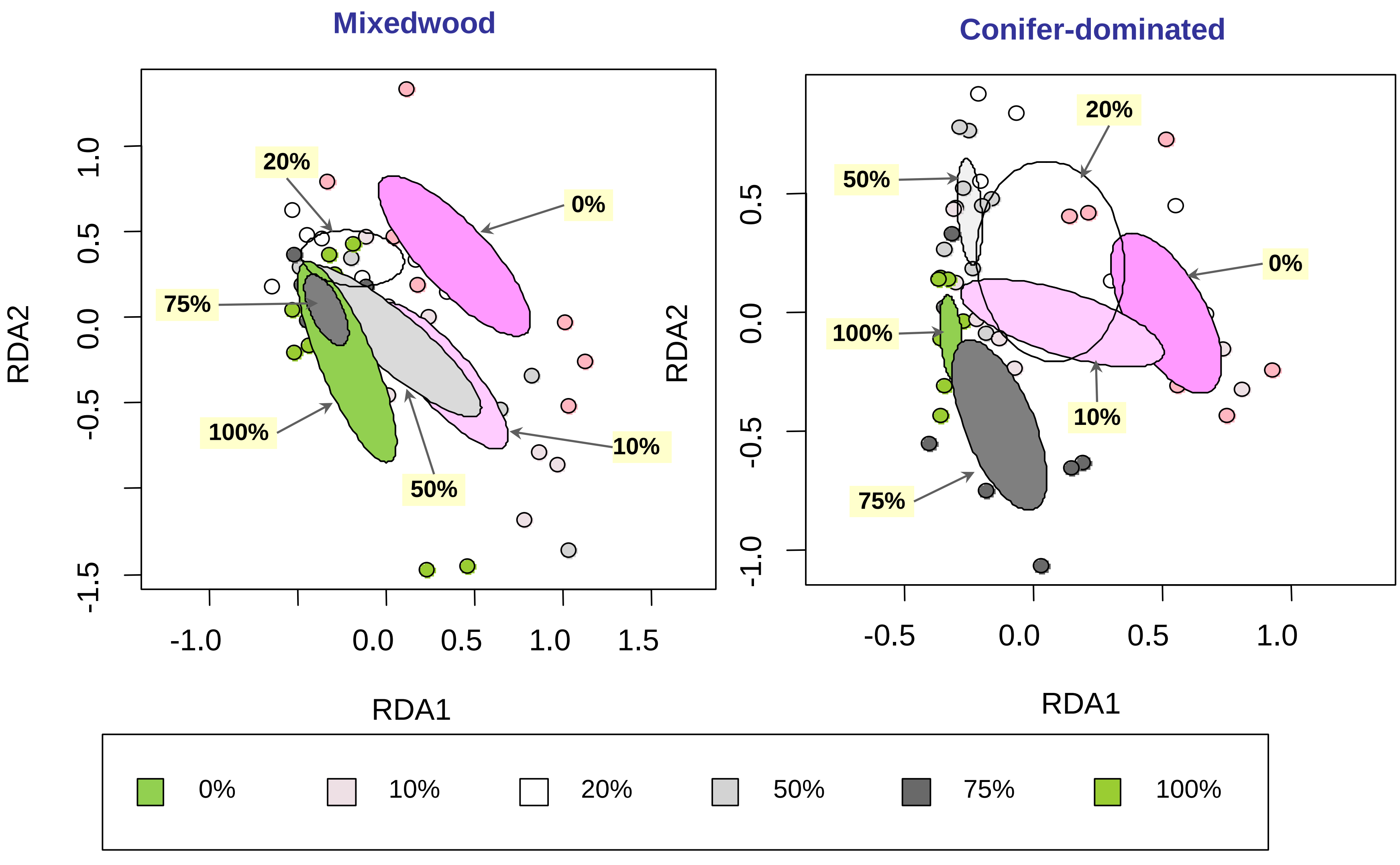
Bryophytes Richness: somewhat lower with low retention, recovered after 10 years



Bartels et al. 2018. JApplEcol 55: 947-957.

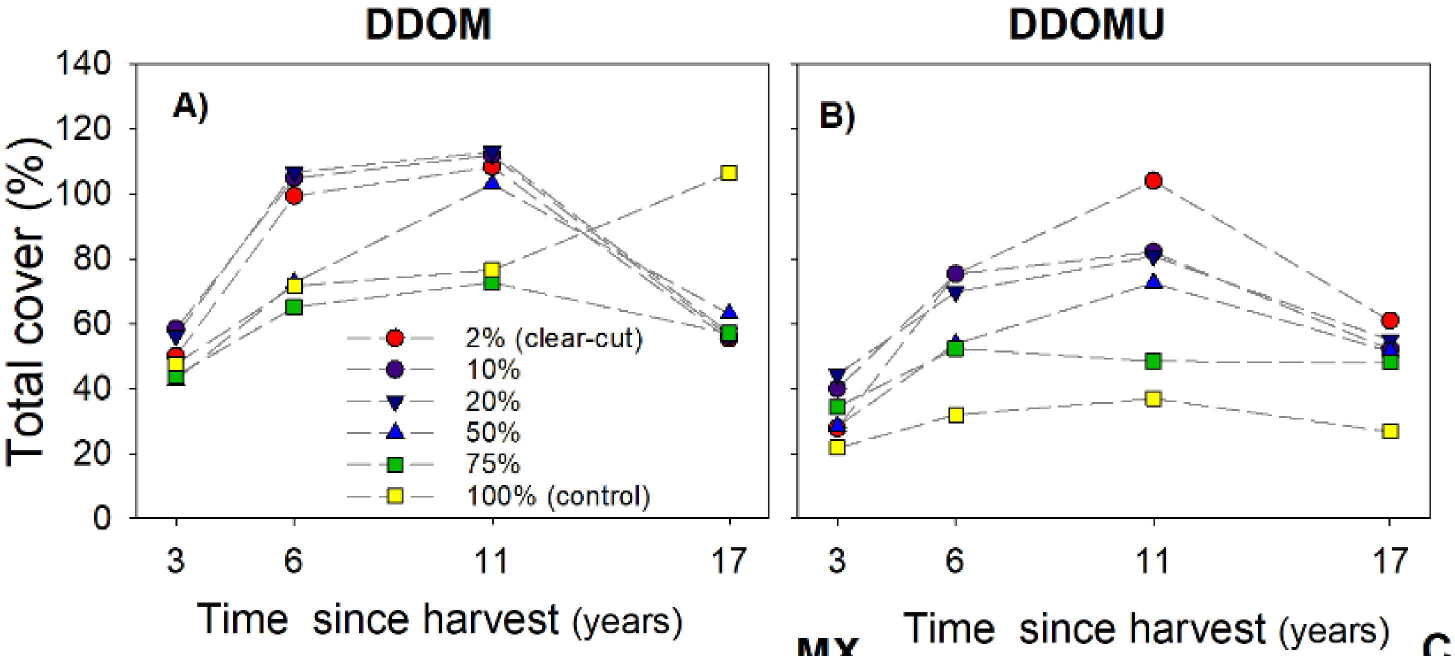
Bryophyte composition: varied with harvest intensity, recovered over time

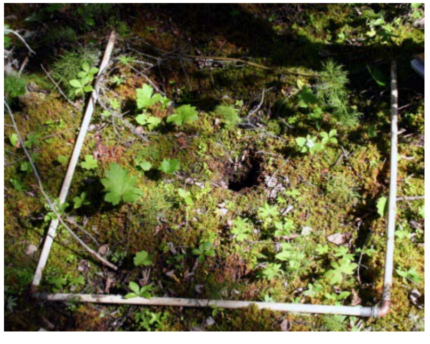
10 years post-harvest

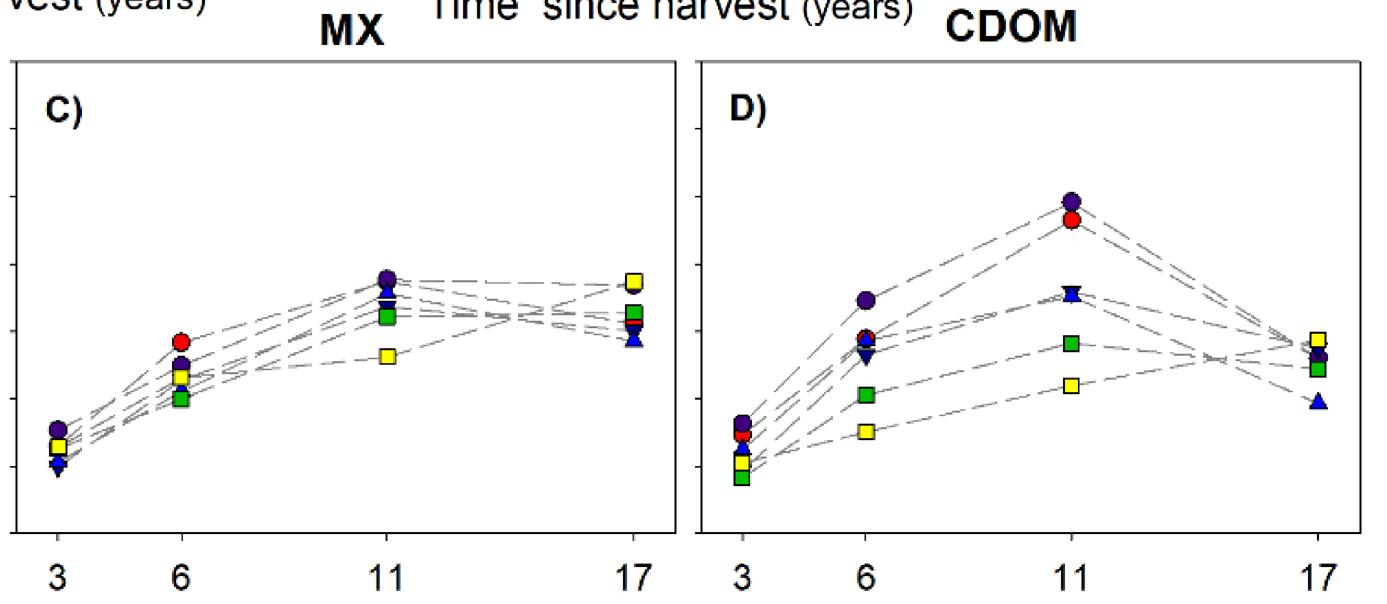


Bartels et al. 2018. JApplEcol 55: 947-957.

Vascular plant cover: increased with low retention, recovered over time

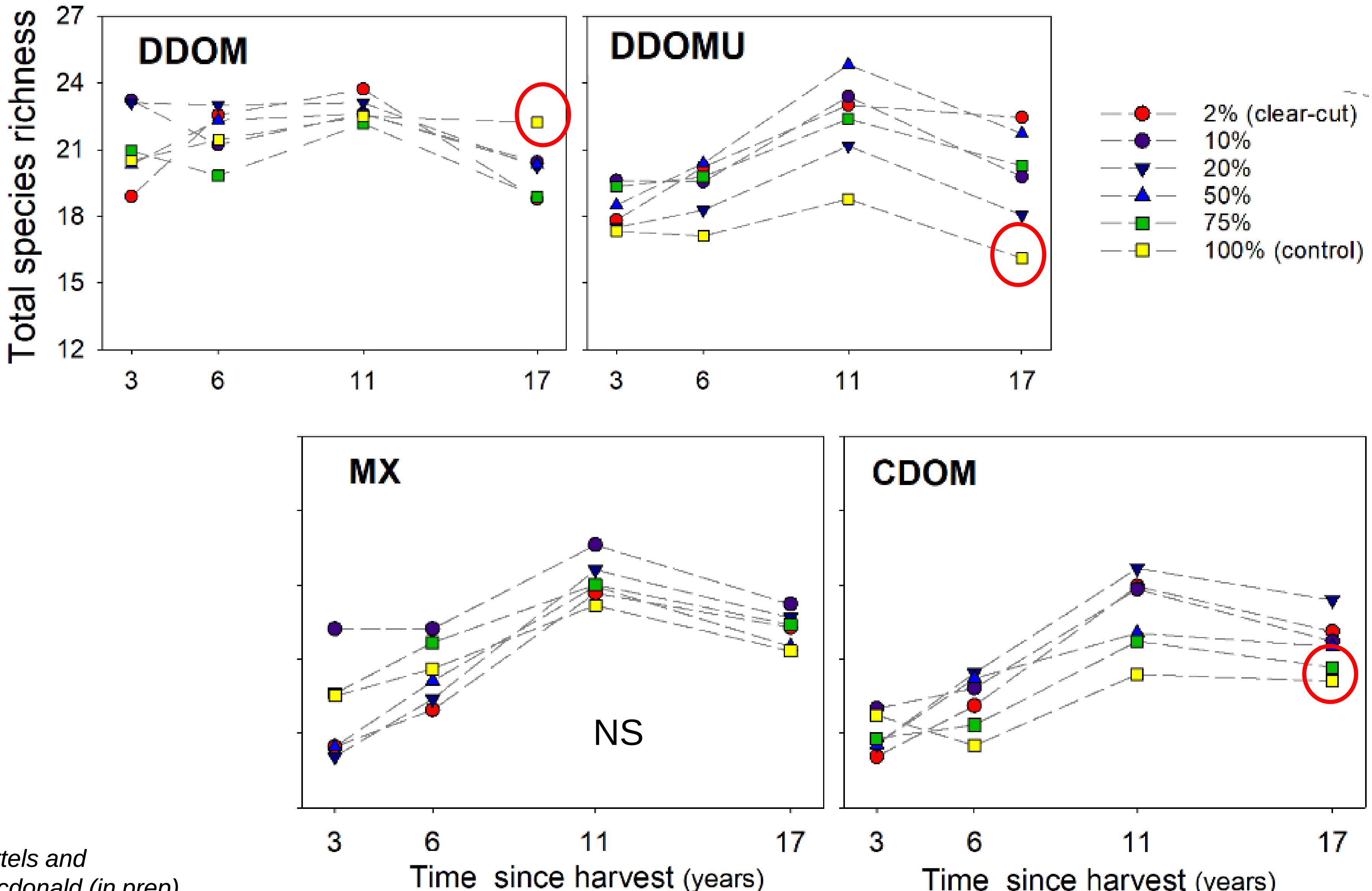






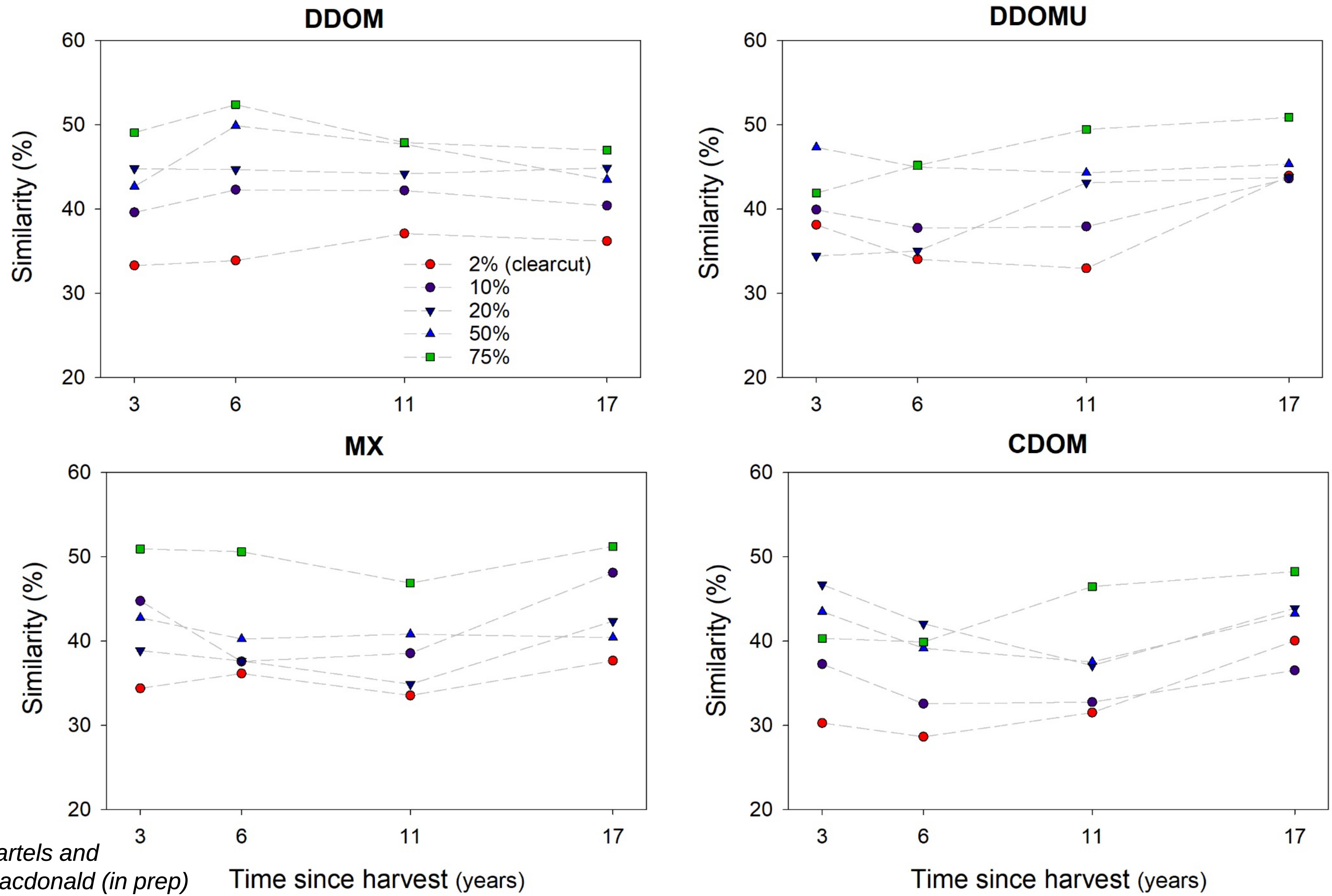
Bartels and Macdonald (in prep)

Vascular plant richness: increased with low retention, responses differed among forest types



Bartels and Macdonald (in prep)

Vascular plant composition: varied with harvesting intensity, weak recovery over time



Bartels and Macdonald (in prep)

Plants: conclusions

Vascular cover & richness increase then decline with harvest
Bryophyte cover & richness decline with harvest
Mostly recovered by 17 years

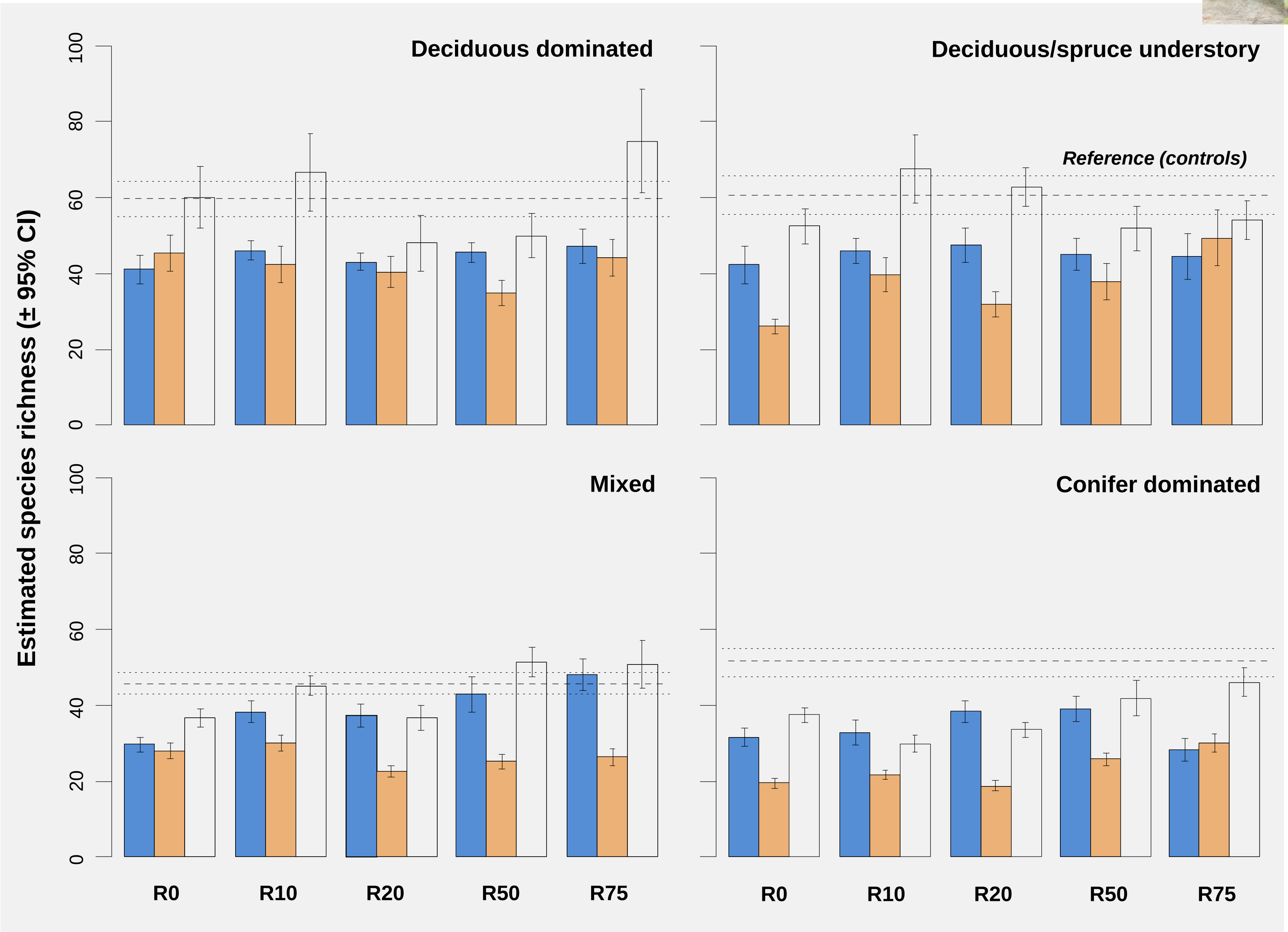
Composition: varied with the gradient of harvesting intensity
Some recovery but still substantial differences 17 years post-harvest

Retention has some value; 20% and higher better
But sensitive species (Liverworts) may require high levels
It may take a long time for composition to recovery
Forest regeneration very influential

Calypogeia suecica

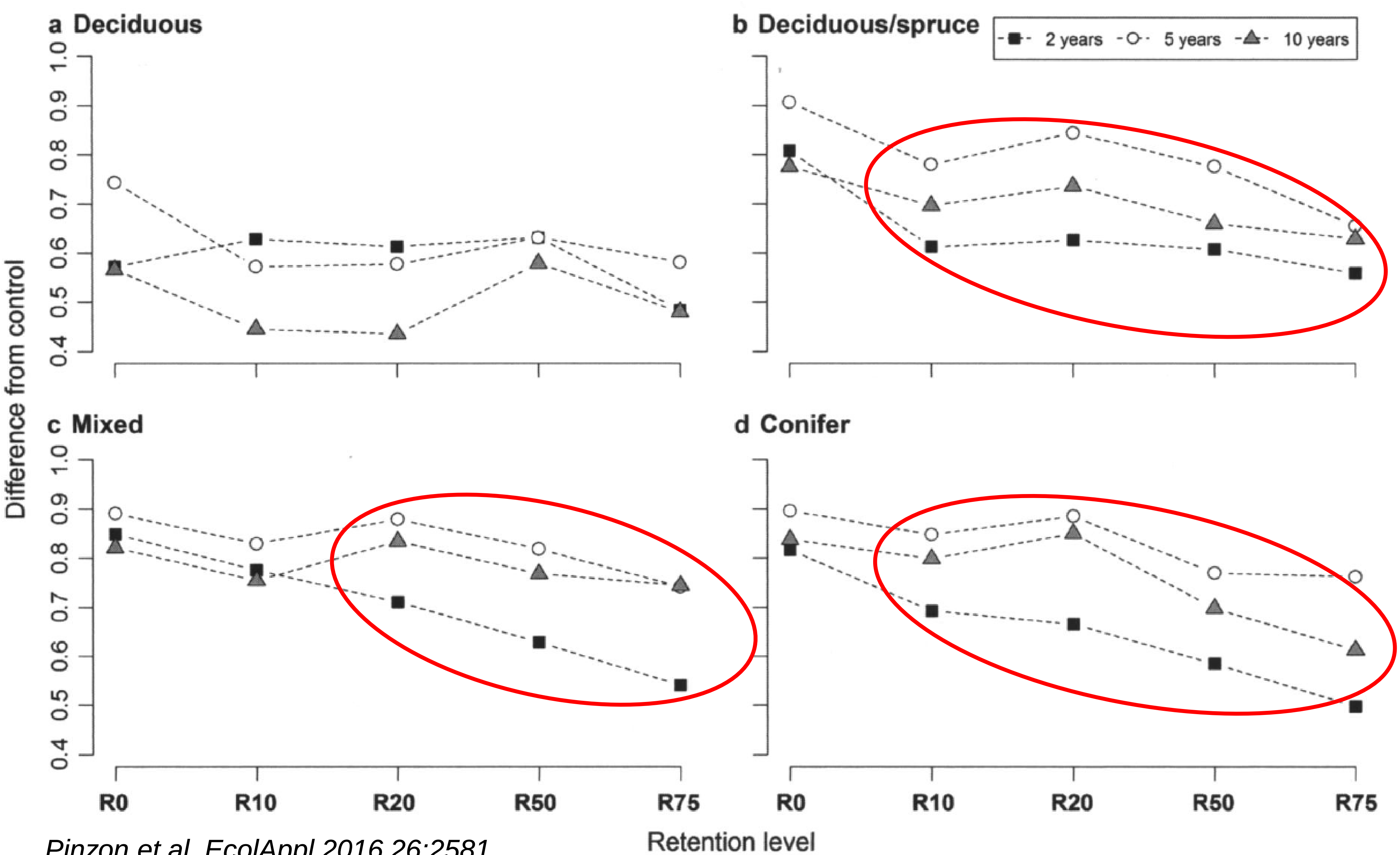

Geocalyx graveolens

Ground spider richness: declined with harvest; recovery over time



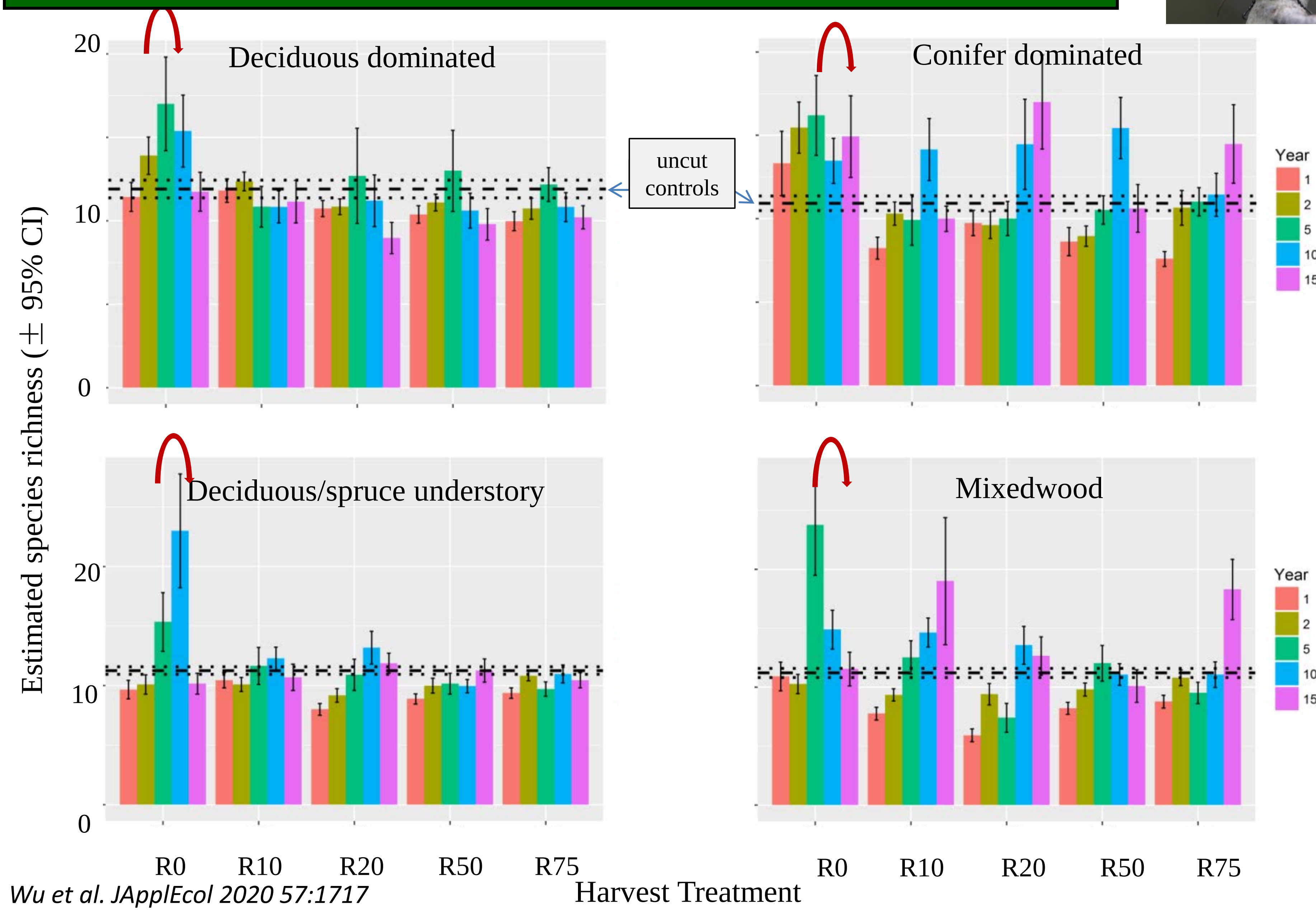
Pinzon et al. EcolAppl 2016 26:2581

Ground spider composition: varied with harvest intensity, some recovery over time (after a lag)



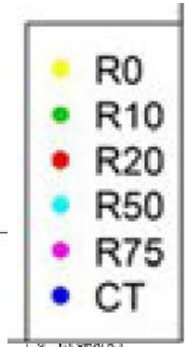
Pinzon et al. EcolAppl 2016 26:2581

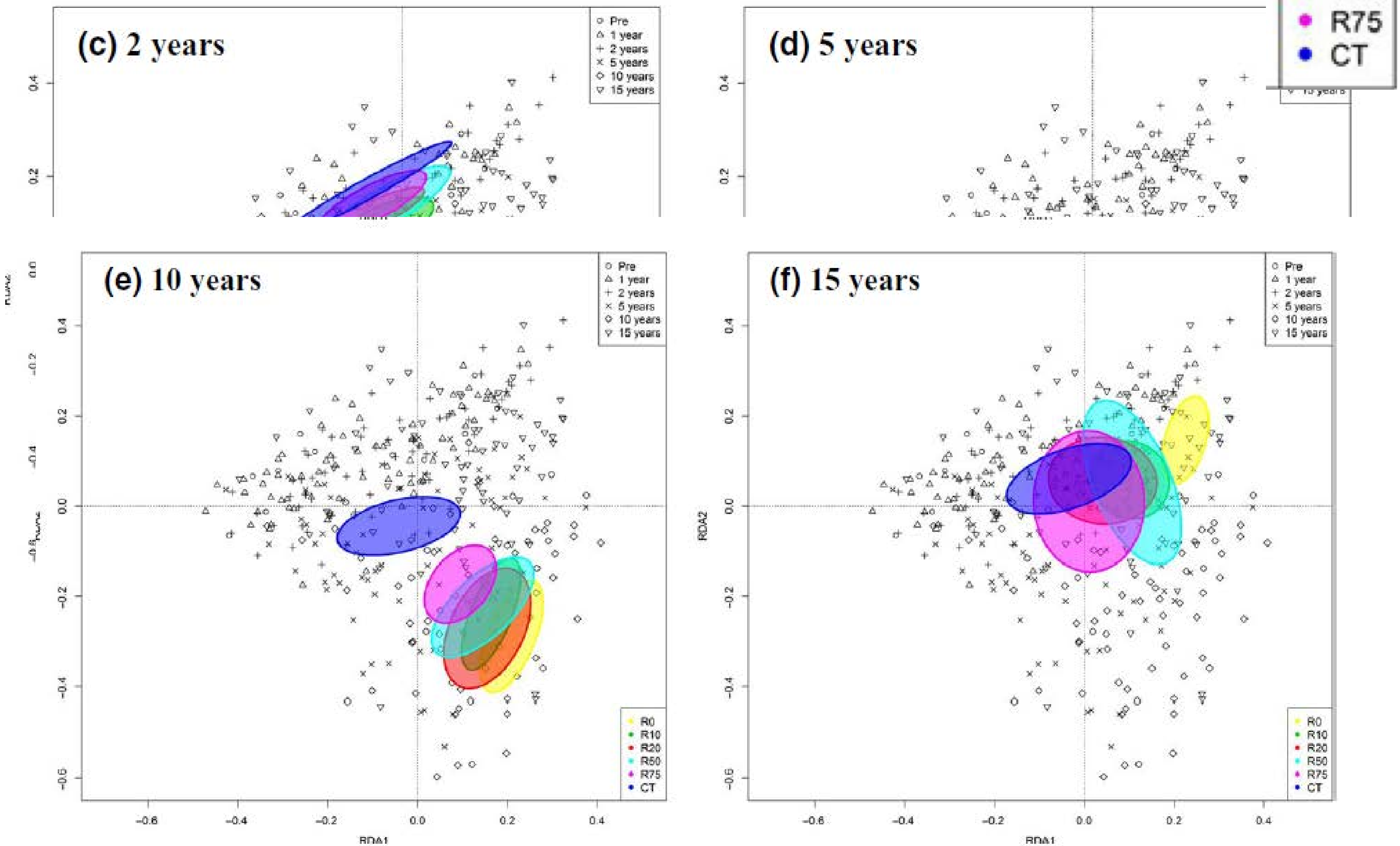
Carabid beetle richness: decrease then increase, forest type differences



Wu et al. JApplEcol 2020 57:1717

Carabid beetle composition: varied with harvest intensity, some recovery over time





Wu et al. JApplEcol 2020 57:1717

Rove beetle richness: increased with harvesting intensity; recovered by 15 years post-harvest

Rove beetle abundance: decreased with harvesting intensity; recovered by 10 years post-harvest

Rove beetle composition: varied along the gradient of harvesting intensity; recovery by 15 years post-harvest

Seung-il Lee et al. in prep

Invertebrates: conclusions

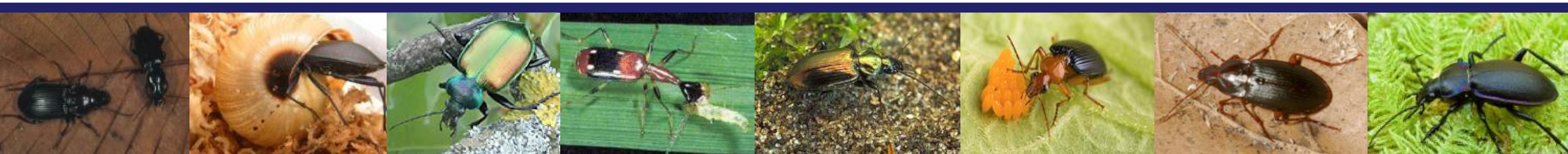
Spiders, Carabid beetles:

- Response along gradient of harvest intensity
- Lag in response (ecosystem memory)
- Long-lasting effects of harvesting

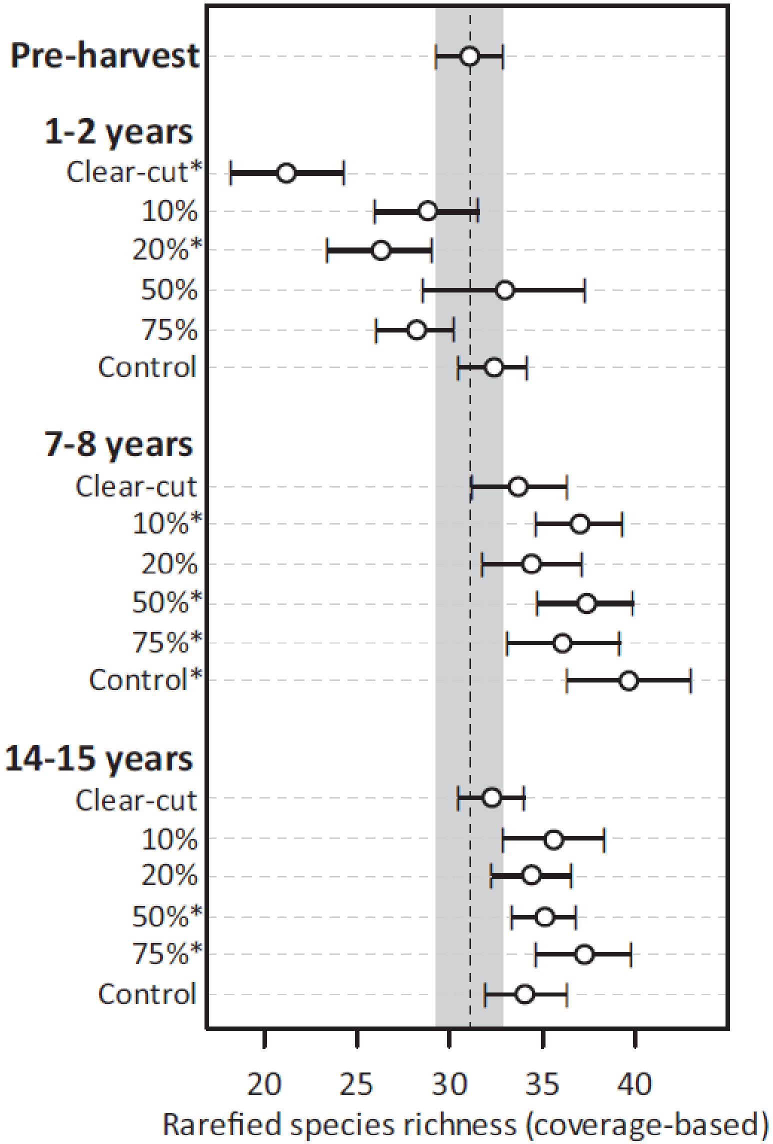
Rove beetles:

- Response along gradient of harvest intensity
- Fairly rapid recovery

Retention has value
No clear threshold
Forest types differ: regeneration and succession

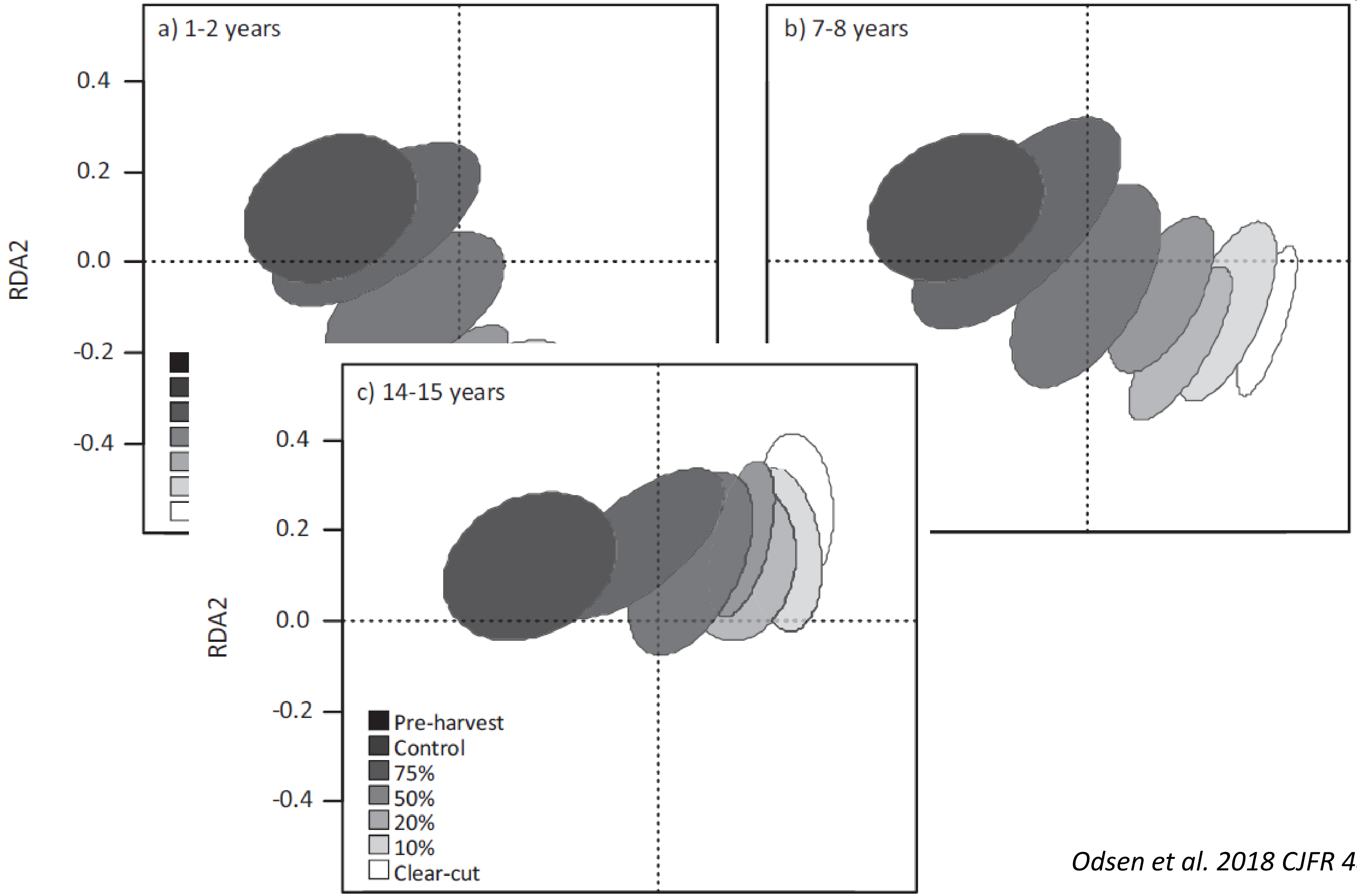


Songbird richness: decreased with harvest then increased



Odsen et al. 2018 CJFR 48: 1495

Songbird assemblage: varied with harvest intensity, some recovery over time



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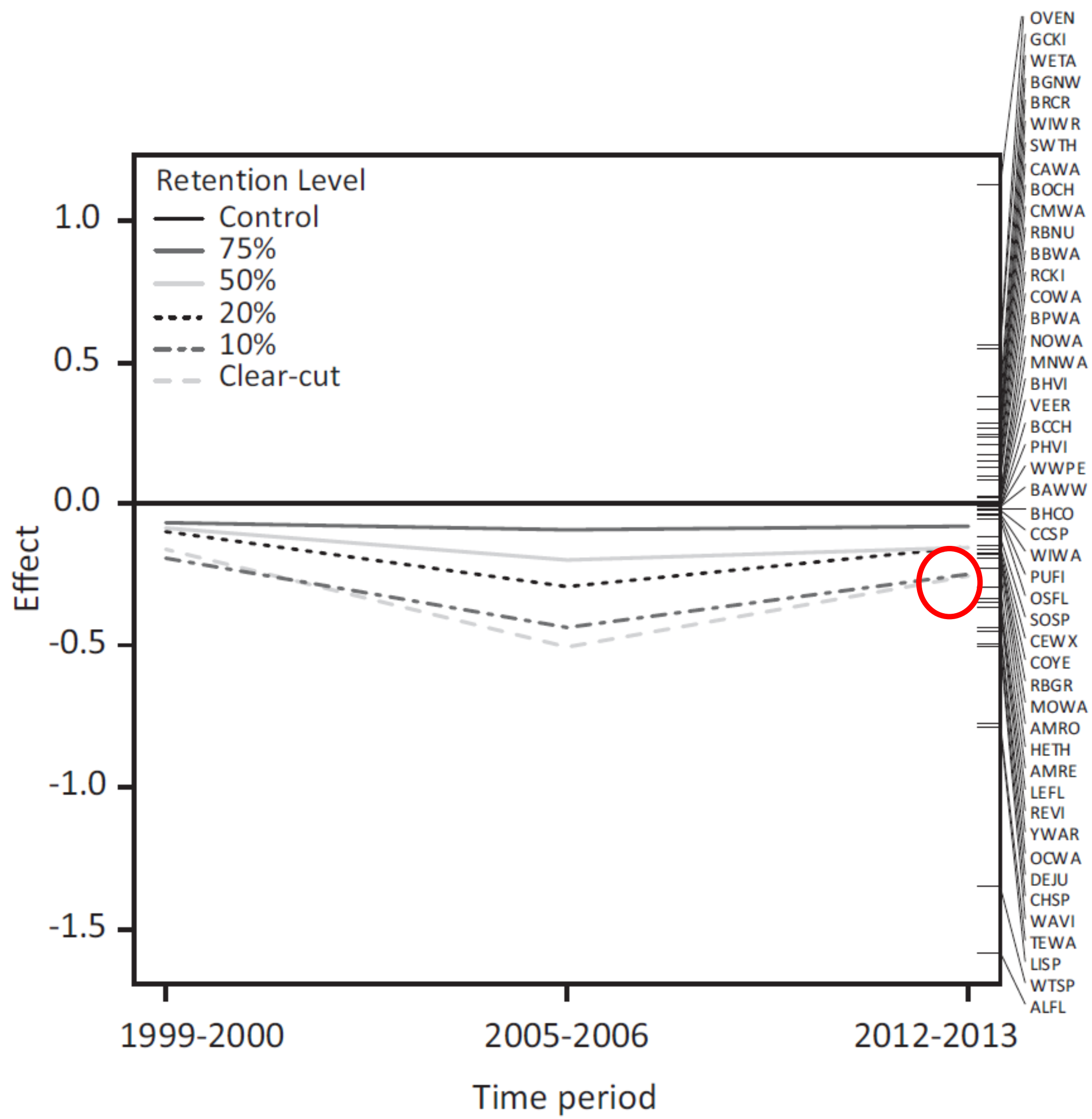
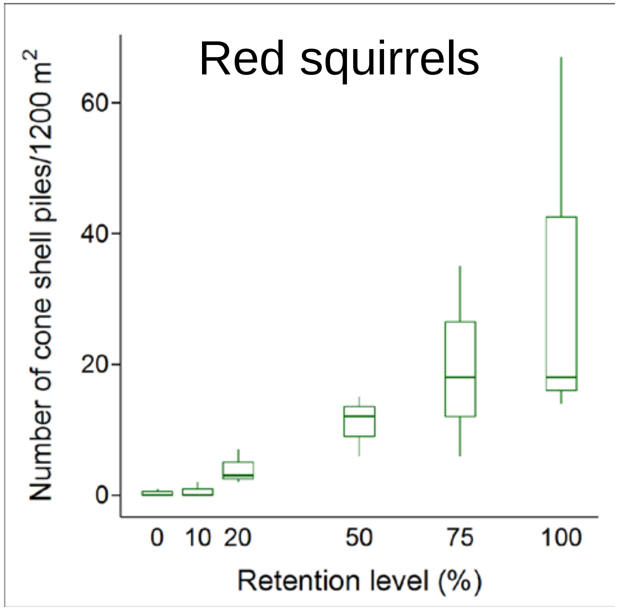


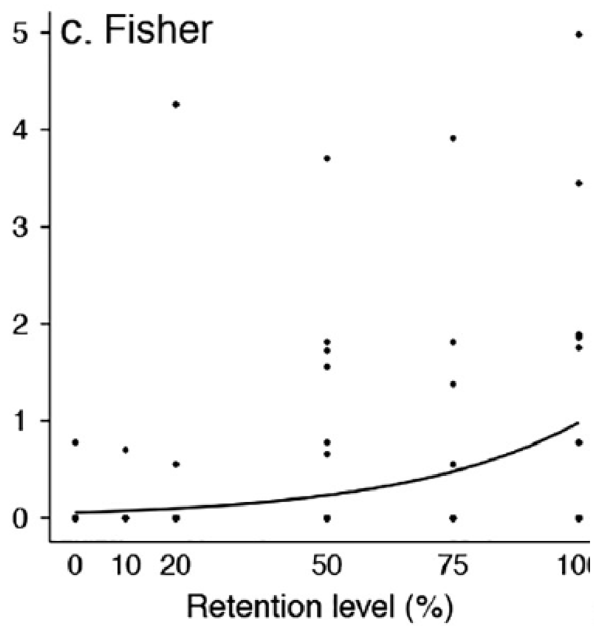
'Old forest' species changing in controls vs pre-harvest = succession and landscape-scale effects

Odsen et al. 2018 CJFR 48: 1495

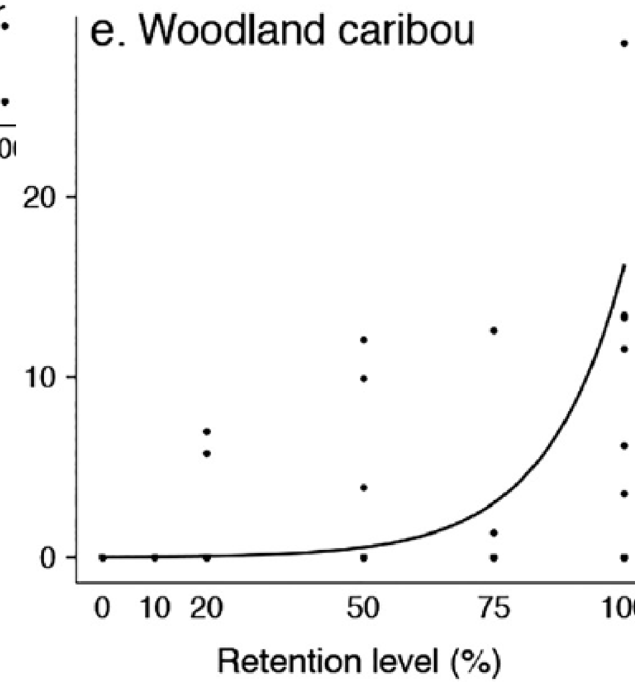
Mammal abundance: decrease with harvest intensity



Conifer forests 15-18 years post-harvest



Black bear
Coyote
Wolverine

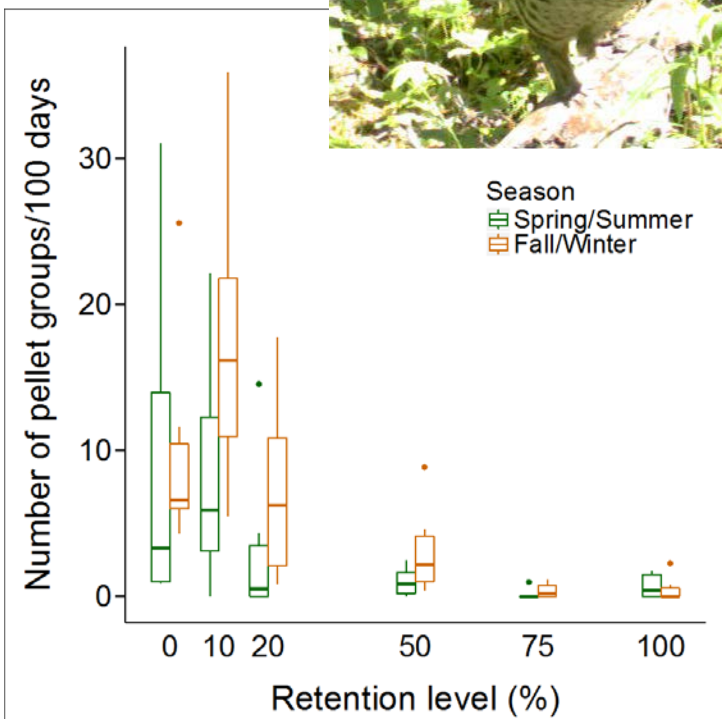


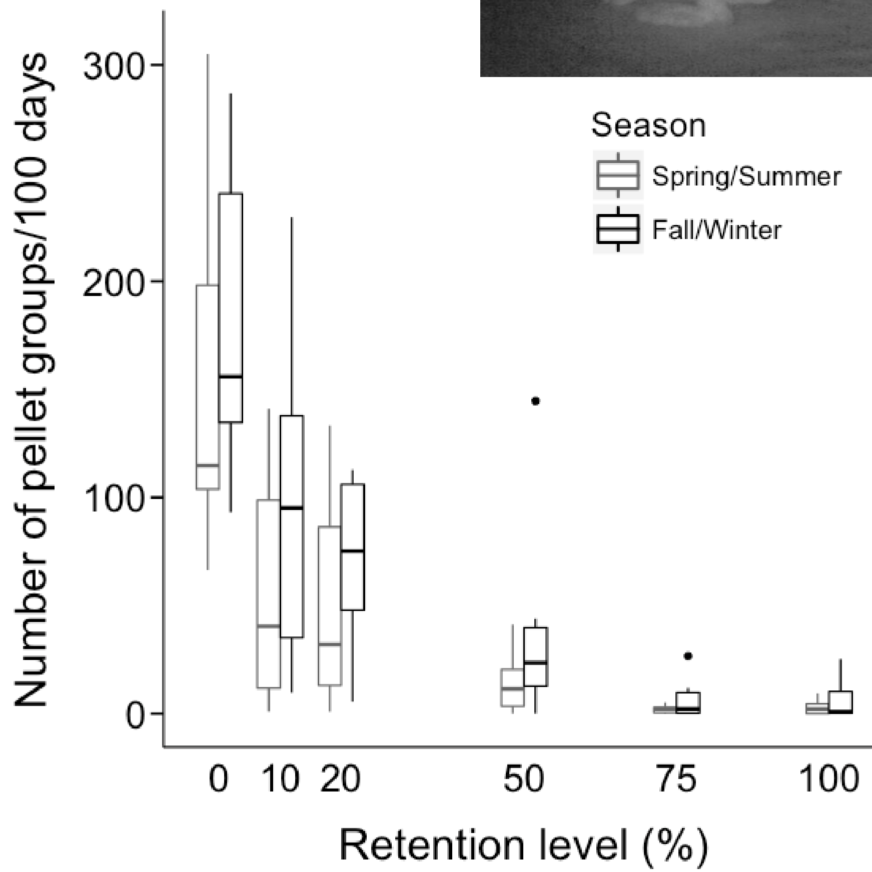
Franklin et al. 2019 Ecosphere 10(3) article e02632

Mammal abundance: increase with harvest intensity

Conifer forests 15-18 years post-harvest

Grouse





Franklin et al. 2019 Ecosphere 10(3) article e02632

Vertebrates: conclusions

Songbirds:

- Response along gradient of harvest intensity
- Retention > 20% conserved songirds and facilitate faster recovery
- Longer-term effects: forest regeneration/succession, landscape footprint effects

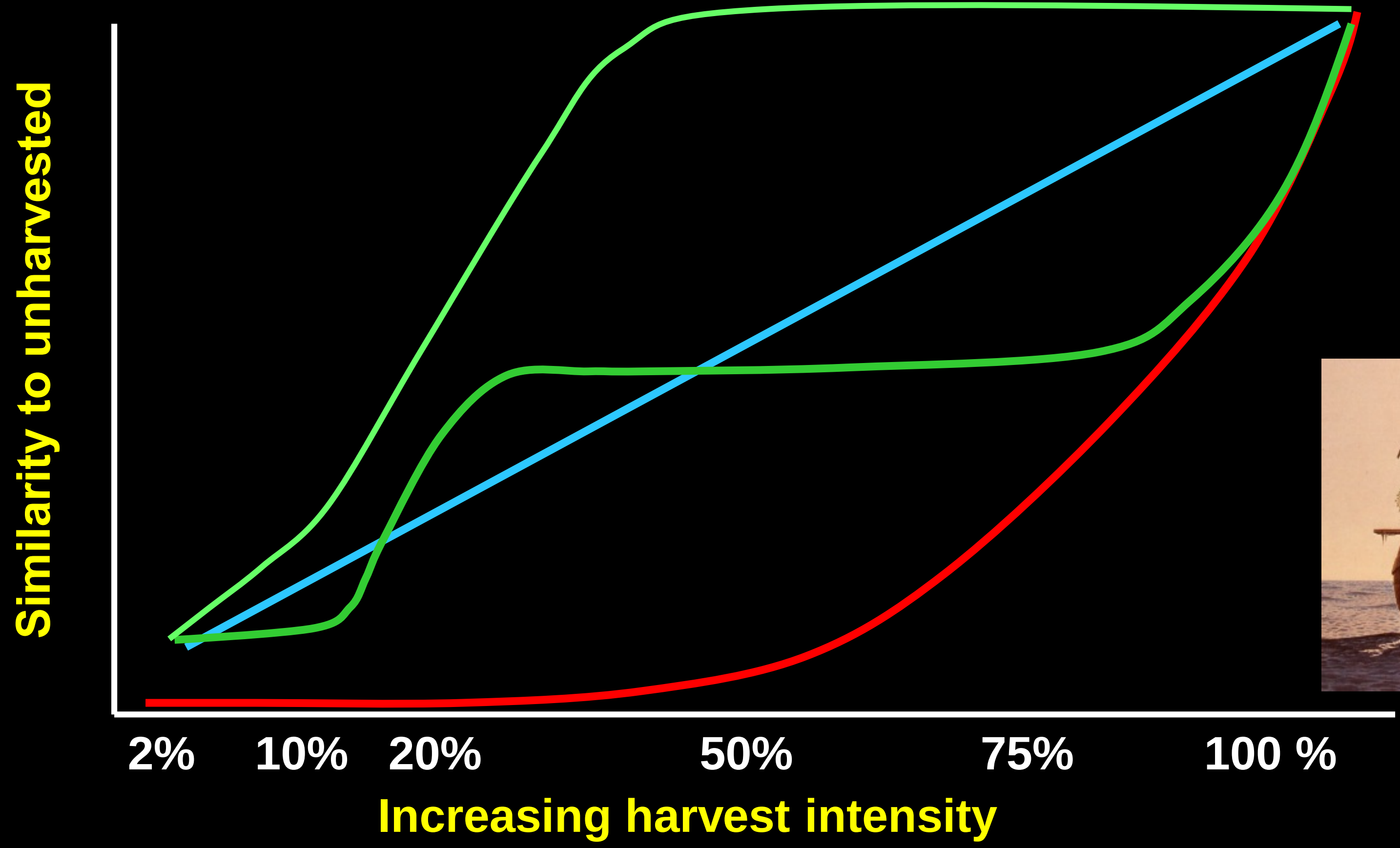
Mammals:

- Species either increased or decreased along gradient of harvest intensity
- Higher levels of retention (> 20%) associated with late-seral species

Dispersed retention: conclusions

- Retention has value for retaining communities or facilitating faster recovery
- Higher levels better (often > 10%)
- Responses differ by biotic group and forest type
- Lag effects: ecosystem memory
- Longer-term effects: forest regeneration/succession

Dispersed retention: conclusions



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Biodiversity responses to dispersed retention:
- Plants
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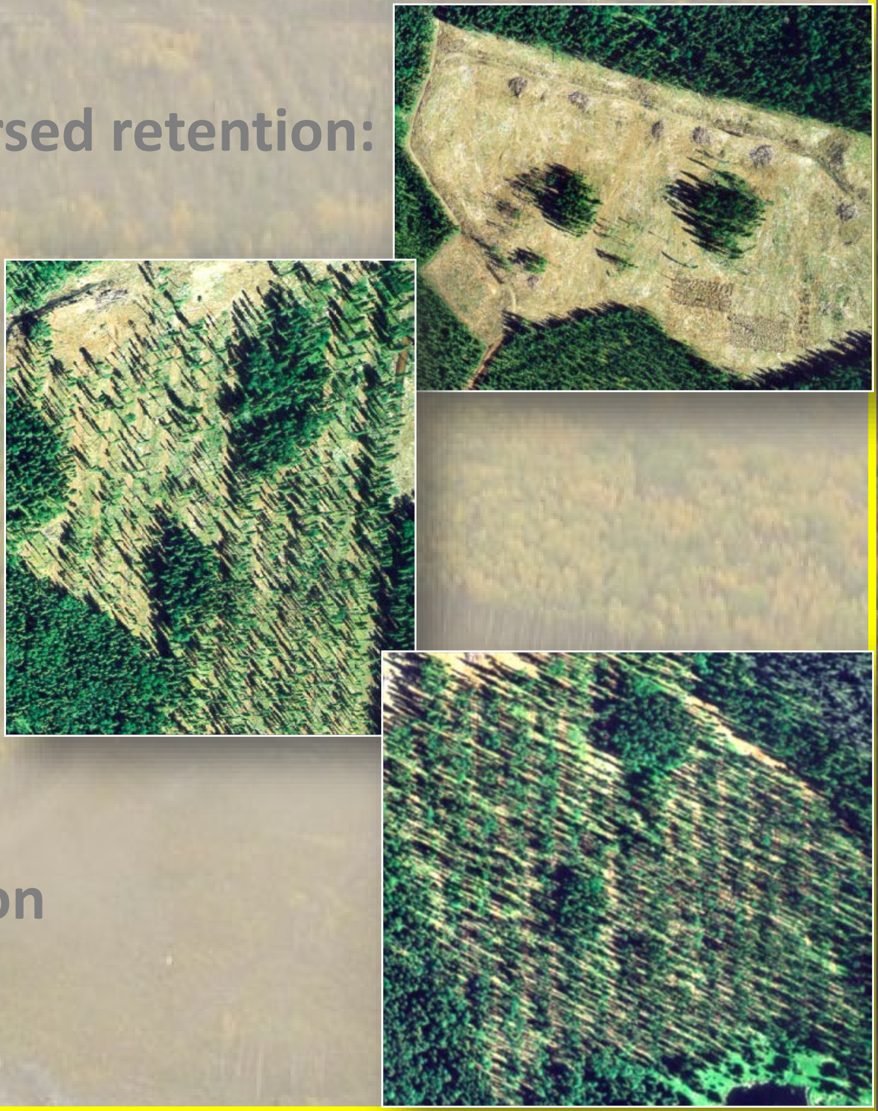
- Songbirds
- Mammals

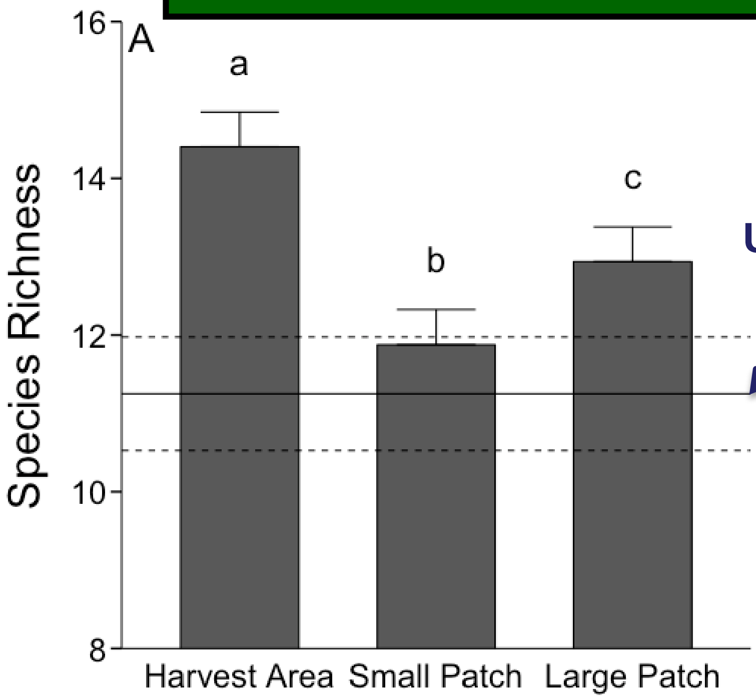
Values of aggregated retention:
- **Plants**
- **Invertebrates**

Informing placement of retention

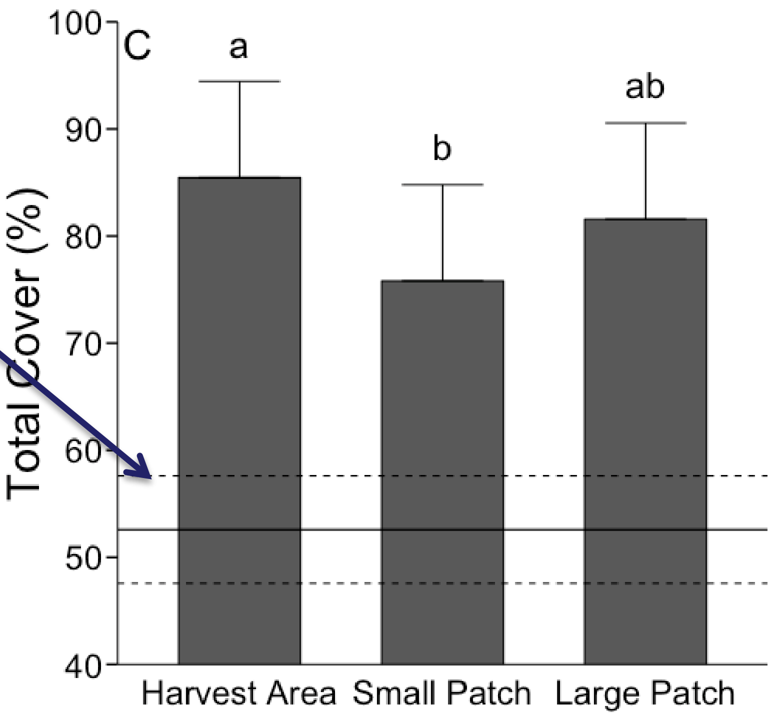
Conclusions



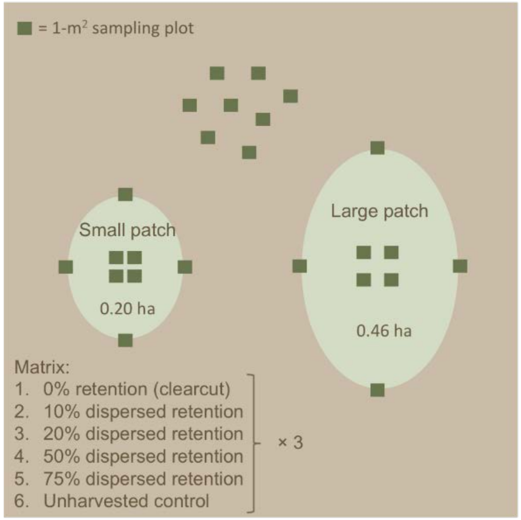
Vascular plants: patches had richness & cover more similar to unharvested control



Unharvested control

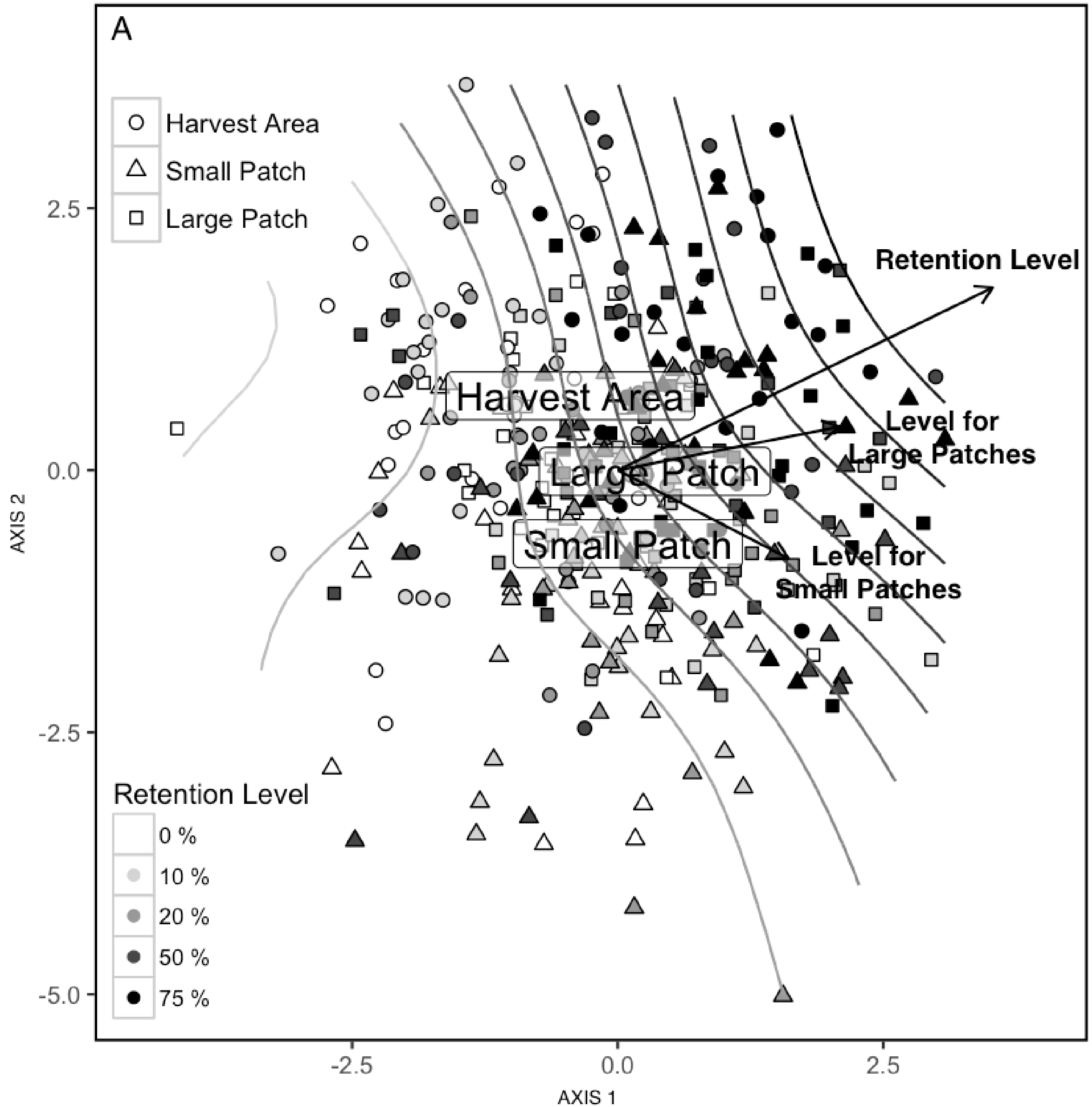


Conifer forests 15 years post-harvest



Franklin et al. 2018. EcolAppl 28:1830

Vascular plant composition: patches more effective when surrounded by higher levels of dispersed retention

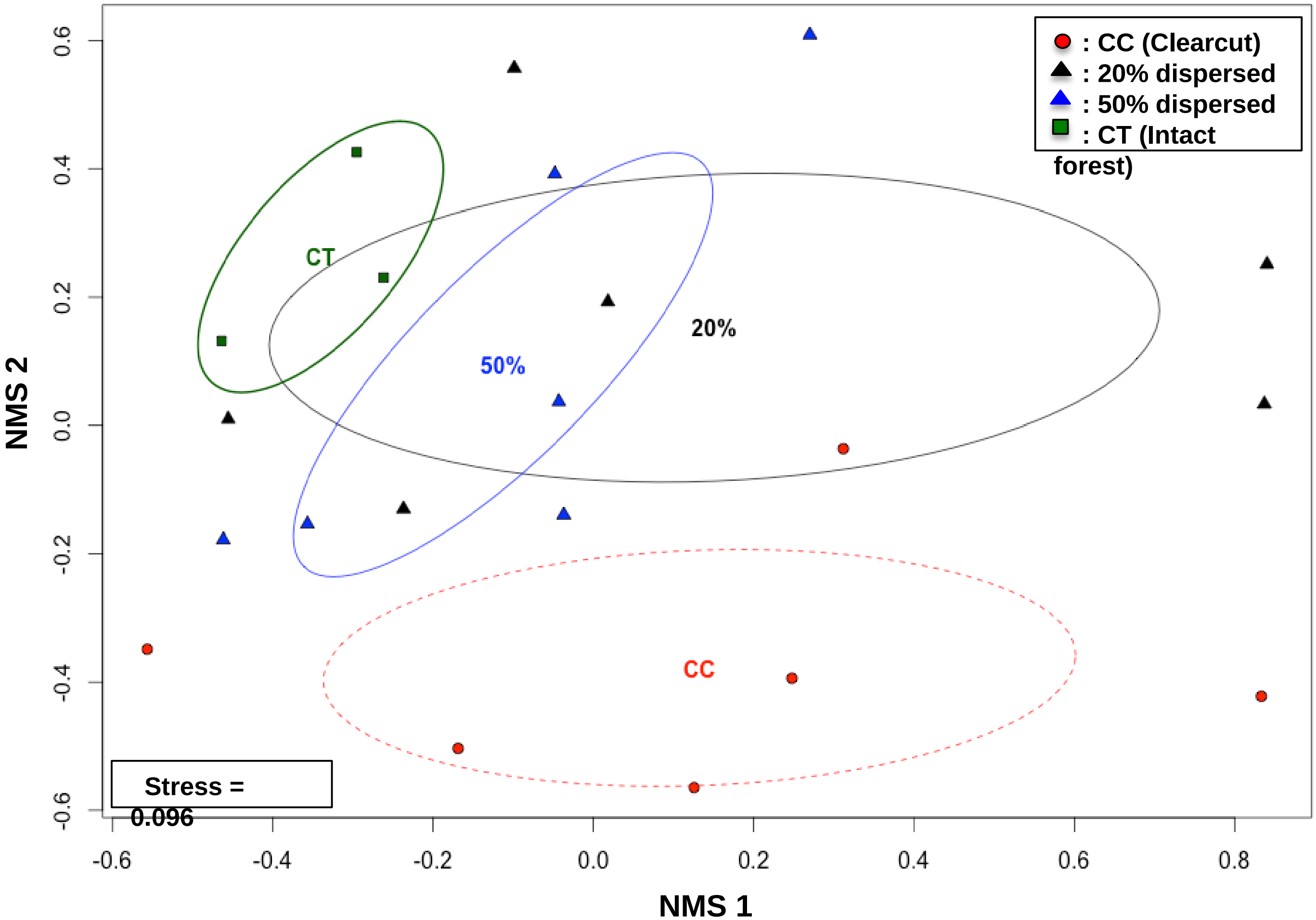


Edge effects penetrated patches

Franklin et al. 2018. EcolAppl 28:1830

Saproxylic beetles: patches more effective when surrounded by higher levels of dispersed retention

PERMANOVA: (Pseudo-F = 1.72, p = 0.018) CC≠(50%, CT)

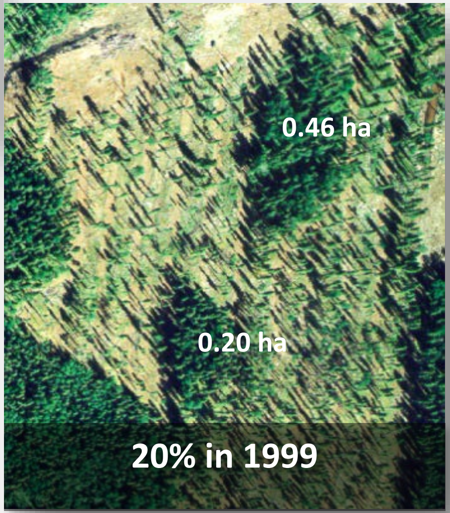


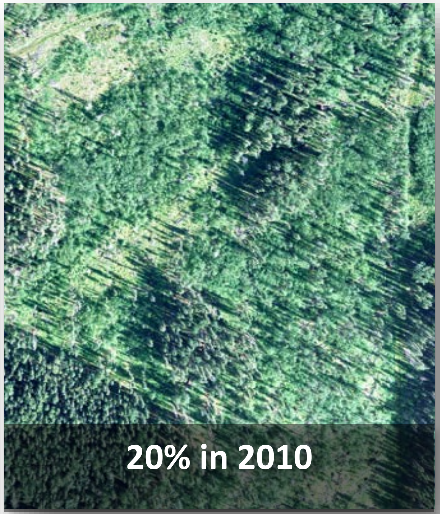
Conifer forests 10 years post-harvest

Lee et al. 2017. ForEcolMgmt 385:116

Aggregated retention: conclusions

- Patches can retain forest-dependent species
- More effective when surrounded by dispersed retention
- Patch + 20 – 50% retention = unharvested
- Longer-term effects: mortality in patches





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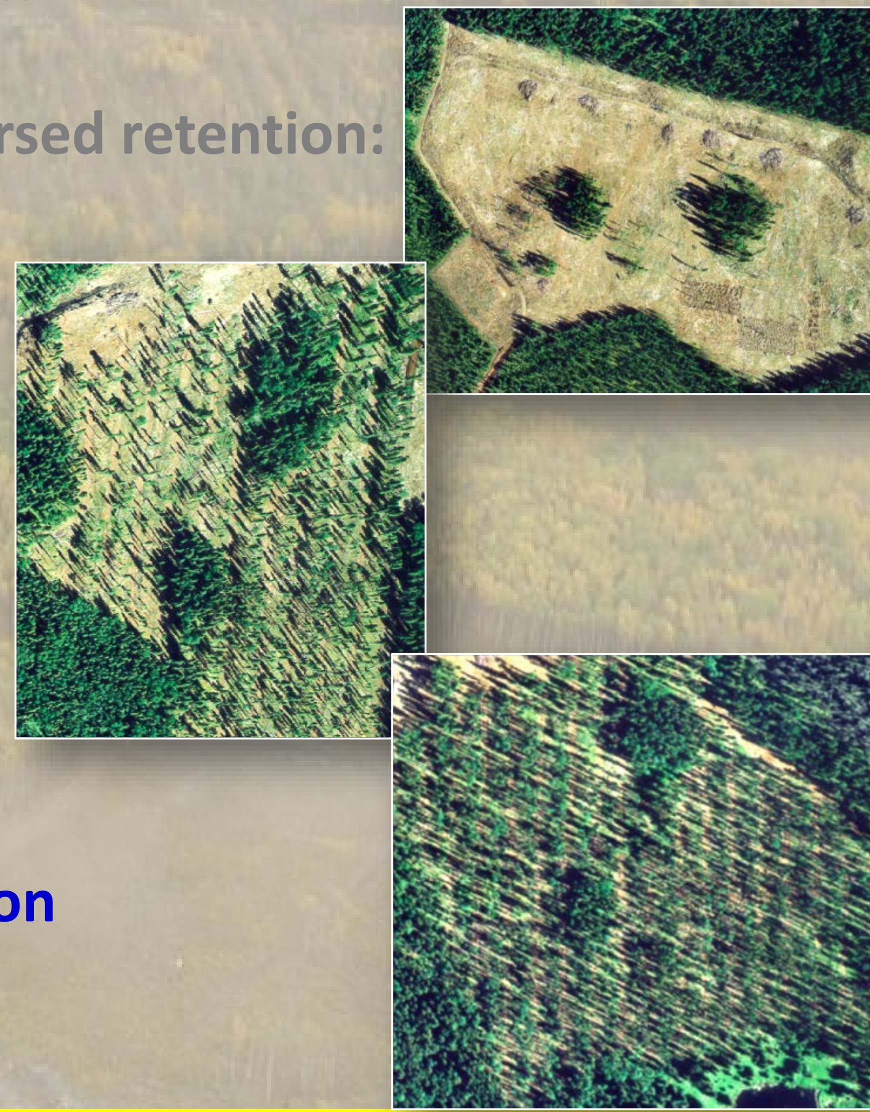
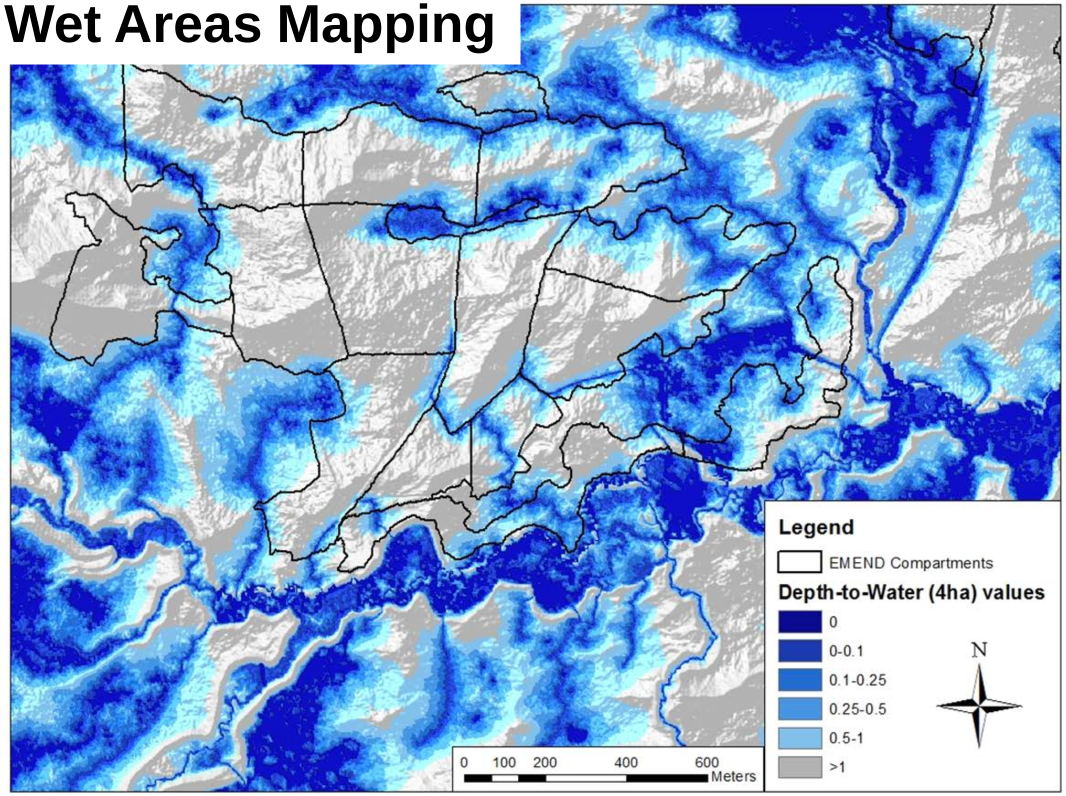


Can we use topographic wetness to guide placement of retention?

Wet Areas Mapping



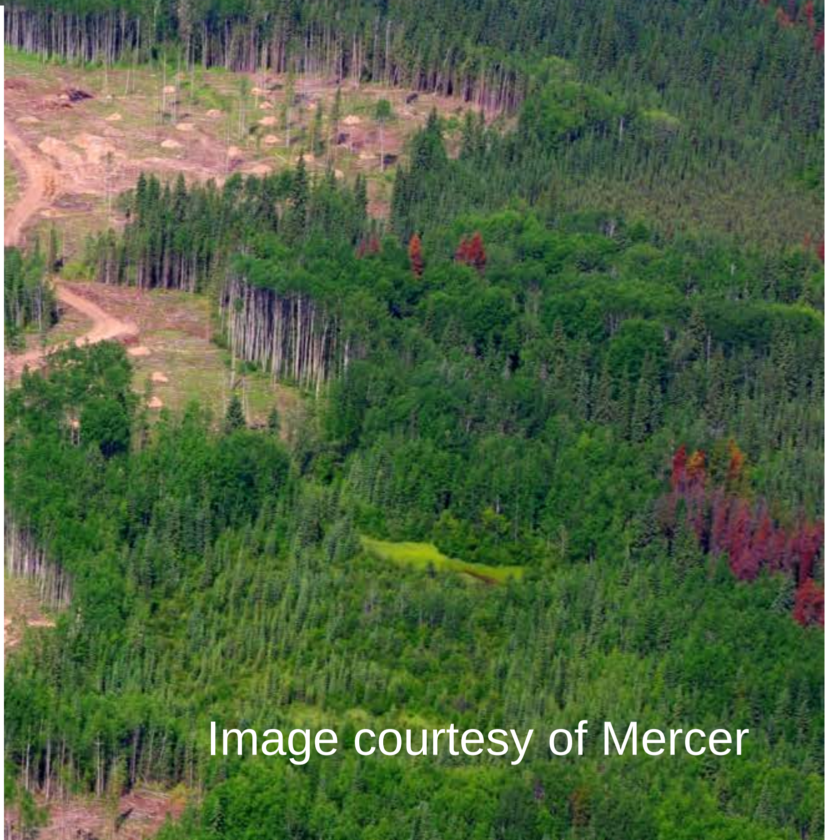
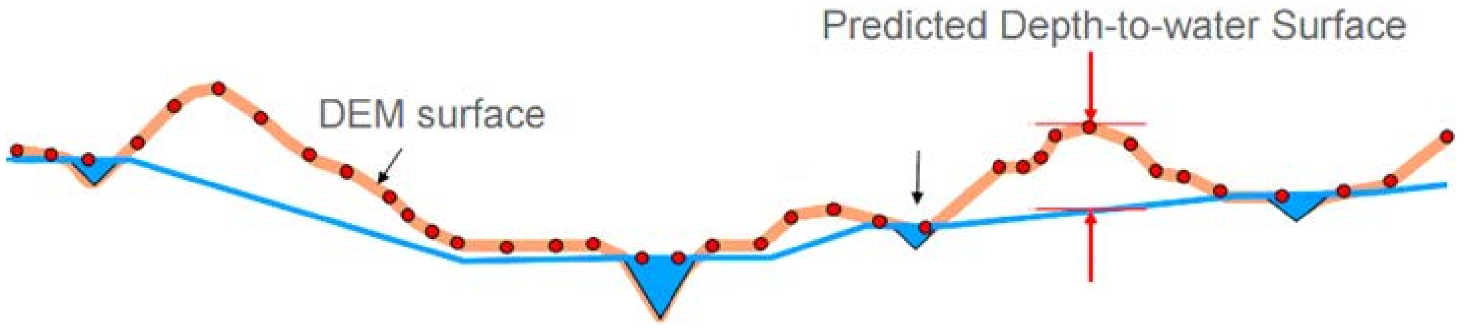


Image courtesy of Mercer

LiDAR-derived depth-to-water (DTW)

- **High accuracy, fine resolution spatial information**
  - **LiDAR (1 m resolution)**
  - **DEM**

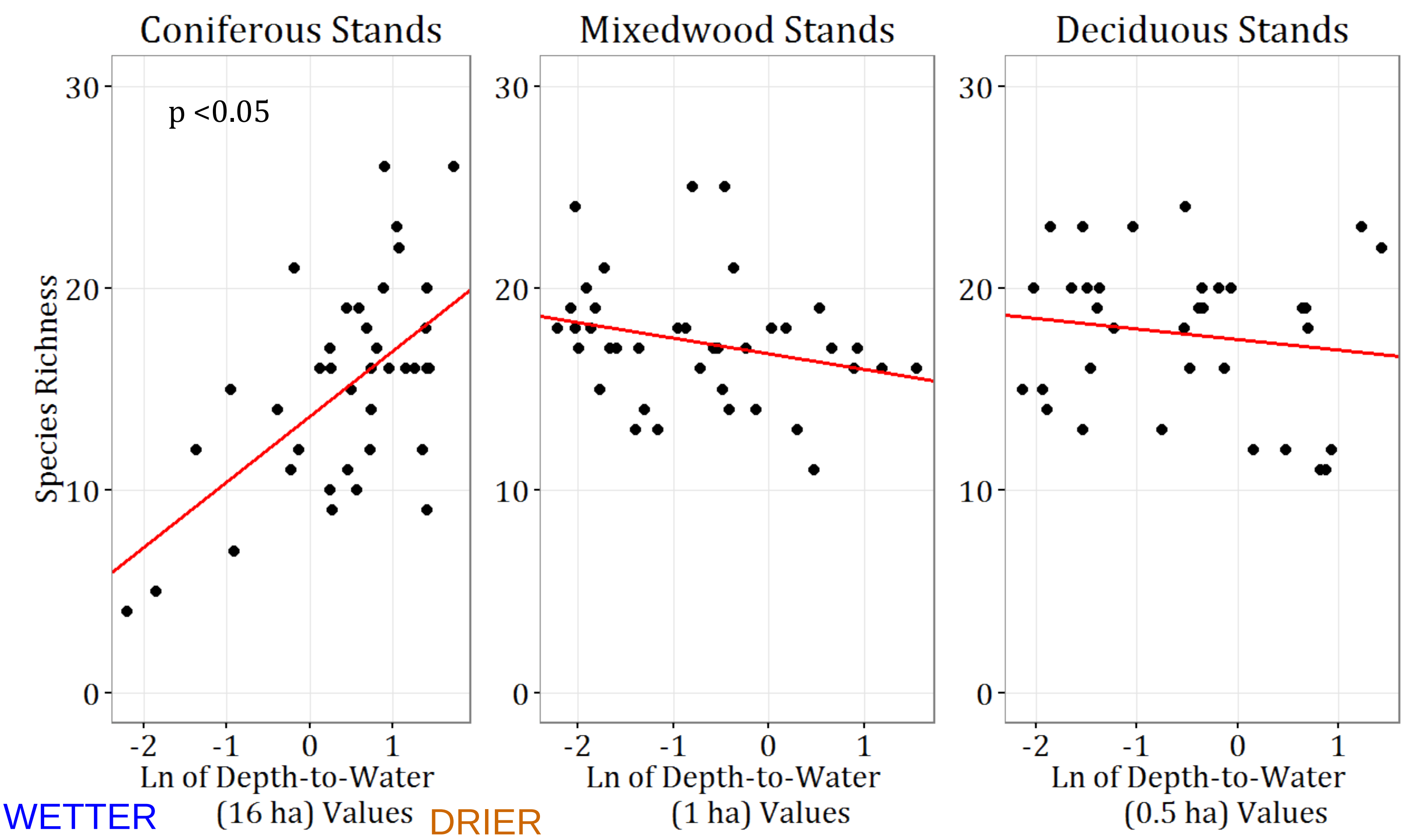


- **Depth-to-water (DTW) index**
  - **wet, moist, and dry spots**
  - **soil drainage (very poor to excessively well-drained)**
  - **vegetation type (xeric to hydric)**

Murphy et al. (2008)

Plant: cover, richness, composition varied with site wetness

Vascular richness

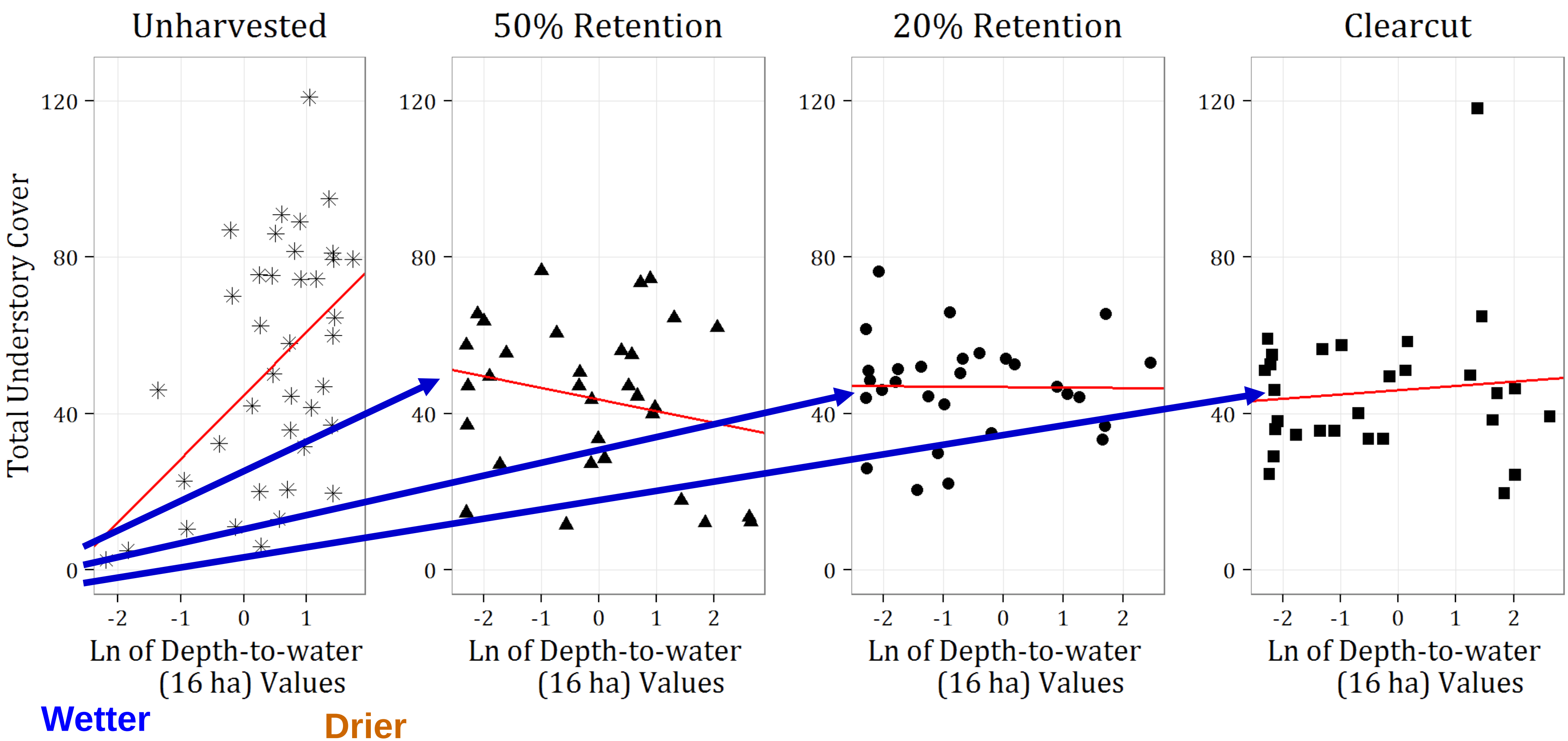


Bartels et al. 2018. FrontPlantSci doi: 10.3389/fpls.2018.00858

Echiverri & Macdonald. 2019. ForEcolMgmt 447: 35-52

Plants: retention harvesting changed relationships with site wetness

Conifer forest, Vascular cover: wet sites more sensitive

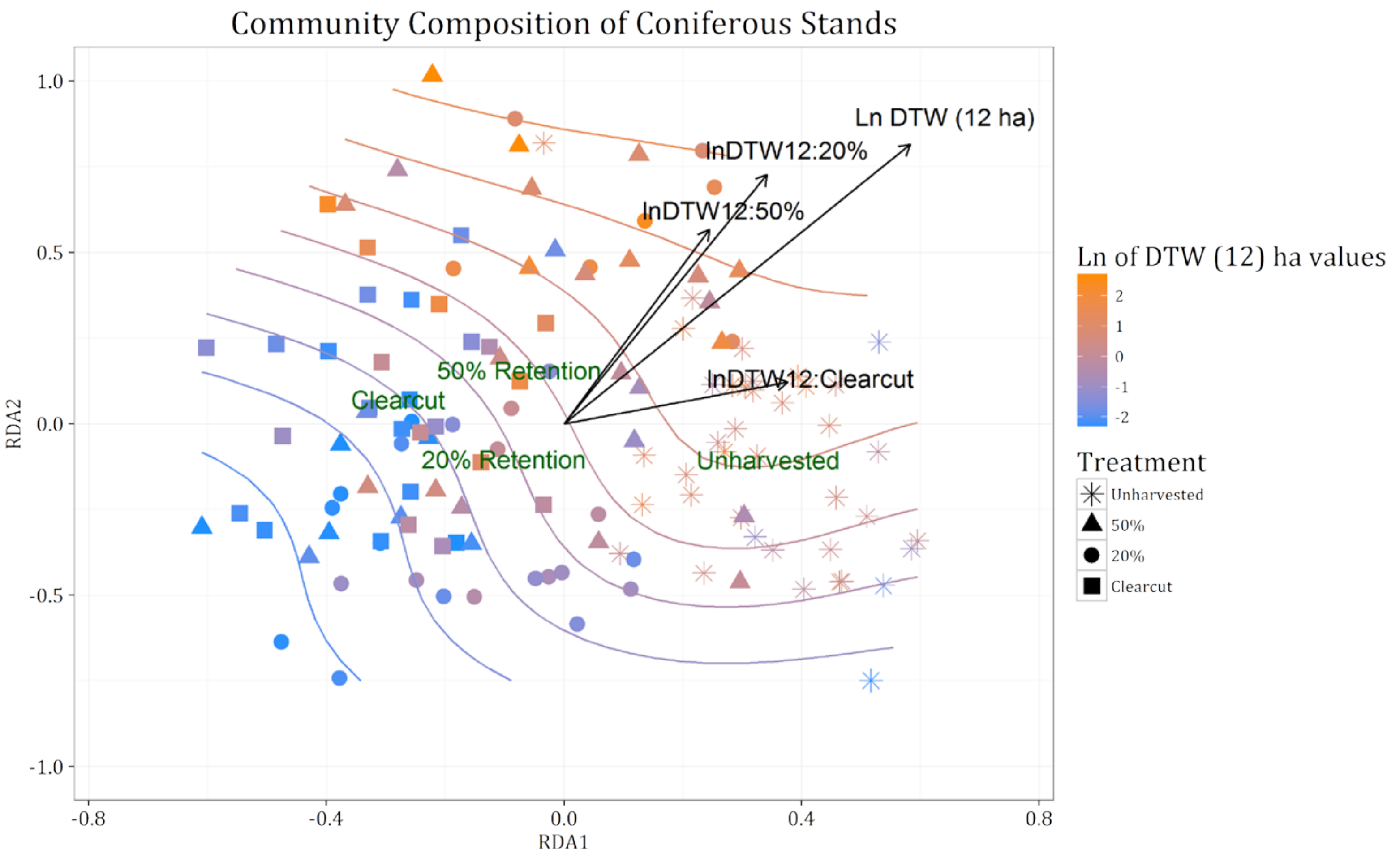


Bartels et al. 2019. JApplEcol 56: 1256

Echiverri & Macdonald. 2020. ForEcolMgmt 474: 118358

Plants: retention harvesting changes relationships with site wetness

Conifer forest, Vascular plants: lower retention, stronger effects



Bartels et al. 2019. JApplEcol 56: 1256
Echiverri & Macdonald. 2020. ForEcolMgmt 474: 118358

Use of wet areas mapping: conclusions

Depth-to-water can be used to inform placement of retention

Conifer & mixedwood forests: wetter sites more sensitive
Deciduous forests: drier sites more sensitive

Leave more retention:
Conifer & mixedwoods: wetter sites
Deciduous forests: drier sites

Conifer forests particularly sensitive to harvesting
Mixedwood forests most resilient

Use of a conservation planning tool to plan retention

Bartels et al. 2019. JApplEcol 56: 1256
Echiverri & Macdonald. 2020. ForEcolMgmt 474: 118358
Robinne et al. 2020. FrontEcolEvol doi: 10.3389/fevo.2020.584291

Overall Conclusions

- Retention can help maintain/recovery biodiversity
- No clear ‘threshold’ of retention
- Combining dispersed and aggregated retention likely more effective
- Responses varied among biotic groups and forest types
- Longer-term responses drive by forest regeneration and succession
- Tools for more effective placement of retention
- Landscape heterogeneity

With effective collaboration and communication we can use science to inform sustainable forest management

Images courtesy of Mercer


Field assistants!
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Questions?