Release from Natural Enemies Belowground Helps Explains the Invasiveness of *Lygodium microphyllum* in Florida: A Cross-continental Comparison…among other things

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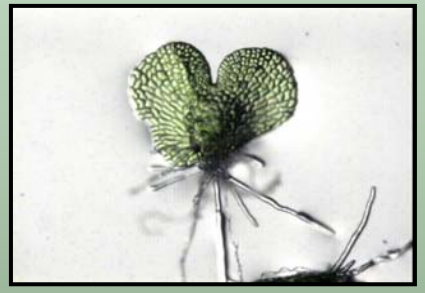
- **Eric Kruger, Valeria Volin, Michael Lott, Sonia Gandiaga, Dianne Owen, Michael Tobin, Kaoru Kitajima, Tony Wright, Matt Purcell, Liz Aitken, and many others…**

Lygodium microphyllum

Old World Climbing Fern

A Journey to Understand an Alien Plant

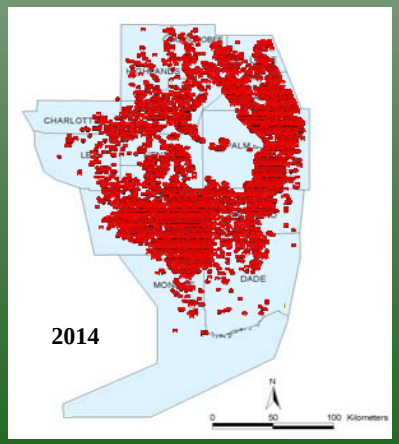
1. Reproductive Biology



2. Whole Plant Growth - Under varying light and hydrological conditions

3. Community Ecology

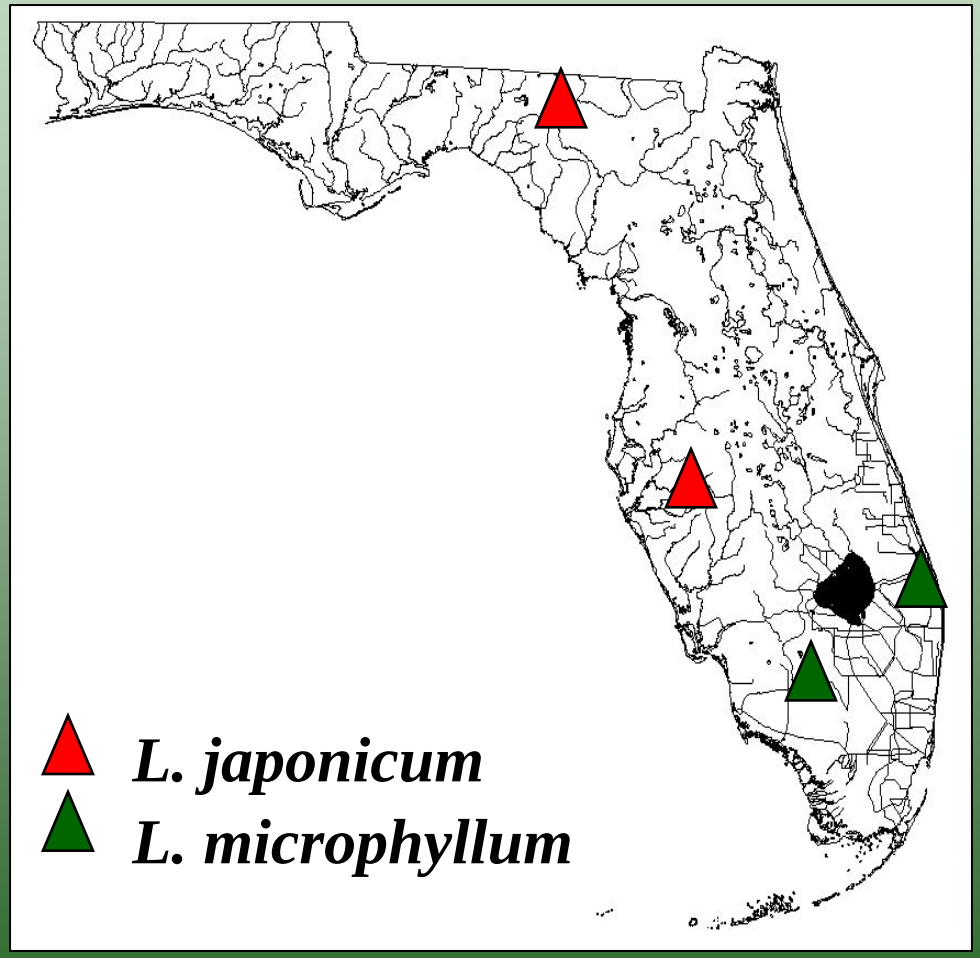
4. Landscape Ecology



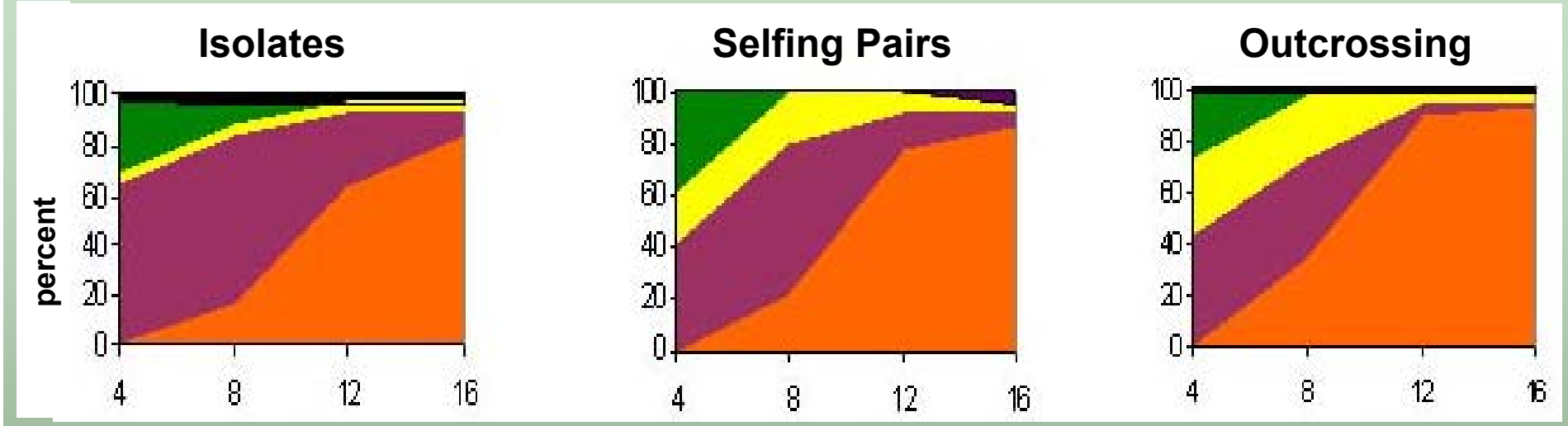
5. Lygodium in its native Australia

1. Reproductive Biology

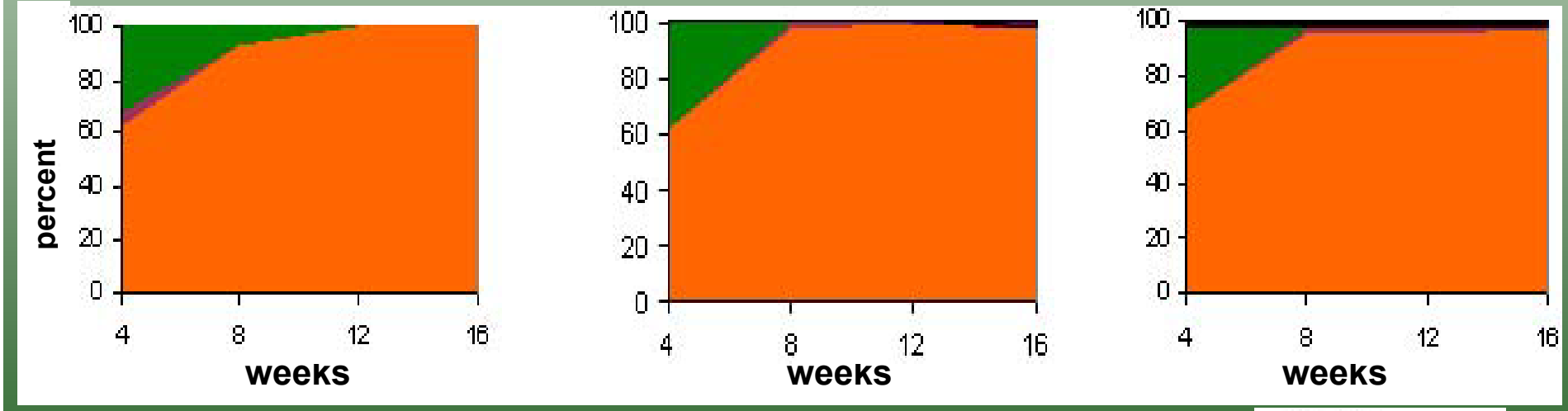
Spore Collection Sites



Lygodium microphyllum
Gametophyte (14 days)



Lygodium microphyllum



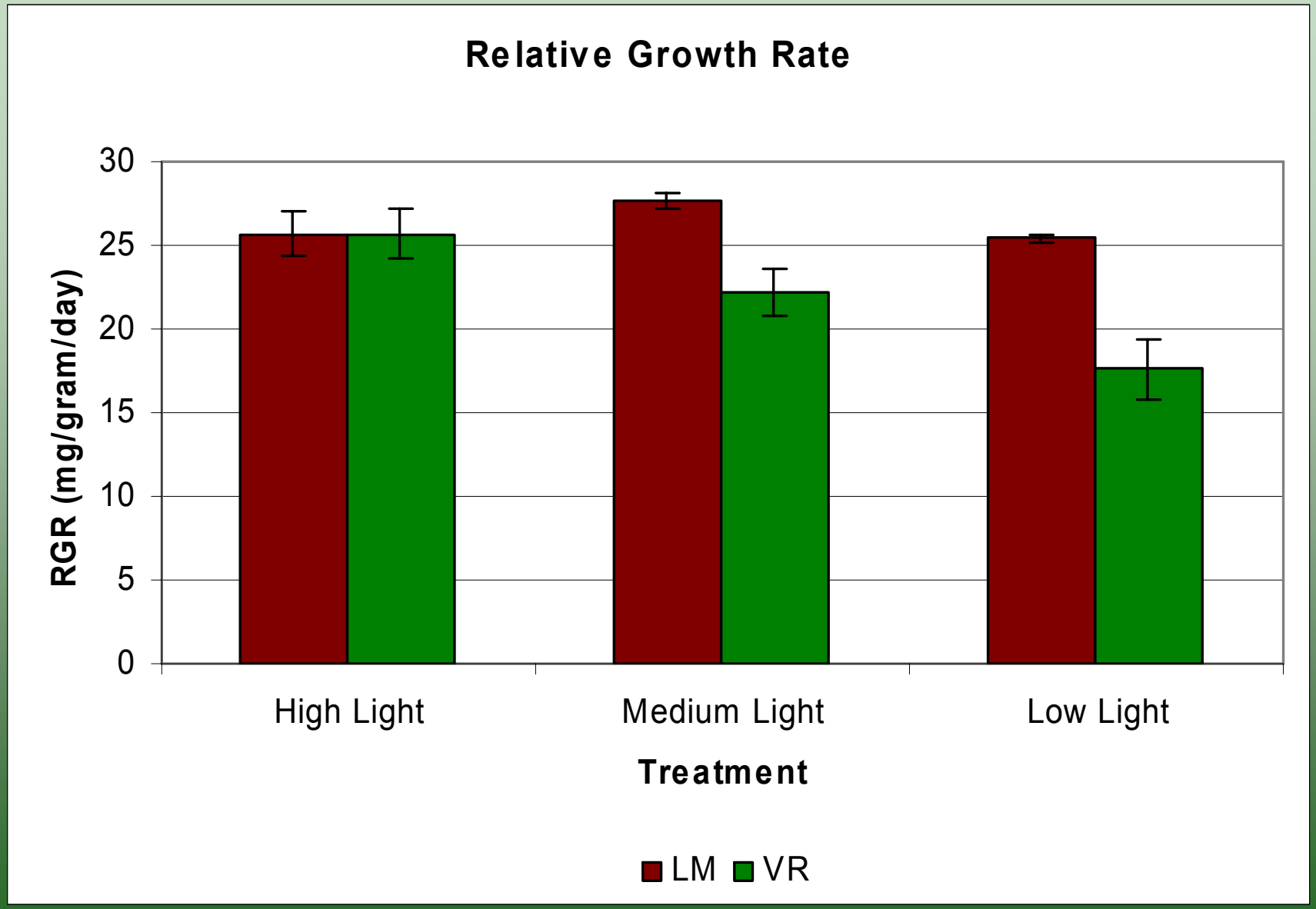
Lygodium japonicum

Lott *et al.* 2003

2. Whole Plant Growth - Under varying light and hydrological conditions

Shade Enclosures

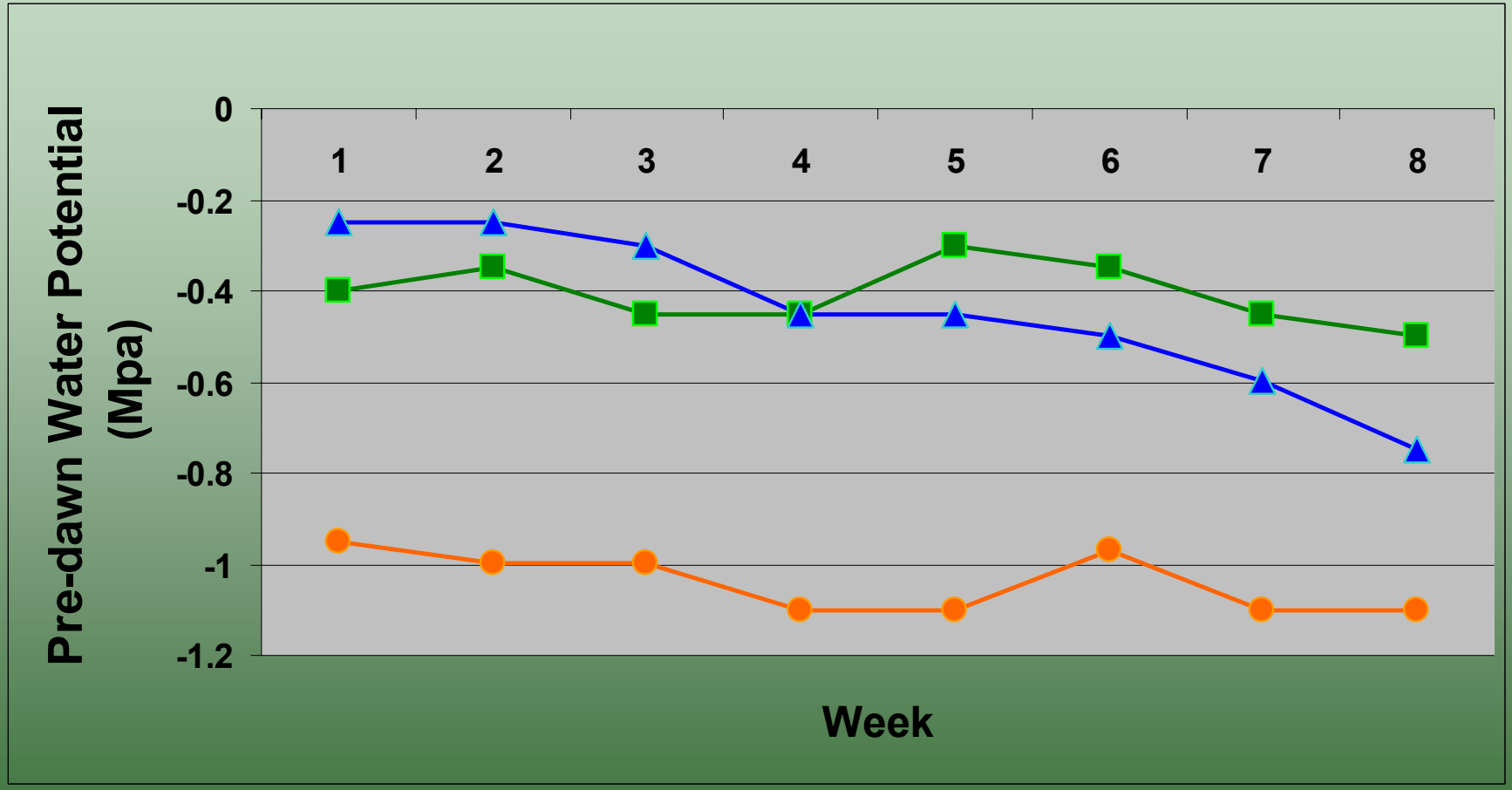
Six month old sporelings


Relative Growth Rate
RGR (mg/gram/day)
30
25
20
15
10
5
0
High Light
Medium Light
Low Light
Treatment
LM
VR

Hydrology Study Hypotheses

	DROUGHT	FIELD CAPACITY	FLOOD
CONTROL	LOW	HIGH	MEDIUM
GA	MEDIUM	HIGHEST	HIGH
PACLO	LOW	MEDIUM	LOW

Hydrological Treatments

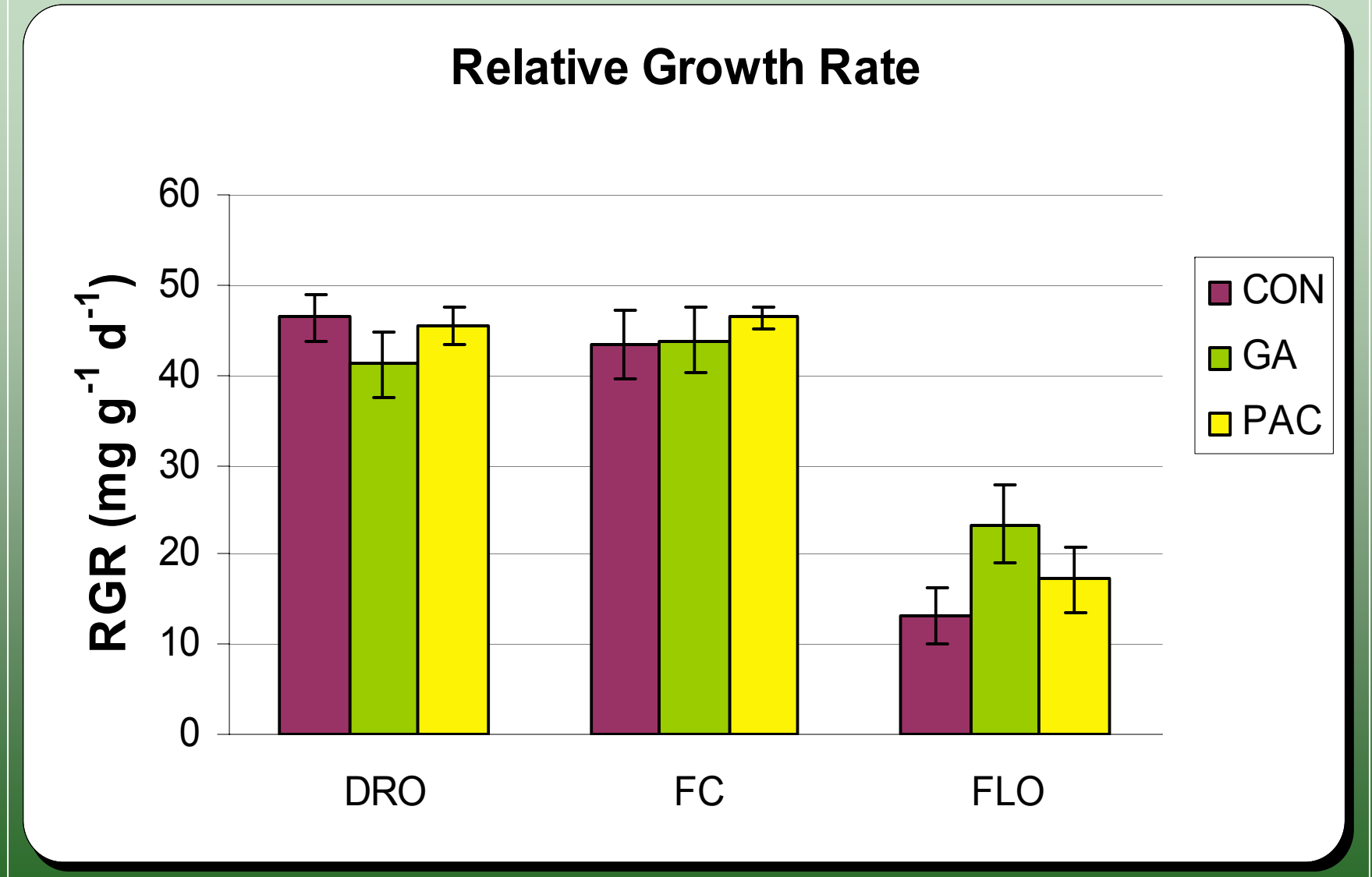


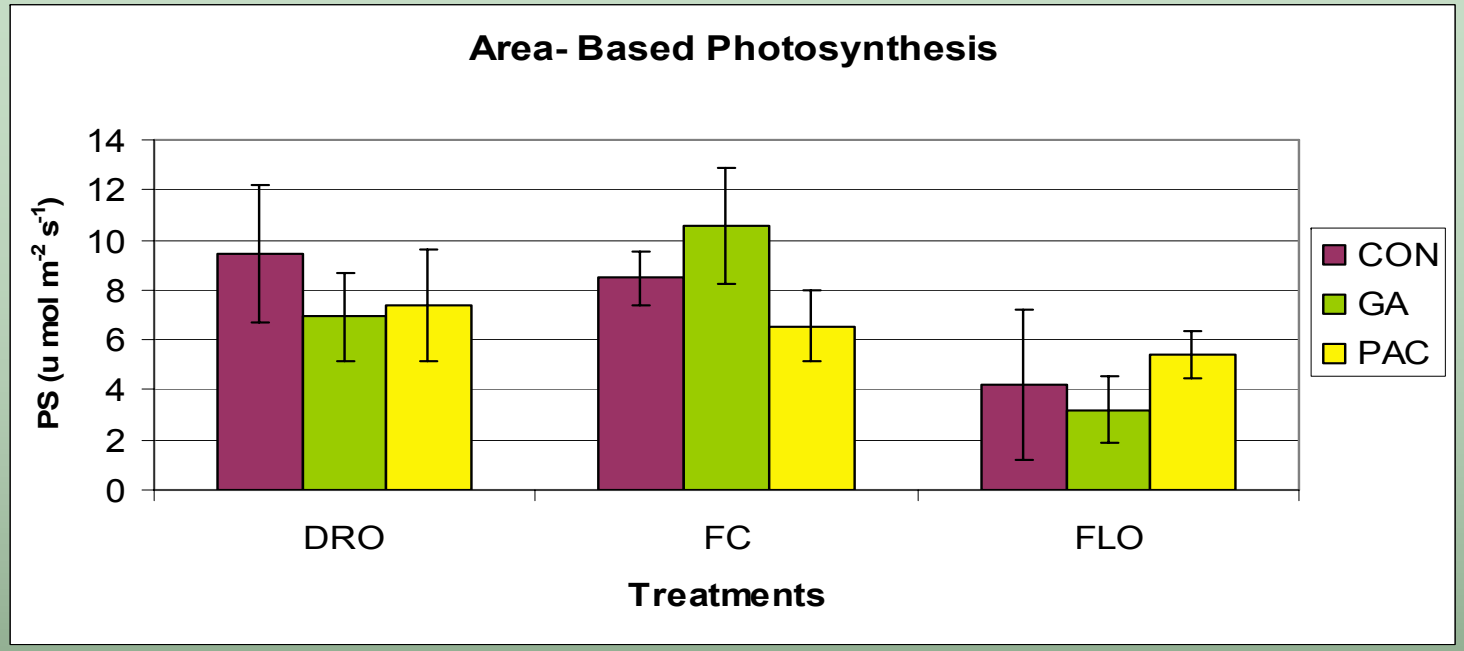
Mean Ψ at watering day (App. Day 7)

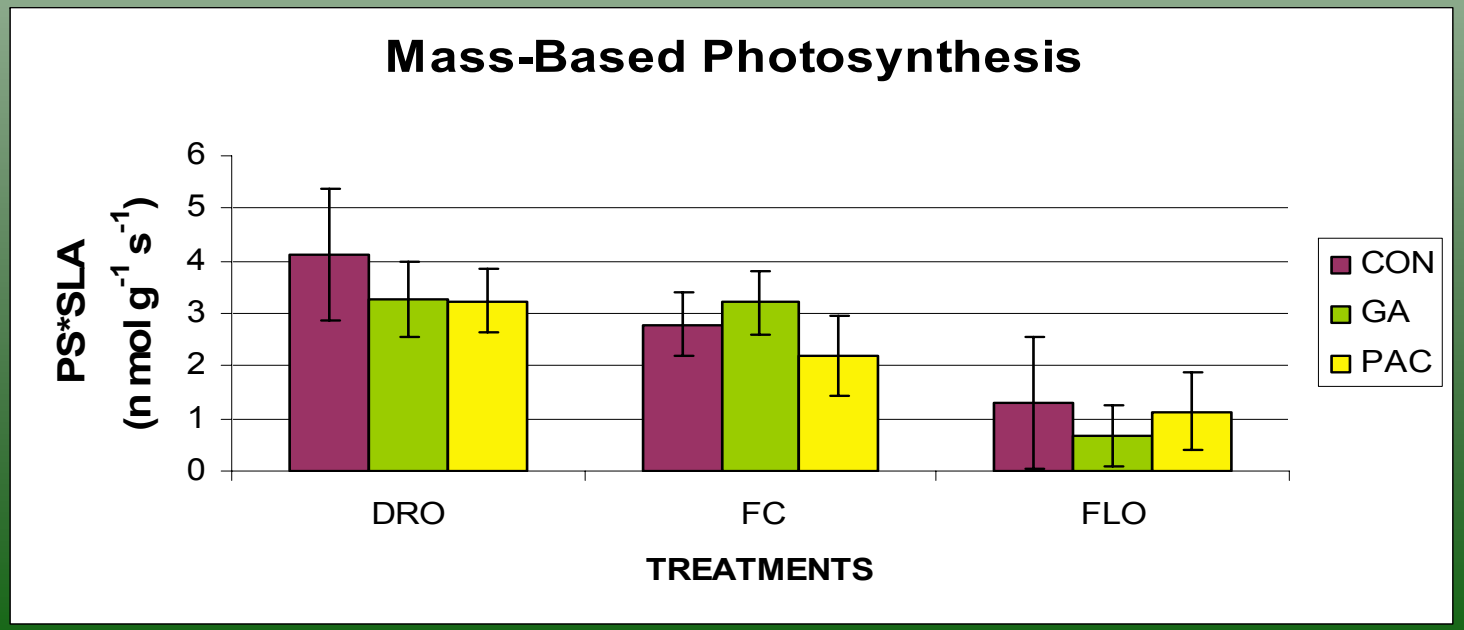
Flood
Field Capacity
Drought

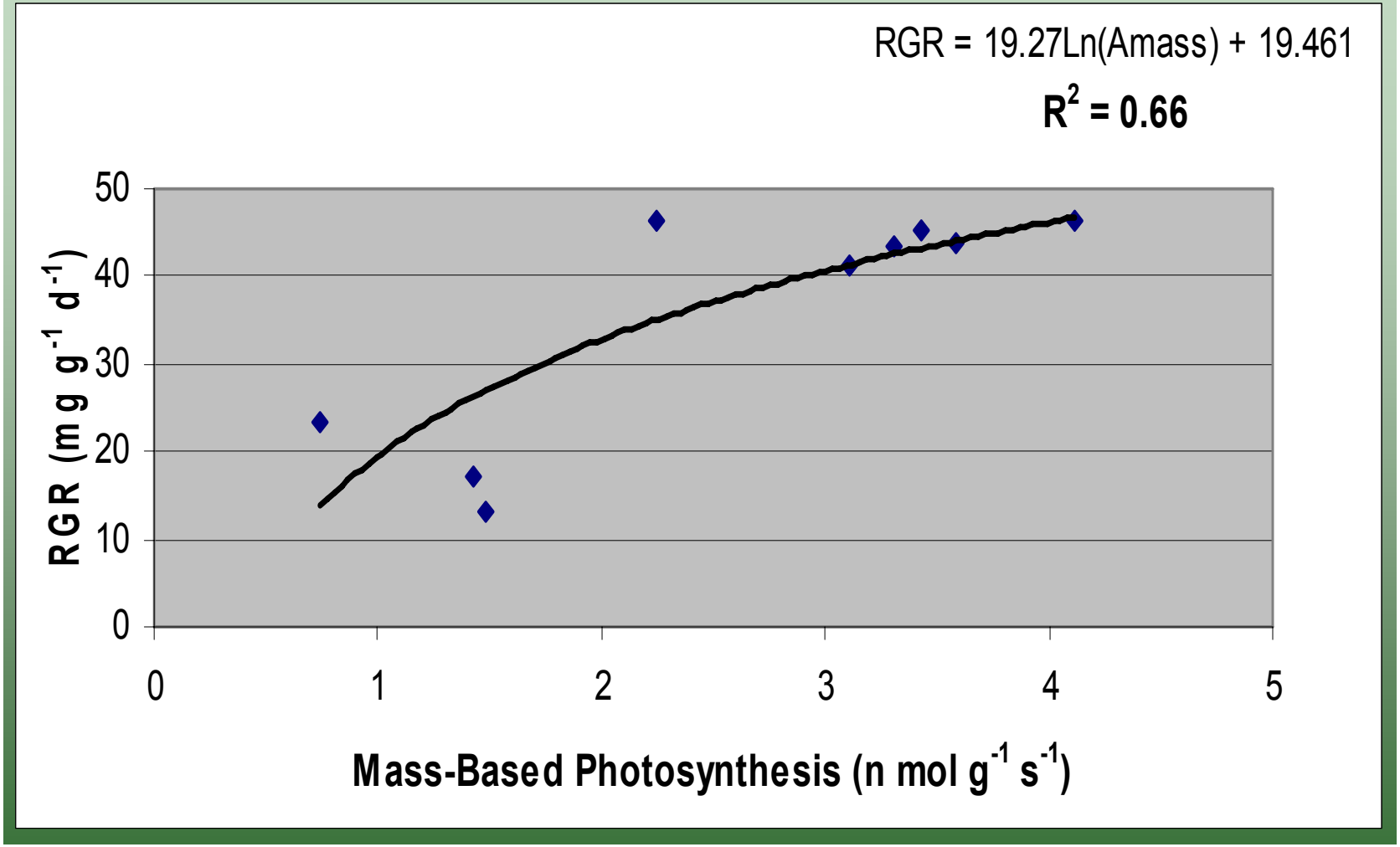

Day 15
EXIT


Day 62


Relative Growth Rate
RGR (mg g-1 d-1)
60
50
40
30
20
10
0
DRO
FC
FLO
CON
GA
PAC


Area- Based Photosynthesis
PS (u mol m-2 s-1)
14
12
10
8
6
4
2
0
DRO
FC
FLO
Treatments
CON
GA
PAC

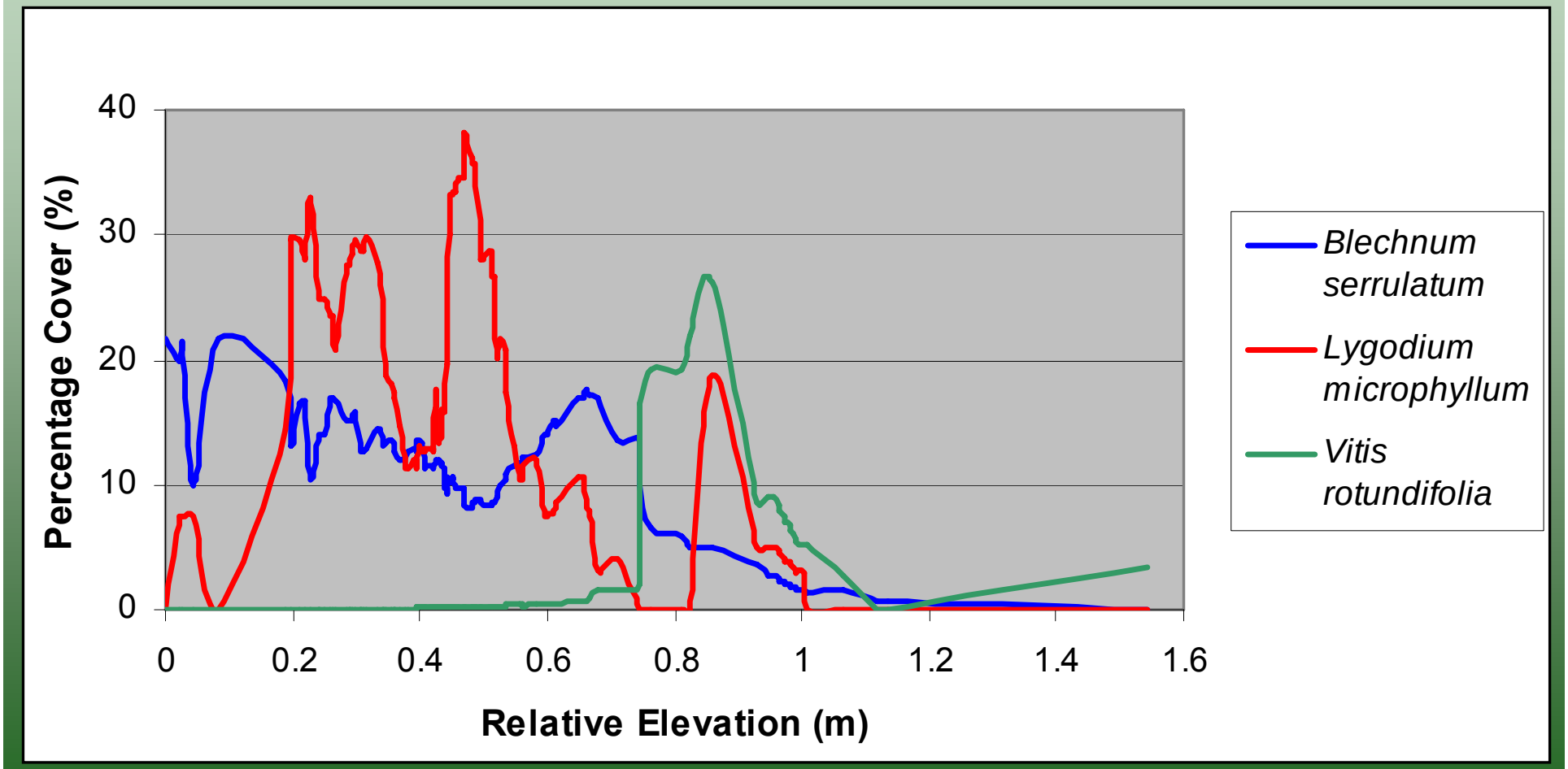

Mass-Based Photosynthesis
PS*SLA
(n mol g-1 s-1)
6
5
4
3
2
1
0
DRO
FC
FLO
TREATMENTS
CON
GA
PAC


RGR = 19.27Ln(Amass) + 19.461
R2 = 0.66
RGR (m g g-1 d-1)
50
40
30
20
10
0
0
1
2
3
4
5
Mass-Based Photosynthesis (n mol g-1 s-1)

3. Community Ecology

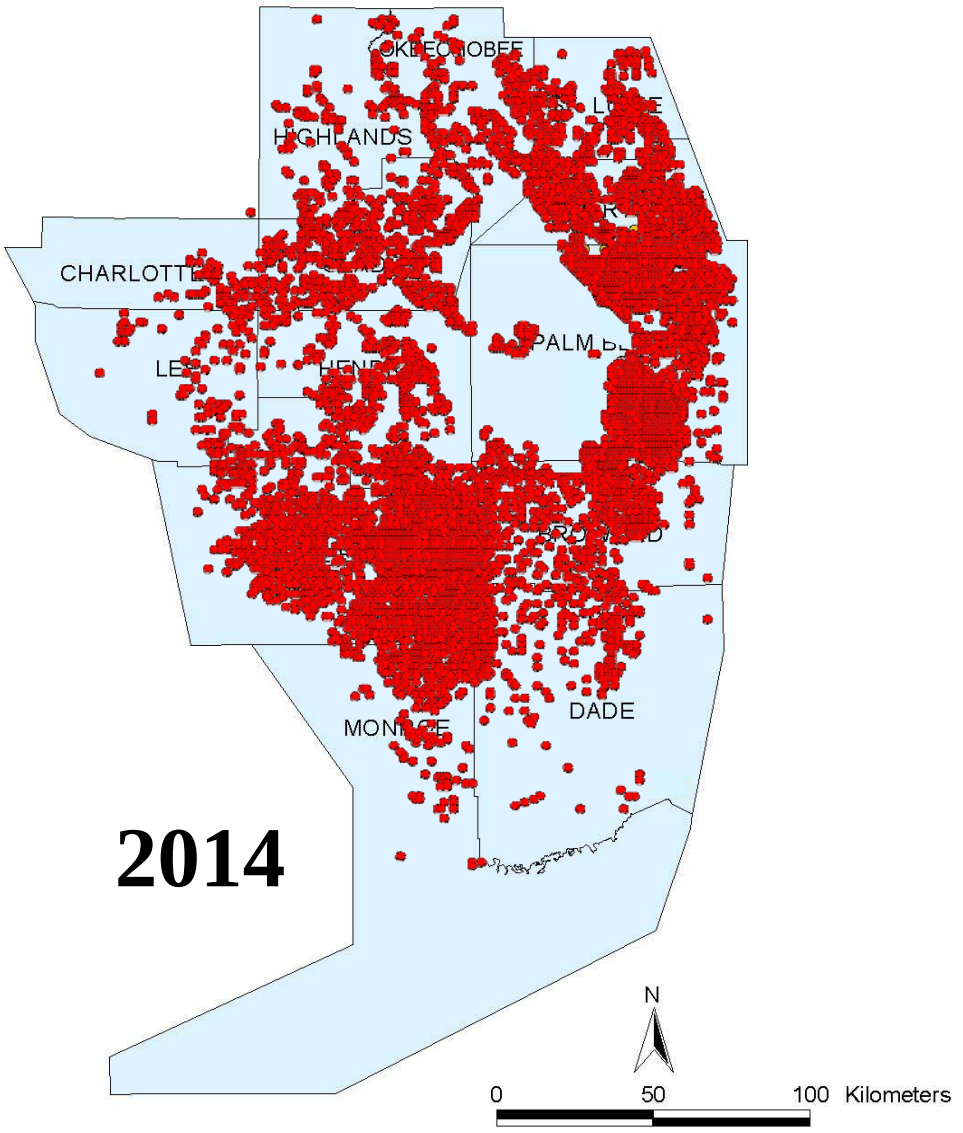
Distribution Along Environmental Gradients

Distribution along elevation gradient



Volin *et al.* 2004

4. Landscape Ecology



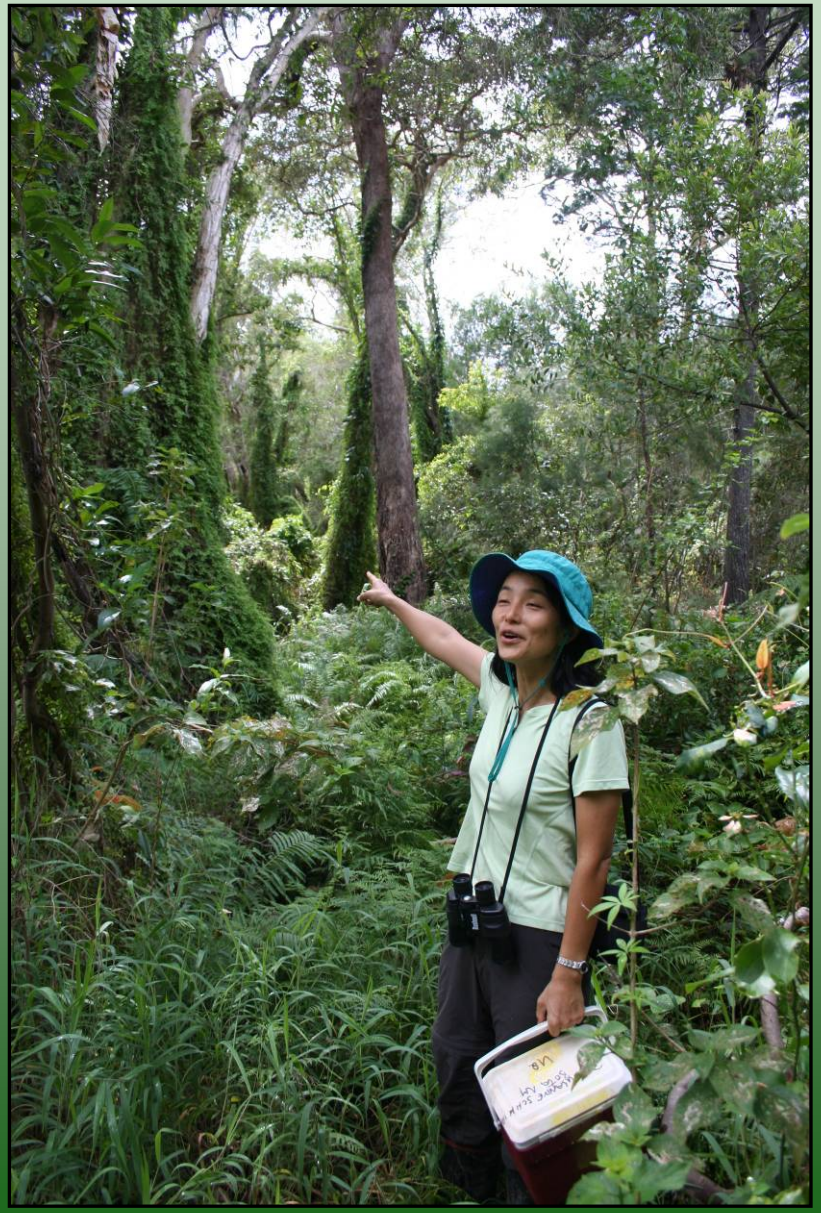
Invasive spread of *Lygodium microphyllum* in southern Florida

Volin *et al.* 2004

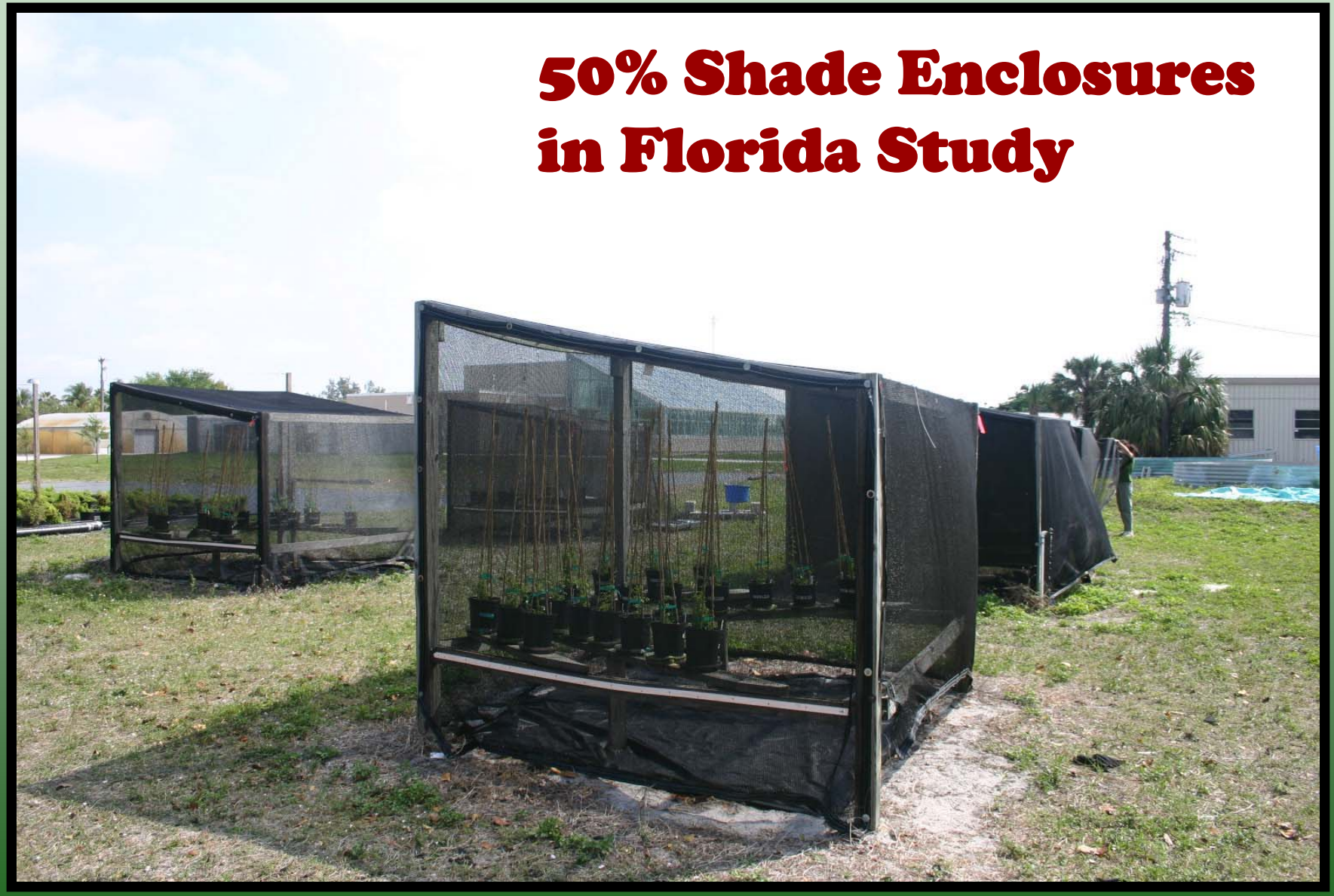
L. microphyllum in a Florida cypress swamp

5. Lygodium microphyllum in its native Australia

Queensland Australia

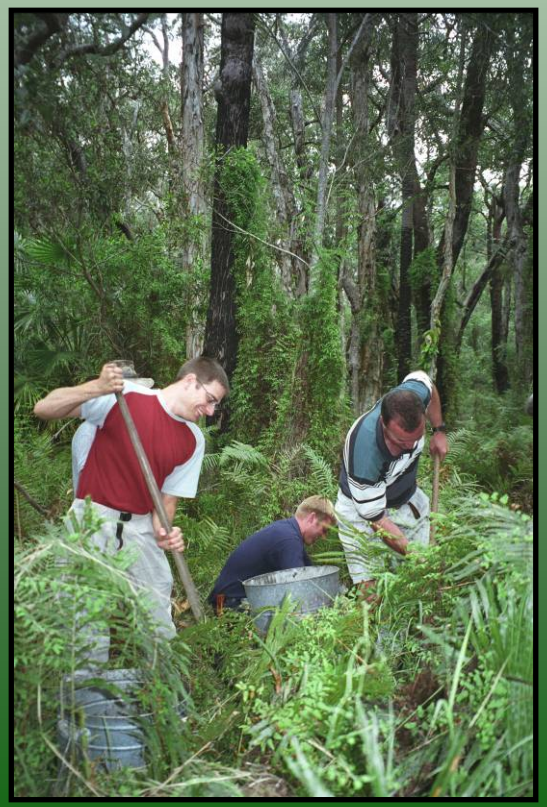


50% Shade Enclosures in Florida Study



Transplanting sporelings for Australia Study

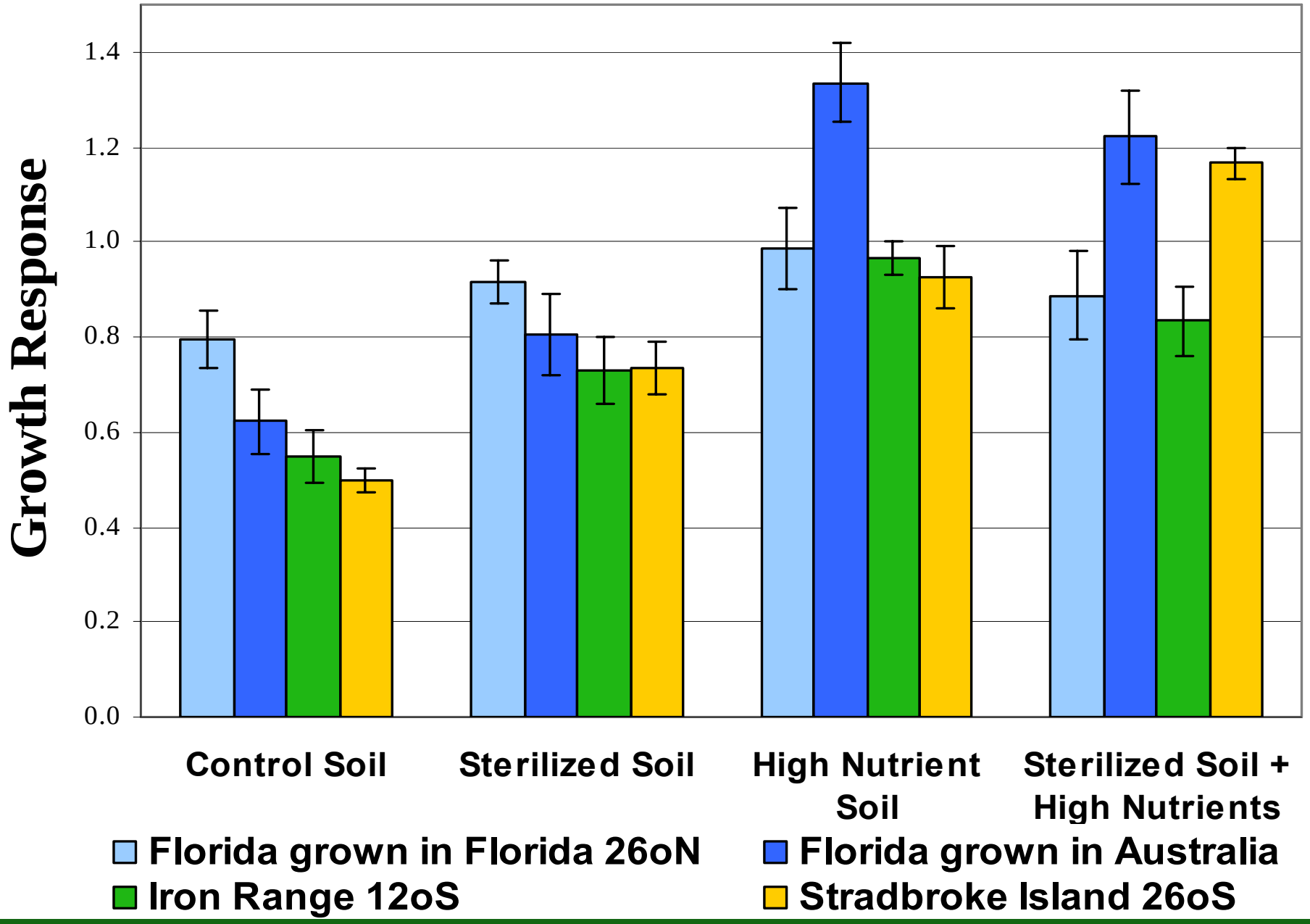
Soil Collection and Sterilization



50% Shade Enclosure in Australia

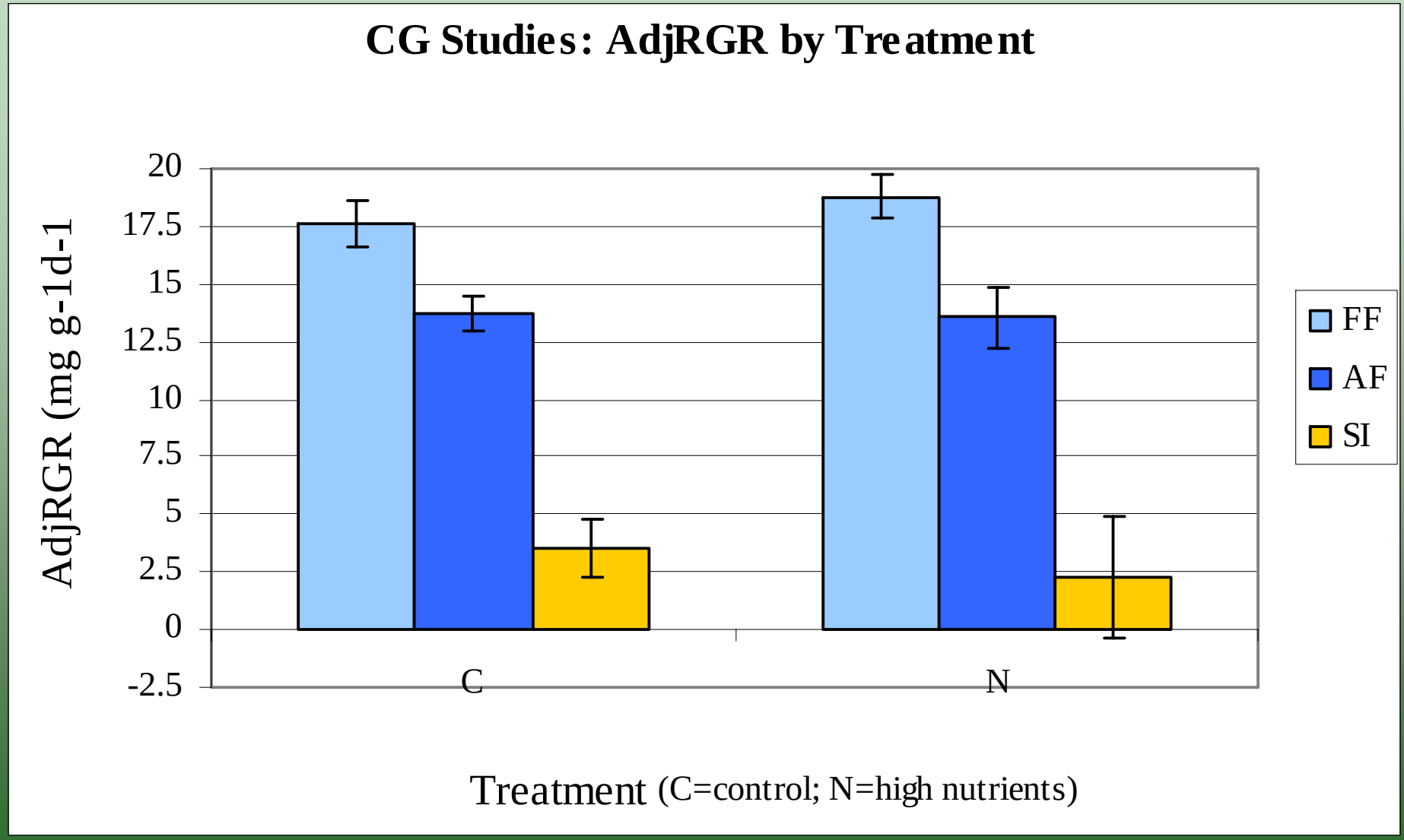
Harvesting Control Study

Growth in Florida versus Australia



Planting Common Garden Study

Planting Common Garden Study


CG Studies: AdjRGR by Treatment
AdjRGR (mg g-1d-1
20
17.5
15
12.5
10
7.5
5
2.5
0
-2.5
C
N
FF
AF
SI
Treatment (C=control; N=high nutrients)

Summary

• Lygodium microphyllum poses several life history strategies that makes it a particularly nasty invasive species

- Reproduction - all three mating strategies, year round production of billions of spores at each location, and capable of reproduction in 6-8 months after spore germination;

- Whole-plant growth - capable of growing (the same rate!) in low to high light levels, as a result of its optimal allocation to stem tissues, capable of growing in dry to continuously flooded conditions, as a result of its mass-based photosynthesis;

Summary Con't

- Release from natural enemies, and likely from key below-ground enemies, facilitates unabated growth in its introduced environment;

- Traits above (i.e., reproduction, continuous growth under varying light and hydrological extremes and release from natural enemies) allow for its long distance spread, establishment and growth far from source populations.

Management/Policy Recommendations

- Flooding is not a viable control technique;

- *L. microphyllum* is a fire-adapted species in its native habitat, and so fire is likely not a viable control technique, and it may do more harm than good;

- Greater emphasis should be placed on identification of potential pathogenic biocontrol agents, especially those that attack below-ground tissues in *L. microphyllum's* native range, should be prioritized;

- Understory surveys of *L. microphyllum* along its invasion front in Florida should be a priority. In conjunction with this, a survey/sampling optimization model or protocol as well as a coordinated quick herbicide response with land management agencies should be developed.

Research Collaborators

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