Liana abundances rebound over a fourteen-year period in a subtropical secondary wet forest: Land-use legacies and hurricane recovery

J. Aaron Hogan' Sylvette Mallorquín*, Jess K Zimmerman*, Jill Thompson*^ & Nicholas Brokaw*

' International Center for Tropical Botany, Department of Biology, Florida International University. Miami, FL USA

* Department of Environmental Science, University of Puerto Rico - Rio Piedras. San Juan, Puerto Rico

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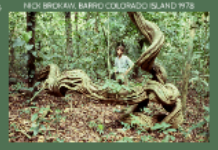

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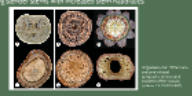

Lianas are important in diversity, structure and biomass in tropical forests.

e.g. Jon Rick: lianas comprise 70% of woody stems, 35% of woody species, 20% of forest leaf area, but <5% of woody biomass (Stefan Schnitzer)

Lianas have negative impacts on all aspects of tree demographics (decreased growth, fecundity, & net carbon accumulation)

In a liana removal experiment in Panama, tree growth increased by 30% (Schnitzer) www.lianaproject.org

Lianas are increase in Neotropical Forests

DL Phillips et al. (2002) Nature 418: 770-774

SJ Wright et al. (2004) Ecology 85(2): 484-489

Conclusions

In congruence with the Neotropical trend & over the 14-year period (2003 - 2015), lianas also have increased to a greater degree in the High Land-use portion of the LFDP (i.e. secondary forest).

Additionally, liana biomass continues to increase in the more-primary forest area of the LFDP where lianas were previously established.

Trends in recruitment dynamics mirrored demographic trends in the liana community.

Tree community-level variables over time, when compared to the liana community, reflect the effects of hurricanes on liana vs. trees.

Differences in demographic rates between the two halves of the LFDP are attributed to 1) land-use differences created by past land-use history, and the compounded recovery of the entire plot to the two hurricanes.

ACKNOWLEDGEMENTS

Sylvette Mallorquín & Nick Brokaw

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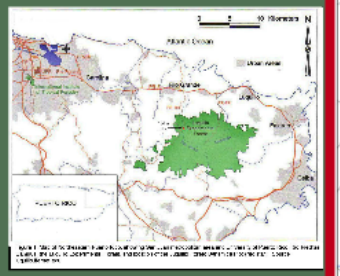
NSF 9021647 & 0613242



Study Site: The Luquillo Forest Dynamics Plot

El Verde, Puerto Rico

TWO HURRICANES
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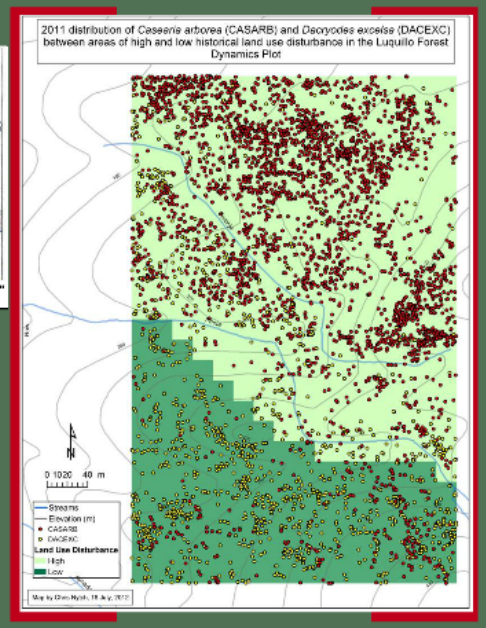

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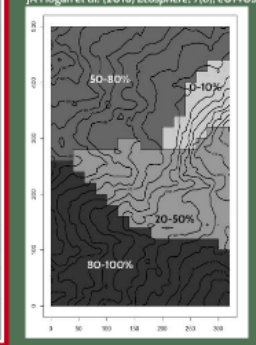


Lianas & Disturbance

Lianas increase following disturbance (e.g. hurricanes, canopy damage etc)

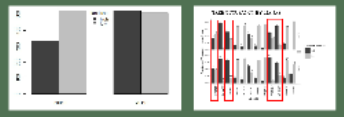
Allen et al. (2005) *Forest Ecology and Management* 218(1):351-367

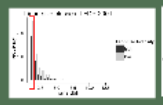
Lianas are greatest in secondary forests and increase in density toward forest edges.

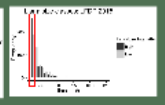
In 2015, we followed up on liana community demographic data from 2001 for a hurricane-affected forest in Puerto Rico, with past land-use legacies, to ask:

1. How has liana abundance, biomass, and reproductive effort change?
2. How has hurricane disturbance interacted with past land to affect liana abundances and reproduction?
3. Does this reflect the Neotropical trend?

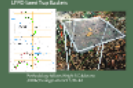
RESULTS







Census Methods



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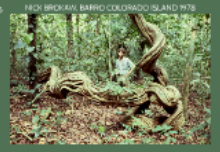

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In comparison with the Neotropical trend (Phillips et al. 2002, Wright et al. 2004) over the 14 year period 2003 – 2015, liana abundances increased to a greater degree in the high-land-use portion of the LFDP (i.e. secondary forest).

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Trends in size-class dynamics mirrored demographic trends in the liana community.

Tree community-level sustainable over time, when compared to the liana community (differential effects of hurricanes on liana vs. tree)

Differences in demographic processes in two habitats of the LFDP are evident in forest age (three eras created by land-use history) and the compound recovery of the entire plot to the two hurricanes.

ACKNOWLEDGEMENTS

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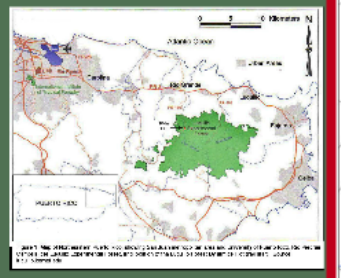
NSF 9509437 & 0212412



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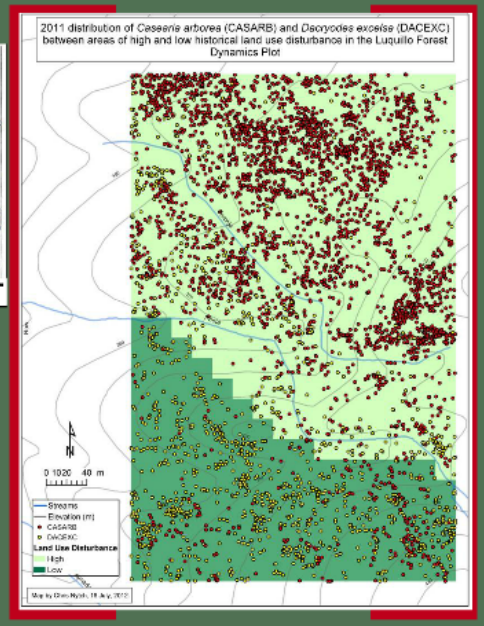

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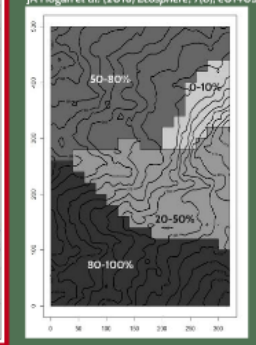

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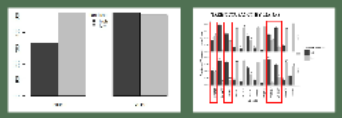

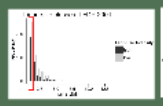

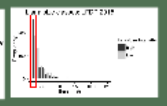

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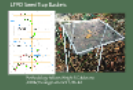

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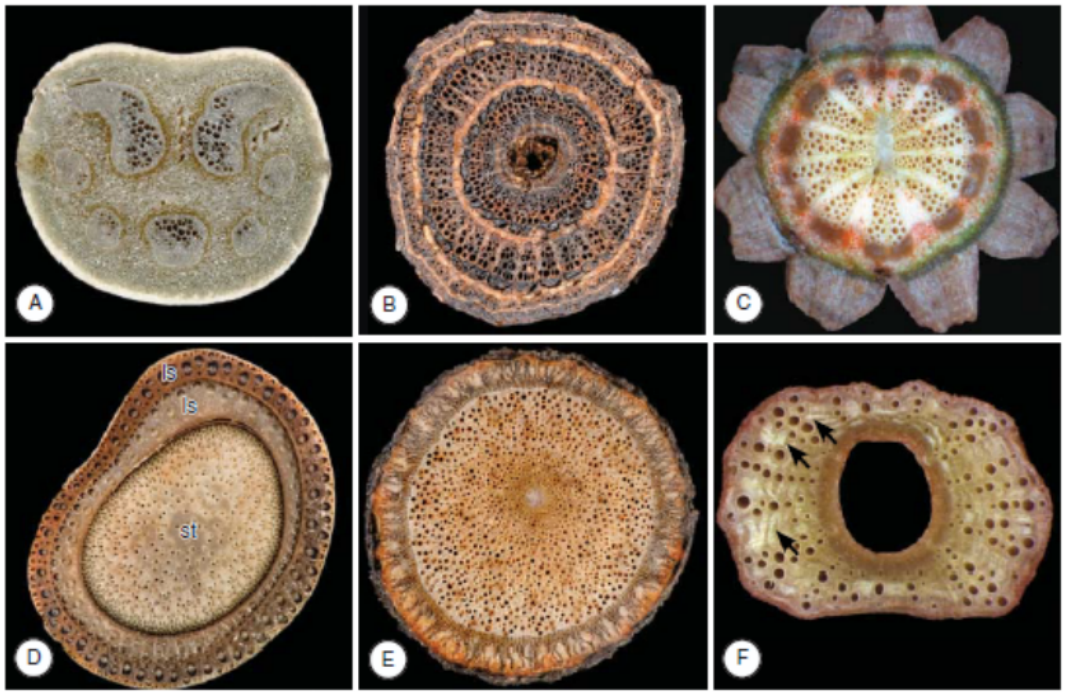

Angyalossy *et al.* (2015) Liana anatomy: a broad perspective on structural evolution of the vascular system. Ch. 19 (253-287)

Rourea surinamensis

Connaraceae

photos by:
Fabiola Areces

Marcgravia rectiflora

Marcgraviaceae

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Paullinia pinnata

Sapindaceae

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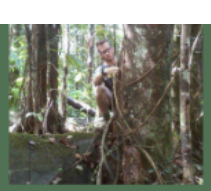

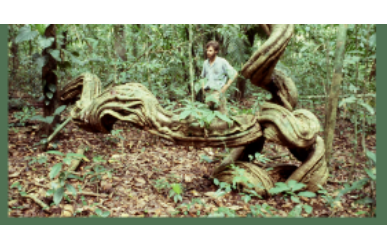

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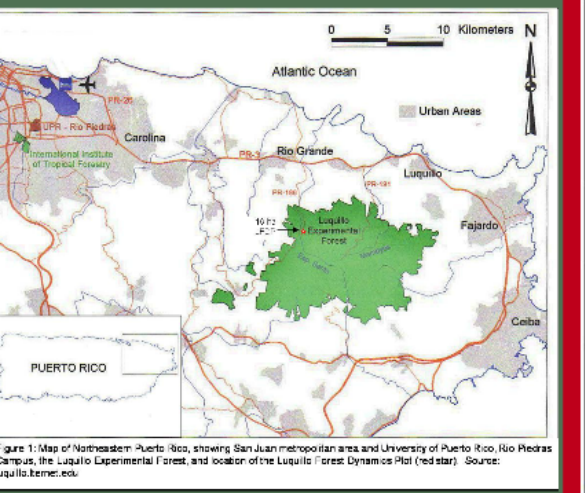

Figure 1: Map of Northeastern Puerto Rico, showing San Juan metropolitan area and University of Puerto Rico, Rio Piedras Campus, the Luquillo Experimental Forest, and location of the Luquillo Forest Dynamics Plot (red star). Source: luquillo.lternet.edu

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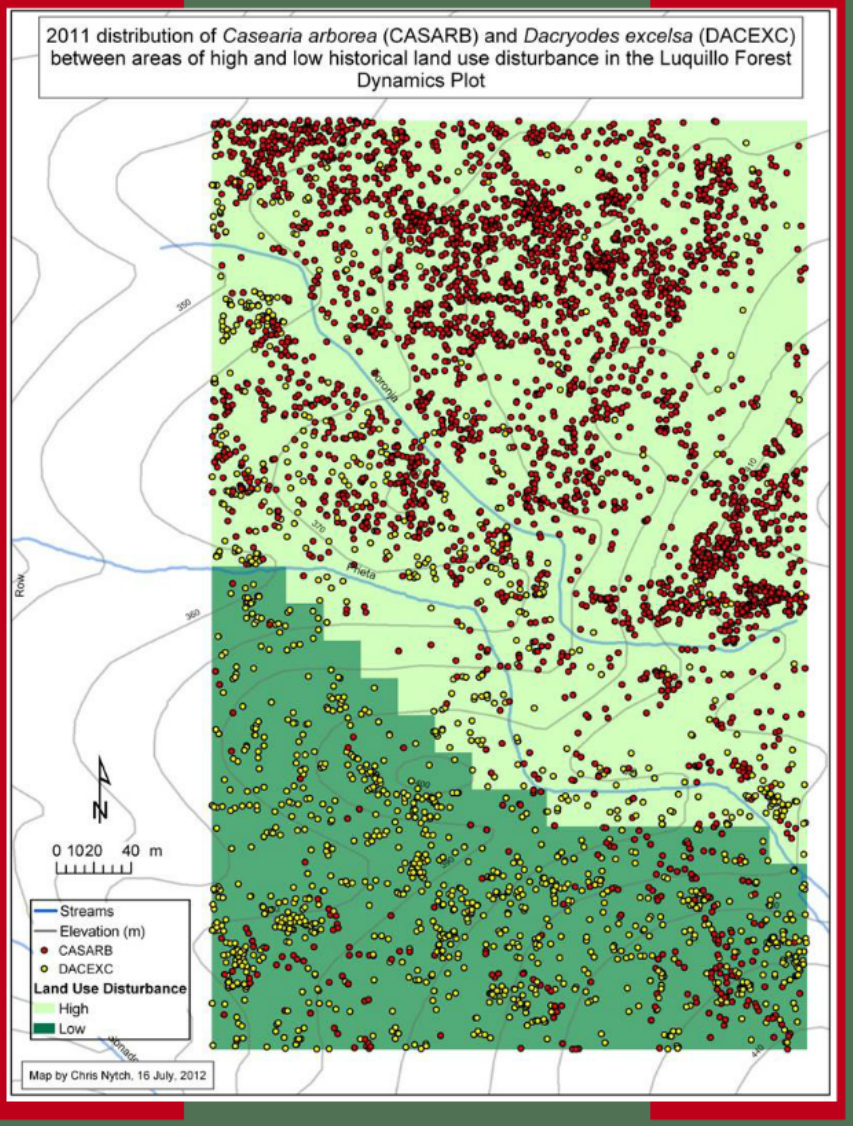

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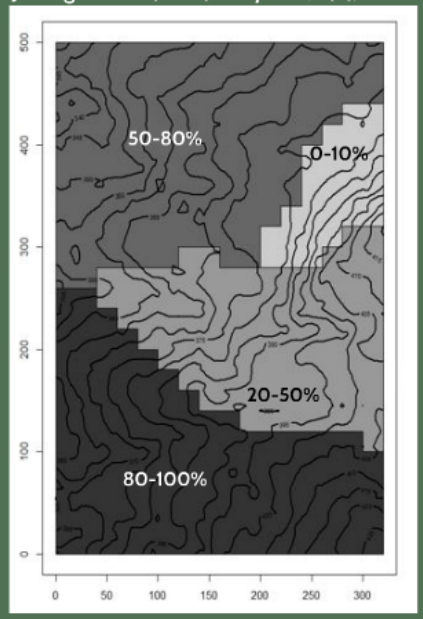

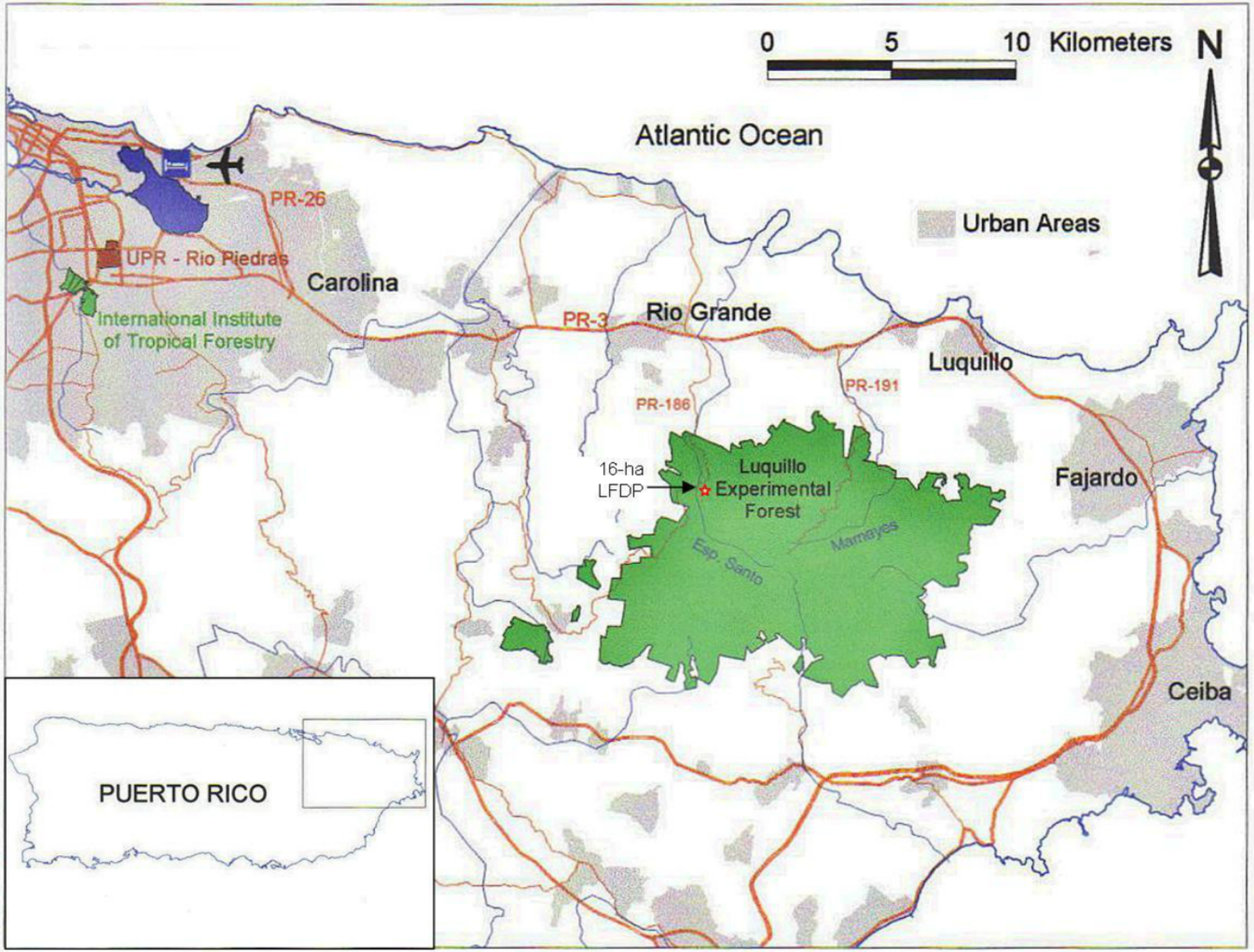

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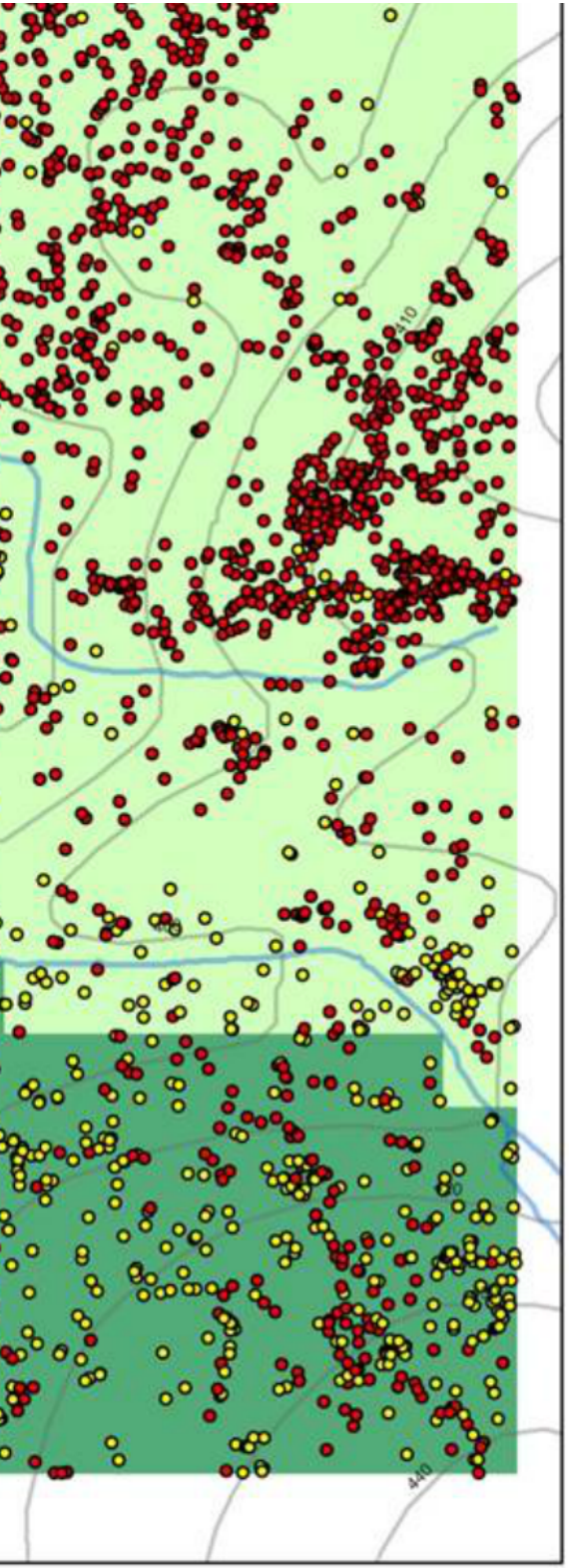

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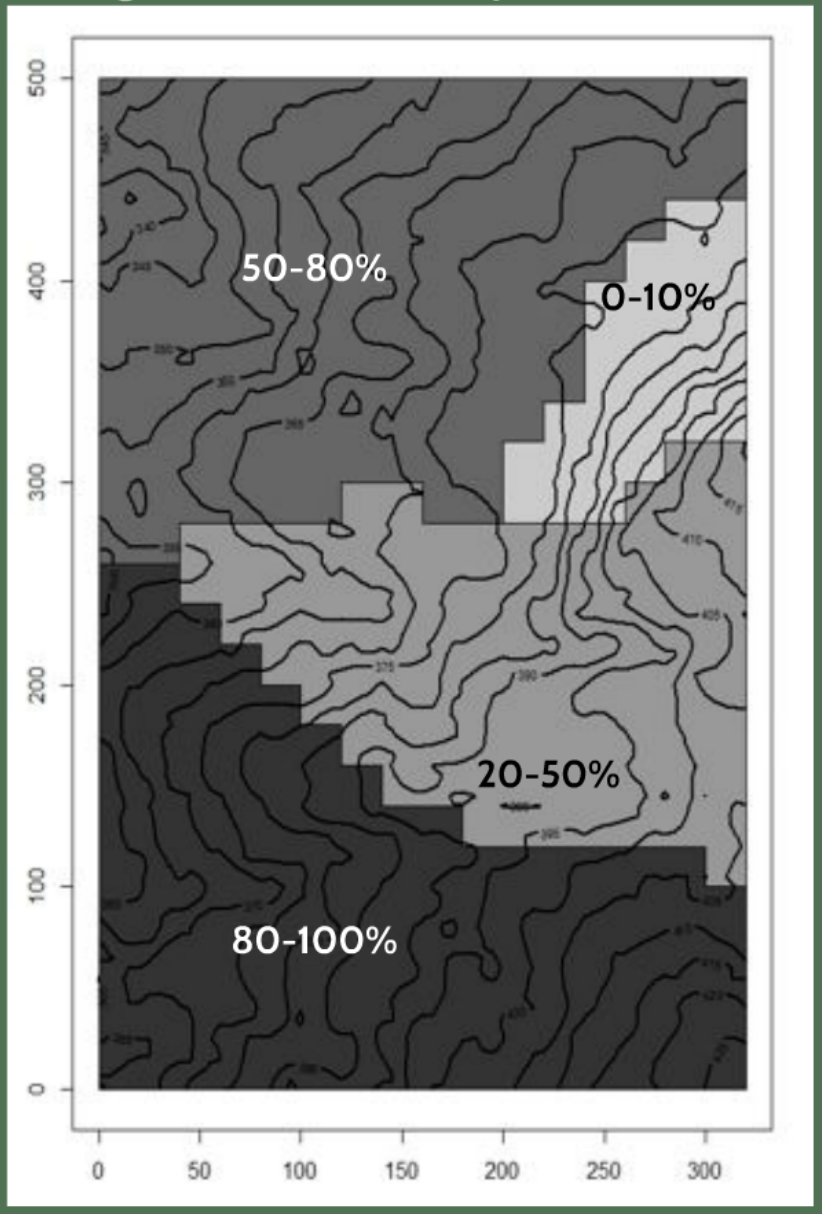

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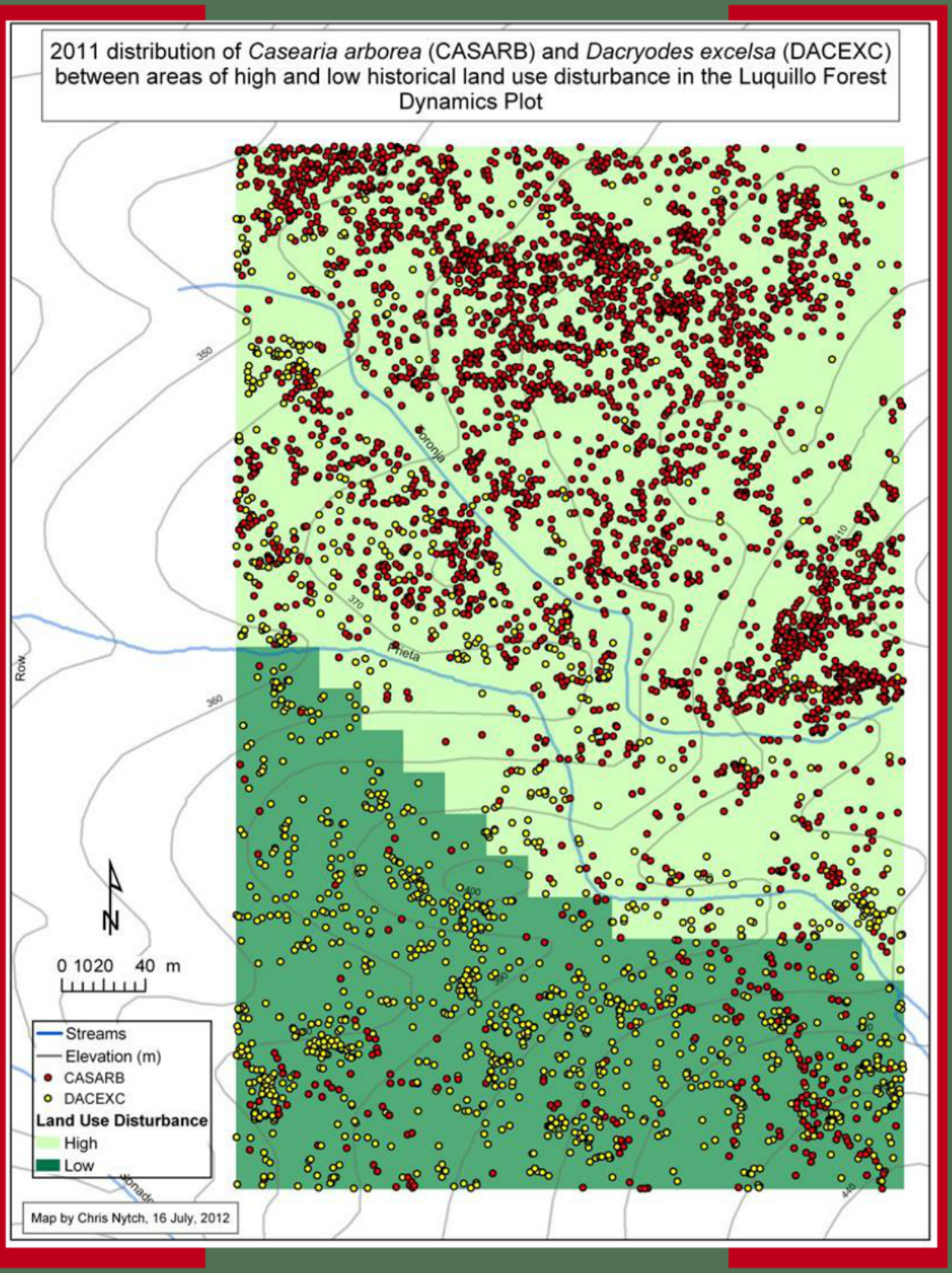

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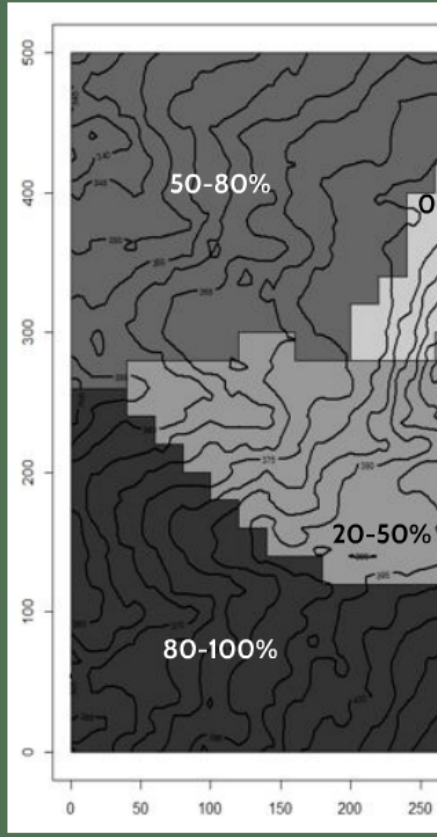
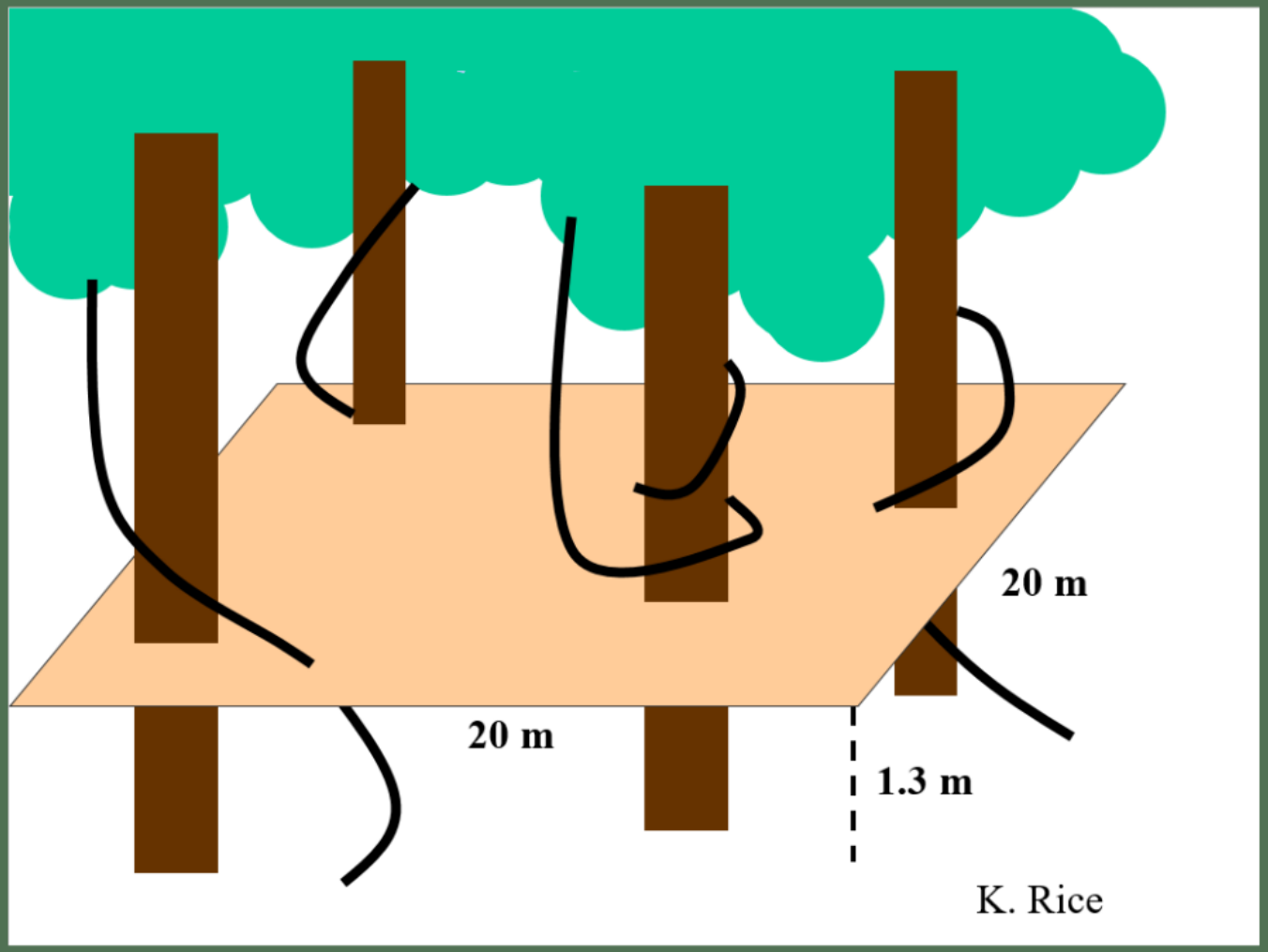


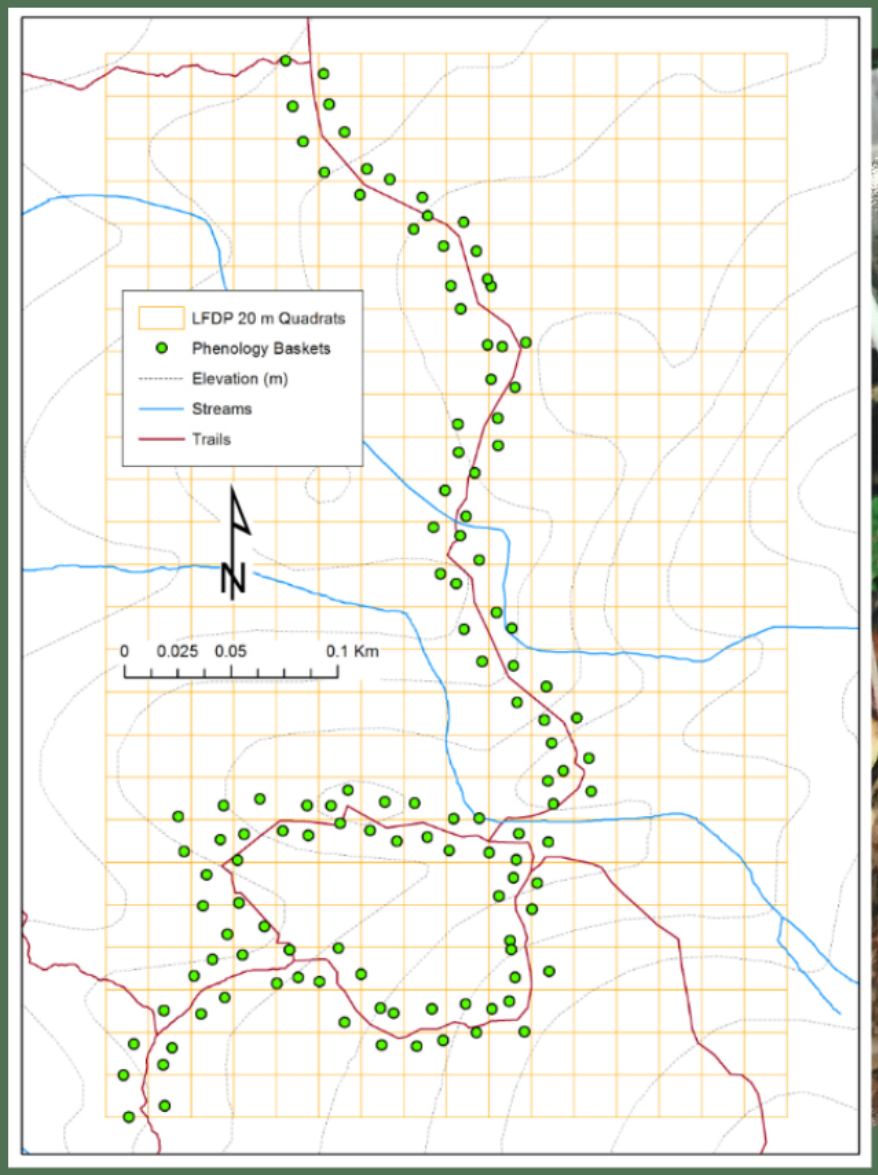
Census Methods

10 quadrats (20x20m) per land-use class

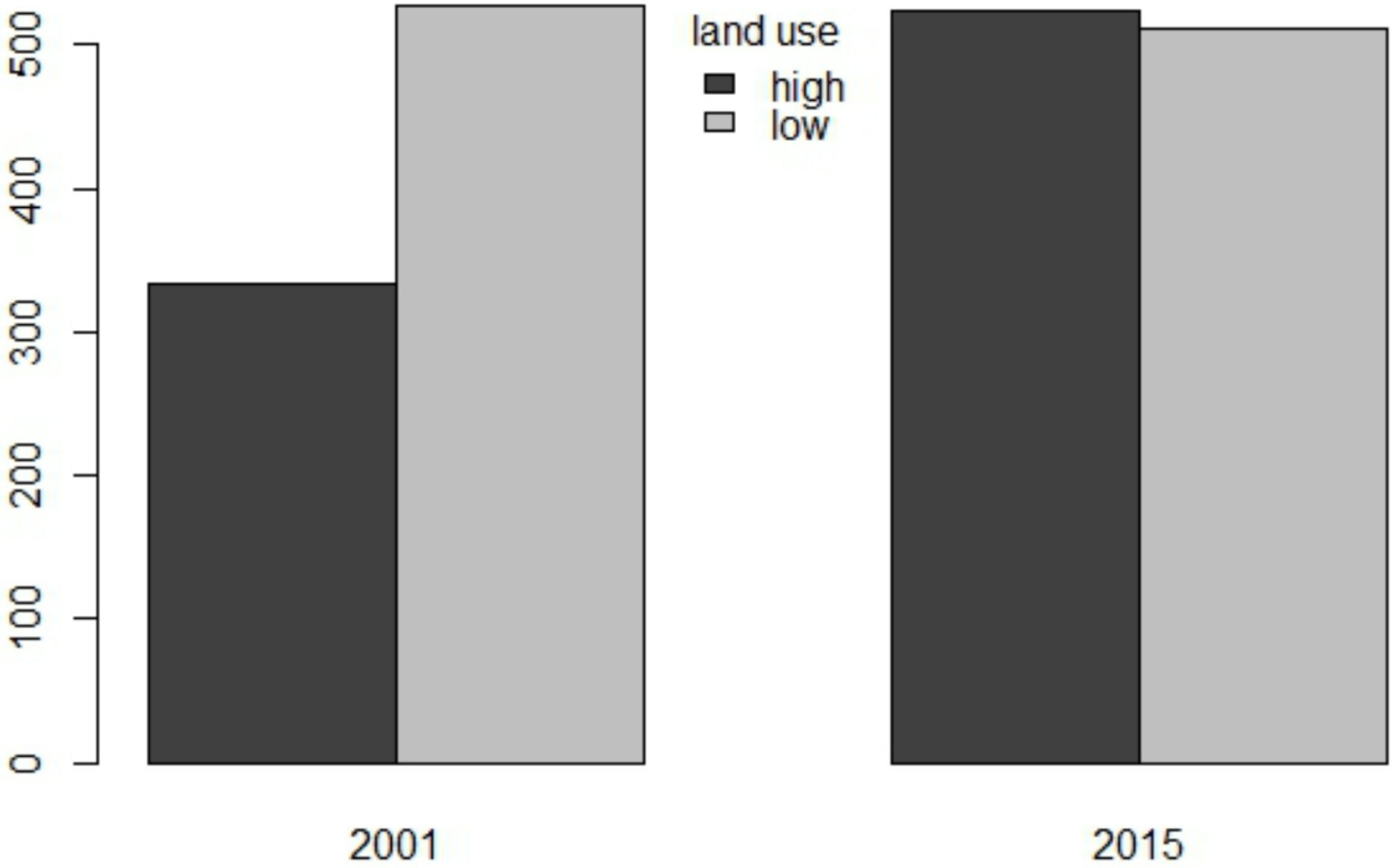


K Rice *et al.* (2001) *Forest Ecology and Management* 190(1) 33-41

LFPD Seed Trap Baskets



Methodology follows Wright & Calderone (2006) Ecology Letters 9(1):35-44


land use
high
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200
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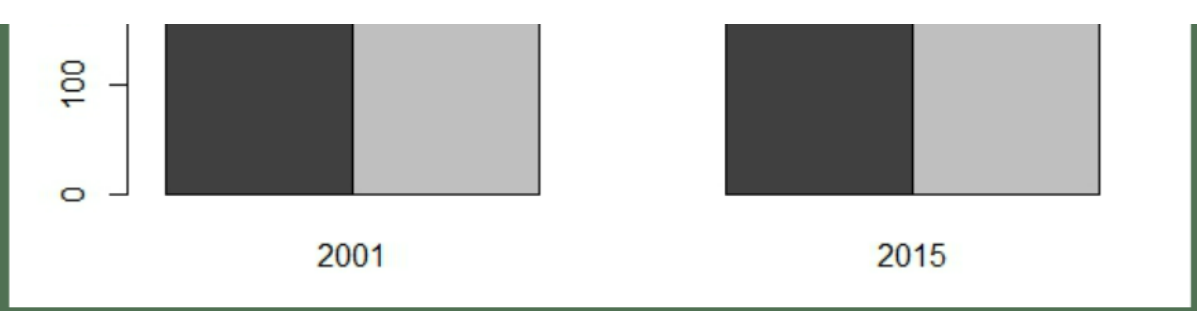
2001
2015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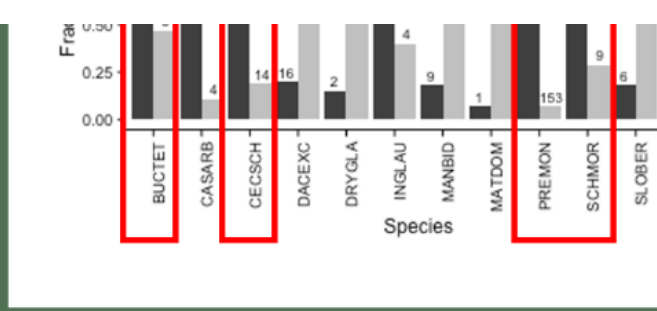
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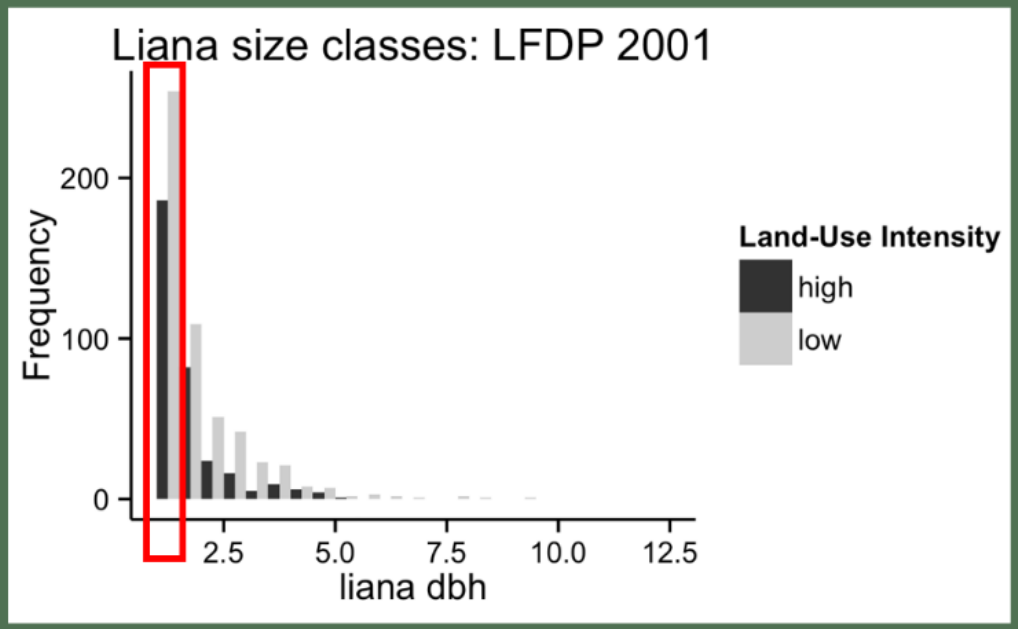
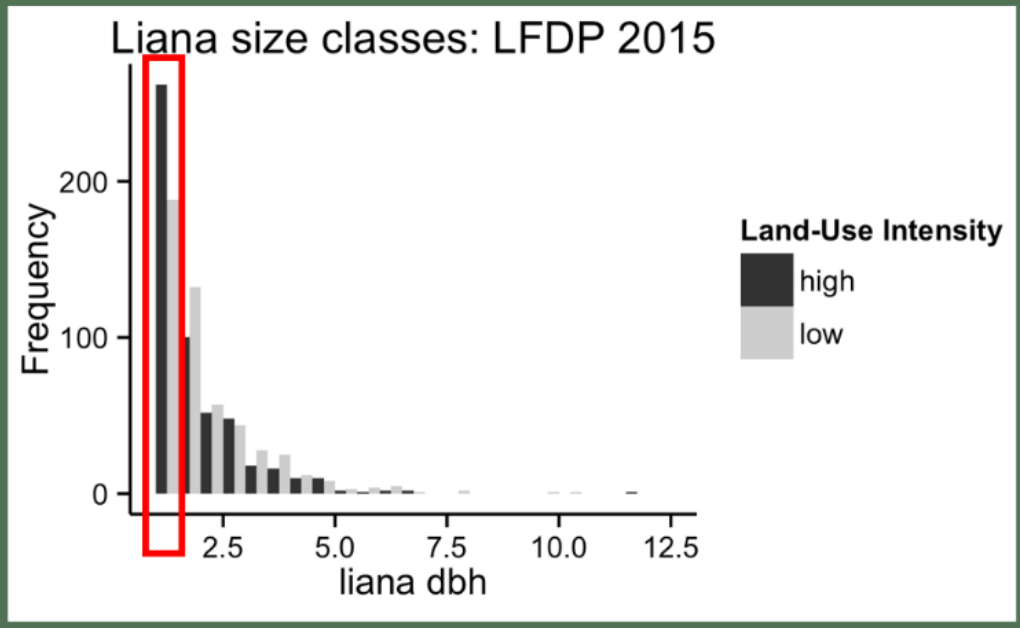
Species


Liana size classes: LFDP 2001
Frequency
200
100
0
2.5
5.0
7.5
10.0
12.5
liana dbh
Land-Use Intensity
high
low


Liana size classes: LFDP 2015
Frequency
200
100
0
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5.0
7.5
10.0
12.5
liana dbh
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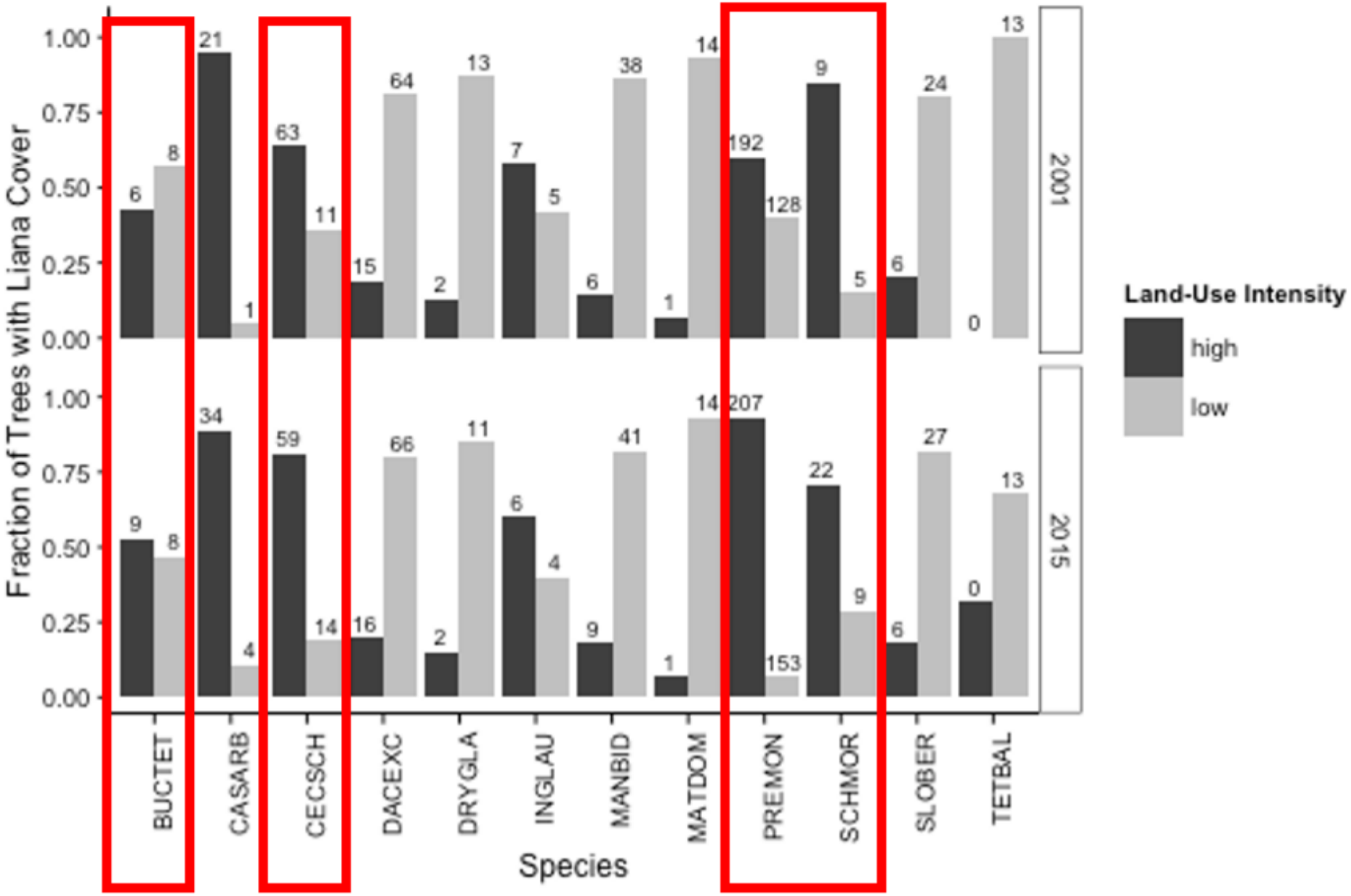
low

TREE OCCUPANCY BY LIANAS



Species	Family	2001				2015				2001 - 2015			
		Abundance		Biomass (kg)		Abundance		Biomass (kg)		Flowers		Seeds	
		high land use	low land use	high land use	low land use	high land use	low land use	high land use	low land use	high land use	low land use	high land use	low land use
Marcgravia rectiflora Triana & Planch	Marcgraviaceae	77	111	217.1	248.18	175	198	736.09	648.94	369	239	34934	1109

fecundity rates 2001- 2015:
high land use: 4.35 seeds/day
low land use: 0.14 seeds/day

RESULTS

Conclusions

In congruence with the Neotropical trend & over the 14-year period (2001 - 2015), liana abundances increased to a greater degree in the high land-use portion of the LFDP (i.e. secondary forest).

Additionally, liana biomass continued to increase in the more-primary forest area of the LFDP, where lianas were previously established.

Trends in recruitment dynamics mirrored demographic trends in the liana community.

Tree community relative stable over time, when compared to the liana commuity (differential effects of hurricanes on lianas v. trees)

Differences in demographics between the two halves of the LFDP are attributed to forest age differences created by past land-use history, and the compound recovery of the entire plot to the two hurricanes.

ACKNOWLEDGEMENTS:

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Liana abundances rebound over a fourteen-year period in a subtropical secondary wet forest: Land-use legacies and hurricane recovery

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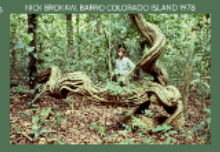

What is a Liana?

woody, climbing vine

climbers that develop secondary wood and are rooted in the soil.

considered "structural parasites" using tropical trees to reach the forest canopy

long slender stems with increased stem hydraulics

Lianas are important in diversity, structure and biomass in tropical forests.

e.g. from BCI, lianas comprise 25% of woody stems, 35% of woody species, 30% of forest leaf area, but <5% of woody biomass (Stefan Schnitzer)

Lianas have negative impacts on all aspects of tree demographics (decreased growth, fecundity, & net carbon accumulation)

In a liana removal experiment in Panama, tree growth increased by 30% (Schnitzer) www.lianaproject.org

Lianas are increase in Neotropical Forests

DL Phillips et al. (2002) *Nature* 418: 770–774

SJ Wright et al. (2004) *Ecology* 85(2): 484–489

Conclusions

In comparison with the Neotropical trend (Phillips et al. 2002, Wright et al. 2004) over the 14 year period 2003 – 2015, liana abundances increased to a greater degree in the high-land-use portion of the LFDP (i.e. secondary forest).

Additionally, liana biomass continues to increase in the more primary forest area of the LFDP, where lianas were previously established.

Trends in size-class dynamics mirrored demographic trends in the liana community.

Tree community-level sustainable over time, when compared to the liana community (differential effects of hurricanes on liana vs. tree)

Differences in demographic processes in two habitats of the LFDP are evident in forest age (three eras created by land-use history) and the compound recovery of the entire plot to the two hurricanes.

ACKNOWLEDGEMENTS

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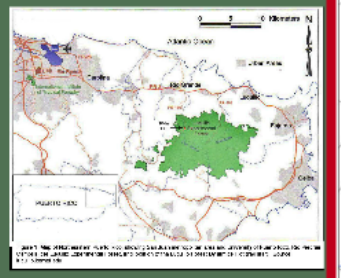
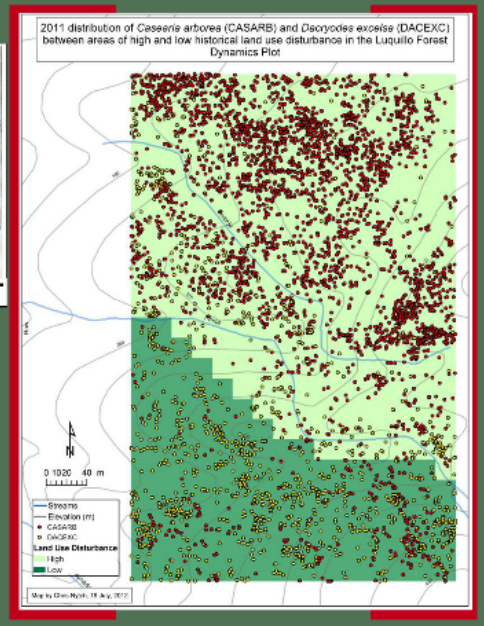


Study Site: The Luquillo Forest Dynamics Plot

El Verde, Puerto Rico

TWO HURRICANES
September 1989- Hugo
September 1998- Georges



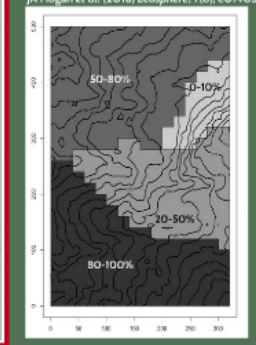
Land-use legacies in the LFDP

Forest cover in 1936 from aerial photographs:
(lightest to darkest): 0-10%, 20-50%, 50-80%, 80-100%, 80-100%

DR Foster, Fluet & Boose (1999) *Ecological Applications*. 9(2), 555-572.

J Thompson *et al.* (2002) *Ecological Applications*. 12(5), 1344-1363.

JA Hogan *et al.* (2016) *Ecosphere*, 7(8), e01405



Lianas & Disturbance

Lianas increase following disturbance (e.g. hurricanes, canopy damage etc)

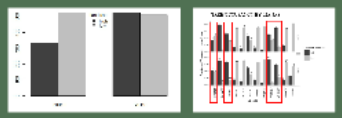
Allen et al. (2005) *Forest Ecology and Management* 218(1):259-269

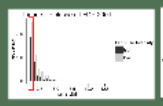
Lianas are greatest in secondary forests and increase in density toward forest edges.

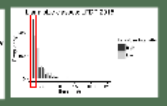
In 2015, we followed up on liana community demographic data from 2001 for a hurricane-affected forest in Puerto Rico, with past land-use legacies, to ask:

1. How has liana abundance, biomass, and reproductive effort change?
2. How has hurricane disturbance interacted with past land to affect liana abundances and reproduction?
3. Does this reflect the Neotropical trend?

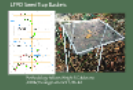
RESULTS







Census Methods



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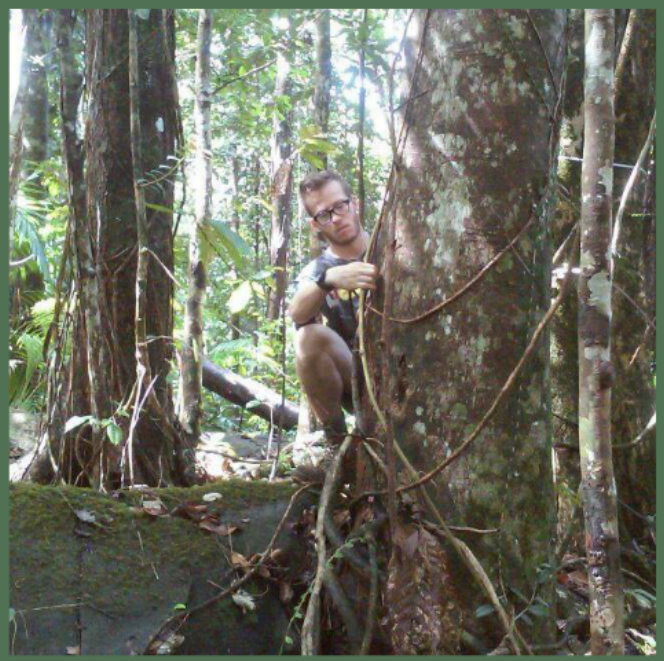
J. AARON HOGAN, LUQUILLO 2015



NICK BROKAW, BARRO COLORADO ISLAND 1978

of *Casearia arborea* (CASARB) and *Dacryodes excelsa* (DACEXC)
f high and low historical land use disturbance in the Luquillo Forest