Hydrology, substrate type and density effects on species growth and survival in created Everglades tree islands

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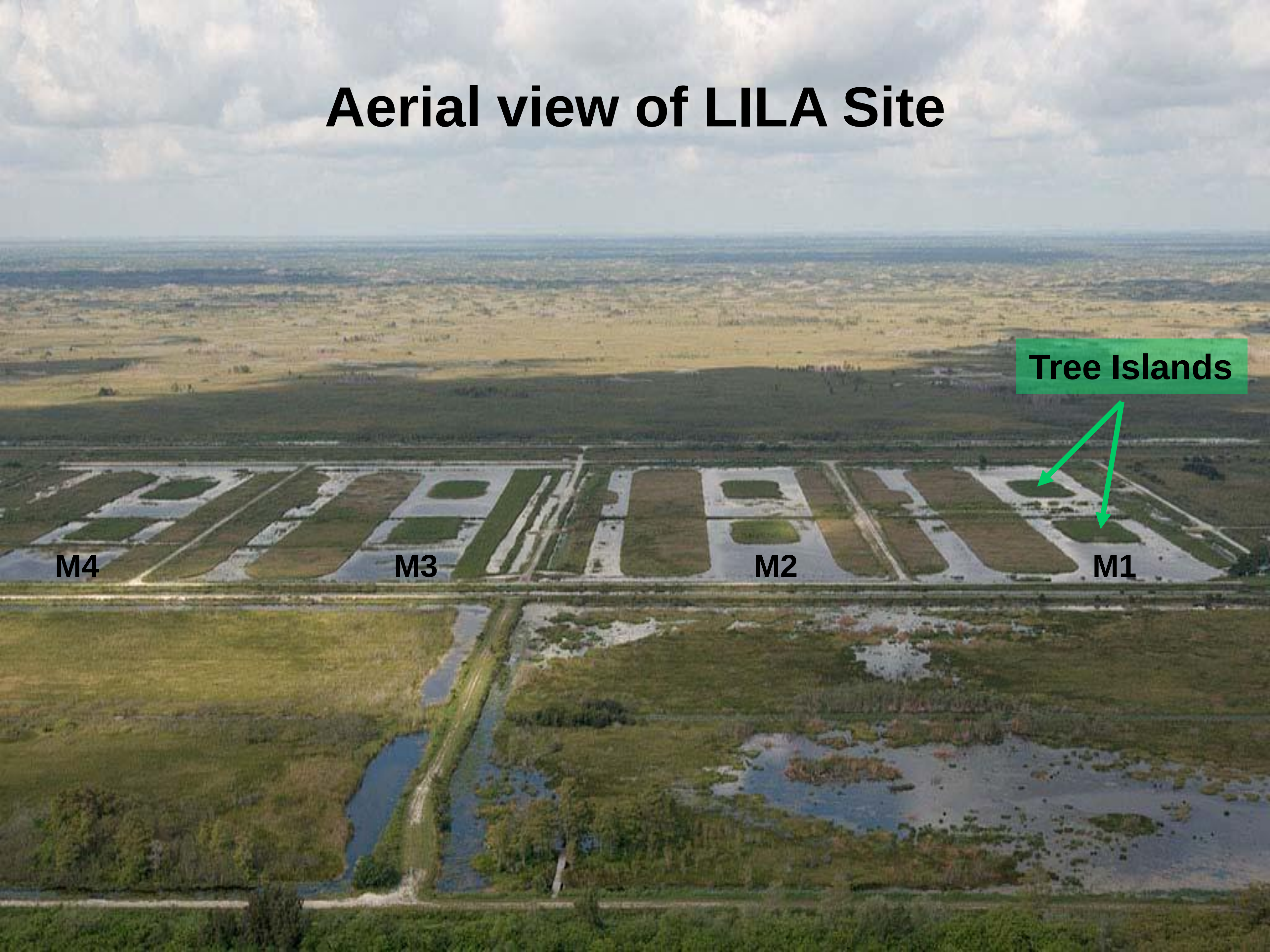
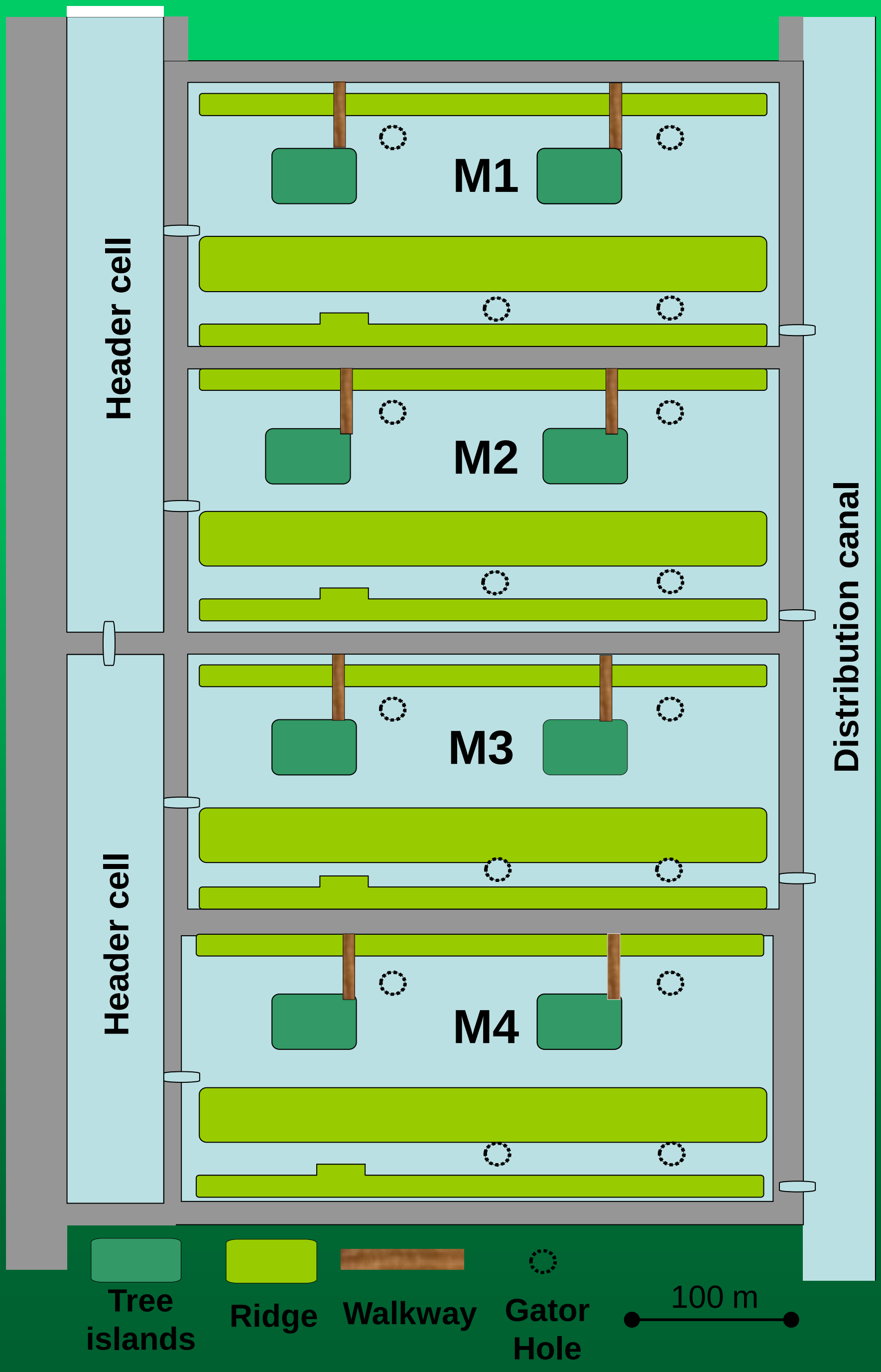
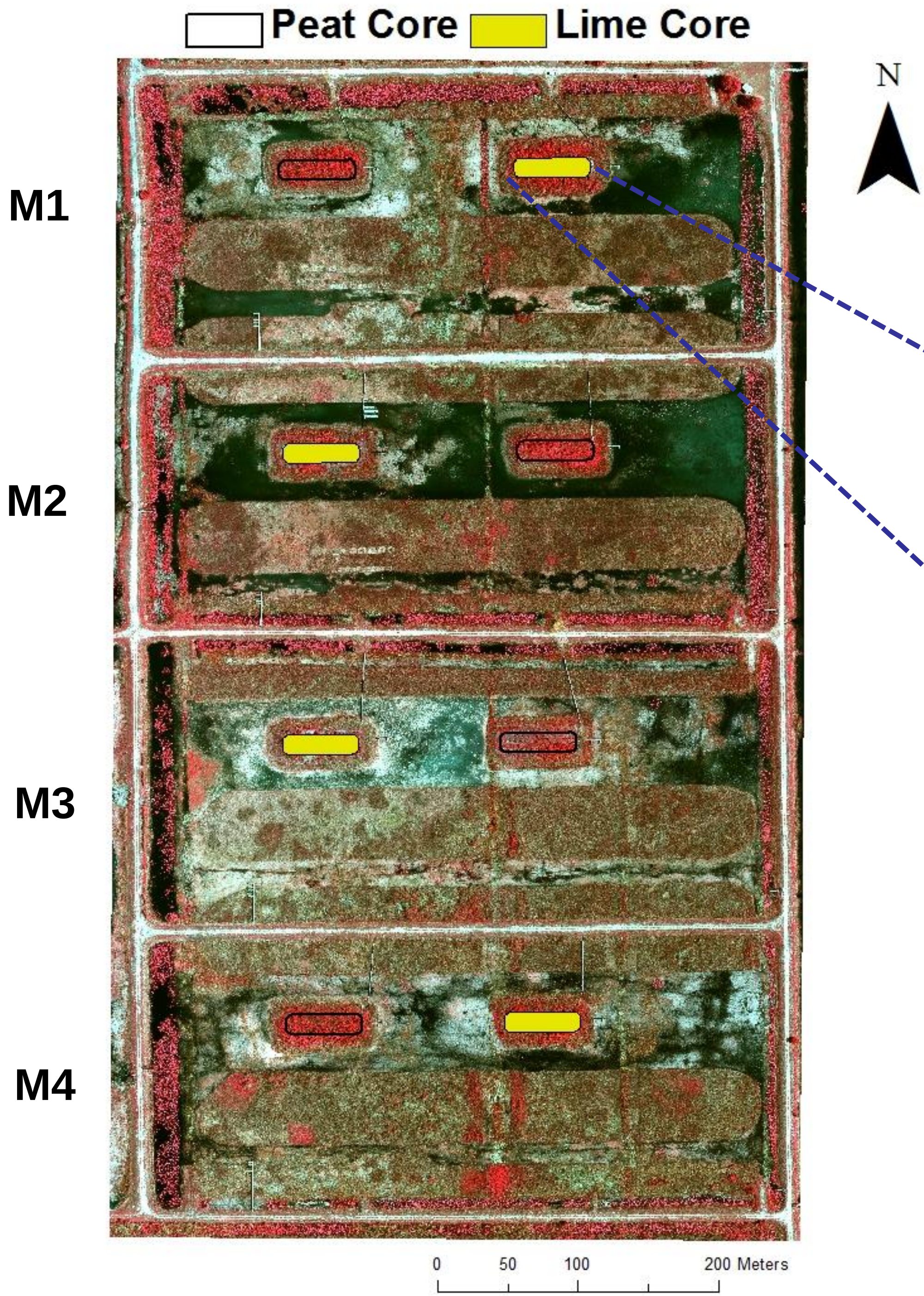
GOLDEN PANTHERS

Aerial view of LILA Site





Water management is a key factor at the LILA site

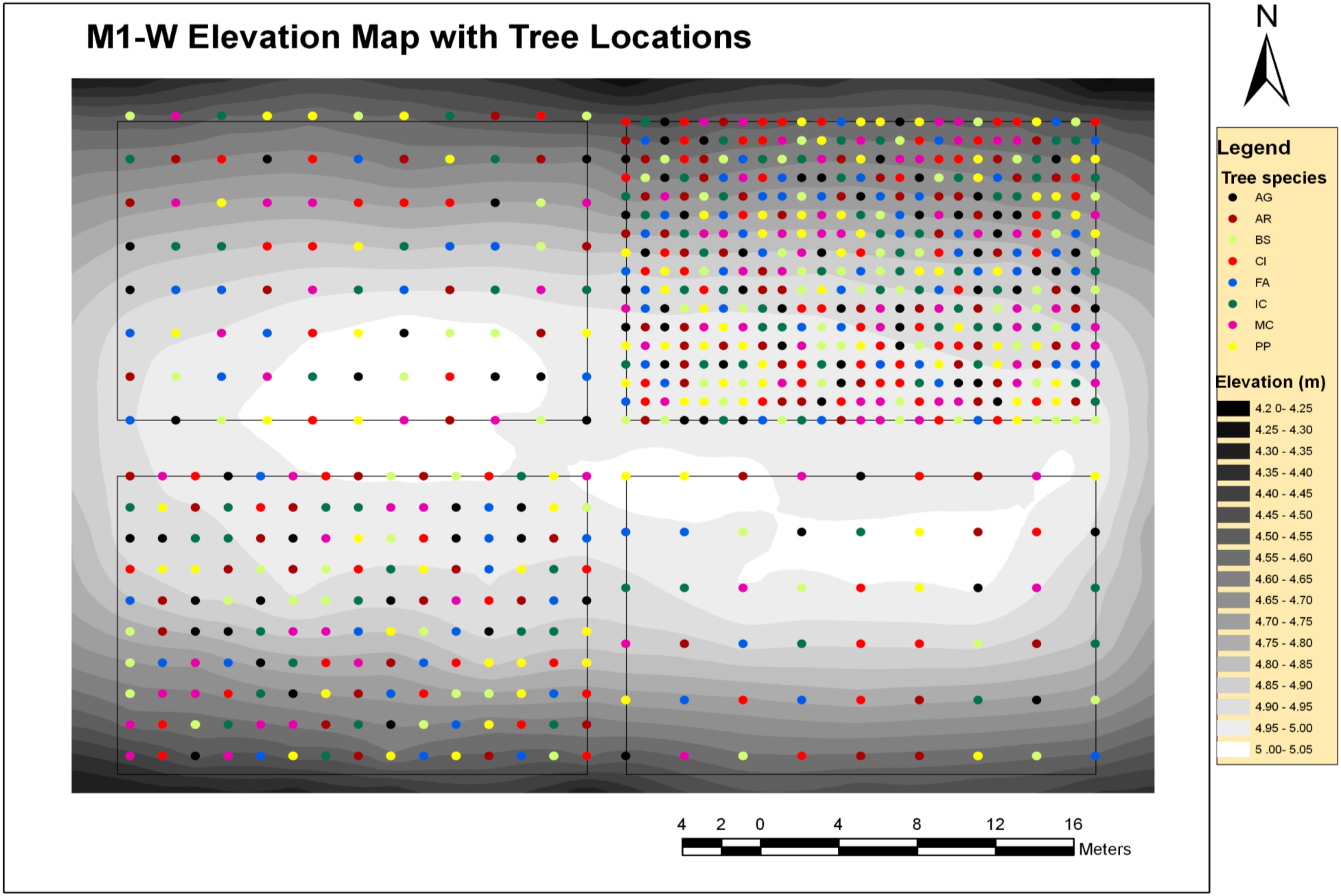


Two types of substrates were used to build tree islands: Limestone and Peat

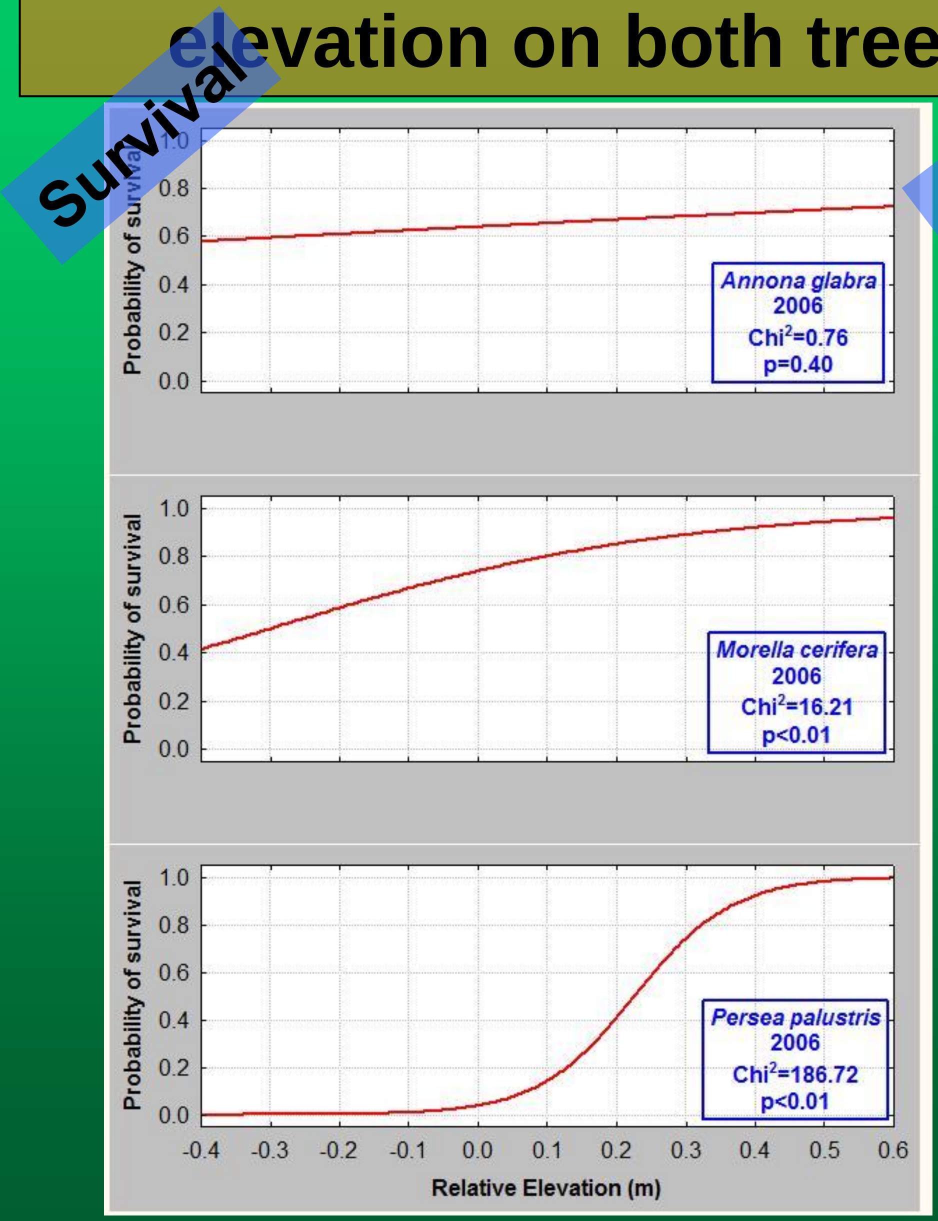
Core: 49 x 14 x 0.3 m

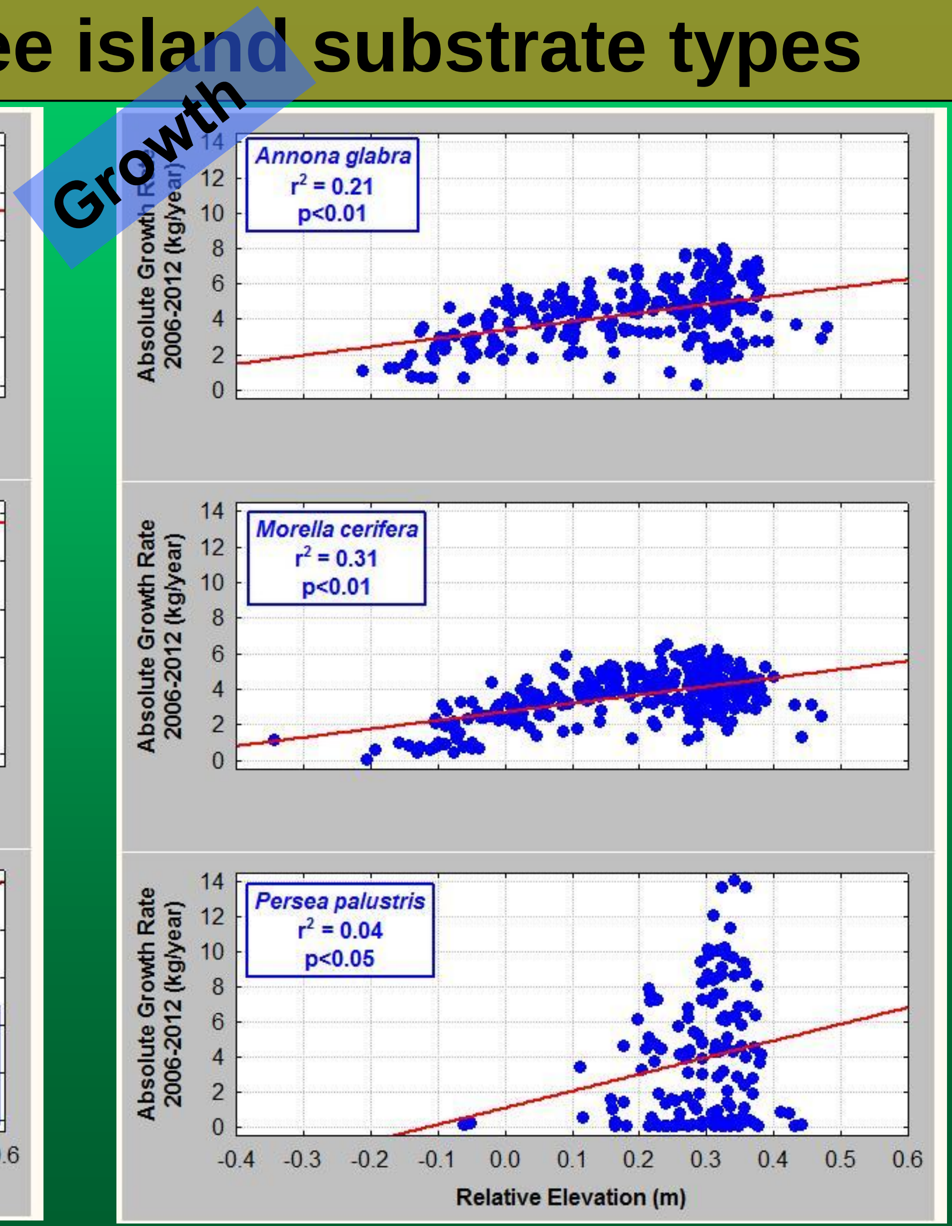
Tree islands were planted in two different years: 2006 and 2007

Tree planting scheme



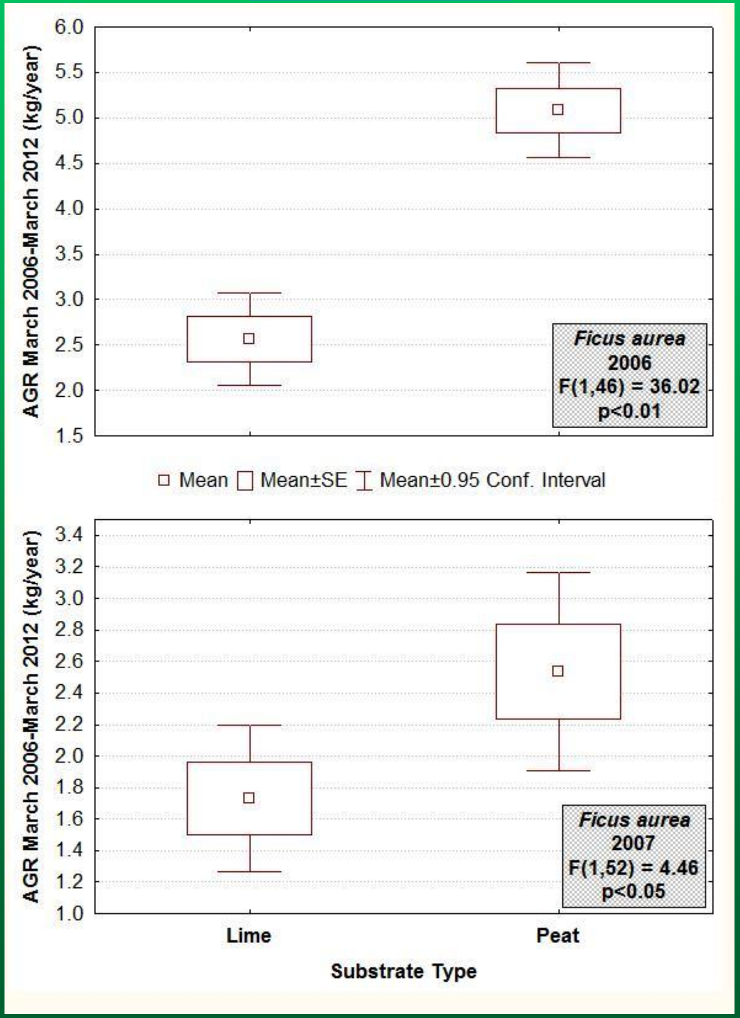
After six years from planting survival and growth remain higher with increasing elevation on both tree island substrate types





After five and six years from planting, tree survival remains higher on limestone tree islands, and growth faster on their peat-based counterparts.

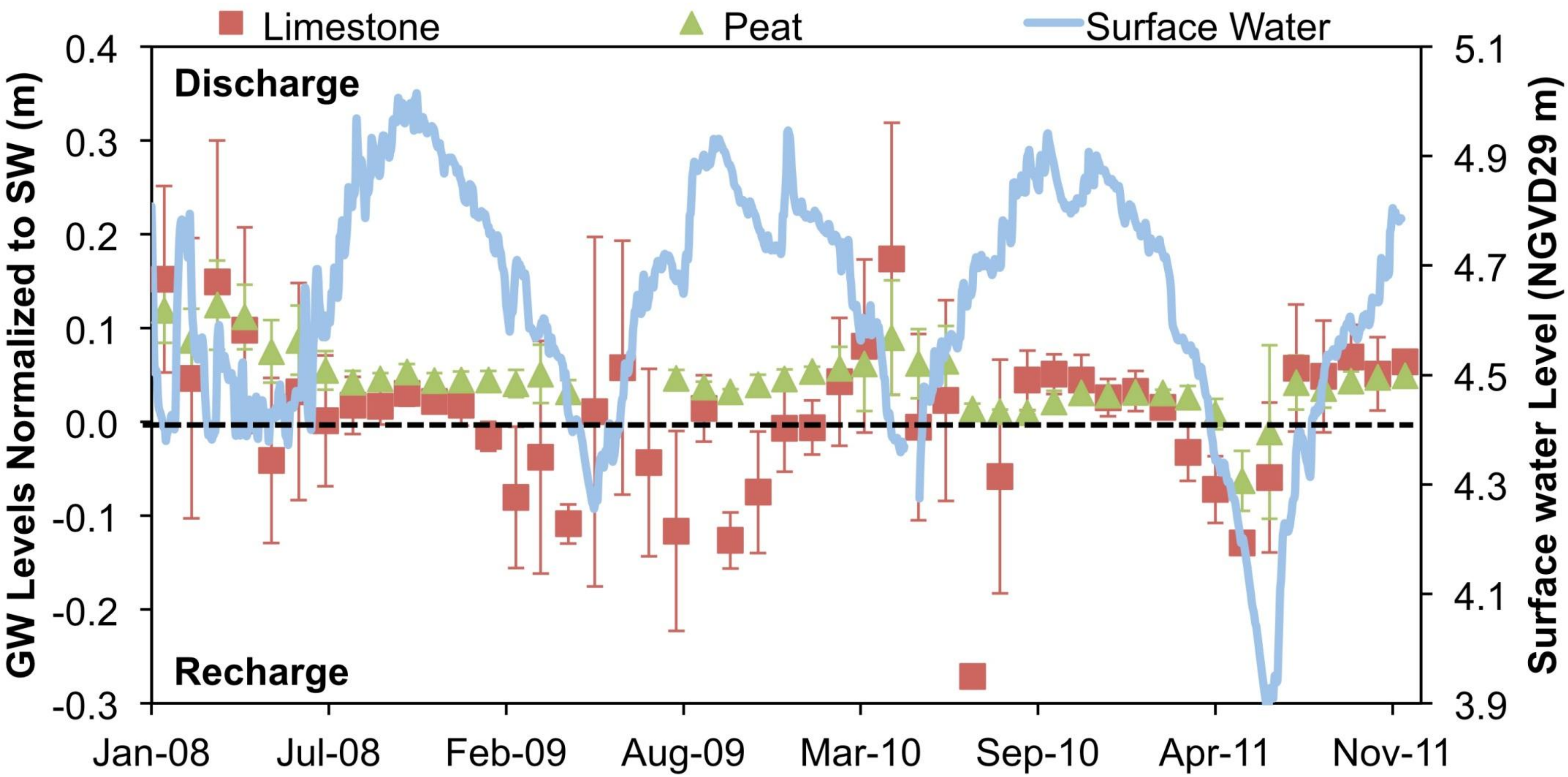
Growth



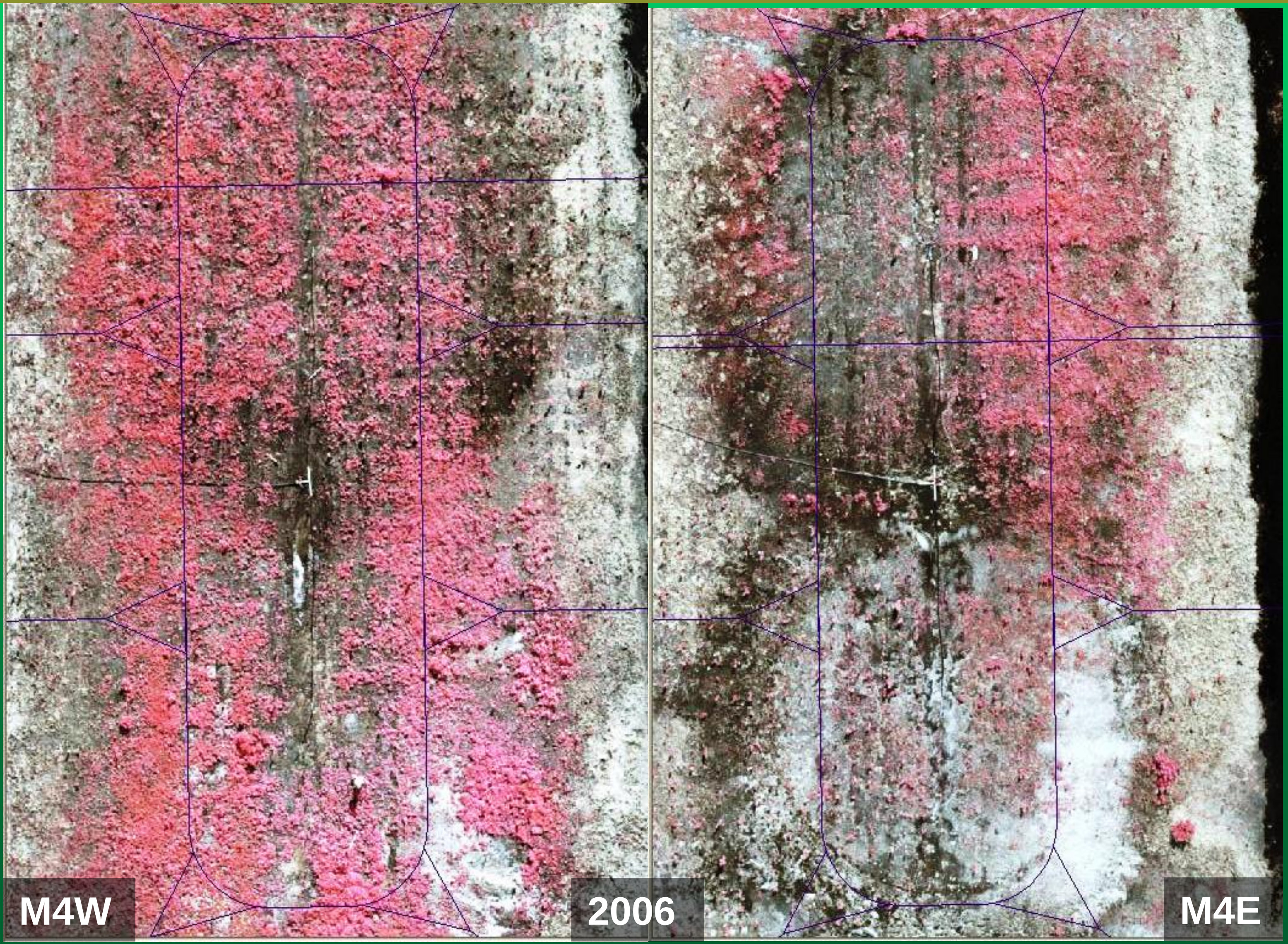
Survival

	2006			2007		
	Limestone	Peat	p-value	Limestone	Peat	p-value
Annona glabra	88	47	<0.01	51	62	NS
Acer rubrum	75	100	NS	91	98	NS
Bursera simaruba	43	27	NS	-	-	-
Chrysobalanus icaco	87	57	<0.01	69	70	NS
Eugenia axillaris	-	-	-	84	75	NS
Ficus aurea	52	26	<0.01	64	34	<0.01
Ilex cassine	82	90	NS	88	54	<0.01
Morella cerifera	97	81	<0.05	91	93	NS
Myrsyne grandiflora	-	-	-	78	46	<0.01
Persea palustris	86	78	NS	89	88	NS

Groundwater levels were higher and less variable in peat than in limestone tree islands



Early in stand development, tree seedlings on the limestone islands grew without serious competition for light, while competition from ruderal species had a negative impact on seedling development on peat islands



Density effect on growth: Methods

Hypothesis:

Biomass growth would be higher at lower initial planting densities because of less competition

Competition Index: $CI_T = \sum T_m / R_m^2$

T_m is the total biomass (in kg/year) of the m^{th} competitor
R_m is the linear distance (in meters) between the target tree and tree m

Regression Analysis:

***Response variable*: Absolute Growth Rate=**

$AGR = (Biomass_{final} - Biomass_{initial})$/time of growth in years

***Predictors*: Initial Biomass=IB and Competition Index=CI**

$$AGR_{Mar09-Mar10} = a + b\,(IB_{Mar09}) + c\,(CI_{Mar09})$$
$$AGR_{Mar10-Mar12} = a + b\,(IB_{Mar09}) + c\,(CI_{Mar10})$$
$$AGR_{Mar09-Mar12} = a + b\,(IB_{Mar09}) + c\,(CI_{Mar09})$$

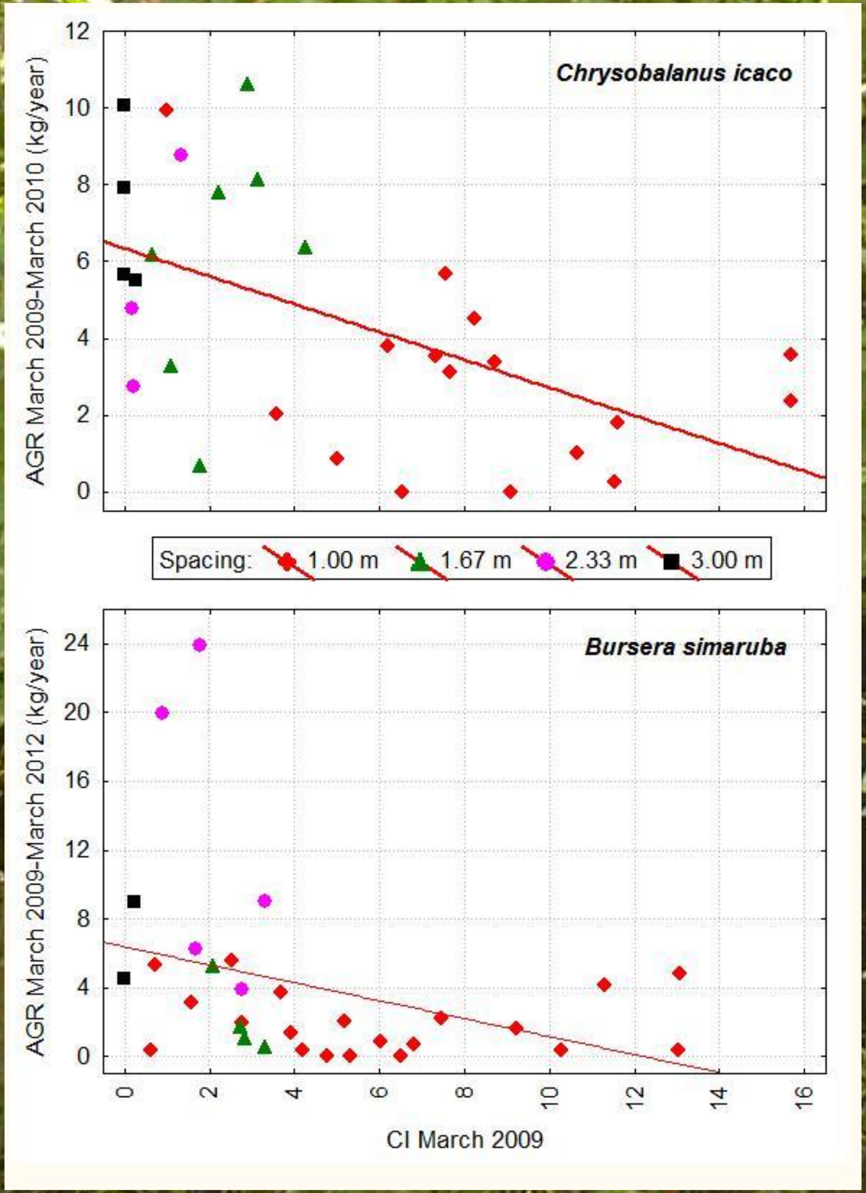
All Species **Both Planting Year** **Both Substrate Types**

Density effect on biomass growth shows an increasing trend in the effects of competition over time

Linear regression coefficients (b) of Initial biomass and Competition index on Absolute Biomass Growth Rate for different periods between March 2009 and March 2012. Numbers in red = $p<0.05$

Species	Biomass estimations based on selected structural measurements					
	$AGR_{Mar09-Mar10}=a+b(\text{Initial Biomass}_{Mar09})+c(CI_{Mar09})$					
	Lime			Peat		
	N	BioMar09	CIMar09	N	BioMar09	CIMar09
Annona glabra	45	0.2301	-0.0593	28	-0.266	0.017
Acer rubrum	45	0.9099	-0.0165	63	0.2736	-0.0038
Bursera simaruba	31	0.2143	-0.0797	15	0.182	-0.190
Chrysobalanus icaco	53	0.4553	-0.2206	30	0.406	-0.354
Ficus aurea	39	1.4791	-0.0304	14	1.9672	0.0382
Ilex cassine	52	0.1892	-0.0075	44	0.3973	-0.0231
Morella cerifera	57	-0.2361	-0.0392	47	-0.379	0.047
Persea palustris	66	1.0366	-0.1268	51	0.2349	-0.0650
	$AGR_{Mar10-Mar12}=a+b(\text{Initial Biomass}_{Mar10})+c(CI_{Mar10})$					
Annona glabra	45	-0.2112	0.0251	28	-0.5807	0.0065
Acer rubrum	37	0.0548	0.0183	63	-0.8121	-0.0027
Bursera simaruba	31	2.4947	-0.1690	15	1.4958	0.0920
Chrysobalanus icaco	53	0.1434	-0.2420	30	0.5104	-0.1812
Ficus aurea	34	1.3424	-0.1011	14	1.9929	-0.5042
Ilex cassine	51	0.9563	-0.0405	43	0.9497	-0.0562
Morella cerifera	57	-0.0140	-0.0027	47	-0.0119	-0.0095
Persea palustris	59	1.7752	-0.0223	45	1.4326	-0.0027
	$AGR_{Mar09-Mar12}=a+b(\text{Initial Biomass}_{Mar09})+c(CI_{Mar09})$					
Annona glabra	46	-0.1611	0.0432	28	-0.7813	0.0307
Acer rubrum	38	0.6252	-0.0076	64	-1.0969	0.0038
Bursera simaruba	31	1.5286	-0.6005	15	1.9494	-0.7480
Chrysobalanus icaco	53	1.0642	-0.4946	29	1.1542	-1.0031
Ficus aurea	34	4.9749	-0.2215	14	7.3064	-0.3160
Ilex cassine	51	1.3540	-0.0785	44	2.0554	-0.1474
Morella cerifera	58	-0.3366	0.0424	47	-0.2631	0.0205
Persea palustris	59	5.6813	-0.4837	45	2.0313	-0.1642

In several species, biomass growth is higher at lower initial planting densities because of less competition



Crown area growth is a better variable to show the effect of competition than Height growth.

Linear regression coefficients (b) of Initial biomass and competition index on Absolute Height (HT), Crown Area (CA) and Crown Volume (CV) Growth Rate between March 2009 and March 2012. Numbers in red = $p<0.05$

Species	$AGR\_HT_{Mar09-Mar12}=a+b(Initial\ HT_{Mar09})+c(CI_{Mar09})$					
	Lime			Peat		
	N	HT_{Mar09}	CI_{Mar09}	N	HT_{Mar09}	CI_{Mar09}
Annona glabra	46	0.2712	0.0057	28	0.0401	0.0021
Acer rubrum	38	1.4529	0.0014	64	0.0657	0.0027
Bursera simaruba	31	0.4234	-0.0023	15	0.3799	-0.0029
Chrysobalanus icaco	53	0.4840	-0.0017	30	0.3937	0.0013
Ficus aurea	34	0.5735	-0.0018	14	0.0466	0.0013
Ilex cassine	51	0.1869	-0.0026	44	0.4640	-0.0031
Morella cerifera	58	0.0644	-0.0004	47	-0.2112	0.0009
Persea palustris	59	0.9066	0.0021	45	0.7045	-0.0080
	$AGR\_CA_{Mar09-Mar12}=a+b(Initial\ CA_{Mar09})+c(CI_{Mar09})$					
	N	CA_{Mar09}	CI_{Mar09}	N	CA_{Mar09}	CI_{Mar09}
Annona glabra	46	0.2198	-0.0001	28	-0.1314	-0.0004
Acer rubrum	38	3.8049	-0.0001	64	1.0198	0.0000
Bursera simaruba	31	1.4066	-0.0003	15	1.9352	-0.0003
Chrysobalanus icaco	53	1.0596	-0.0003	29	1.0626	-0.0006
Ficus aurea	34	3.9360	-0.0003	14	4.7007	-0.0002
Ilex cassine	51	0.3881	0.0000	44	1.0312	-0.0002
Morella cerifera	58	1.1381	-0.0004	47	0.7513	-0.0006
Persea palustris	59	2.8246	-0.0001	45	1.2415	-0.0001
	$AGR\_CV_{Mar09-Mar12}=a+b(Initial\ CV_{Mar09})+c(CI_{Mar09})$					
	N	CV_{Mar09}	CI_{Mar09}	N	CV_{Mar09}	CI_{Mar09}
Annona glabra	46	1.0677	-0.0002	28	0.4387	-0.0014
Acer rubrum	38	10.3137	-0.0007	64	3.5238	0.0000
Bursera simaruba	31	7.9931	-0.0007	15	5.2205	0.0004
Chrysobalanus icaco	53	2.7806	-0.0009	29	2.8553	-0.0021
Ficus aurea	34	8.6479	-0.0008	14	12.1459	-0.0001
Ilex cassine	51	1.5146	-0.0002	44	2.9573	-0.0005
Morella cerifera	58	2.0263	-0.0020	47	1.8675	-0.0024
Persea palustris	59	5.5809	-0.0006	45	2.4230	-0.0004

Acknowledgements

- SFWMD Everglades Division for funding and support.
- Terrestrial Ecology Lab staff and Dr. Michael Ross students for field data collection.


Thank you