Silviculture for FLR:

Finding the best silviculture to support FLR

Jerry Vanclay

Dean & Head of Environment, Science & Engineering

Southern Cross University

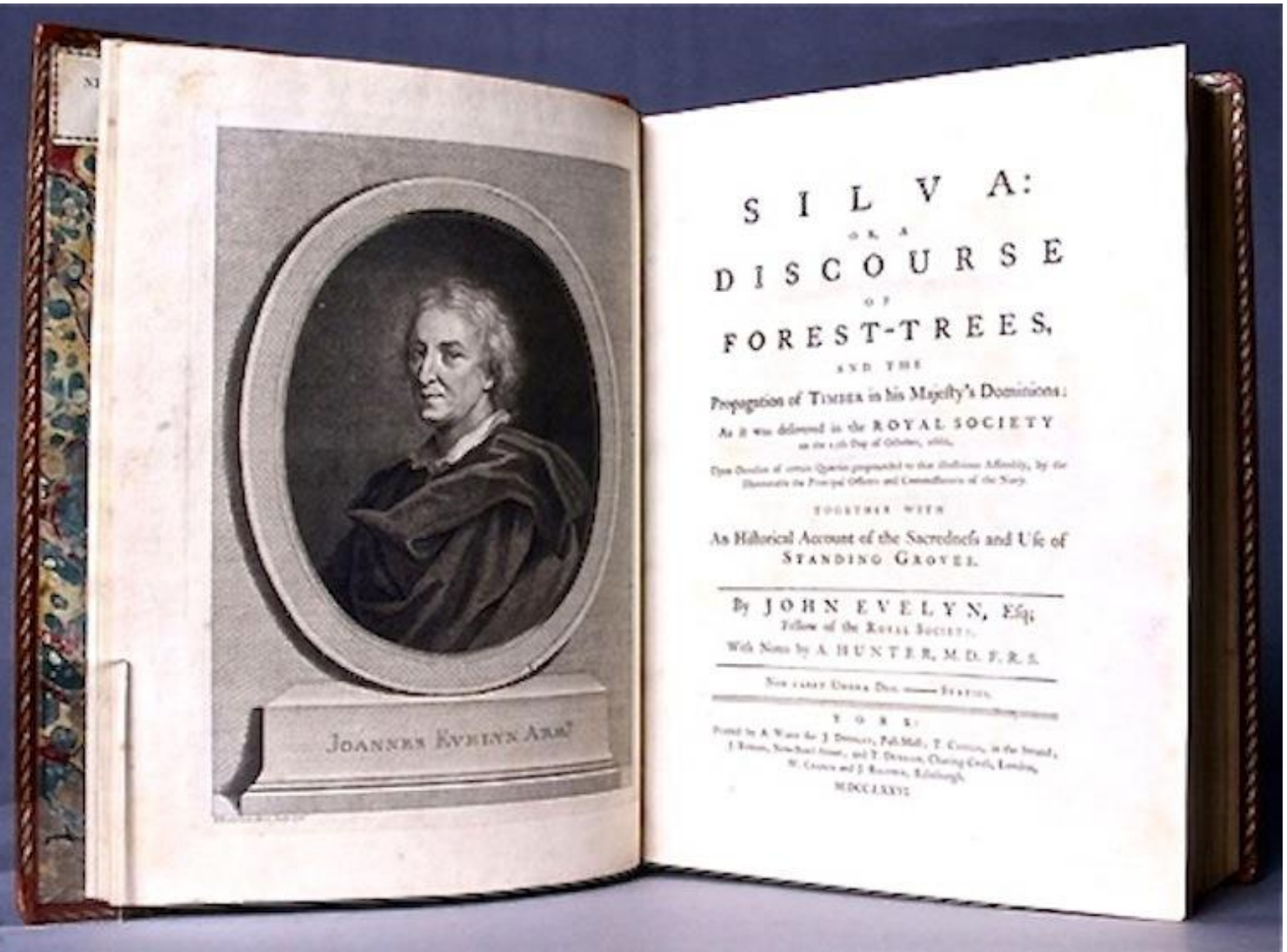
Chair, Congress Scientific Committee
XXV IUFRO Congress, 2019, Curitiba Brazil

Southern Cross University

Silviculture

Silva: noun, 16th century, from Latin *silva* “forest”

Culture: verb, middle-English (12th-15th century), from Latin *cultura* “grow, cultivate”



The Planting

"Mixed species and random planting" with a planting density of three seedlings per meter square.

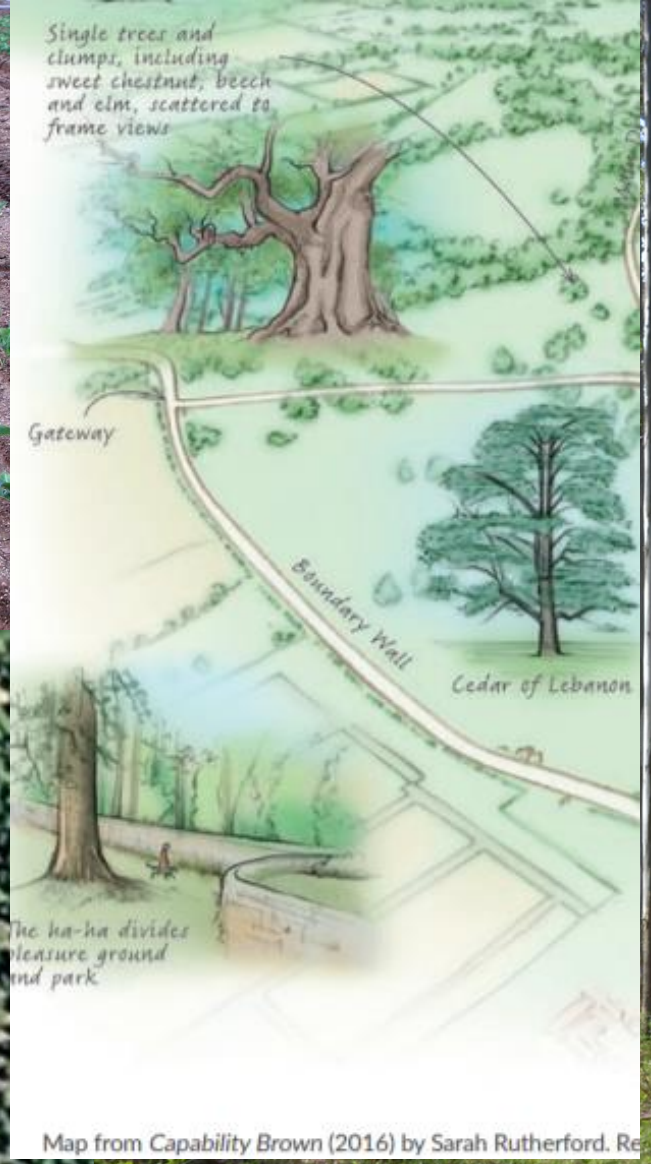
Don't forget !! Mulching.

Prof Akira Miyawaki
30,000/ha
native species

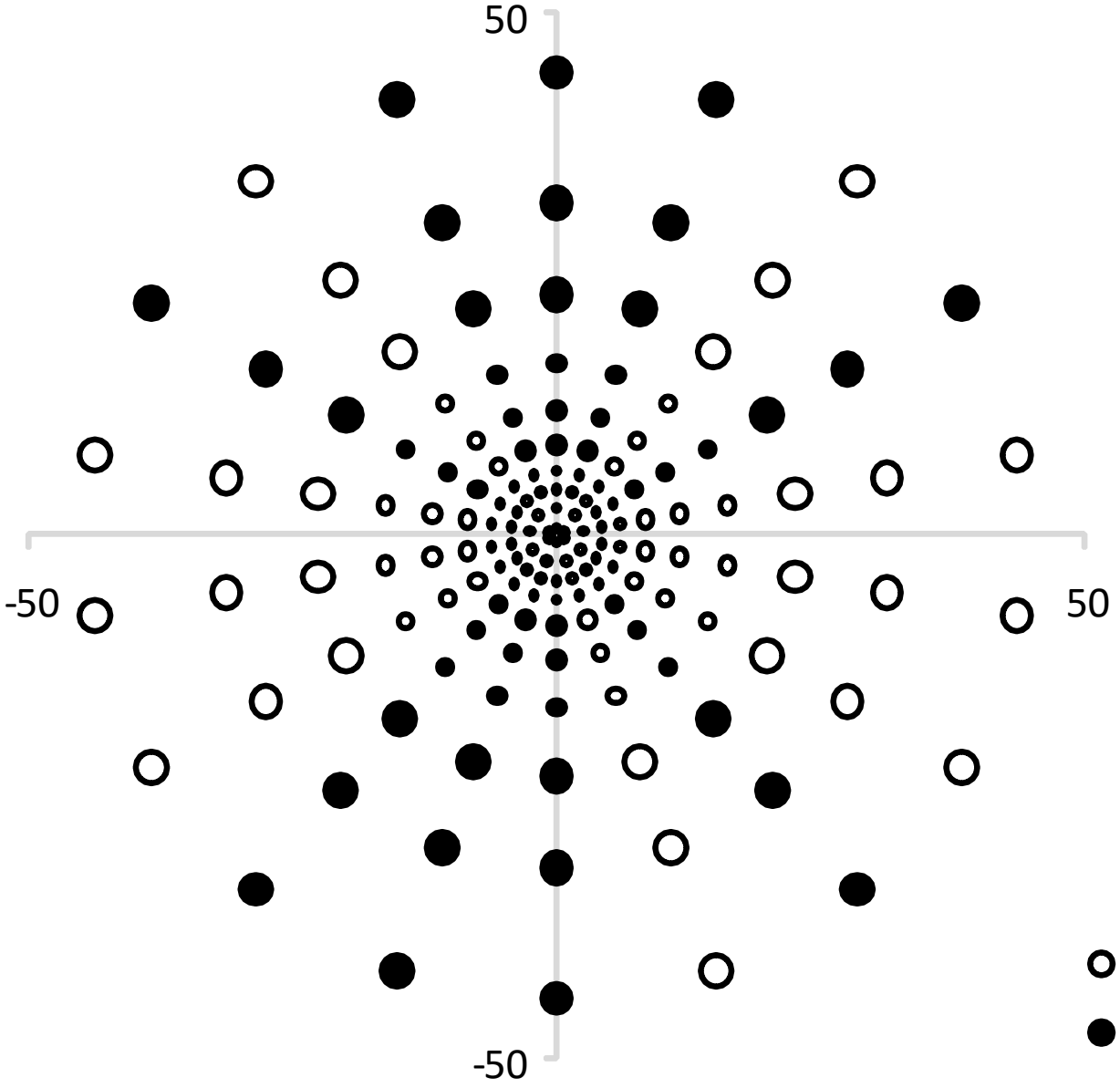
Framework species
1,000/ha Acacia
(Tran Lam Dong)

Chapter 4. Impact of Acacia *hybrid on degraded*

20/person/day or 2,000/person/day

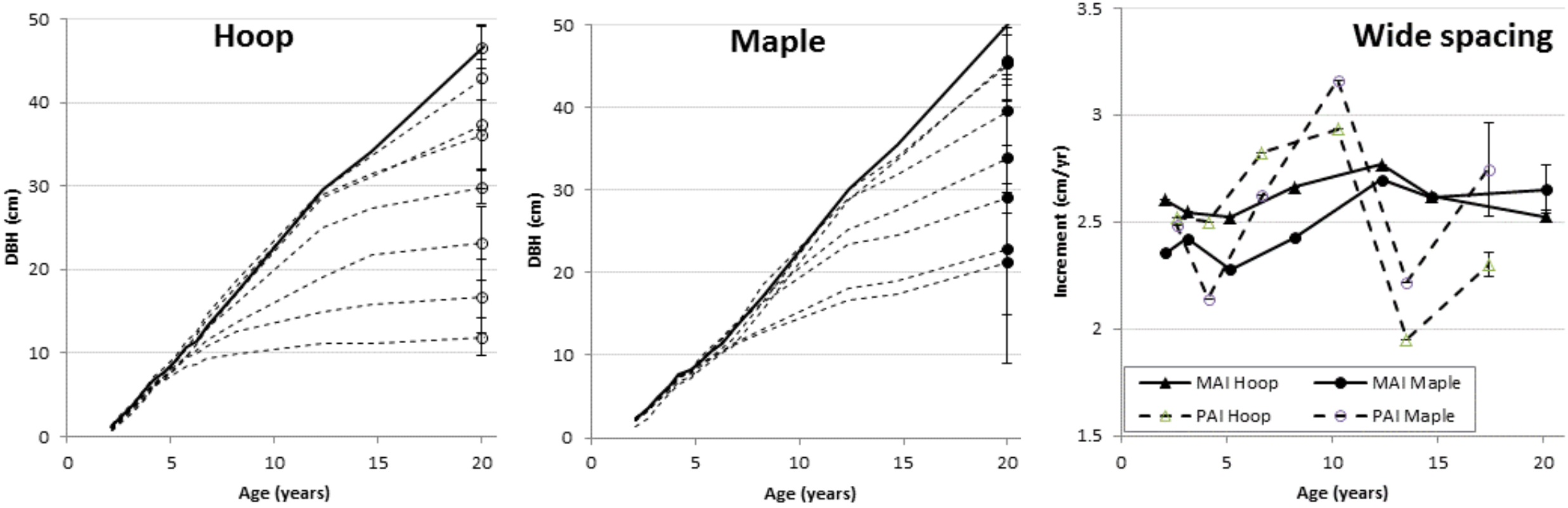


Map from *Capability Brown* (2016) by Sarah Rutherford. Re

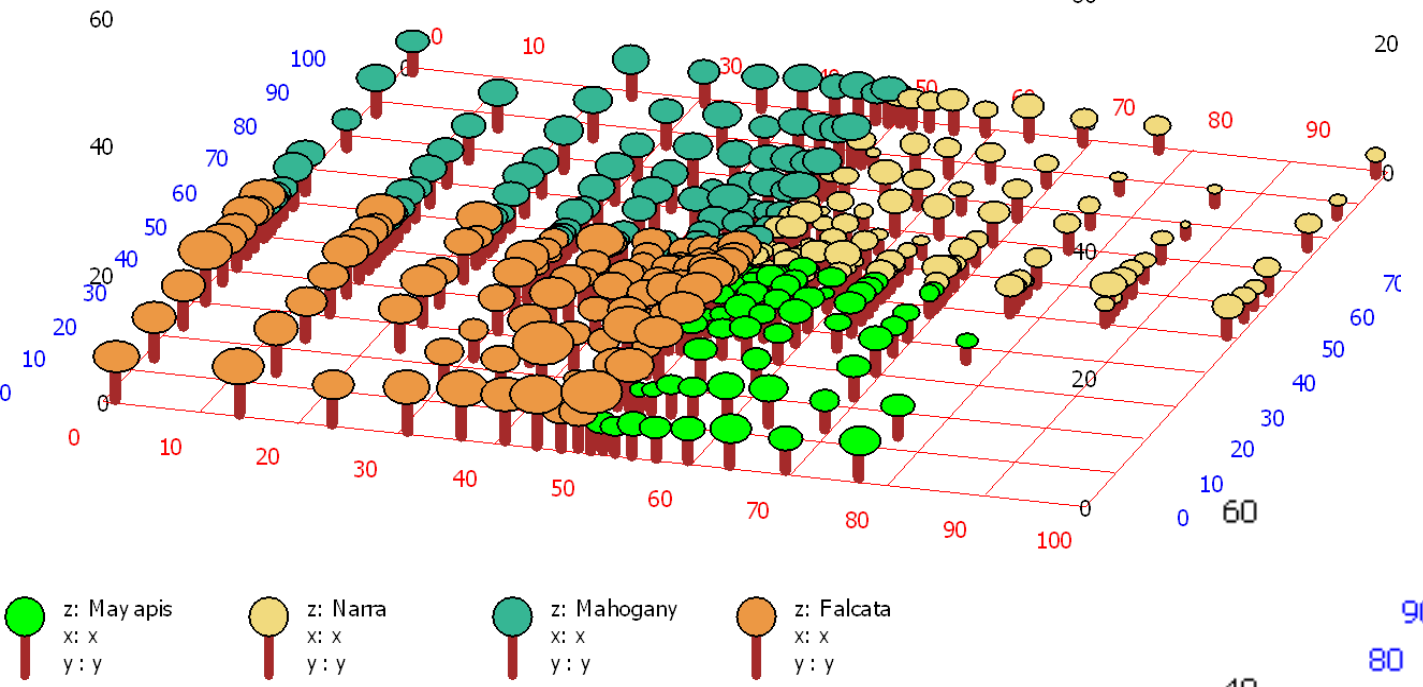


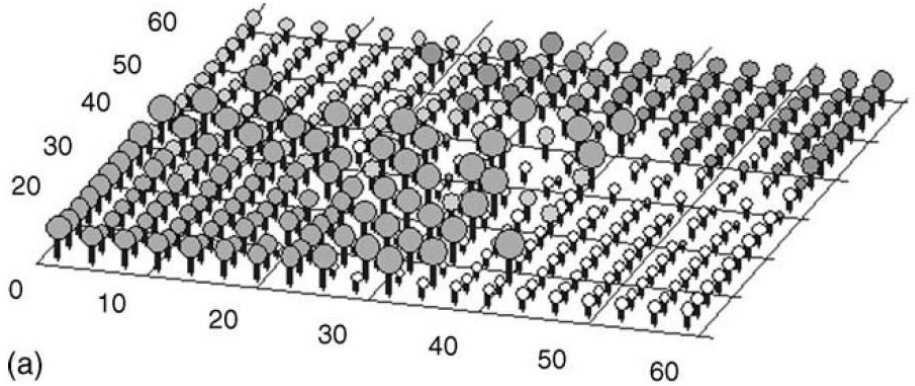
Araucaria cunninghamii

Flindersia brayleyana

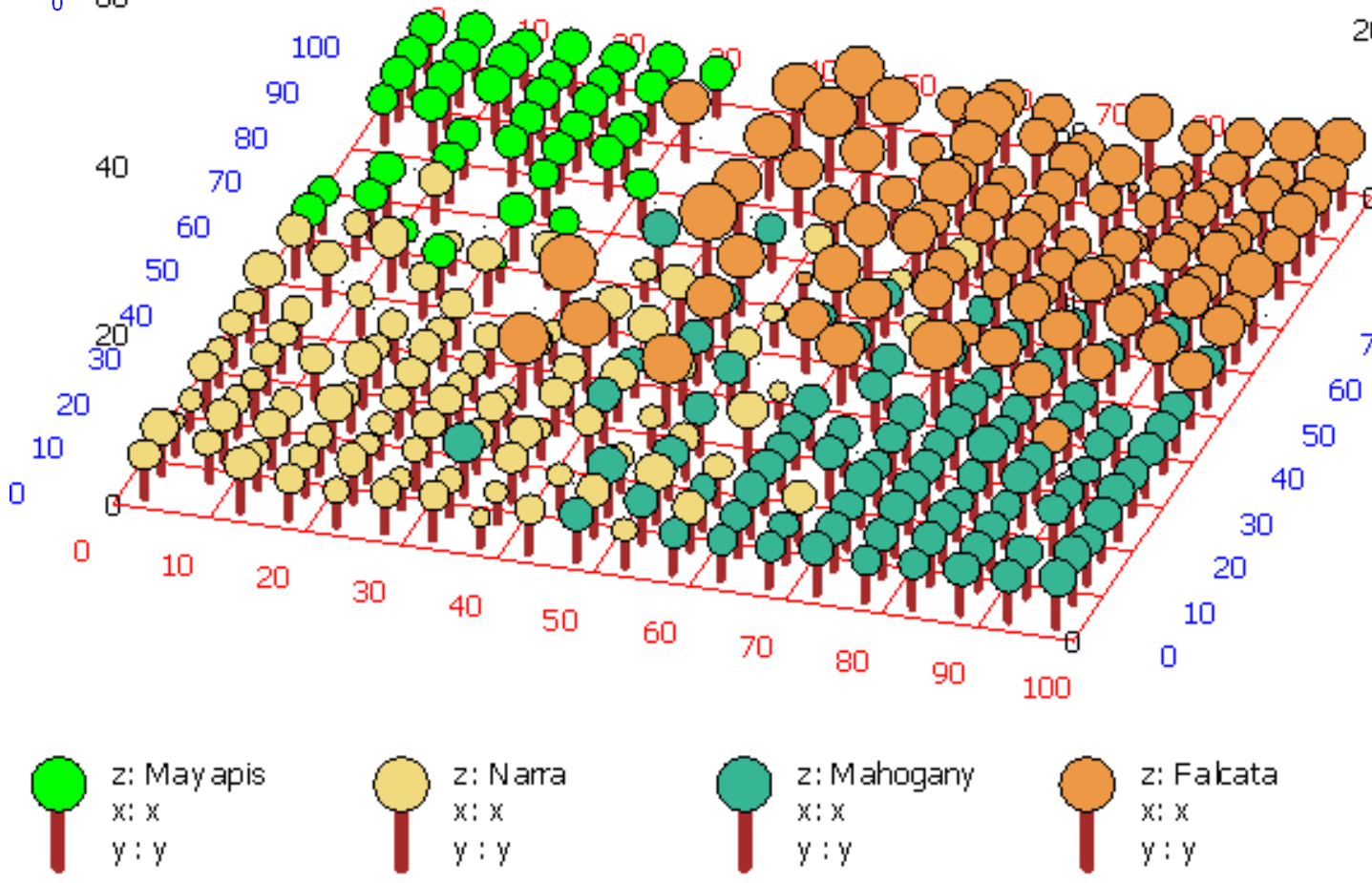


Mean diameter of the two species in the Nelder trial (left and centre), with lines representing the 8 different ‘rings’ in the experiment. The rightmost graph shows the growth rates of trees at the widest spacing: the solid line is mean annual increment (dbh/age), dashed line is periodic annual increment (Δdbh/Δage). Vertical bars show ±1 standard error.

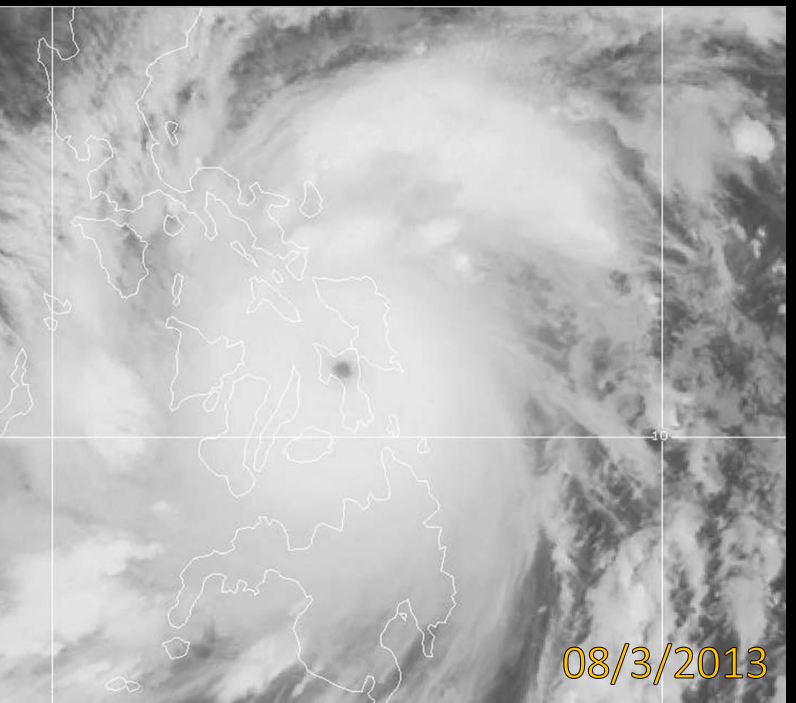




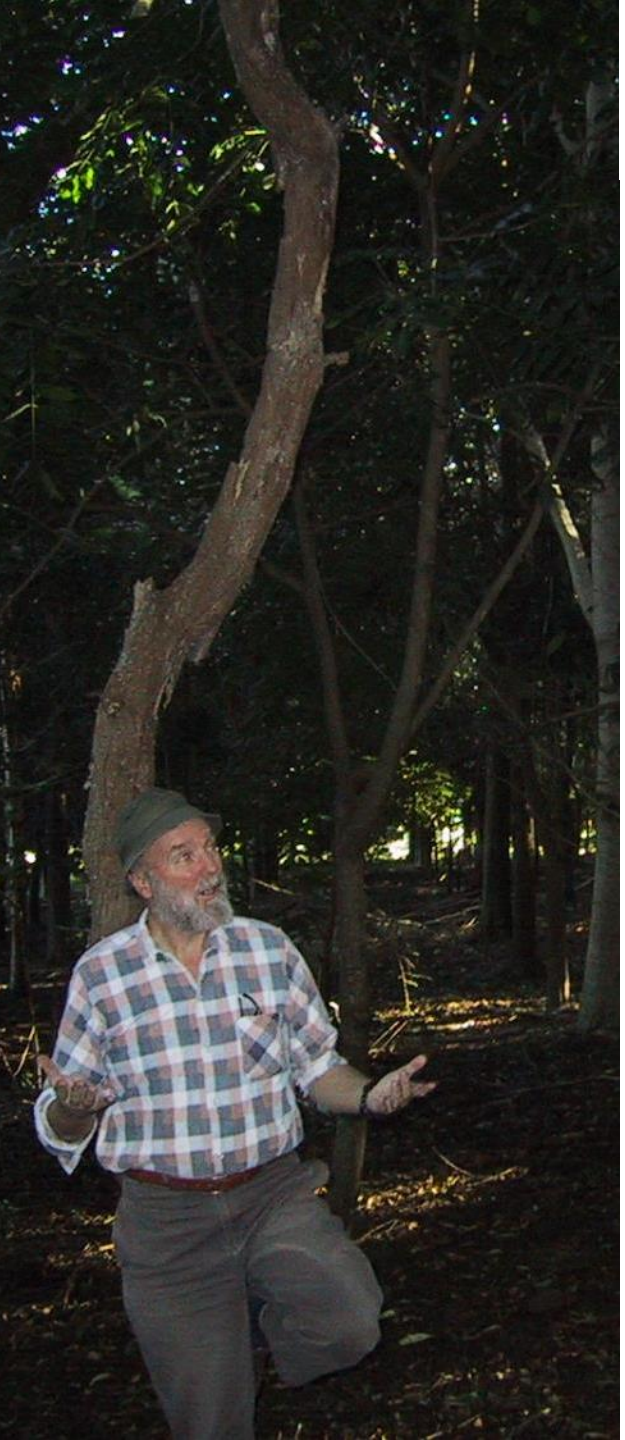
Wl
neithe
exami
under
resear
compo
intere
spacir




18/11/2013 10:49


08/3/2013


17/3/2017

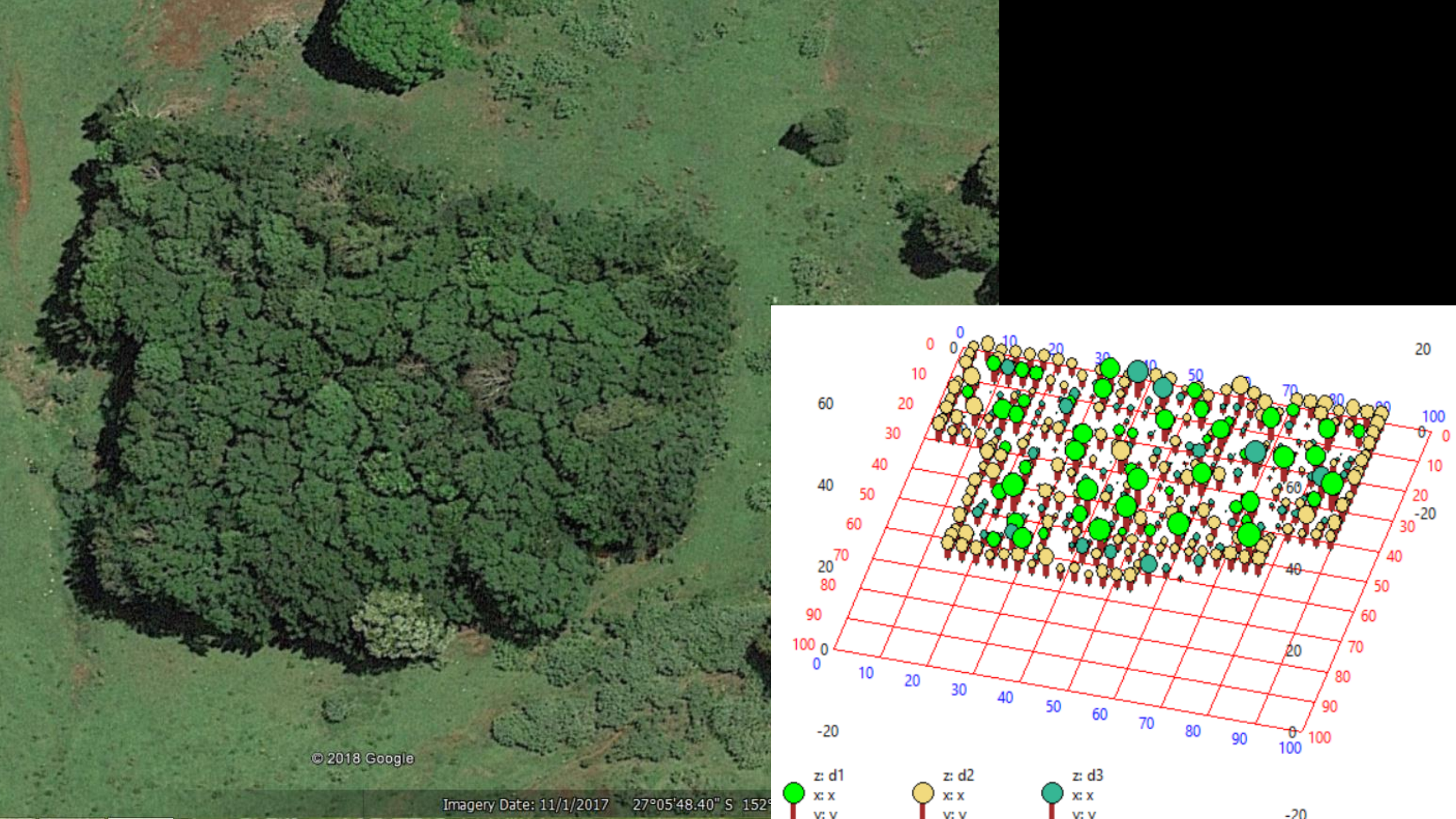


David Lamb's mixed-species trial at Mt Mee near USC

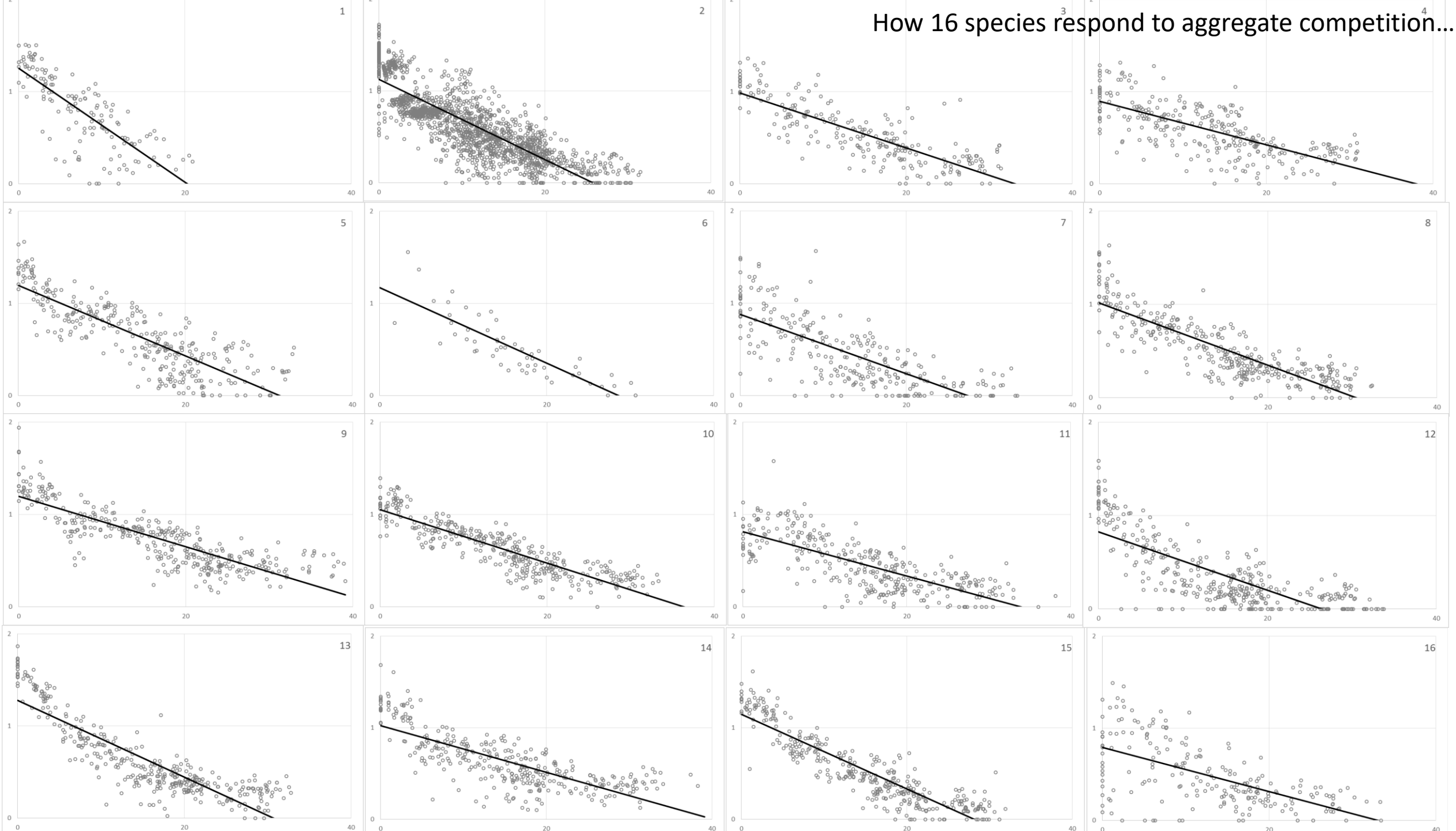
Planted 1991 (2002 photo); 16 spp x 28 reps, randomised complete block

1	14	2	11	3	1	6	15	4	9	14	5	6	14	12	9	15	8	3	10	10	15	13	3	10	14	2	6
6	13	5	9	9	10	14	7	12	3	2	10	8	5	13	1	7	16	4	12	14	4	8	7	1	16	7	13
12	4	16	7	2	16	8	4	11	13	8	16	3	10	11	15	9	5	13	6	6	9	1	12	8	9	5	3
10	3	8	15	12	11	5	13	6	15	1	7	7	2	16	4	11	2	14	1	5	2	16	11	15	4	11	12
13	5	11	12	13	8	7	5	1	15	4	12	5	16	9	7	16	13	9	7	11	10	15	14	1	13	2	16
4	8	16	2	3	11	2	4	8	16	11	13	13	1	4	14	4	3	14	8	13	2	12	8	14	9	3	8
7	14	10	9	9	16	10	14	3	7	14	2	3	6	8	15	12	5	11	6	16	5	7	9	12	4	10	6
15	6	1	3	6	15	1	12	10	9	6	5	10	12	2	11	1	10	2	15	4	1	6	3	7	11	5	15
				11	15	8	5	13	2	15	6	14	12	3	10	8	12	2	10	16	7	1	14	1	8	7	9
				13	1	4	16	3	9	5	8	7	13	4	6	3	14	9	16	6	15	12	11	15	14	13	6
				10	14	2	6	14	10	4	16	16	2	5	1	13	1	6	11	2	10	8	3	16	5	3	4
				7	3	9	12	12	1	11	7	11	8	9	15	7	15	4	5	4	13	9	5	11	12	10	2
				15	2	10	1	12	1	15	6	15	5	11	7	12	3	7	10	1	5	13	11				
				6	11	5	12	14	10	16	9	6	10	4	12	6	14	4	5	14	6	4	3				
				16	13	9	7	4	2	11	3	8	3	9	14	8	1	16	11	2	16	10	15				
				4	3	14	8	5	7	8	13	16	2	13	1	13	15	9	2	7	8	12	9				
				4	6	16	14	11	10	16	15	12	13	15	14												
				2	7	12	9	2	13	5	3	8	9	1	2												
				15	11	8	5	12	14	1	4	5	10	4	16												
				10	3	13	1	9	8	6	7	3	6	11	7												

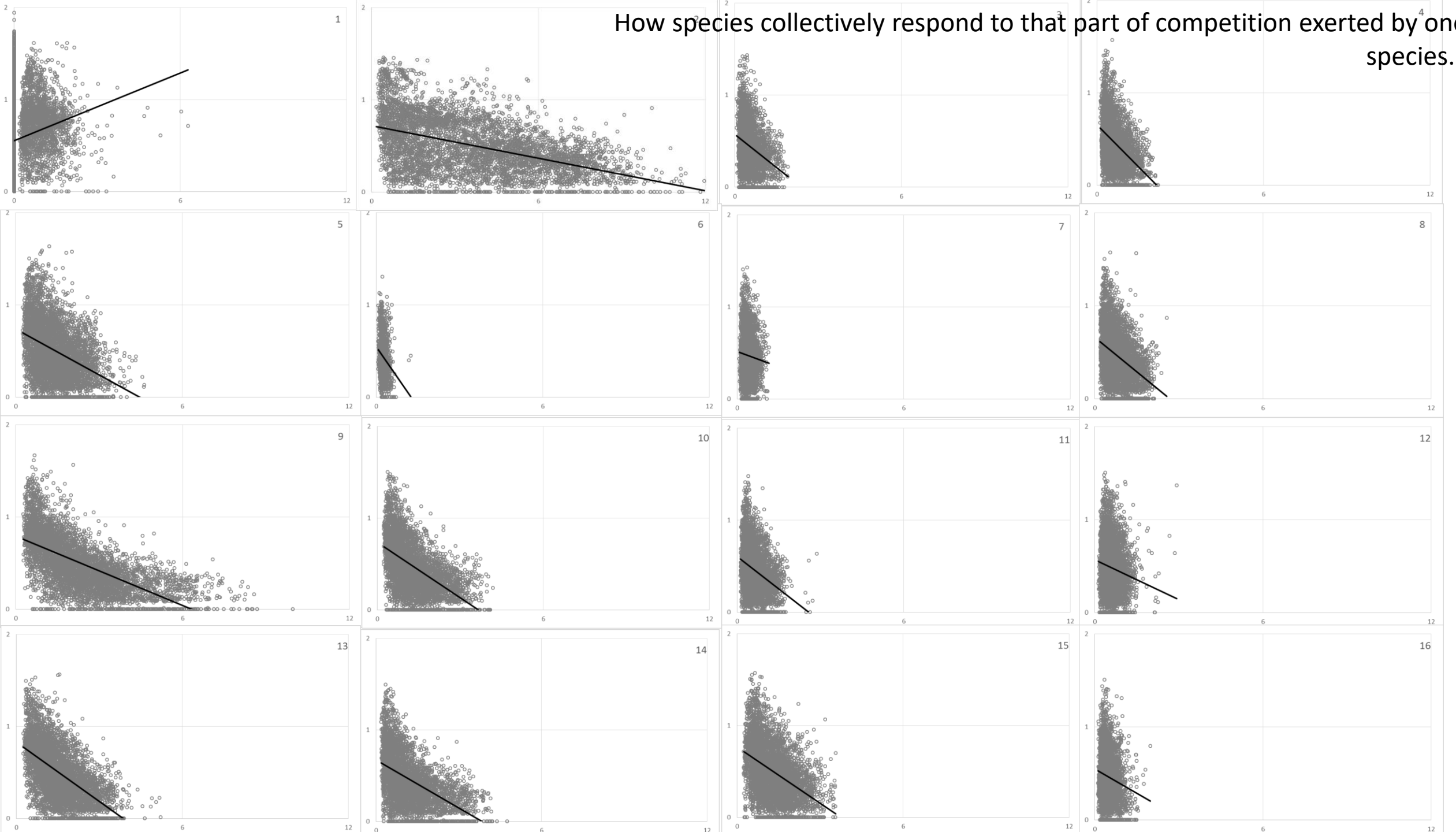
3 x 3 m spacing – total 90 x 66 m = 0.6 ha
28 blocks, each of 16 species
Single row of species 2 planted on perimeter


© 2018 Google
Imagery Date: 11/1/2017 27°05'48.40" S 152°
z: d1
x: x
y: y
z: d2
x: x
y: y
z: d3
x: x
y: y

How 16 species respond to aggregate competition…



How species collectively respond to that part of competition exerted by one species…



Slope of relationship between increment and competition index

Hoop pine

Cedrela odorata

Flindersia schottiana

Perpetrator

Victim

	1	2	3	4		6	7	8	9	10	11	12	13	14	15	16	All
1	-0.48	-0.23	-0.71	-0.91	-0.3	-1.47	-0.72	-0.62	-0.46	-0.55	-0.89	-0.47	-0.48	-0.81	-0.42	-0.66	-0.06
2	0.17	-0.11	-0.66	-0.68	-0.3	-1.42	-0.85	-0.62	-0.22	-0.38	-0.71	-0.78	-0.38	-0.37	-0.42	-0.69	-0.04
3	0.11	-0.08	-0.48	-0.38	-0.21	-0.30	-0.51	-0.38	-0.13	-0.25	-0.32	-0.55	-0.22	-0.23	-0.24	-0.36	-0.03
4	0.12	-0.06	-0.30	-0.35	-0.16	-0.67	-0.19	-0.29	-0.11	-0.18	-0.32	-0.41	-0.19	-0.17	-0.19	-0.22	-0.02
5	0.24	-0.11	-0.66	-0.69	-0.42	-0.90	-0.74	-0.53	-0.23	-0.39	-0.64	-0.62	-0.39	-0.36	-0.41	-0.78	-0.04
6	0.10	-0.13	-0.14	-0.34	-0.12	-0.08	-0.16	-0.28	-0.13	-0.19	-0.41	0.02	-0.20	-0.19	-0.20	-0.72	-0.04
7	0.09	-0.07	-0.39	-0.41	-0.16	-0.20	0.15	-0.37	-0.11	-0.28	-0.26	-0.08	-0.22	-0.21	-0.23	-0.23	-0.03
8	0.19	-0.08	-0.51	-0.53	-0.28	-0.69	-0.53	-0.55	-0.15	-0.28	-0.42	-0.50	-0.28	-0.25	-0.32	-0.40	-0.03
9	0.23	-0.09	-0.48	-0.48	-0.29	-0.96	-0.71	-0.42	-0.18	-0.26	-0.49	-0.57	-0.27	-0.26	-0.29	-0.62	-0.03
10	0.20	-0.08	-0.46	-0.47	-0.23	-0.75	-0.59	-0.44	-0.15	-0.27	-0.45	-0.50	-0.26	-0.24	-0.29	-0.46	-0.03
11	0.17	-0.05	-0.27	-0.32	-0.15	-0.45	-0.24	-0.26	-0.10	-0.18	-0.25	-0.25	-0.17	-0.17	-0.19	-0.19	-0.02
12	0.02	-0.06	-0.44	-0.38	-0.26	-0.38	-0.35	-0.34	-0.11	-0.23	-0.38	-0.18	-0.23	-0.20	-0.28	-0.32	-0.03
13	0.26	-0.12	-0.60	-0.67	-0.38	-1.01	-0.71	-0.59	-0.21	-0.39	-0.68	-0.89	-0.39	-0.36	-0.44	-0.84	-0.04
14	0.19	-0.07	-0.39	-0.36	-0.25	-0.35	-0.52	-0.39	-0.14	-0.20	-0.35	-0.37	-0.24	-0.23	-0.23	-0.48	-0.03
15	0.27	-0.11	-0.56	-0.68	-0.36	-1.01	-0.59	-0.55	-0.20	-0.35	-0.64	-0.70	-0.35	-0.33	-0.41	-0.68	-0.04
16	0.11	-0.06	-0.37	-0.36	-0.16	-0.77	-0.28	-0.28	-0.13	-0.24	-0.33	-0.36	-0.19	-0.20	-0.[illegible]	-0.36	-0.02
All	-0.04	-0.05	0.03	-0.02	-0.07	-0.05	-0.09	0.00	-0.04	-0.03	0.02	-0.06	-0.04	0.03	-0.08	[illegible]	-0.03

Acacia melanoxylon

Grevillea robusta

What to learn from this review?

Most introductory texts on plantation silviculture are unhelpful for FLR

Cannot test every interesting species in traditional trials – for strong evidence…
… we need bold hypotheses, efficient designs, robust methods for analysis

Still confined by “controlled growing environments” on homogeneous sites
… innovate systematic designs for site variation and social interactions

Don’t just copy … devise thoughtful experiments for inform our knowledge gaps

Competition via Hegyi (1974) index:
Relative size divided by relative distance
for all trees within a search radius 40 times sum of diameters

$$\sum_{j=1}^{n} \frac{d_j}{d_i} \cdot \frac{1}{dist_{ij}}$$

Simple, insightful, robust, …

Diameter increment data over-dispersed, so use square-root transform:

Increment$^{0.5}$