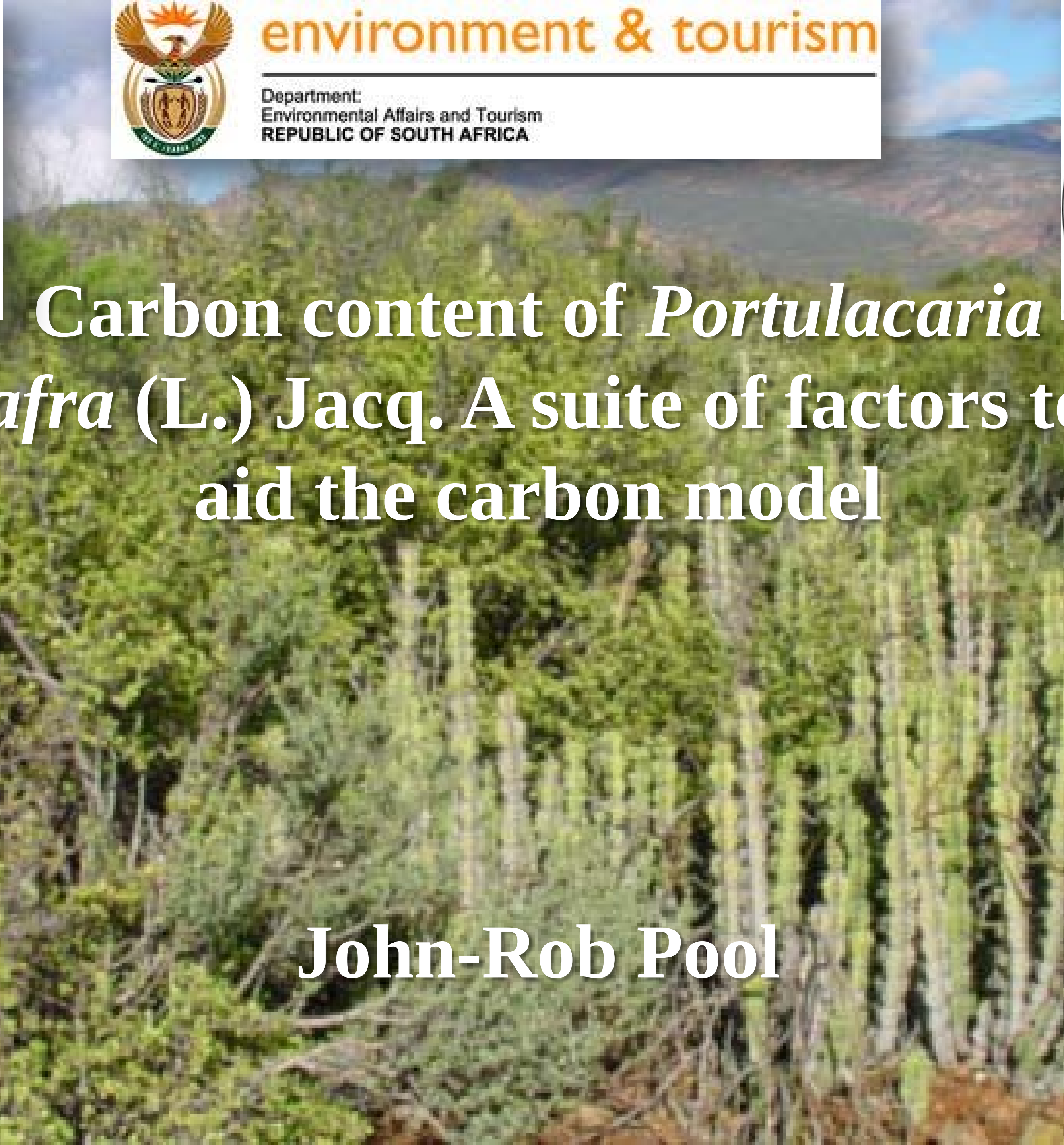
What is thicket to me?

Gamtoos Irrigation Board
Gamtoos-Besproeiingsraad

environment & tourism
Department:
Environmental Affairs and Tourism
REPUBLIC OF SOUTH AFRICA

Rhodes Restoration Research Grou

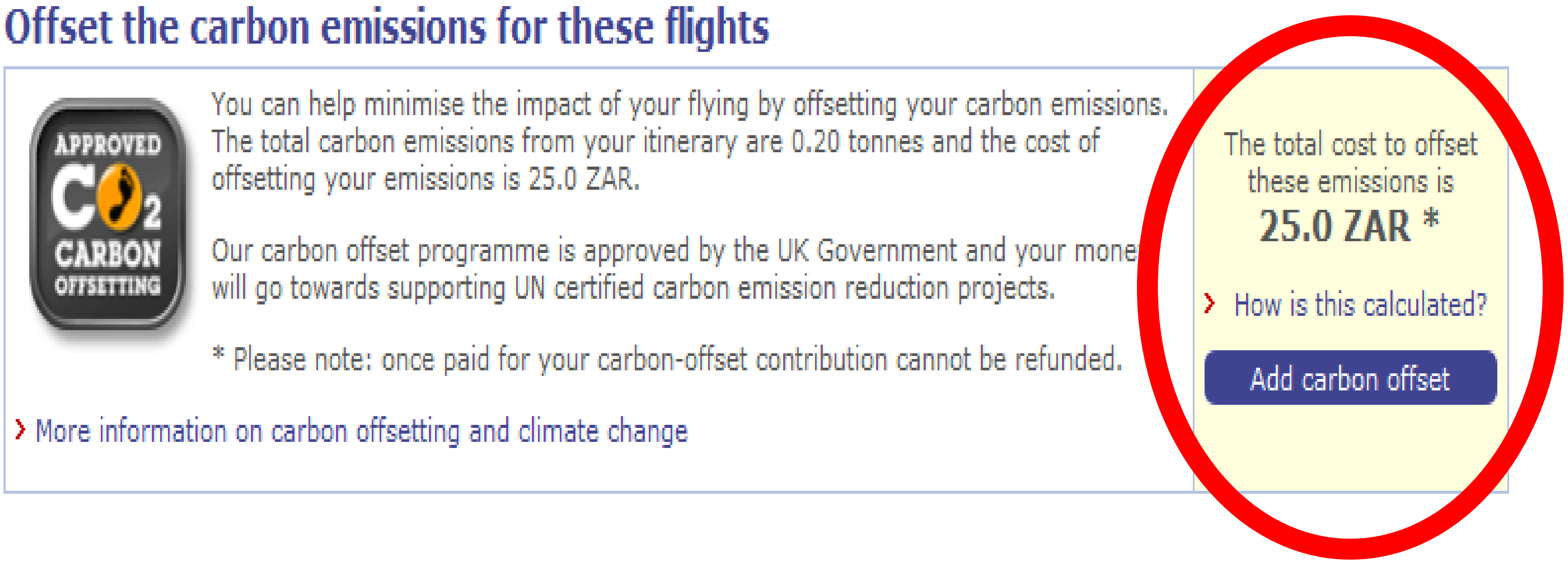


Carbon content of *Portulacaria afra* (L.) Jacq. A suite of factors to aid the carbon model

John-Rob Pool

Introduction:

- Climate change and the Anthropocene
- Carbon credits



Offset the carbon emissions for these flights

You can help minimise the impact of your flying by offsetting your carbon emissions. The total carbon emissions from your itinerary are 0.20 tonnes and the cost of offsetting your emissions is 25.0 ZAR.

Our carbon offset programme is approved by the UK Government and your mone will go towards supporting UN certified carbon emission reduction projects.

* Please note: once paid for your carbon-offset contribution cannot be refunded.

› More information on carbon offsetting and climate change

The total cost to offset these emissions is

25.0 ZAR *

› How is this calculated?

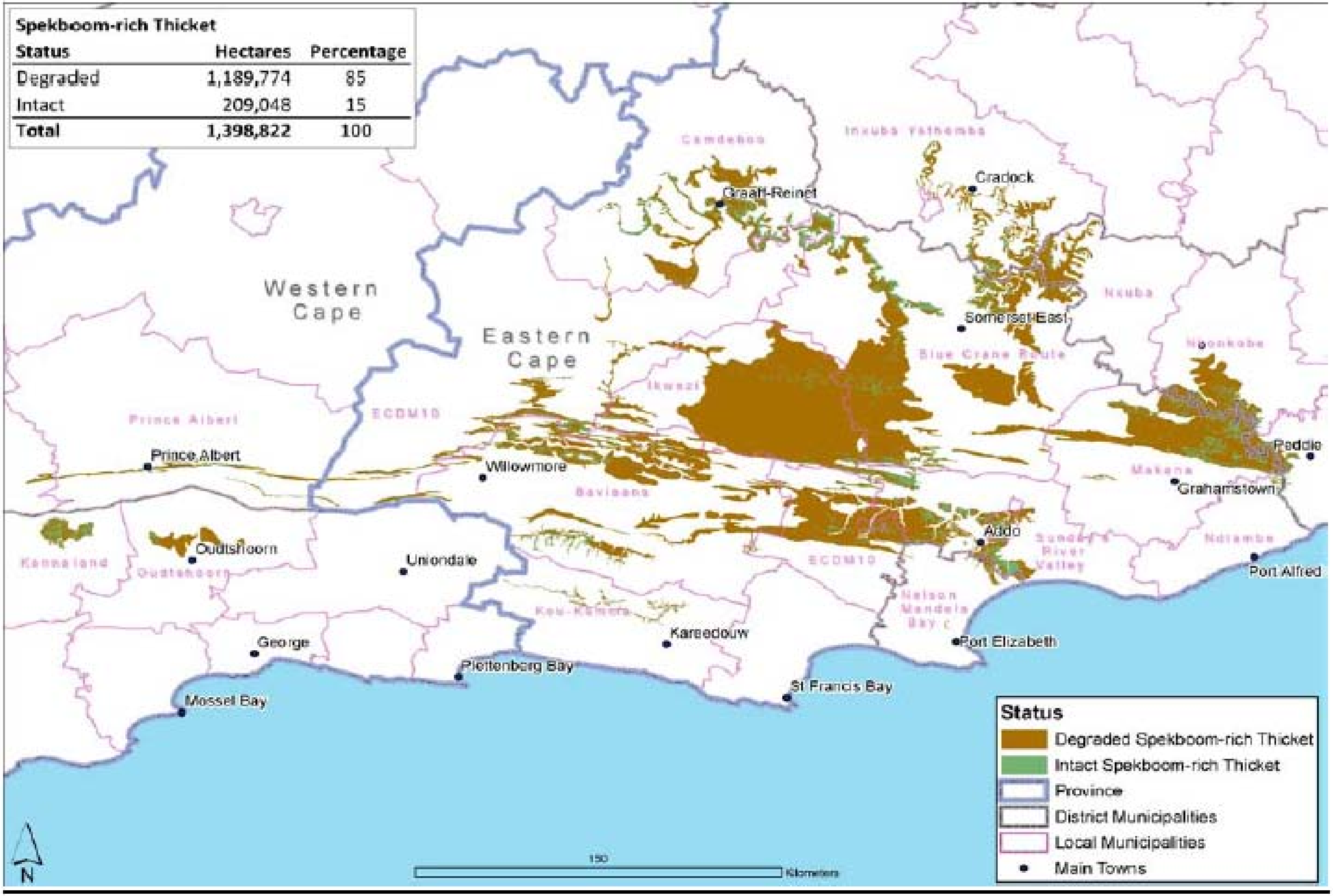
- Carbon market

Carbon offsetting initiatives

- Many initiatives worldwide.
- Each involve either generating renewable energy or restoring natural vegetation in degraded ecosystems.
  - Hydroelectricity scheme and wind farm (China)
  - Bayin'aoboa Wind Farm (Mongolia)
  - Wild Rose Conservation Site (Alberta, USA)
  - **Thicket Restoration (Eastern Cape, RSA)**

Albany Thicket

- *Portulacaria afra* rich thicket is indigenous to the SW part of the Eastern Cape.
- Falls under Albany Thicket (Mucina & Rutherford 2006).
- 1 400 000 hectares formerly covered.
- Now only 200 000 hectares remain (Figure 1)
- Degraded through overstocking of livestock and human activity (Blignaut *et al*. 2009).
- Contributor to Anthropogenic climate change

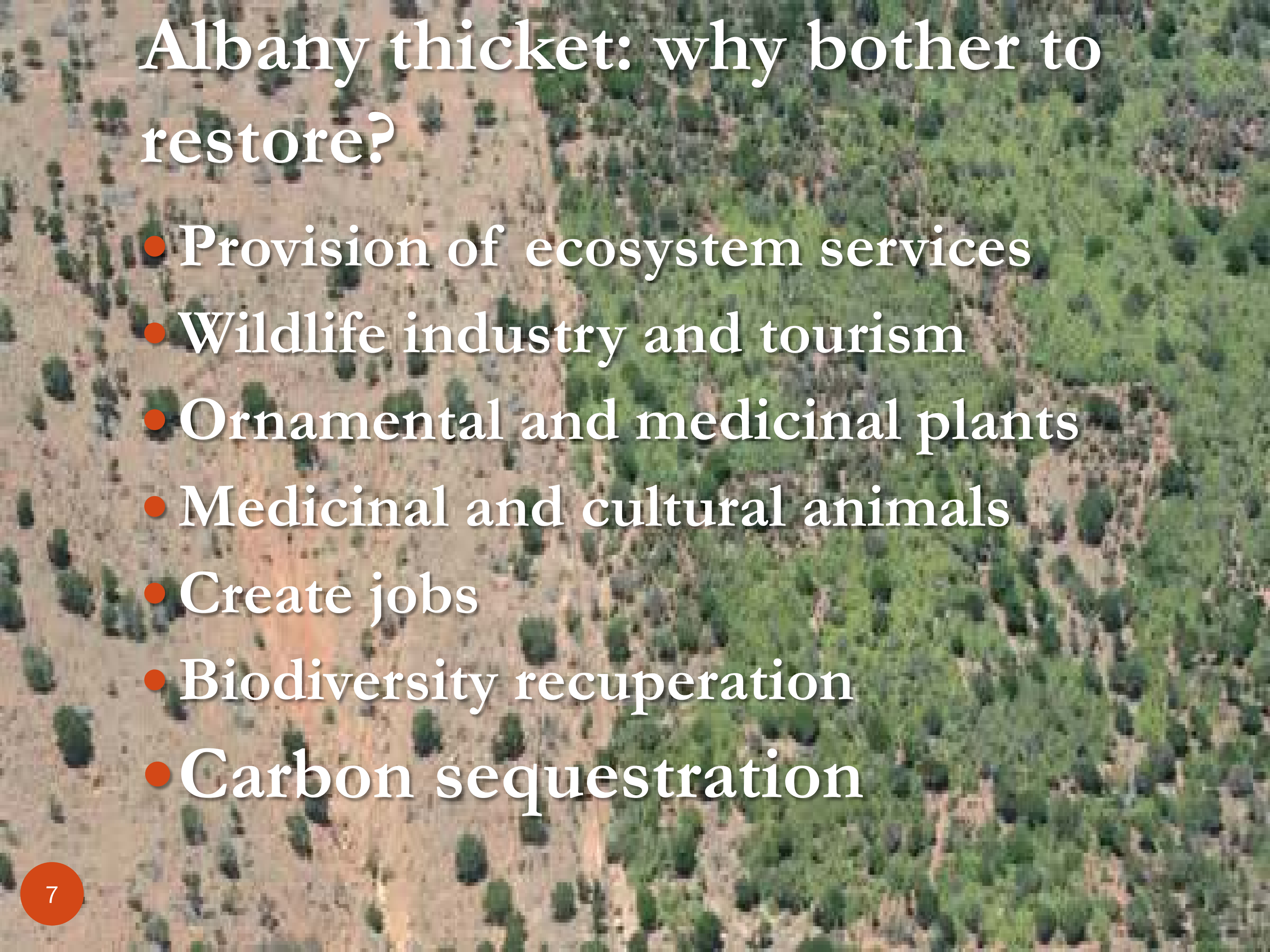


Spekboom-rich Thicket

Status	Hectares	Percentage
Degraded	1,189,774	85
Intact	209,048	15
Total	**1,398,822**	**100**

Figure 1: Degradation status of *P. afra* rich thicket in EC

Albany thicket: why bother to restore?



- Provision of ecosystem services
- Wildlife industry and tourism
- Ornamental and medicinal plants
- Medicinal and cultural animals
- Create jobs
- Biodiversity recuperation
- Carbon sequestration

Carbon sequestration by *P. afra*

- It is able to sequester proportionately large amounts of C compared with other plants (Guralnick *et al.* 1984).
- C_3 Photosynthesis
- CAM
- Plants excel in their arid and semi-arid environments (Guralnick & Ting 1986).
- Low rainfall results in slow decomposition rates so high carbon content in soil litter.

The great and elusive carbon model

- My research aims to contribute to the larger **carbon model** which *when/ever* complete will aid in:

  - buying and selling of carbon;
  - and provide a more accurate calculation of carbon credits held in *P. afra*

Aims

1. To find regressions, and subsequently develop allometric equations, between physical (measurable) parameters in both monostemmed and multistemmed specimens.
2. To identify the wet: dry ratios of both monostemmed and multistemmed plants.
   a. Are these different between components?
   b. Do ratios change, in the different components, as the plants grow larger?
3. To identify the proportion contributed by each component to the total dry biomass.
   a. Does this change as the plants grow larger?
4. To identify the exact carbon content (% of biomass) of *P. afra* components.
   a. Does carbon content of components change as the plants grow larger? Implications for stability of sequestered carbon!

Methods

- Transects laid out in an area of little herbivory and with good cohorts of *P. afra*
- Plants destructively sampled
- Physical parameters measured
- Plants split into components (Figure 2)
- Components weighed (total weight for plant calculated)
- Components dried until constant mass and reweighed
- Wet: dry ratios
- Material ground and homogenised for % C & N (g) analysis
- Regression analyses

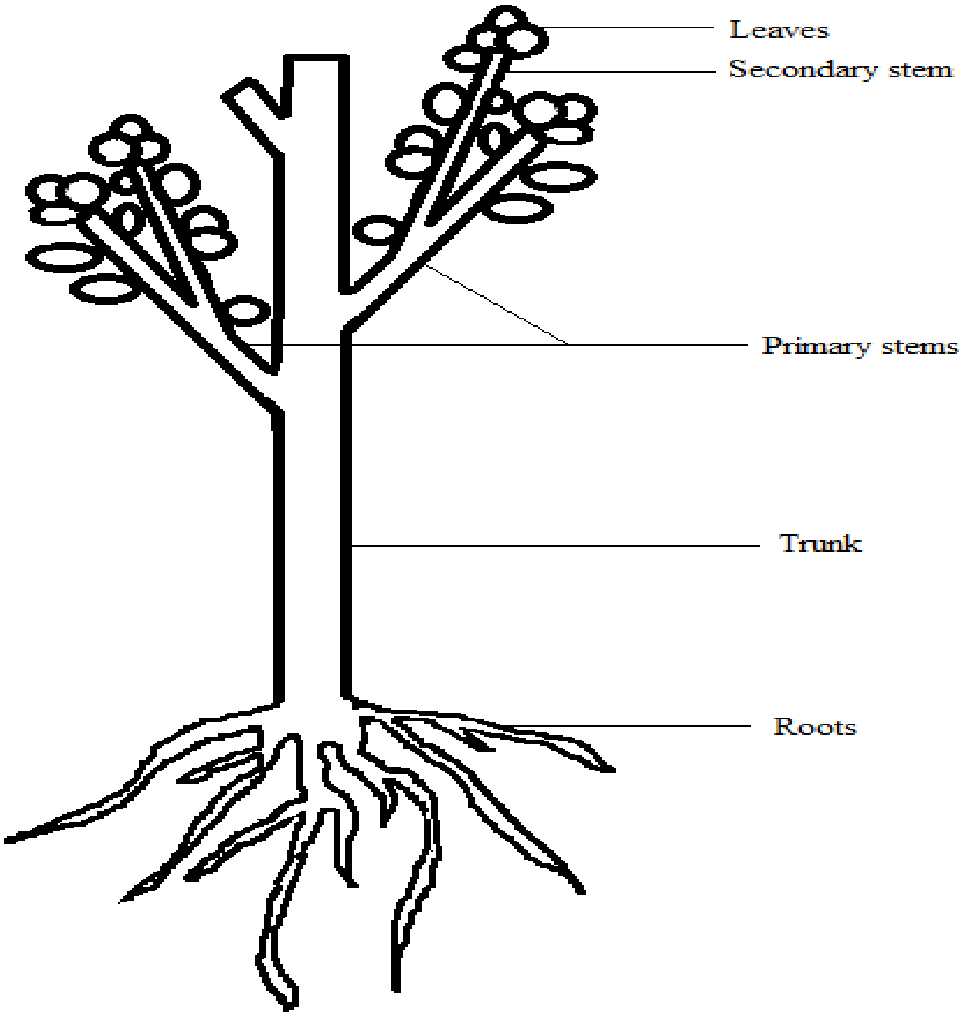


Figure 2: Simplified diagram of the components of *P. afra*

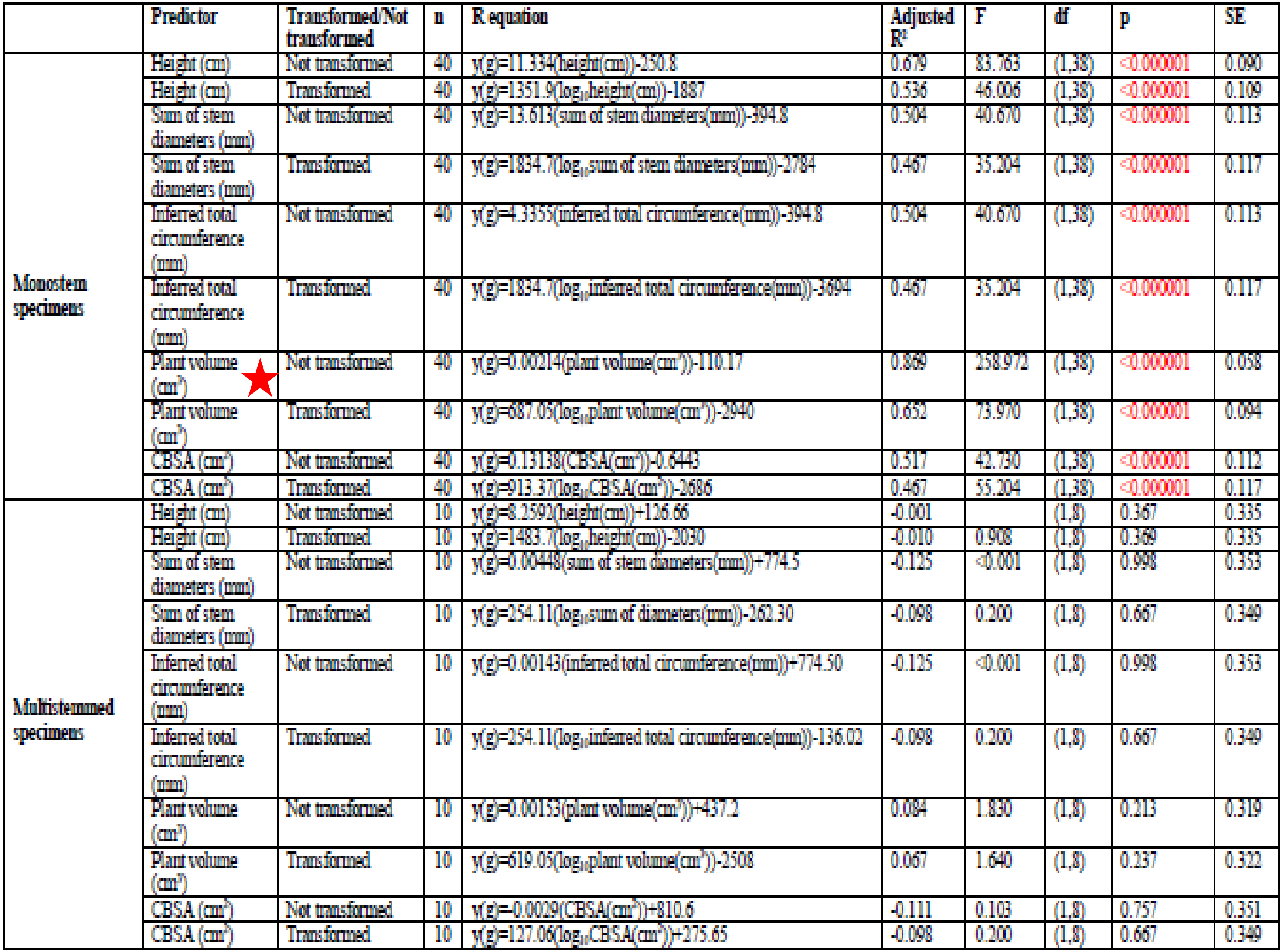
- No secondary stems

- No roots

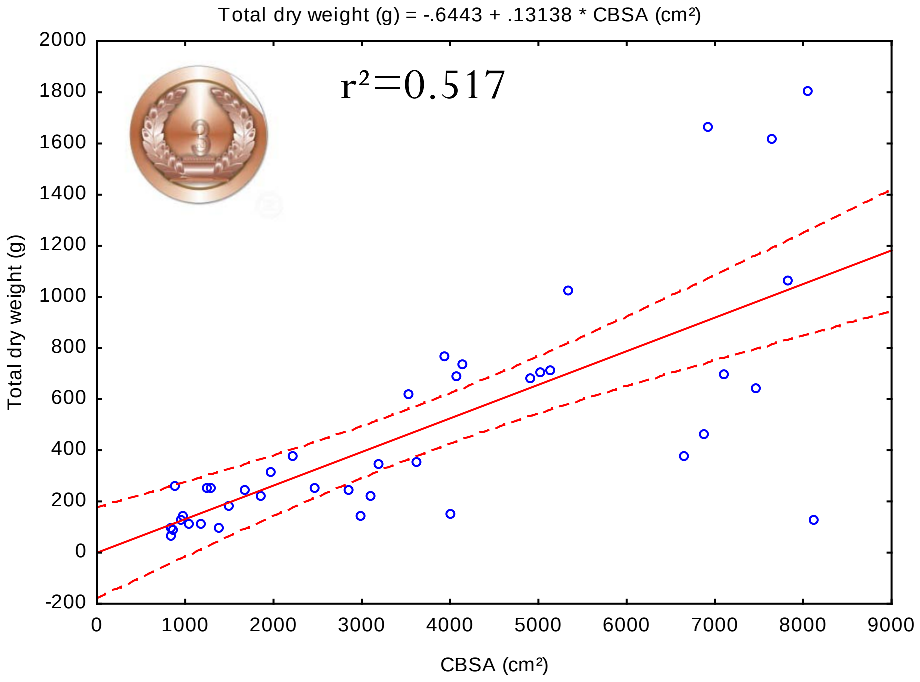
Results

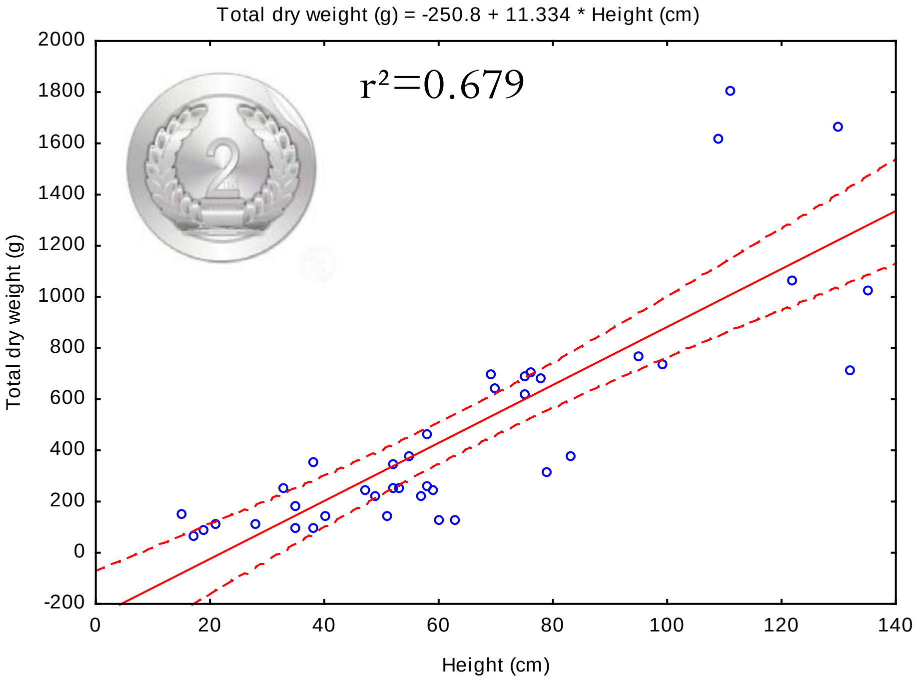
Regression analyses and allometry

Table 1: Regression table of predictors for monostemmed and multistemmed plants



	Predictor	Transformed/Not transformed	n	R equation	Adjusted R^2	F	df	p	SE
Monostem specimens	Height (cm)	Not transformed	40	$y(g)=11.334(\text{height(cm)})-250.8$	0.679	83.763	(1,38)	<0.000001	0.090
	Height (cm)	Transformed	40	$y(g)=1351.9(\log_{10}\text{height(cm)})-1887$	0.536	46.006	(1,38)	<0.000001	0.109
	Sum of stem diameters (mm)	Not transformed	40	$y(g)=13.613(\text{sum of stem diameters(mm)})-394.8$	0.504	40.670	(1,38)	<0.000001	0.113
	Sum of stem diameters (mm)	Transformed	40	$y(g)=1834.7(\log_{10}\text{sum of stem diameters(mm)})-2784$	0.467	35.204	(1,38)	<0.000001	0.117
	Inferred total circumference (mm)	Not transformed	40	$y(g)=4.3355(\text{inferred total circumference(mm)})-394.8$	0.504	40.670	(1,38)	<0.000001	0.113
	Inferred total circumference (mm)	Transformed	40	$y(g)=1834.7(\log_{10}\text{inferred total circumference(mm)})-3694$	0.467	35.204	(1,38)	<0.000001	0.117
	Plant volume (cm^3)	Not transformed	40	$y(g)=0.00214(\text{plant volume}(cm^3))-110.17$	0.869	258.972	(1,38)	<0.000001	0.058
	Plant volume (cm^3)	Transformed	40	$y(g)=687.05(\log_{10}\text{plant volume}(cm^3))-2940$	0.652	73.970	(1,38)	<0.000001	0.094
	CBSA (cm^2)	Not transformed	40	$y(g)=0.13138(\text{CBSA}(cm^2))-0.6443$	0.517	42.730	(1,38)	<0.000001	0.112
	CBSA (cm^2)	Transformed	40	$y(g)=913.37(\log_{10}\text{CBSA}(cm^2))-2686$	0.467	55.204	(1,38)	<0.000001	0.117
Multistemmed specimens	Height (cm)	Not transformed	10	$y(g)=8.2592(\text{height(cm)})+126.66$	-0.001		(1,8)	0.367	0.335
	Height (cm)	Transformed	10	$y(g)=1483.7(\log_{10}\text{height(cm)})-2030$	-0.010	0.908	(1,8)	0.369	0.335
	Sum of stem diameters (mm)	Not transformed	10	$y(g)=0.00448(\text{sum of stem diameters(mm)})+774.5$	-0.125	<0.001	(1,8)	0.998	0.353
	Sum of stem diameters (mm)	Transformed	10	$y(g)=254.11(\log_{10}\text{sum of diameters(mm)})-262.30$	-0.098	0.200	(1,8)	0.667	0.349
	Inferred total circumference (mm)	Not transformed	10	$y(g)=0.00143(\text{inferred total circumference(mm)})+774.50$	-0.125	<0.001	(1,8)	0.998	0.353
	Inferred total circumference (mm)	Transformed	10	$y(g)=254.11(\log_{10}\text{inferred total circumference(mm)})-136.02$	-0.098	0.200	(1,8)	0.667	0.349
	Plant volume (cm^3)	Not transformed	10	$y(g)=0.00153(\text{plant volume}(cm^3))+437.2$	0.084	1.830	(1,8)	0.213	0.319
	Plant volume (cm^3)	Transformed	10	$y(g)=619.05(\log_{10}\text{plant volume}(cm^3))-2508$	0.067	1.640	(1,8)	0.237	0.322
	CBSA (cm^2)	Not transformed	10	$y(g)=-0.0029(\text{CBSA}(cm^2))+810.6$	-0.111	0.103	(1,8)	0.757	0.351
	CBSA (cm^2)	Transformed	10	$y(g)=127.06(\log_{10}\text{CBSA}(cm^2))+275.65$	-0.098	0.200	(1,8)	0.667	0.349





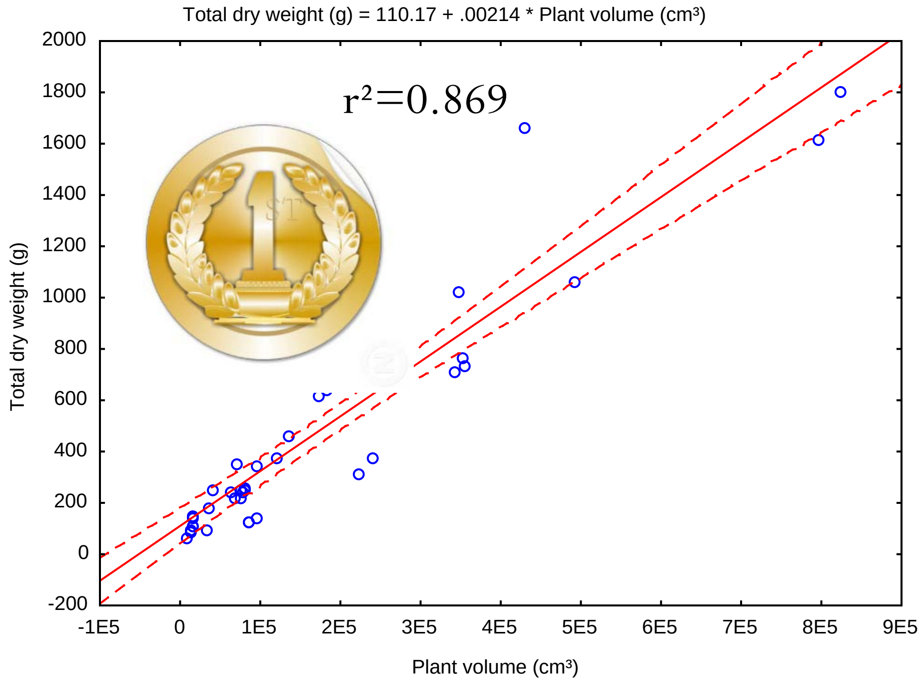


Figure 3: Plant volume (1), height (2), and CBSA (3) best predictors for above ground dry biomass

Wet: dry ratios

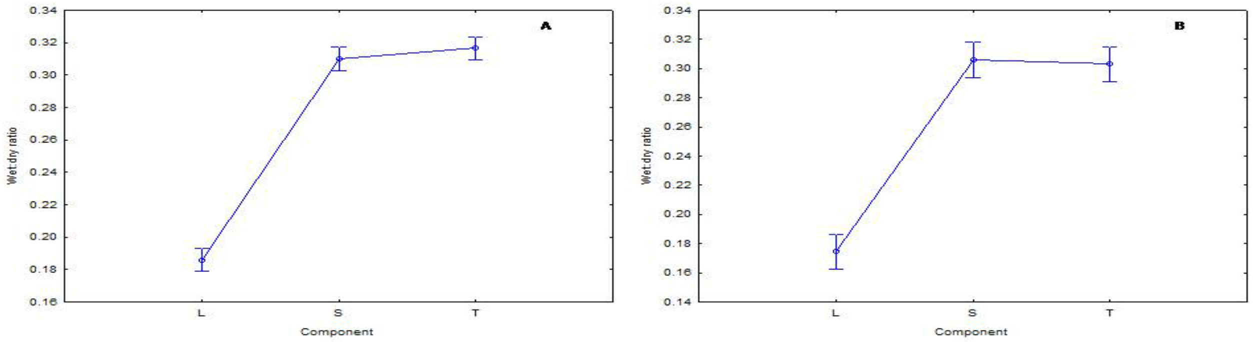


Figure 4: Statistical differences in wet: dry ratios. A = monostemmed; B = multistemmed

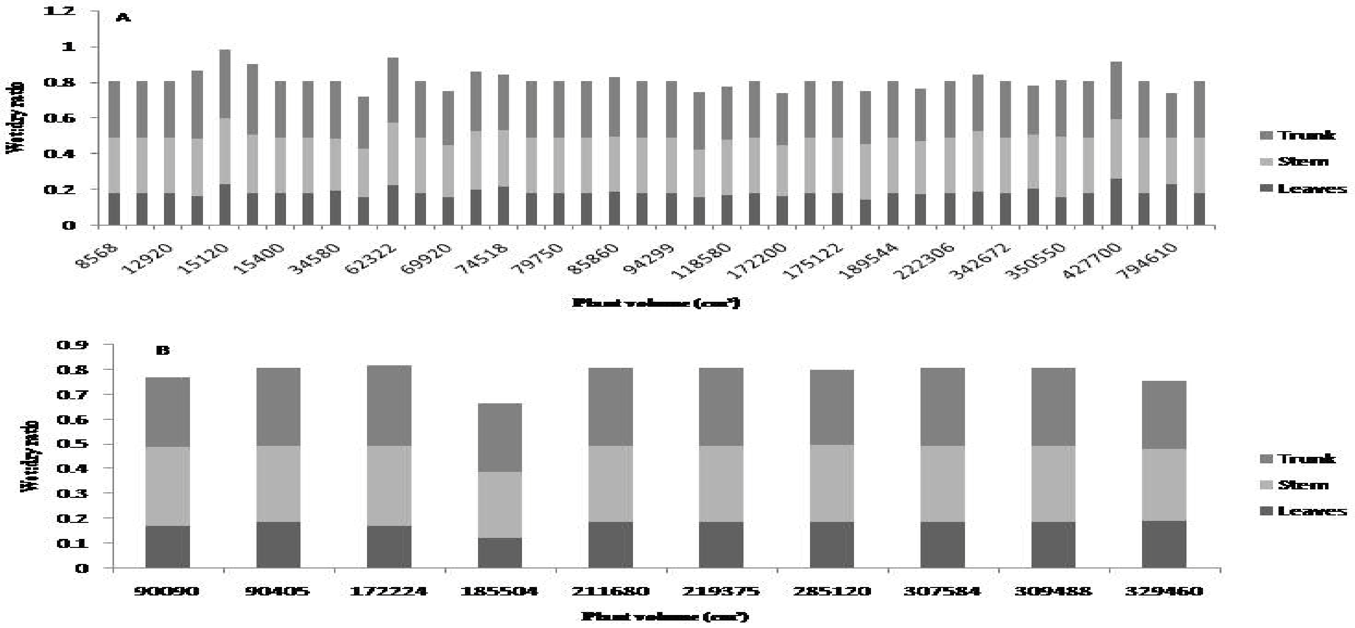


Figure 5: Wet: dry ratios over plant size (informed by plant volume) range.
A = monostemmed;
B = multistemmed

Contribution to total dry mass

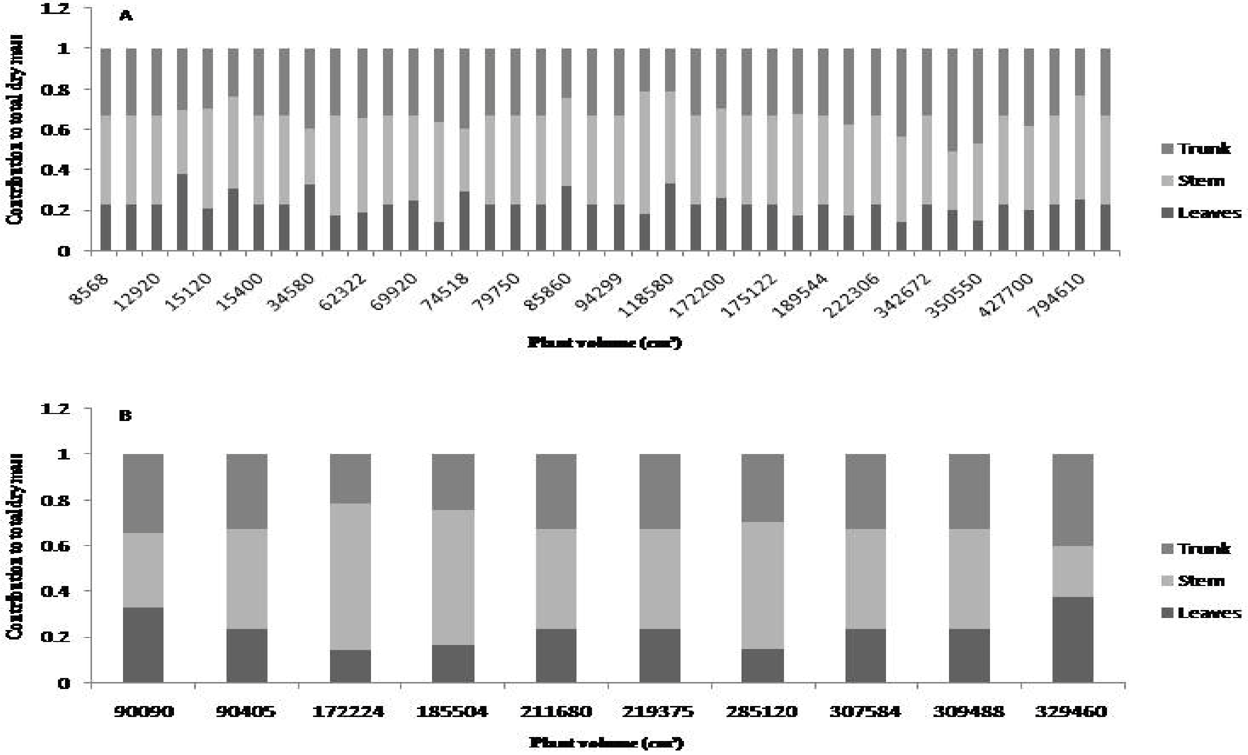


Figure 6: Contribution of each component to total dry mass over size range (informed by plant volume)

Percentage carbon & nitrogen content of *P. afra* components

Results still pending!

...will be made available...

Discussion of results

- Plant volume, height, CBSA best predictors of total plant dry biomass (Table 1; Figure 3).
- Good predictors for multistemmed specimens are elusive (Table 1)! (Sample size???)
- Wet: dry ratios are significantly different between leaves and (stems and trunks) (Figure 4). Statistical analysis of changes in ratios as size increases are lacking (Figure 5).
- Contribution to total biomass appears to relatively uniform (Figure 6). Nonetheless, needs to be subjected to statistical analysis.

Complicating factors

- Sampling effort and sampling method

- Herbivory
- Cohabitation

- Extreme morphological differences in *P. afra*
- Shape and size of plants over rainfall gradient
- Genetics? Sub-species?

Conclusion
Playing devil's advocate

- **The only constant in life is change!**
- Scientific licence: **The only constant in nature is change**
- If this is the case, and nature and thicket is constantly changing (*P. afra* morphology!) then how can we base such an extensive and potentially lucrative economy on fixed and static models and understandings!

References 1

- Blignaut, J., Cowling, R., Knipe, A., Marais, C., Marais, S., Mills, A., Powell, M., Sigwela, A., Skowno, A., 2009. Restoring degraded thicket, creating jobs, capturing carbon, and earning green credit. *Department of Environmental Affairs and Tourism*.
- Department of Environmental Affairs and Tourism, South Africa. 2011. (Online) http://soer.deat.gov.za/State_of_the_Environment.html (Accessed 10 April 2011).
- Guralnick, L.J., Rorabaugh, P.A, Hanscom, Z., 1984. Seasonal shifts of Photosynthesis in Portulacaria afra (L.) Jacq. *Plant Physiology* 76, 643-646.
- Guralnick, L.J., Ting, I.P., 1986. Seasonal response to drought and rewatering in Portulacaria afra (L.) Jacq. *Oecologia* 70, 85-91.
- Milton, S.J., Dean, R.J., 1995. South Africa's arid and semiarid rangelands: Why are they changing and can they be restored? *Environmental monitoring and assessment* 37, 245-264.

References 2

- Mucina, L., Rutherford., M.C., (eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia 19*. South African National Biodiversity Institute, Pretoria.
- Penzhorn, B.L., Robbertse, P.J., Olivier, M.C., 1974. The influence of the African Elephant on the vegetation of the Addo Elephant National Park. *Koedoe* 17, 137-158.
- Powell, M.J., 2009. Restoration of degraded subtropical thickets in the Baviaanskloof Megareserve, South Africa. MSc. Thesis, Rhodes University, South Africa.
- Raupach, M.R., Canadell, J.G., 2010. Carbon and the Anthropocene. *Current Opinion in Environmental Sustainability* 2, 210-218.
- Sedjo, R.A., Marland, G., 2003. Inter-trading permanent emissions credits and rented temporary carbon emissions offsets: some issues and alternatives. *Climate Policy* 3, 435-444.
- Society for Conservation Biology. 2011. (Online) http://www.conbio.org/Activities/Committees/EcologicalFootprint/CarbonOffset/index.cfm (Accessed 10 April 2011).

Thank you

Questions?