Plant Functional Types on Marion Island

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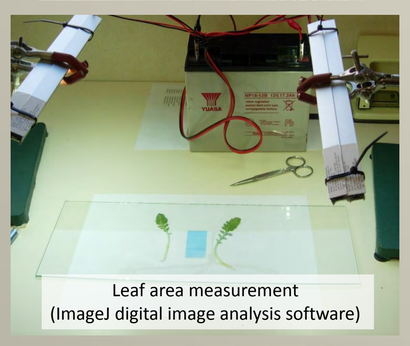
What are Plant Functional types (PFT's) ?

- Groupings of species by similarities in their resource use and response to environmental and biotic controls.
- Alternative to taxonomic species-based approach to plant community description.
- Members of a PFT - share similar functional traits or properties and hence a similar ecology.

Why should this approach be used ?

- Classical species-based approach is too complicated and onerous to achieve a whole-island assessment of ecosystem functioning.
- Group the species into plant functional types (PFTs) to reduce this complexity.
- Use the PFT groupings in models to predict how ecosystem function will respond to climate change and other perturbations such as the introduction of invasive alien organisms by humans or changes in seabird and seal populations.


Plant height measurement


Leaf area measurement
(ImageJ digital image analysis software)


Plant tag – Leaf lifespan/phenology

Weighing procedure


Cross section for bryophyte identification


Chlorophyll fluorescence measurement

The following traits were measured on 25 vascular species (*) and 21 bryophyte species (^) at 78 sites

Plant Functional traits	Traits related to or associated with :	Measure-ment unit	Number of reps*	Equipment/approach
Vegetative traits				
Growth form * ^	Plant strategy and climatic factors	Cat.	5	Field observation
Plant height * ^	Competitive vigour, fecundity and above ground biomass	Mm	25	Ruler, callipers
Clonality * ^	Ability to reproduce vegetatively	Cat.	10	Field observation
Leaf traits				
Leaf lifespan *	Plant growth rate, plant protection and strategy to conserve nutrients	month	10	Plant tags, Field observation
Leaf phenology *	Competition avoidance strategies	month	10	Plant tags, Field observation
Specific leaf area *	Relative growth rate, mass-based maximum photosynthesis rate, fertility status, leaf structural and defence components	$mm^2\ mg^{-1}$	$10^a,2^b$	Digital Camera, ImageJ digital image analysis software
Leaf size *	Leaf energy and water balances, heat and cold stresses and water stress	mm^2	$10^a,2^b$	Digital Camera, ImageJ digital image analysis software
Leaf dry matter content *	Leaf tissue density, relative growth rate and productivity	$mg\ g^{-1}$	$10^a,2^b$	Balance
Leaf N, P, K , Ca, Na and Mg concentration #	Plant fertility	$mg\ g^{-1}$	4	Bemlab, Somerset West
Chlorophyll content * ^	Photosynthesis rate, leaf fertility status and productivity	$mg\ m^2$	$10^a,2^b$	CCM-300 Chlorophyll Content Meter
Stomata density *	Transpiration rate, desiccation tolerance, photosynthesis rate and productivity	stomata mm^{-2}	$10^a,2^b$	Microscope, varnish impression
Relative water content *	Desiccation tolerance, leaf water status and osmoregulation	$g\ g^{-1}$	$10^a,2^b$	Balance
Stem traits				
Stem specific density *	Plant structural strength , relative growth rate and stem defenses against pathogens	$mg\ mm^{-3}$	10	Balance, ImageJ digital image analysis software
Stem dry matter content *	Relative growth rate	$mg\ g^{-1}$	10	Balance
Below-ground traits				
Root :shoot mass ratio *	Strength of allocation of resources to belowground sphere	$g\ g^{-1}$	10	Balance
Specific root length *	Rates of water and nutrient uptake etc	$m\ g^{-1}$	2	Calliper, balance, ImageJ digital image analysis software
Regenerative traits				
Dispersal mode *	Regeneration	Cat.	3	Field observation, microscope
Dispersule size and shape *	Depth and longevity in the soil seed bank	unitless	$10^a,5^b$	Calliper
Seed mass *	Dispersability and seedling survivability	mg	$10^a,5^b$	Balance
Physiological traits				
Optimal quantum yield of photosynthesis * ^	Maximum quantum yield	unitless	$4^a,1^b$	Hansatech FMS2 and Heinz Walz PAM-2500 pulse amplitude modulated fluorometers
Effective quantum yield of photosynthesis * ^	The actual probability the light absorption causes electron transport	unitless	$4^a,1^b$	
Photochemical quenching * ^	Proportion of open PSII reaction centers	unitless	$4^a,1^b$	
Non-photochemical quenching*^	Heat dissipation of absorbed energy	unitless	$4^a,1^b$	
Photosynthetic electron transport rate (ETR) * ^	Rate at which electrons move through the thylakoid electron transport chain to produce NADPH and ATP	$\mu mol\ m^{-2}\ s^{-1}$	$4^a,1^b$	
Maximum ETR * ^	Maximum electron transport rate attainable by the particular sample	$\mu mol\ m^{-2}\ s^{-1}$	$4^a,1^b$	Analysis of the ETR:PAR response using the Nonlinear Estimation Procedure in STATISTICA 10 (Statsoft, 2010) with the Eilers, Peeters and Platt models.
Initial slope of ETR: PAR response * ^	Quantum efficiency of photosynthesis	$mol\ mol^{-1}$	$4^a,1^b$	
Onset of light saturation of ETR (I_k) * ^	Minimum saturating irradiance	$mol\ m^{-2}\ s^{-1}$	$4^a,1^b$	

*** Number of samples taken at each locality. Where there are two numbers**, [a] is the number of individuals and [b] the number of leaves from each individual. Cat. = categorical variable.
# 11 vascular species and 11 bryophyte species sampled every second month for nutrient analysis.

Results

- Measurements are complete, the results are currently being analysed.
- Preliminary conclusions are that functional type is associated with taxonomic identity (bryophyte/monocot/dicot), growth form (forb/graminoid/cushion/shrub) and the relative importance of the ecological forcing variables (manuring, salt spray, exposure and moisture) at any particular site.
- Since these forcing variables determine habitat type, what functional type/s occur is largely a function of habitat.

Recommendations for further research

- This study addressed mainly "soft" traits – structural characteristics and pigment concentrations - that are surrogates of plant function.
- The "hard" trait measurements (chlorophyll fluorescence characteristics) should be expanded to include gas exchange measurements of photosynthesis and transpiration rates and of stomatal conductance.
- Because of their dominance in the island's vegetation, bryophytes deserve special attention, again focussing on hard traits revealed by fluorescence and gas exchange measurements.