More figures!

Cape vs SWA publication

Ruan van Mazijk

2018-08-13

Defining the models

I have fit the following models, separately for the Cape and SWA:

1. $HDS\ richness \sim \overline{QDS\ richness}$
2. $HDS\ richness \sim \overline{QDS\ richness} + \overline{QDS\ turnover}$
3. $HDS\ richness \sim \overline{QDS\ richness} * \overline{QDS\ turnover}$

And a null model ($\overline{HDS\ richness}$), too, for each region.

Comparing model parameterisations nos. 0–3

I compared these models using likelihood ratio tests and ΔAIC-scores.

What I find (Tables 1,2) is that there is support for there being an interaction between mean QDS richness and turnover in affecting HDS richness. Interestingly, the models with only additive effects (model parameterisation no. 2), is incredibly poorly supported.

I think, then, we should and can interpret the interaction-effects models (parameterisation no. 3), the summaries of the coefficients of which are in Table 3.

Interpreting model parameterisation no. 3

If we imagine the HDS richness surface as a function of mean QDS richness and turnover, then Fig. 3 represents Fig. 1 with regression lines that are "slices" of the regressed HDS richness surface ("sliced" at the turnover values keyed).

From this we can see that increasing mean QDS turnover causes mean QDS richness to have a greater positive effect on HDS richness.

This makes sense to me, as it shows how QDS richness and turnover act synergistically to produce HDS richness.

What is nice to compare between Fig. 4 and 5 (Cape and SWA models, respectively), is that this synergy is strongest in SWA. I.e., Cape richness is more strongly determined by higher alpha richness.

This is complicated by how SWA has lower observed turnover values…

But I shall leave that for a discussion with you two in person.

Exploring the distributions of partitioned turnover and richness

Additive definition of γ

After our meetings on Monday (2018-08-13), if we take Whittaker's additive definition of broader scale diversity,

$$\gamma = \alpha + \beta$$

Then we can define a sort of "residual" β, or turnover:

$$\beta_{residual} = \gamma - \alpha$$

Alternatively, we can take Whittaker's multiplicative definition of γ,

$$\gamma = \alpha \times \beta$$

Such that the residual turnover is:

$$\beta_{residual} = \frac{\gamma}{\alpha}$$

Either way (we can discuss which definition is more suited to our work… See Jost 2007 Ecology 88(10)) we can explore how these metrics of the "partitioning" of HDS richness ($\approx \gamma$) into QDS richness ($\approx alpha$) and turnover ($\approx beta$), the things that come together to produce HDS richness.

Let us compare the distributions of additive-style residual turnover values between the Cape and SWA. I check for normality and homoscedasticity using Shapiro-Wilk and variance/F-ratio tests respectively (normal when $P_{ShapiroWilk} \geq 0.05$; equal variance when $P_F \geq 0.05$). If are normal and homoscedastic, a student's t-test was performed between the two regions' values. If data could not be normalised with a $log(x + 1)$-transformation, a Mann-Whitney U-test was performed.

```
## $assumptions
## normal_and_homoscedastic
##                     TRUE
##
## $test
##
##  Welch Two Sample t-test
##
## data:  x and y
## t = 2.1943, df = 151.19, p-value = 0.02974
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##   10.4545 199.4721
## sample estimates:
## mean of x mean of y
##  489.2695  384.3061
```

Now let us compare the distributions of mean QDS turnover values, raw, just for interest's sake

```
## $assumptions
## normal_and_homoscedastic
##                     TRUE
```

```
##
## $test
##
##  Welch Two Sample t-test
##
## data:  x and y
## t = 8.0733, df = 236.84, p-value = 3.453e-14
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.06728132 0.11071571
## sample estimates:
## mean of x mean of y
## 0.9015812 0.8125827
```

If we scale additive residual turnover and mean QDS richness to be components of HDS richness,

$$\beta_{residual_{prop}} = \frac{\beta_{residual}}{\gamma} \alpha_{prop} = \frac{\alpha}{\gamma}$$

These are the additive "components" of HDS richness ($\approx \gamma$).

Let's compare the distributions of these between the Cape and SWA.

```
## $assumptions
##     normal_and_homoscedastic log_normal_and_homoscedastic
##                        FALSE                        FALSE
##
## $test
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x and y
## W = 12374, p-value = 0.0007264
## alternative hypothesis: true location shift is not equal to 0
```

```
## $assumptions
##     normal_and_homoscedastic log_normal_and_homoscedastic
##                        FALSE                        FALSE
##
## $test
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x and y
## W = 7635, p-value = 0.0007264
## alternative hypothesis: true location shift is not equal to 0
```

Multiplicative definition of γ

Now what about the other way of defining "residual" turnove (using Whittaker's multiplicative definition)?

$$\beta_{residual} = \frac{\gamma}{\alpha}$$

I call this the "product" residual turnover, as it stems from a γ defined as the produce of α and β.

Table 1: LRT of models. Each row represents the change in signficance etc. of that model relative to the one directly above it (models are nested).

model	Res.Df	RSS	Df	Sum of Sq	Pr(>Chi)
Cape models					
Cape_m0	96	54006496.1	NA	NA	NA
Cape_m1	95	2375858.0	1	51630638.152	0.0000000
Cape_m2	94	2372603.2	1	3254.761	0.6768949
Cape_m3	93	1743197.1	1	629406.079	0.0000000
SWA models					
SWA_m0	167	36685006.9	NA	NA	NA
SWA_m1	166	2072184.7	1	34612822.293	0.0000000
SWA_m2	165	1910075.2	1	162109.443	0.0000000
SWA_m3	164	743692.7	1	1166382.509	0.0000000

Table 2: Delta AIC-scores of models.

model	k	AIC	DeltaAIC
Cape models			
Cape_m0	2	1562.575	327.03820
Cape_m1	3	1261.571	26.03486
Cape_m2	4	1263.438	27.90189
Cape_m3	5	1235.537	0.00000
SWA models			
SWA_m0	2	2546.141	648.94725
SWA_m1	3	2065.349	168.15478
SWA_m2	4	2053.663	156.46936
SWA_m3	5	1897.194	0.00000

```
## $assumptions
##     normal_and_homoscedastic log_normal_and_homoscedastic
##                        FALSE                        FALSE
##
## $test
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x and y
## W = 12374, p-value = 0.0007264
## alternative hypothesis: true location shift is not equal to 0
```

Table 3: Cape and SWA models no. 3

term	estimate	std.error	statistic	p.value
Cape models				
(Intercept)	765.3761251	299.3725688	2.5566007	0.0121897
mean_QDS_richness	0.3713908	0.3427447	1.0835783	0.2813531
mean_QDS_turnover	-749.2468701	315.0719881	-2.3780180	0.0194520
mean_QDS_richness:mean_QDS_turnover	2.3457178	0.4048015	5.7947365	0.0000001
SWA models				
(Intercept)	20.4177285	95.1402761	0.2146066	0.8303407
mean_QDS_richness	-0.3788205	0.1661047	-2.2806121	0.0238587
mean_QDS_turnover	-29.9402826	104.3226427	-0.2869970	0.7744769
mean_QDS_richness:mean_QDS_turnover	3.5804810	0.2232522	16.0378321	0.0000000

Table 4: ...

variable	median	quantile_5perc	quantile_95perc
Cape			
add_mean_QDS_richness_prop	0.3693416	0.2799315	1.0000000
add_residual_turnover	379.5000000	0.0000000	1269.9000000
add_residual_turnover_prop	0.6306584	0.0000000	0.7200685
SWA			
prod_residual_turnover	2.7075209	1.0000000	3.5723039
add_mean_QDS_richness_prop	0.4129280	0.3119986	1.0000000
add_residual_turnover	419.7500000	0.0000000	804.3500000
add_residual_turnover_prop	0.5870720	0.0000000	0.6880014
prod_residual_turnover	2.4217298	1.0000000	3.2059276

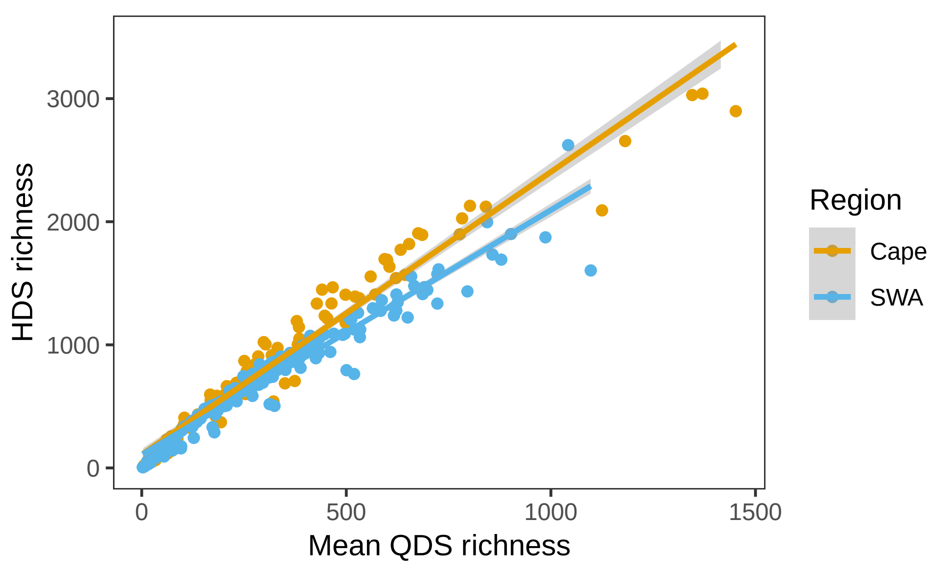

Figure 1: Newly generated mean QDS richness vs HDS richness—now with same axis limits as Fig. 2!

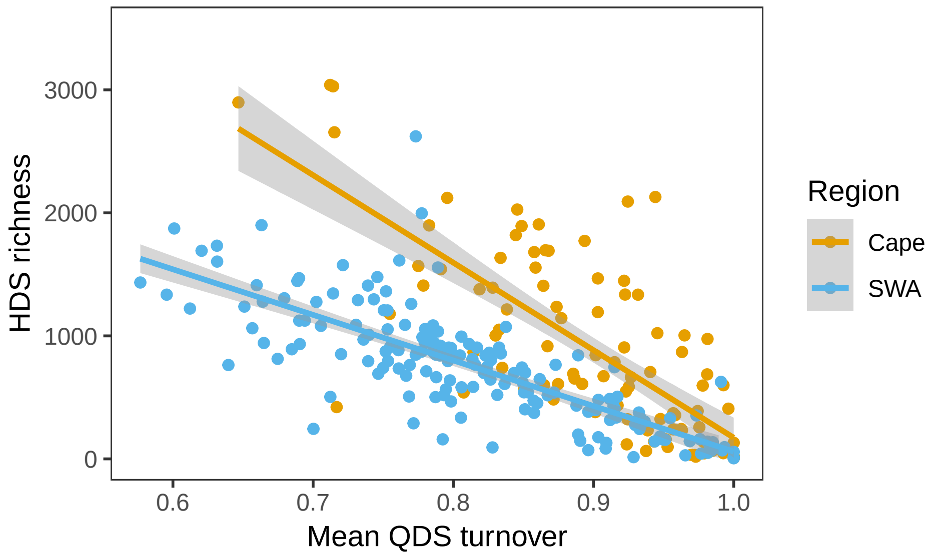

Figure 2: Newly generated mean QDS turnover vs HDS richness—now with same axis limits as Fig. 1!

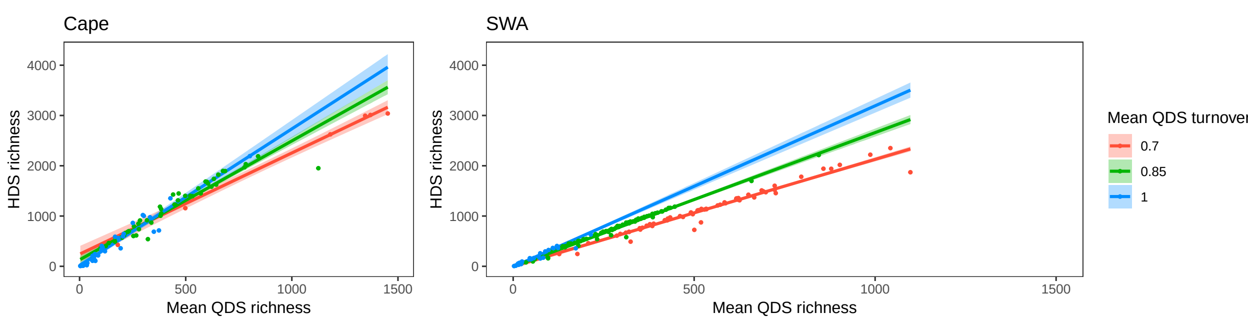

Figure 3: Cape and SWA models with parameterisation no. 3

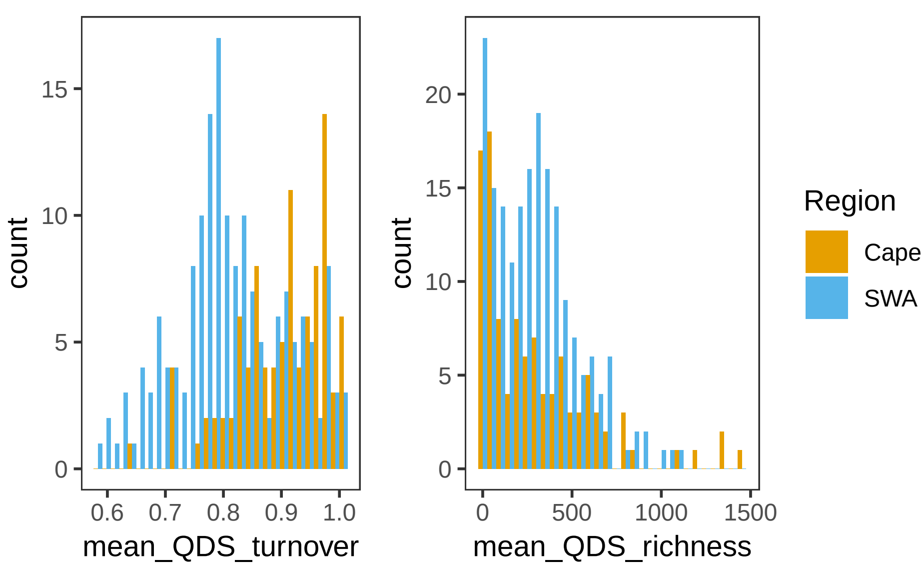

Figure 4: Distributions of observed mean QDS turnover and richness values for both regions.

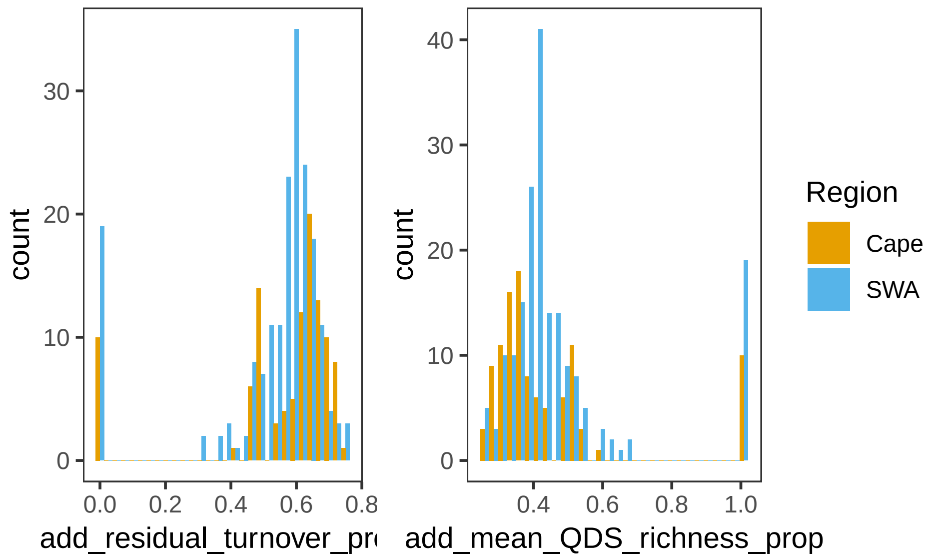

Figure 5: Distributions of additively defined contributions of β and α to HDS richness.

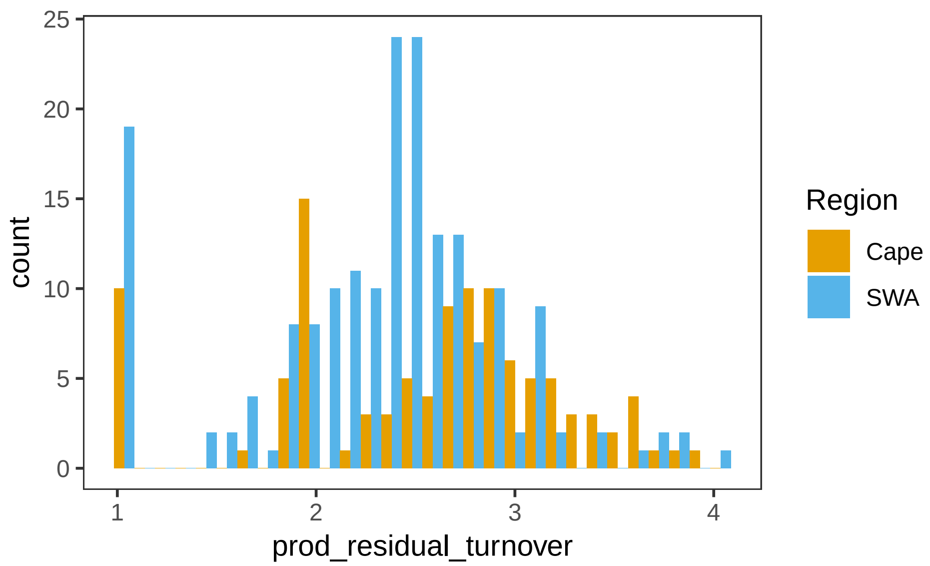

Figure 6: Distributions of multiplicatively defined β values.