Differences in the spatial structure of the primary and secondary tropical rain forests

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Spatial analyses and TRFs

We expect that during stand aging

- patterns start from clumped (aggregated) and change to random or regular
- decreasing autocorrelation of plant sizes

Focus on the spatial patterns in TRFs

- the first analyses by Greig-Smith in Trinidad in early 50s
- strong aggreation observed (Hubbell 1979; Condit et al. 2000) explained due to environmental heterogeneity (Bagchi et al. 2011)
- after separating environmental heterogeneity interactions of individuals should remain

Diversity of TRFs and Questions

- the most of species is diversity neutral (Wiegand et al. 2007)
- segregation and aggregation decrease with species richness (Wiegand et al. 2012)

Our questions

Using homogeneous TRF plots

- what spatial differences and which species interactions we can observe in different successional stages of TRF?
- what are spatial diversity patterns of successional stages of TRF?

Study sites

- tropical rain forest (TRF) in Papua New Guinea
  - two homogeneous 1ha plots
  - 100-200 m above sea level
  - annual rainfall of 3500 mm
  - annual mean monthly temperature around 26.5 C
- primary TRF "late succession"
  minimally >60 years no human disturbance
- secondary TRF "early succession"
  abandoned garden for a decade
- 2456 trees with DBH $\geq$5cm :
  position, species identity, DBH, height

Border of primary TRF

Myristicaceae, Horsfieldia basifissa, Teijsmanniodendron bogoriense

Border of secondary TRF

Euphorbiaceae, Macaranga tanarius, Ficus variegata

Study sites - field work *F. nodosa*

Study sites - common species

Horsfieldia basifissa (Primary), *Ficus pungens* (Secondary)

Marked points pattern analyses

Individuals pattern

- pair correlation function

Marks pattern

- mark correlation function
- mark variogram (mark autocorrelation)
- spatial diversity function ("K-function + SAR")
  - species number and Simpson diversity along spatial scale

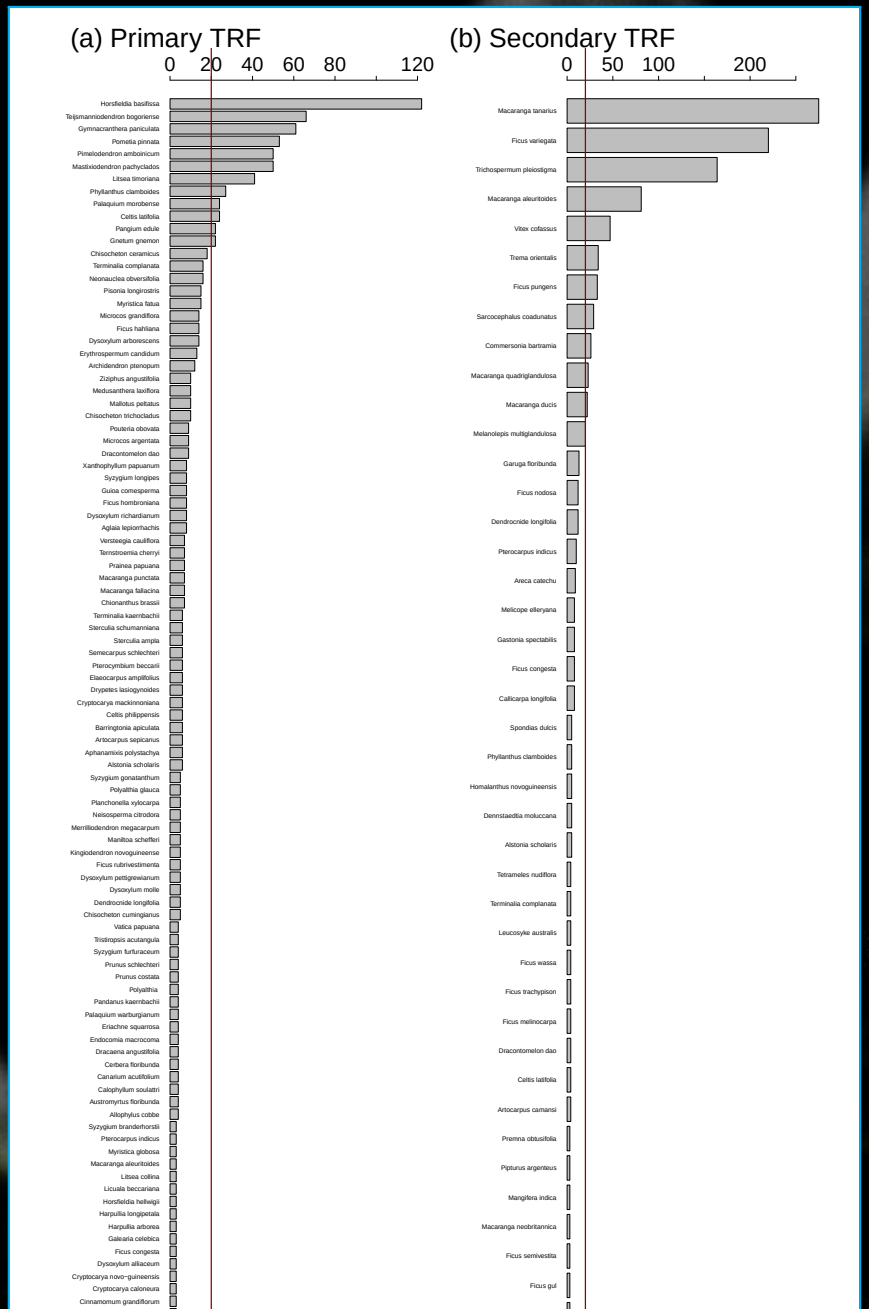
Null models

- no-marks: random and inhomogeneous positions
- marks: random relabelling and species shifting

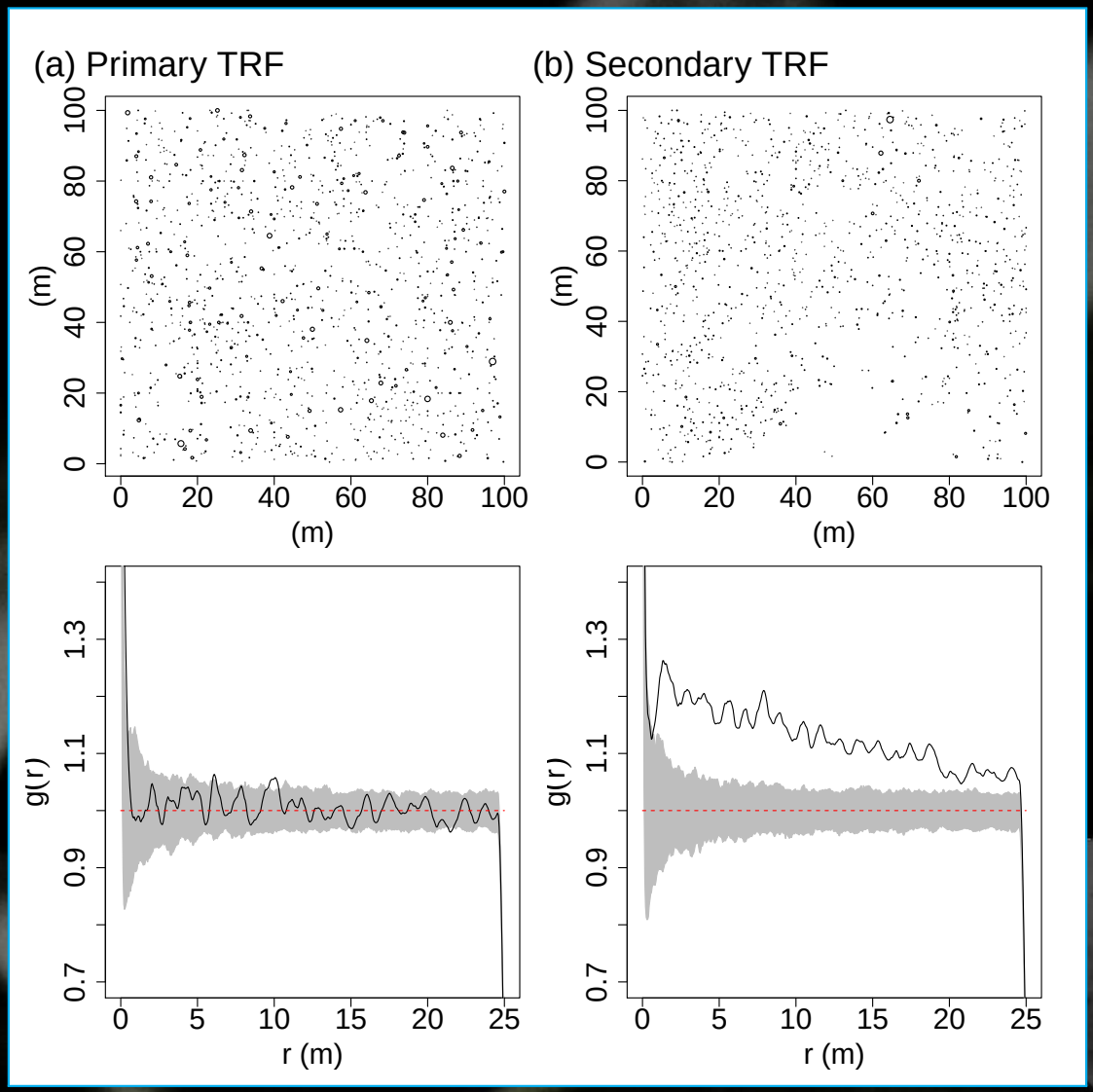
Comparison in numbers

Characteristics	Primary TRF	Secondary TRF
# individuals	1255	1201
Basal area (m^2/ha)	29.9	13.6
# species	198	88
# species with 1 individual	64	36
# species with $\geq$ 20 individuals	12	12
- # these individuals	562	974
# shared species	45	45
- # these individuals	579	821

Number of individuals per species

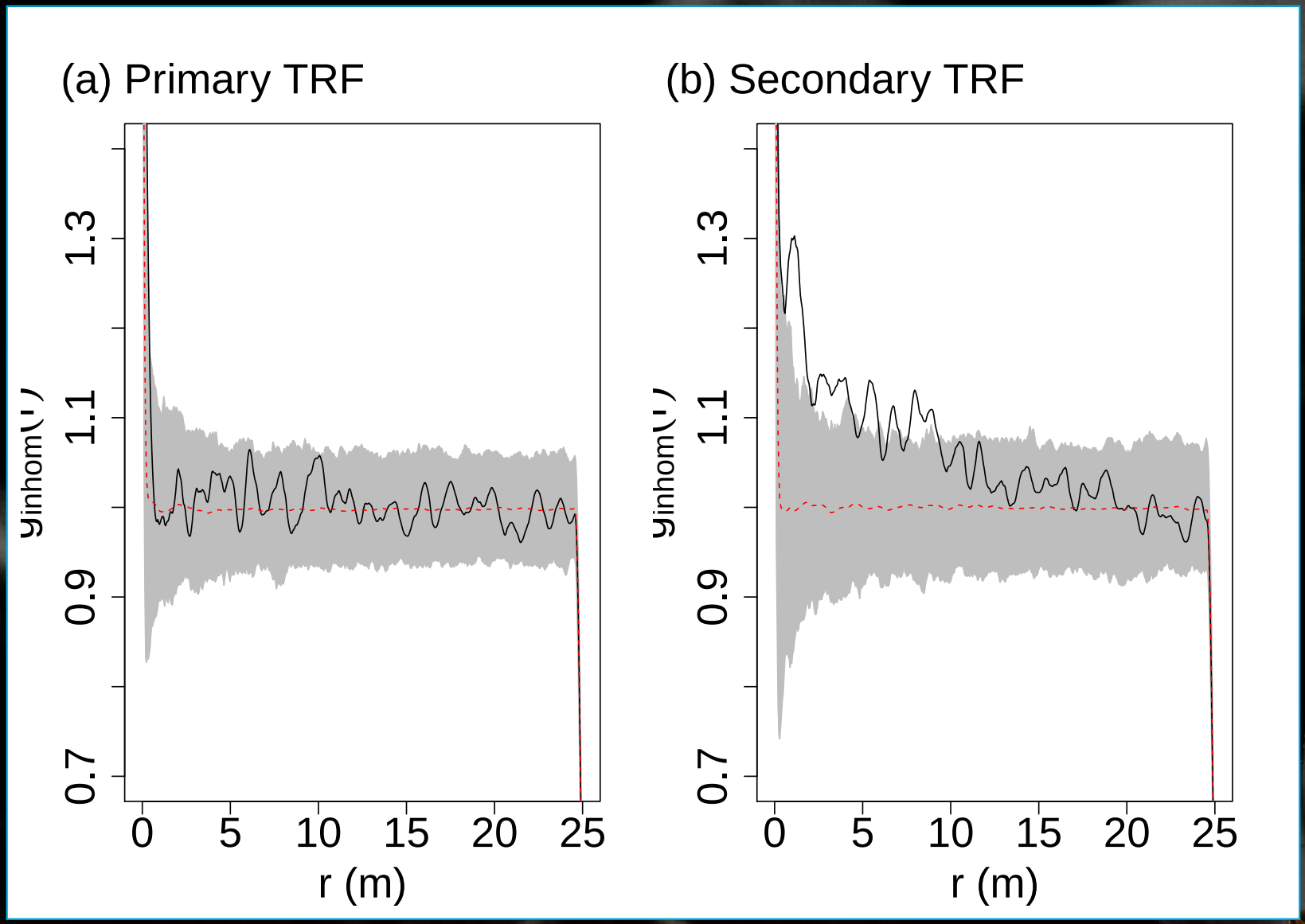


Plots and their pair corr. functions

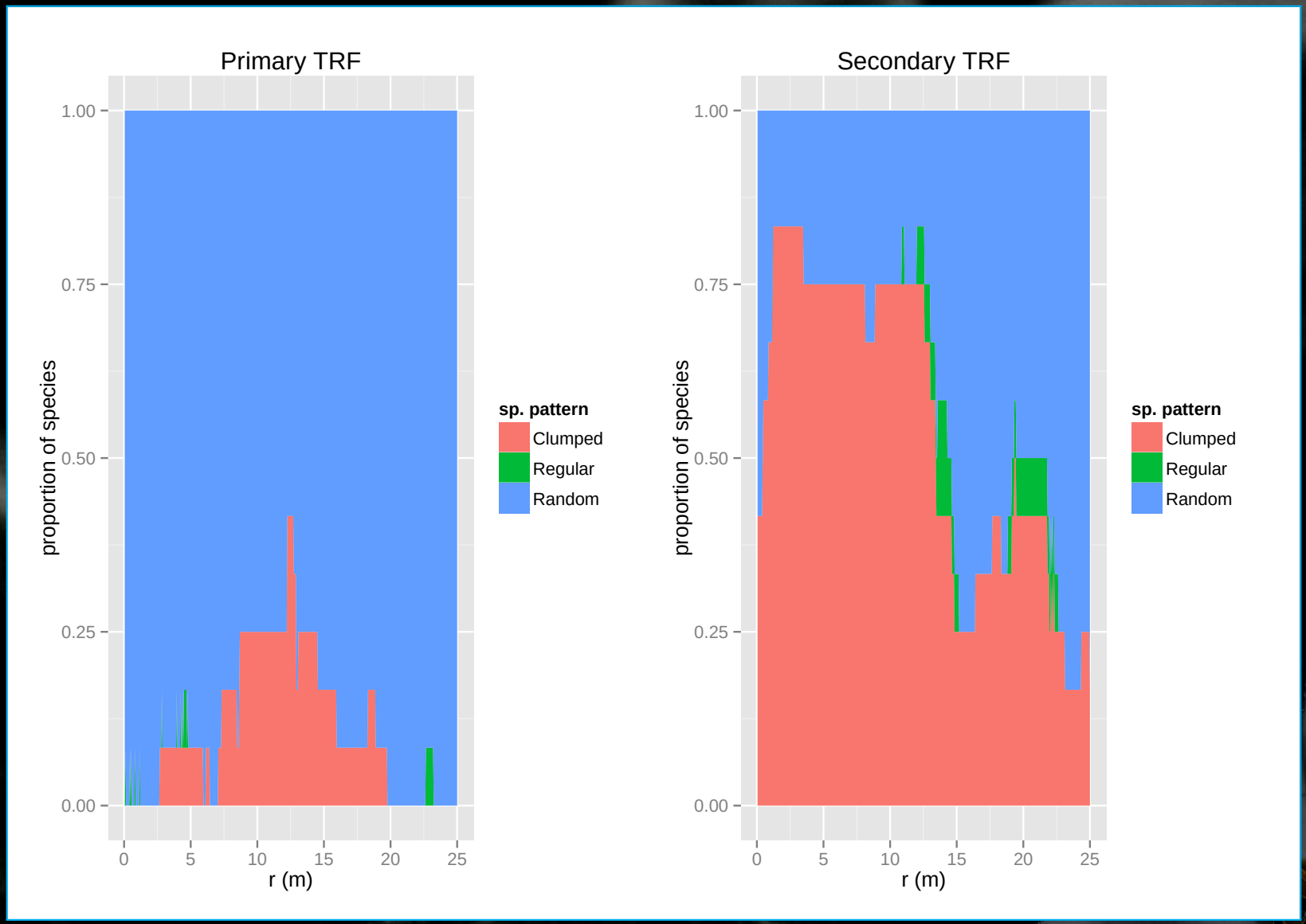


gray area = null model, solived line = observed pattern

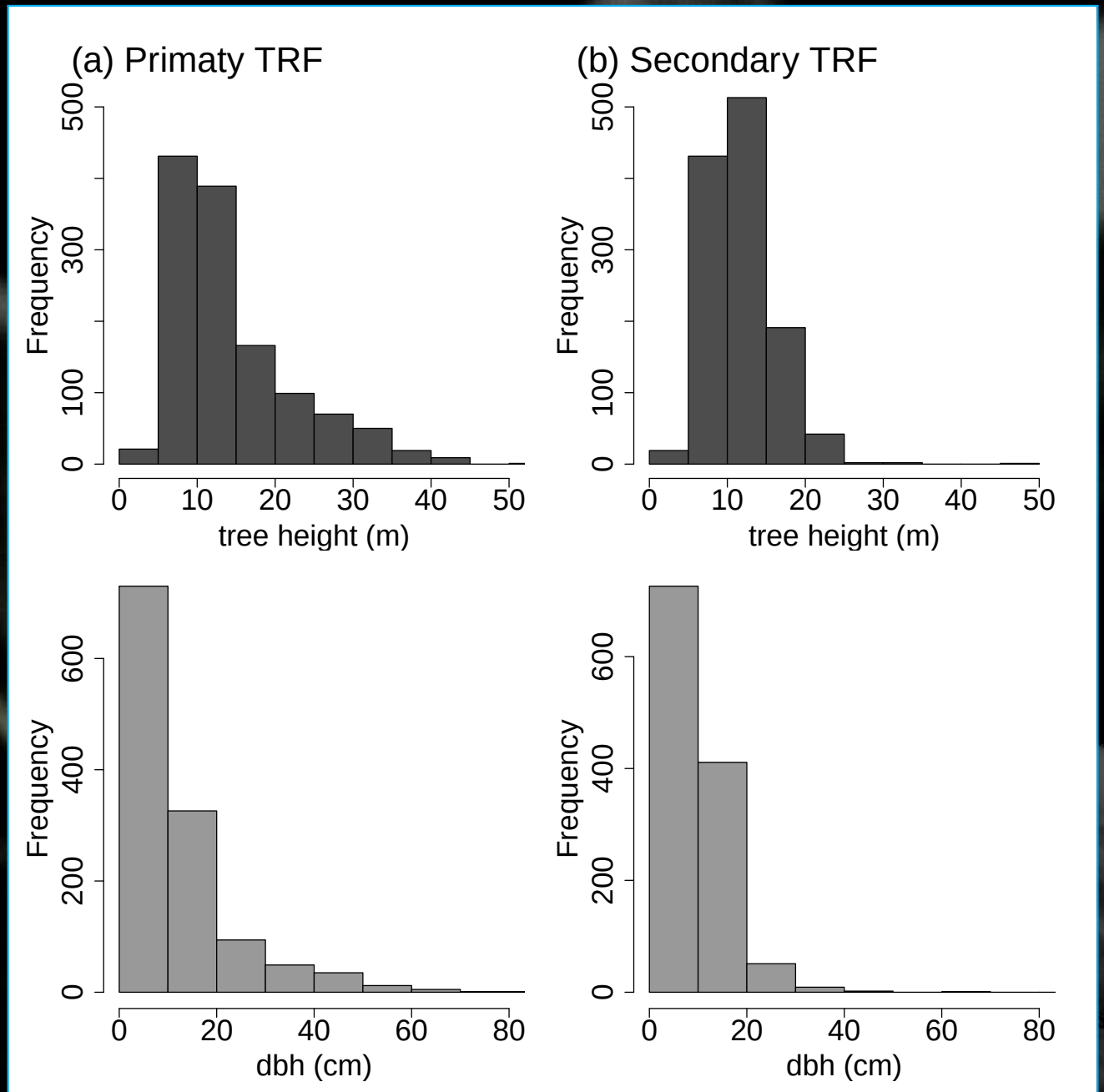
Inhomogeneous pair corr. functions



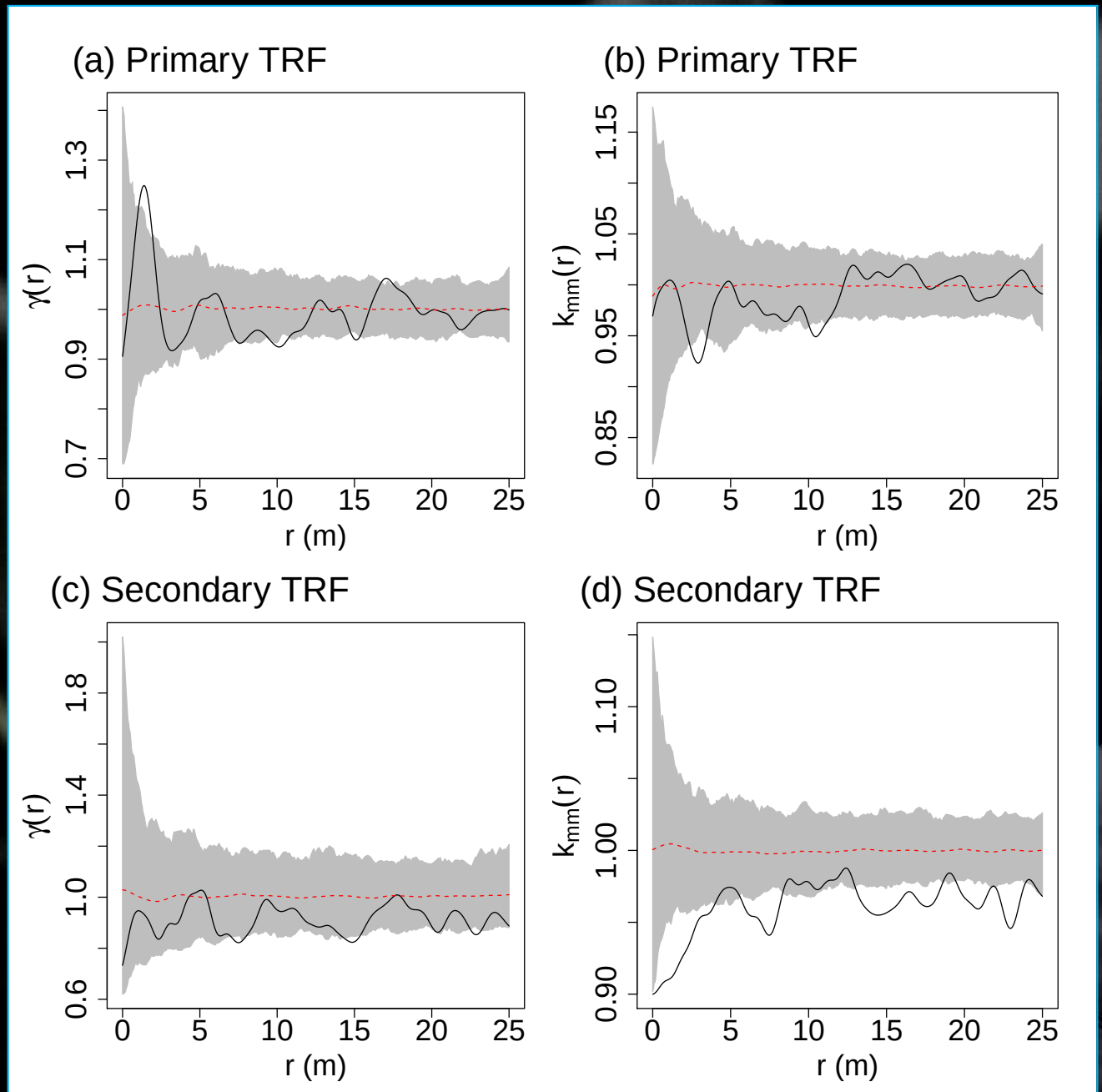
Proportions of patterns of 12 most common species



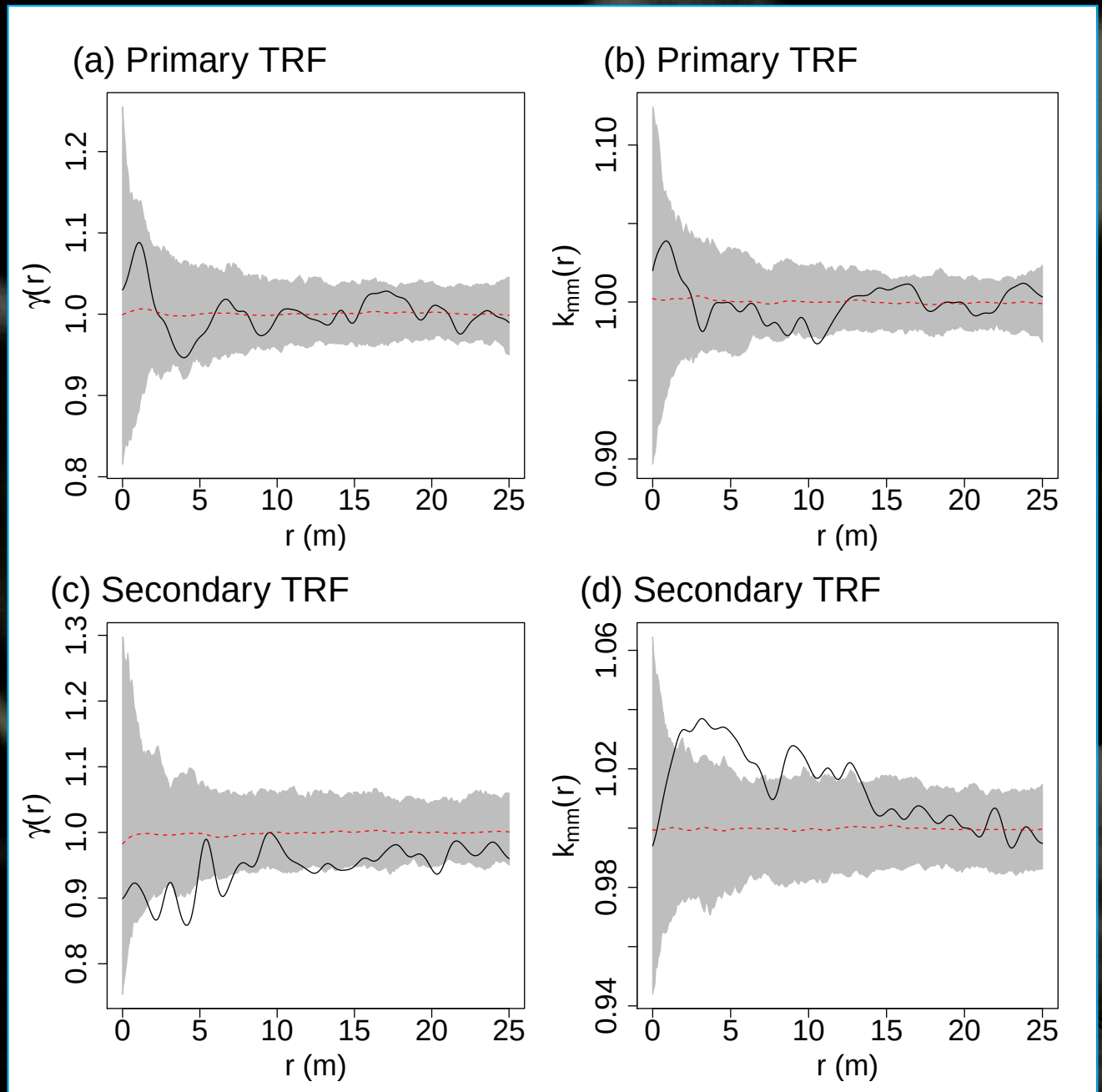
Height and DBH histograms



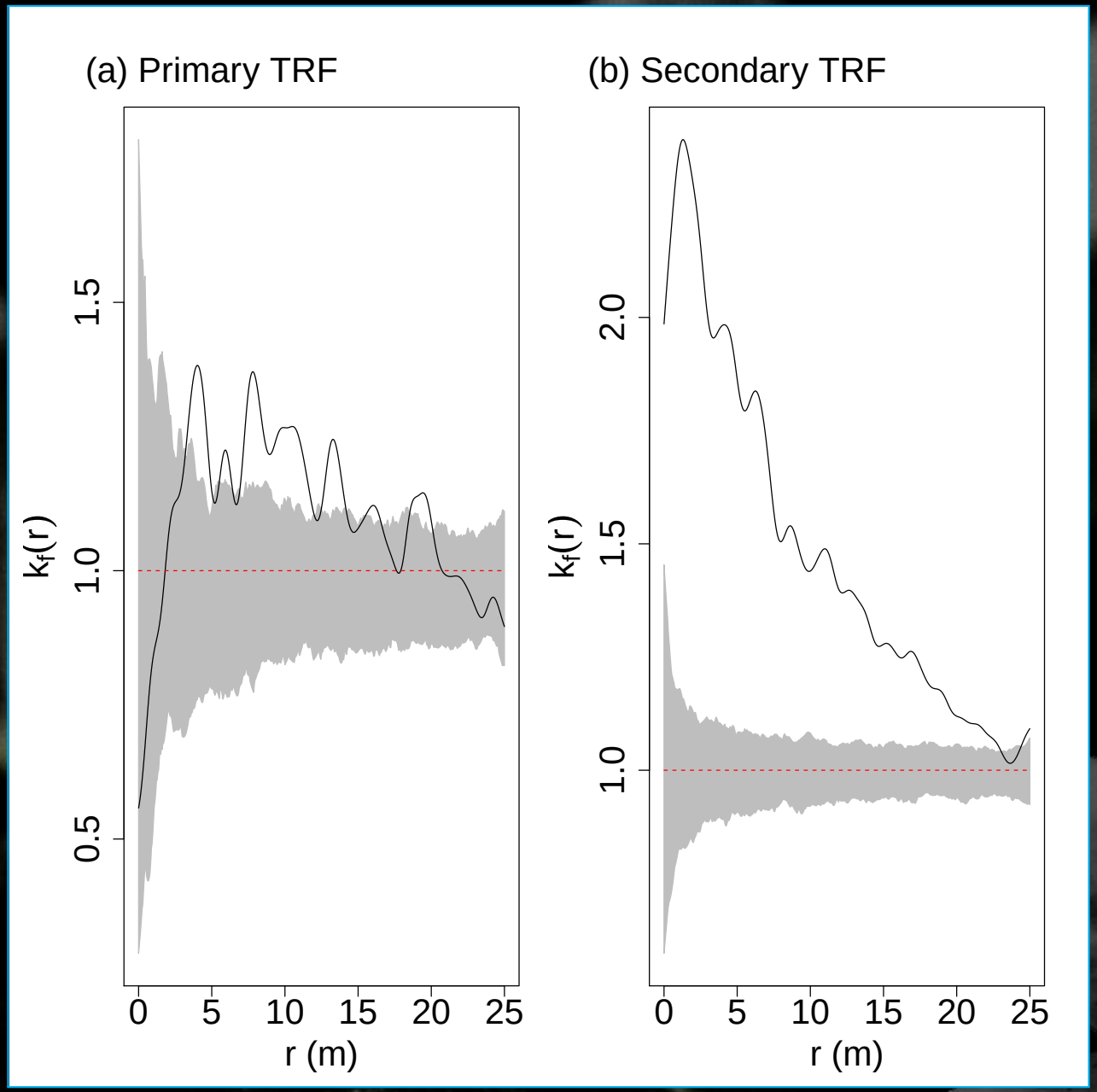
γ(r) - vario.,κ(r) - corr. marks DBH



γ(r) - vario.,κ(r) - corr. marks height

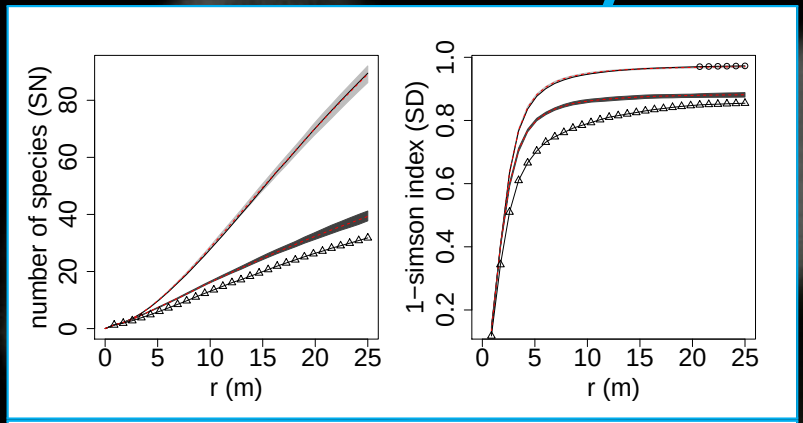


κ(r) mark corr. of species identity

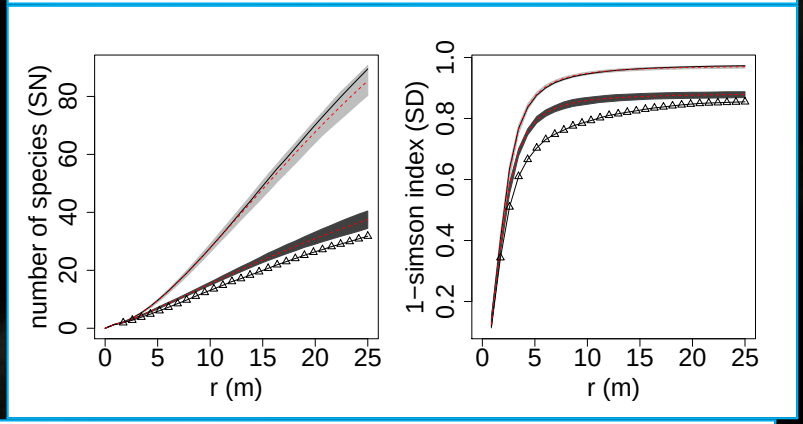


Species number and diversity

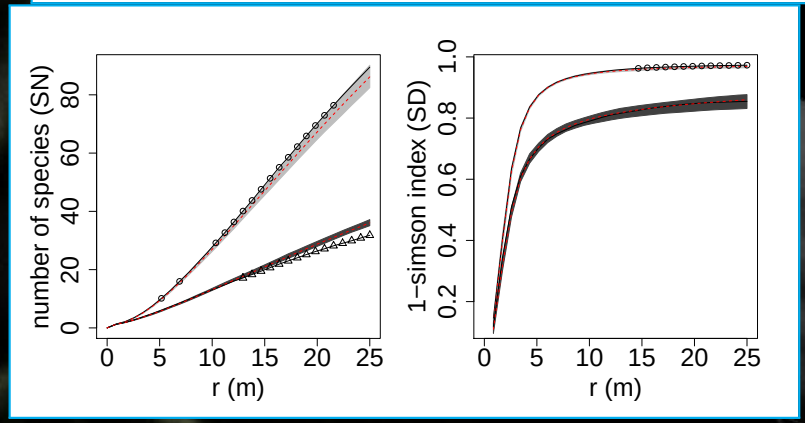
random labelling



inhom. positions



shifting of species



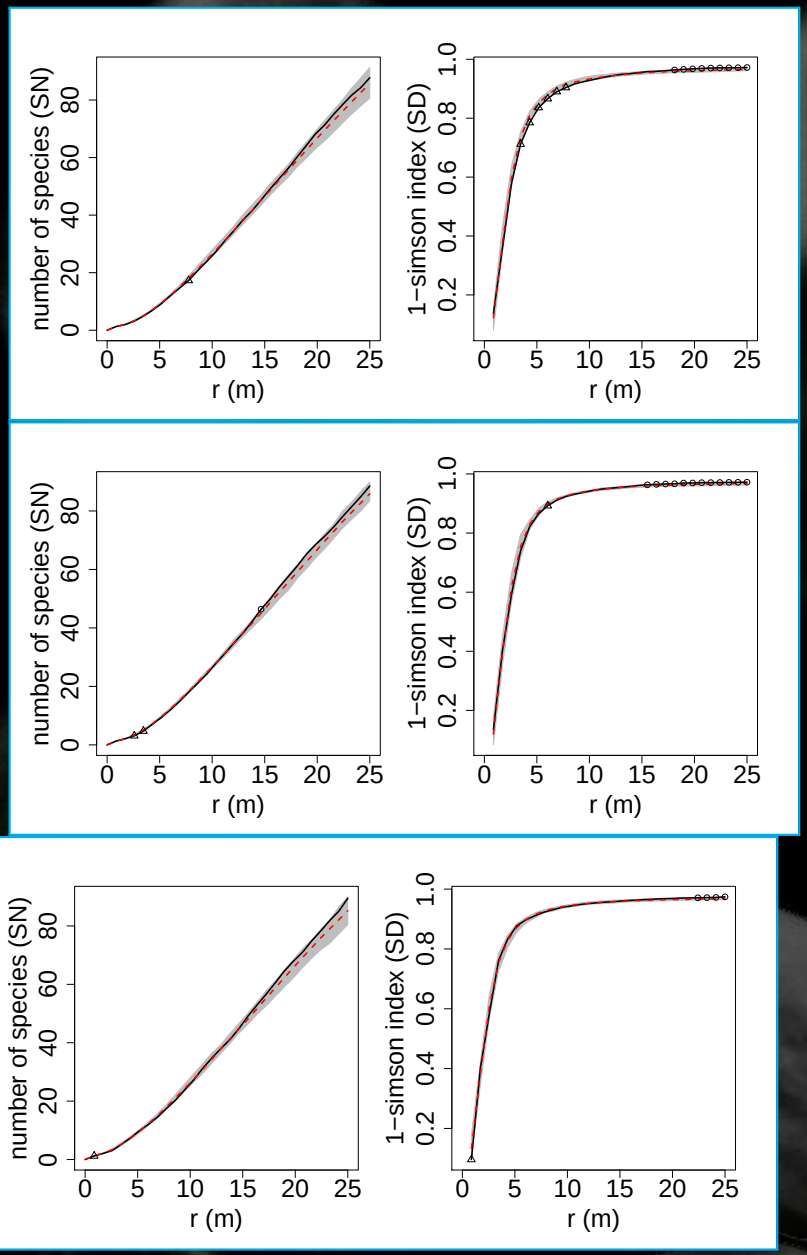
light gray = primary TRF, dark gray = secondary TRF

Spatial div. - Primary TRF shifting

Horsfieldia basifissa (122 inds.)

Teijsmanniodendron bogoriense (66 inds.)

Gymnacranthera paniculata (61 inds.)

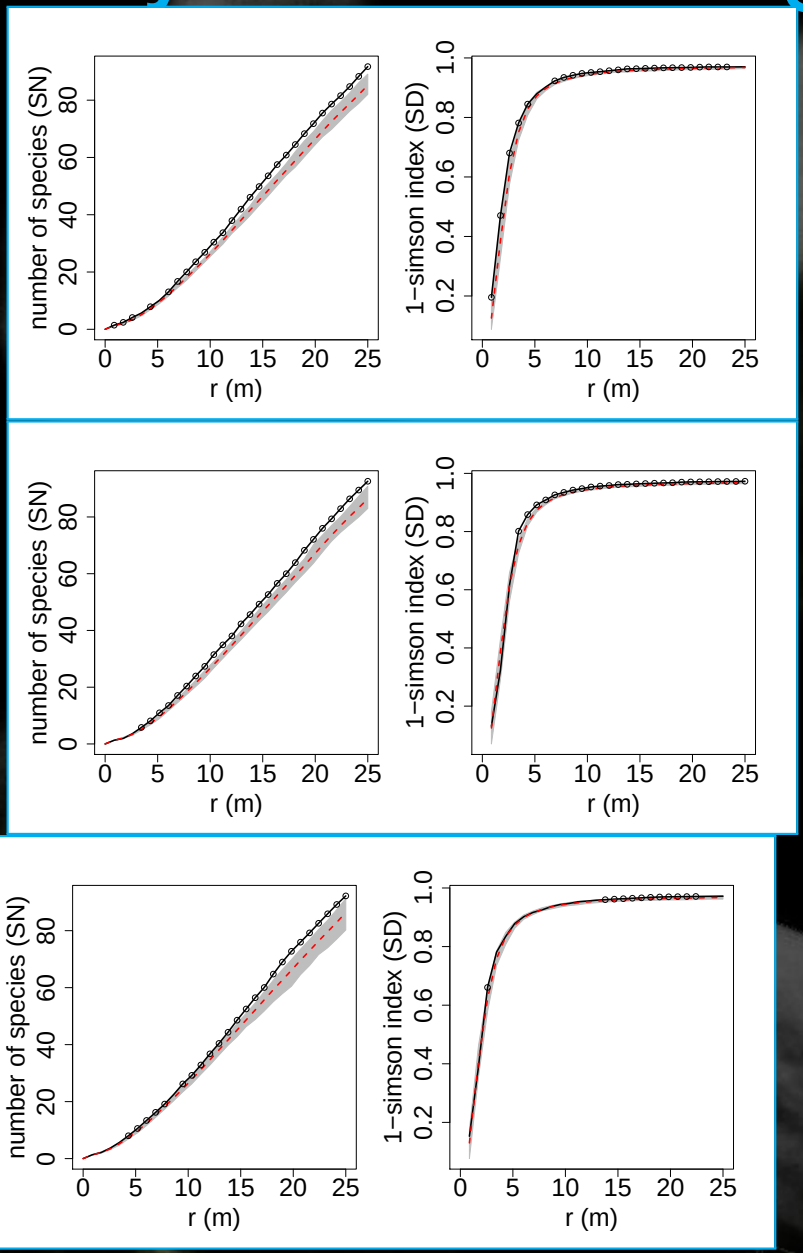


Spatial div. - Primary TRF shifting

Pometia pinnata (53 inds.)

Pimelodendron amboinicum (50 inds.)

Mastixiodendron pachyclados (50 inds.)

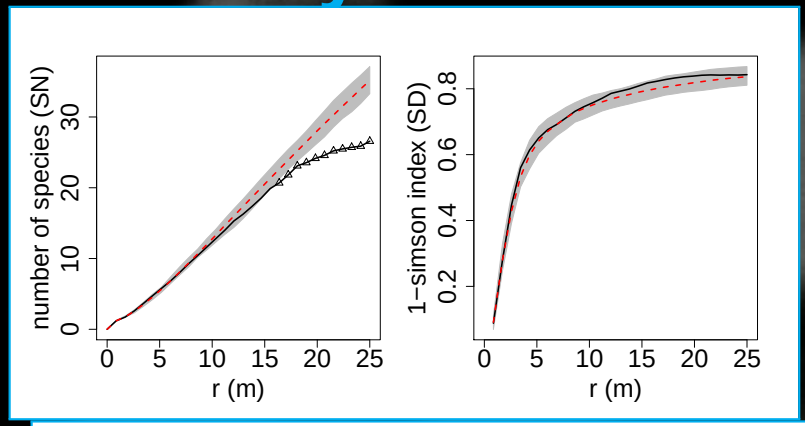


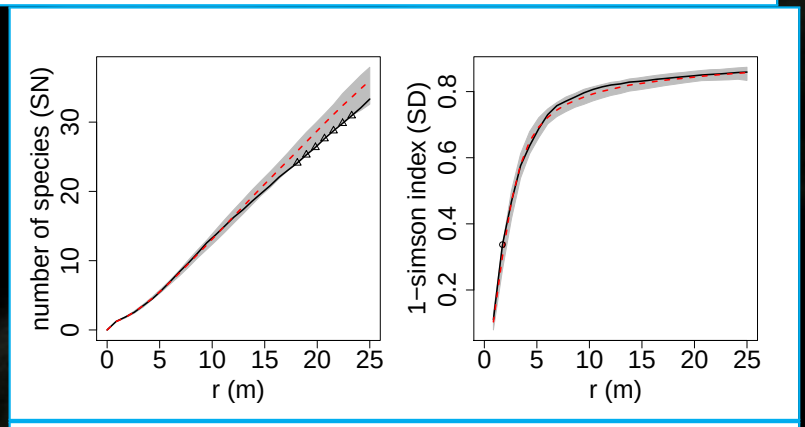
Spatial div. - Secondary TRF shifting

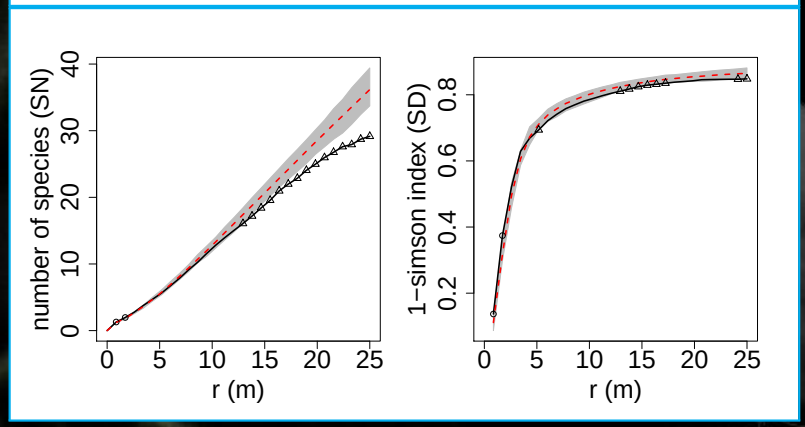
Macaranga tanarius (275 inds.)

Ficus variegata (220 inds.)

Trichospermum pleiostigma (164 inds.)





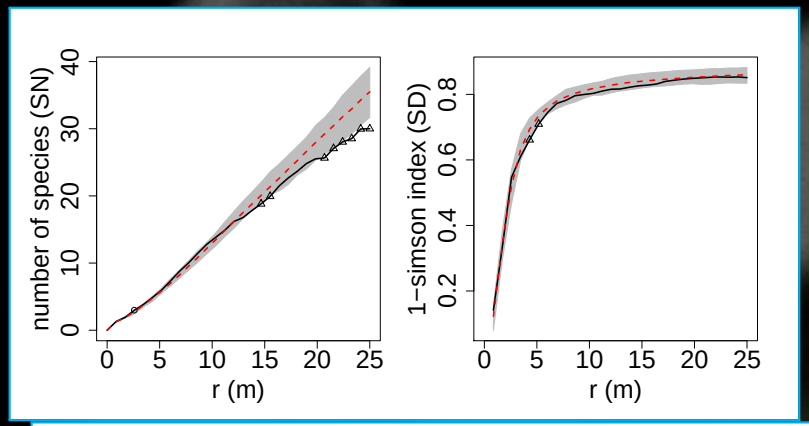


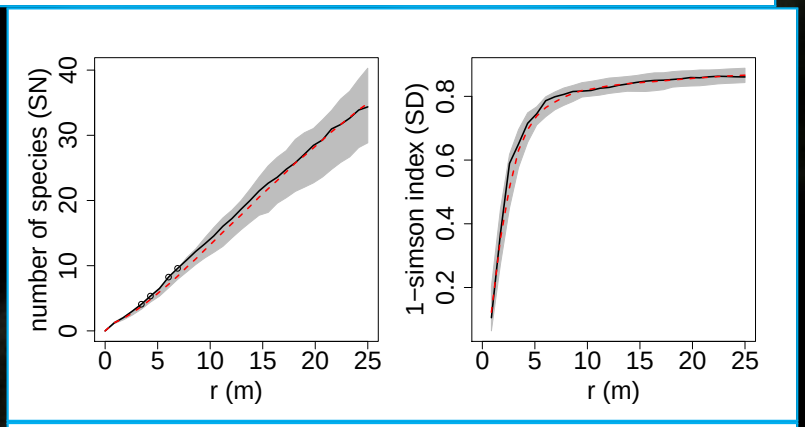
Spatial div. - Secondary TRF shifting

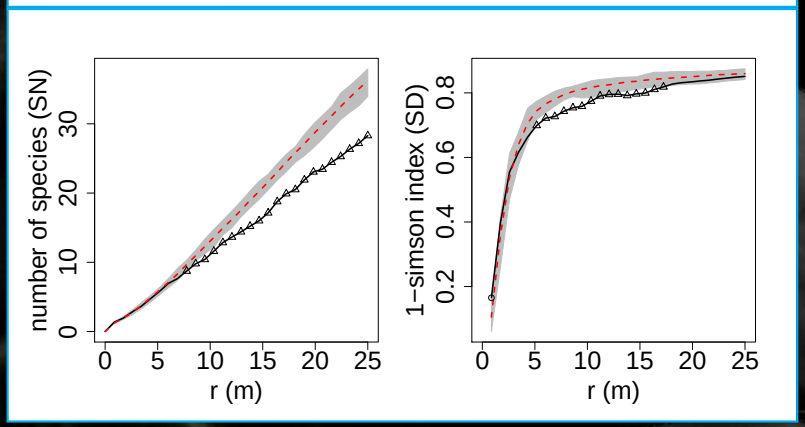
Macaranga aleuritoides (81 inds.)

Vitex cofassus (47 inds.)

Trema orientalis (34 inds.)







Spatial patterns, DBH and height –conclusions

- in the homogeneous primary TRF, there was mostly random pattern of all and within the most common species individuals
- early succession stage, the secondary TRF, was clumped (all and the most common species individuals), even if inhomogeneity was filtered out
- distribution of DBH and height
  - random in the primary TRF
  - clumps of thin and clumps of high individuals in the secondary TRF

Spatial diversity – conclusions

- the results out of confidence envelopes mostly at the lager scales
- in the secondary TRF, clumps of conspecific neighbours followed by low spatial diversity mostly due to dominant species functioning as "diversity repellers"
- in the primary TRF, less negative or more positive inter-specific interactions than intra-specific interactions, some of dominant species were "diversity accumulators"

Future work and Questions

Spatial investigation of

- plant traits
- phylogeny
- herbivory

THANK YOU FOR ATTENTION.
Questions
and/or
comments?