cobra.report

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12/10/2019

# Introduction

Oceanic islands are home to a large numbers of endemic species, which together with other native species, create unique communities (Whittaker et al, 2007). These communities are often more sensitive to the introduction of exotic and potential invasive species (Jager, 2007). Biological invasions are a major driver of biodiversity loss (Vitousek et al, 1996; Butchart et al 2010), with ecological and economic implications (Lockwood et al, 2007) and oceanic islands are especially sensitive to this process, and is where the most extinctions took place so far (Whittaker & FernÃ¡ndez-Palacios, 2007. Additionally, being isolated, many populations are unable to recover from past disturbance events, mainly driven by habitat loss and species introductions (Whittaker & FernÃ¡ndez-Palacios, 2007). Habitat loss is a complex processes with many variables to consider: isolation, matrix quality, patch area, shape complexity and edge effects (Didham, 2012). Edge effect defines as the exposure of a given fragmented community to the influence of the surrounding matrix (Cook et al, 2002). Many species avoid edges, and a high proportion edge area in a small habitat can devalue its conservation significance. Edges can change the capacity of fixation of a species, due to changes microclimate such as temperature, humidity, wind speed, etc (Tscharntke et al, 2002). The disruption of native ecosystems by landscape alterations is often a source of immigrant species and complex source-sink dynamics creating opportunities to higher turnover in non-native species (Matthews et al. 2019 ) . This process can alter the established biotic interactions, eventually providing new ecological opportunities for invaders (Didham, 2007). Native forest fragments in the Azores are characterized by hard edges, with abrupt changes from native habitats to anthropogenic habitats (Borges et al, 2006, 2008; Matthews et al. 2019). As such, it is likely to expect a constant arrival of non-native species into the native forest, via a source-sink effect (Matthews et al., 2019). However, the establishment of an exotic species implies overcoming several barriers: first, the successful arrival to the new territory (Diez et al, 2012) and then being able to reproduce and to disperse from that point. Invasion is considered successful when a species establishes a self-sustaining population, who can expand to new areas (Blackburn et al, 2011). Regarding Arthropod dispersal movements between native forest patches and the surrounding habitats in the Azores, two main types of arthropod dispersal trends were described: i) endemic and native species are dispersing from native habitats to human-altered habitats; and ii) many exotic species are dispersing to the native forest (Borges et al., 2008). In our study, we aim to understand and quantify the entry of exotic species into the Azorean native forest. The study of beta-diversity patterns, interpreted as the extent of change in a community composition (Whittaker, 1960), is a crucial tool for such task, since it aims to understand the processes that originate community variation (Carvalho et al., 2013). This variation can be originated in species composition (species being replaced by others), species richness (one community has more species than the other), or both. A considerable number of approaches have been proposed to study beta-diversity patterns, and recently it was proposed to partition the components that originate from underlying processes (Baselga, 2010, Carvalho et al., 2012). Carvalho and colleagues defended that beta values should be disentangled into algebraically comparable fractions, reflecting the replacement and richness-difference components in an ecologically meaningful way, which was also supported by Legende (2015). ( Initially, the analysis of such processes were mostly based on the number of taxa and distribution of abundances â Taxonomic Diversity (TD). However, this measure ignores the ecological functions provided by each species in an ecosystem and consequently the role of Functional Diversity (FD). For example, several species in an ecosystem can exhibit a small variation of traits, while few species may perform a large variation of those (VillÃ©ger et al., 2012, 2013). Functional diversity (FD) quantifies the components of biodiversity that influence how an ecosystem operates or functions (Tilman et al., 2001). (Desenvolver mais este tema)Both TD and FD, together with Philogenetic Diversity (PD), have been unified under a methodological and statistical framework for the study of spatial and temporal heterogeneity including its phylogenetic and functional components (Cardoso et al., 2014) along with a statistical package incorporating these innovations (Cardoso et al., 2015). Adding to the relatively well-documented ecological disturbance processes above described, the increasing rate of visitation of protected areas raises concerns as to whether recreation and tourism activities in protected areas can be sustainably managed (Monz et al., 2009). Several studies even suggest that perceived impacts by users can degrade the quality of visitorâs experience (Leung et al., 2013). In response to these concerns, a specialized field of study â recreation ecology â has emerged. Recreation ecology began in the early 1960s (Leung et al., 2013) and is commonly defined as the study of the impacts of outdoor recreation and nature-based tourism activities in natural or semi-natural environments. Modelling the relationship between use and ecological change stood as one of the most sought generalizations in this field. It is often generalized as a curvilinear, asymptotic relationship (Hammitt et al., 1987), largely due to research that focused on easily observable ecological responses and a limited set of variables, such as changes in vegetation cover (Queiroz et al, 2014(1)(2)). Despite recognition that speciesâ responses to perturbations are not random and that different species may be more or less sensitive to particular disturbance depending on their life-history traits. It is increasingly recognized that functional traits (i.e. components of an organismâs phenotype that influence ecosystem level processes) better predict the effects of human-disturbance ecosystem functioning than taxonomic species identity alone (Swenson, 2011).

Intensity of use is the variable most commonly studied in the past for obvious reasons, as it should be both directly related with impact and easily measurable. Yet, other variables of interest should be quantified for better-informed decisions. Recent proposals for modelling the relationship between use and impacts (Monz et al., 2009) are based on long-term studies and suggest that ecological change may be more dynamic and spatially diffuse than these generalizations imply (Kim, 2012). Consequently, future research could more directly model the useâresponse relationship through more sensitive methods of measurement and improved experimental designs focused on long term monitoring. Studies focusing on measurement of dispersal on seeds directly by humans demonstrated that they differ from wind dispersion, confirming that human-associated dispersal allows for seeds to spread to longer distances than the wind. The pattern of propagation is logarithmic, largely decreasing the amount of seeds as distance from the beginning of the trail increases (Whichmann et al., 2009). In the Azores, habitat and plant variables have a significant effect in the richness of arthropod endemic species (Florencio et al, 2016), which in turn are a surrogate group for the arthropod community in these forests (Procurar referÃªncia â jÃ¡ li isto). The source-sink process also explains the presence of non-indigenous species, by means of proximity of a certain point of the forest to its edge (Mathews et al., 2019).

Our hypothesis are: (1) human recreational activities affect the vegetation composition and structure, which in turn affect the spider community. Since this effect is expected to be amplified in the beginning of the trail, pairwise spatial beta taxonomic (TD) and functional (FD) diversity will decrease as the sampling sites go further into the trail; (2) The distance to the edge is a measure of scale for the source-sink effect, and therefore the closest the trail is to the edge, the more likely it is that pairwise spatial beta TD and FD variation is explained by non-human related factors. (3) Both distance to the beginning of the trail and edge distance explain the variation observed in pairwise spatial beta TD and FD values. Confirming or invalidating these relations will allow us to understand the current relevance of recreational activities on arthropod community dynamics (using spiders as indicators), aiding relevant information to where to prioritize efforts in management of the touristic pressure in the Azorean and Macaronesian native forests.

# Materials and Methods

## Study area

The Azorean archipelago is located in the North Atlantic Ocean, roughly between the coordinates 37Âº-40ÂºN and 25-31ÂºW longitude. It consists of nine volcanic islands separated into three groups: the western group (Flores and Corvo), the central group (Fail, Pico, S. Jorge, Graciosa and Terceira) and the eastern group (S. Miguel and S. Maria), in addition to small islets. The climate is temperate oceanic, strongly influenced by the surrounding ocean and the topography of the island, which together produce high levels of relative atmospheric humidity and low temperature variation throughout the year. The study was made in the evergreen laurel forest (Laurisilva). Its original area in the archipelago has been drastically reduced since human settlement, and nowadays covers about 5% of the archipelago, in the most unaccessible and mountainous regions. For the current investigation was done in pedestrian trails in Terceira and S. Miguel that passed through a patch of native forest. The forest from both islands does not present structural differences, both being characterized by reduced tree structure (up to 5m, rarely going to 10), shallow soil and roughed terrain. The degree of conservation is, however, much worse at S. Miguel, presenting a dominance by Clethra arborea, while in terceira the forest structure is much closer to a pristine state. From each trail, only the segments that were in native forest were included, excluding other habitats from the study. Once the vegetation structure represented the forest, that as considered the beginning of the study area. Distance within this segment is counted using the most common direction of traffic by tourists.

## Site Selection

Since in propagation in space from a point, the area increases logarithmically, we have used this scale to select the sites. The trail segment was identified in satellite photography, and then fine tuned in the field. From there, three sites were selected upon a logarithmic gradient of distance by the beginning of the trail, at 0m, 50m and 250m. Another site was added in the section of the trail with the most pristine surrounding forest (Max), and two controls were placed inside the forest, at 50m and 250m from the nearest trail point. Two sites sampled in 2013, with the same methodology, were at about 250m from trails from this study, and such data was used for this study.

##Sampling procedures

Spiders were sampled using plots of 50x50m. Sampling followed the COBRA Monitoring protocol presented in Borges et al (2018). For each forest fragment, and in order to obtain confidence about the representativity of the sampling , one COBRA Inventory protocol is necessary. The latter comprises four hours of aerial search (AAS), four hours of tree beating (BEAT), four vegetation Sweeping (SEW) and 48 pitfall traps, posteriorly arranged in groups of 4 to make a sample unit. For consistency, the Inventory protocol was always done in the most pristine area known in the fragment. The remaining sites were sampled with the COBRA Monitoring protocol (4 hours AAS and 2 Hours BEAT) Sorting was made between December 2017 and October 2018 with the aid of an expert taxonomist. The resulting database was then completed with the functional data known to each spider species in the Azores.

## Data Analyses

We analysed the data in three subsets: all species, Indigenous and Non-Indigenous. All analyses were repeated for each subset. We considered the distance from each sampling point to the trail as a factor, since we expect that the controls will have less non-indigenous species, for not having the edge effects caused by trail infrastructure and the impacts from human use. Distance to edge was elected as a covariate, since the source-sink effect magnitude is dependant on the souce distance. The distance to the beginning of the trail was selected to represent the treatments, since it converts them to a continuous variable and defines precisely the distance of the sampling area to the beginning of the trail. We considered as dependent variables the three components of beta-diversity: Total, Richness and Relapcement, for taxonomic and functional traits separately. These variables were regressed against the three considered variables in a GLMM, including trail identitiy as a random factor, in order to exclude the location effect from the treatments. The GLMM were implemented in R using Lm4 package. We checked for outliers and correlations between the covariates.

# Results

## SAC

### Loading packages

### Importing the independent variables

Variables <- read.csv2(here("data","GLMM\_Variables.csv"), row.names=1, header=TRUE, stringsAsFactors = T, dec = ".")  
Variables$Dist\_trail <- as.numeric(Variables$Dist\_trail)  
Variables$Dist\_edge <- as.numeric(Variables$Dist\_edge)  
Variables$Dist\_trail\_beginning <- as.numeric(Variables$Dist\_trail\_beginning)

### Scaling the independent variables

Variables$Dist\_trail\_std <- scale(Variables$Dist\_trail, center = F)  
Variables$Dist\_edge\_std <- scale(Variables$Dist\_edge, center = F)  
Variables$Dist\_trail\_beginning\_std <- scale(Variables$Dist\_trail\_beginning, center = F)  
Variables

## ForestID Dist\_trail Dist\_edge  
## Guilherme\_Moniz Guilherme\_Moniz 0 0  
## Lagoinha\_0 Lagoinha 0 0  
## Lagoinha\_50 Lagoinha 0 0  
## Lagoinha\_250 Lagoinha 0 0  
## Lagoinha\_Control\_50 Lagoinha 50 293  
## Lagoinha\_Control\_250 Lagoinha 235 50  
## Mist\_Negros\_0 Mist\xe9rios\_Negros 0 0  
## Mist\_Negros\_250 Mist\xe9rios\_Negros 0 0  
## Mist\_Negros\_Max Mist\xe9rios\_Negros 0 25  
## Mist\_Negros\_Control\_50 Mist\xe9rios\_Negros 50 50  
## Mist\_Negros\_Control\_250 Mist\xe9rios\_Negros 600 600  
## Sta\_Barbara\_0 Santa\_Barbara 0 510  
## Sta\_Barbara\_50 Santa\_Barbara 0 481  
## Sta\_Barbara\_250 Santa\_Barbara 0 436  
## Sta\_Barbara\_Max Santa\_Barbara 0 404  
## Sta\_Barbara\_Control\_50 Santa\_Barbara 50 441  
## Sta\_Barbara\_Control\_250 Santa\_Barbara 300 600  
## Malhadas\_0 Pico\_Vara 0 0  
## Malhadas\_50 Pico\_Vara 0 0  
## Malhadas\_250 Pico\_Vara 0 0  
## Malhadas\_Max Pico\_Vara 0 0  
## Dist\_trail\_beginning Dist\_trail\_std Dist\_edge\_std  
## Guilherme\_Moniz 0 0.000000 0.00000000  
## Lagoinha\_0 50 0.000000 0.00000000  
## Lagoinha\_50 250 0.000000 0.00000000  
## Lagoinha\_250 250 0.000000 0.00000000  
## Lagoinha\_Control\_50 250 0.312279 0.96318857  
## Lagoinha\_Control\_250 250 1.467711 0.16436665  
## Mist\_Negros\_0 0 0.000000 0.00000000  
## Mist\_Negros\_250 200 0.000000 0.00000000  
## Mist\_Negros\_Max 960 0.000000 0.08218333  
## Mist\_Negros\_Control\_50 200 0.312279 0.16436665  
## Mist\_Negros\_Control\_250 1880 3.747348 1.97239980  
## Sta\_Barbara\_0 0 0.000000 1.67653983  
## Sta\_Barbara\_50 50 0.000000 1.58120718  
## Sta\_Barbara\_250 250 0.000000 1.43327719  
## Sta\_Barbara\_Max 401 0.000000 1.32808253  
## Sta\_Barbara\_Control\_50 401 0.312279 1.44971386  
## Sta\_Barbara\_Control\_250 401 1.873674 1.97239980  
## Malhadas\_0 0 0.000000 0.00000000  
## Malhadas\_50 50 0.000000 0.00000000  
## Malhadas\_250 250 0.000000 0.00000000  
## Malhadas\_Max 400 0.000000 0.00000000  
## Dist\_trail\_beginning\_std  
## Guilherme\_Moniz 0.00000000  
## Lagoinha\_0 0.09482271  
## Lagoinha\_50 0.47411353  
## Lagoinha\_250 0.47411353  
## Lagoinha\_Control\_50 0.47411353  
## Lagoinha\_Control\_250 0.47411353  
## Mist\_Negros\_0 0.00000000  
## Mist\_Negros\_250 0.37929082  
## Mist\_Negros\_Max 1.82059594  
## Mist\_Negros\_Control\_50 0.37929082  
## Mist\_Negros\_Control\_250 3.56533373  
## Sta\_Barbara\_0 0.00000000  
## Sta\_Barbara\_50 0.09482271  
## Sta\_Barbara\_250 0.47411353  
## Sta\_Barbara\_Max 0.76047810  
## Sta\_Barbara\_Control\_50 0.76047810  
## Sta\_Barbara\_Control\_250 0.76047810  
## Malhadas\_0 0.00000000  
## Malhadas\_50 0.09482271  
## Malhadas\_250 0.47411353  
## Malhadas\_Max 0.75858164

### Loading Inventory Cobra data for SAC

### Traits matrix - all species

Traits <- read.csv2(here("data","Traits\_All\_Fin.csv"), row.names=1, header=TRUE, stringsAsFactors = T, dec = ".")  
Traits <- Traits[,-c(1:3)]   
species <- rownames(Traits)  
str(Traits)

## 'data.frame': 39 obs. of 27 variables:  
## $ N.E.I : Factor w/ 3 levels "E ","I","N": 3 3 1 1 3 2 2 2 1 1 ...  
## $ IND.NONNAIND : Factor w/ 2 levels "IND","NONNAIND": 1 1 1 1 1 2 2 2 1 1 ...  
## $ HABITATNALeaves..branches..flowers..seeds..fruits..surface.: int 1 1 1 1 1 1 1 0 1 1 ...  
## $ HABITATNAinside.stems..roots..fruits..pods..fungi : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ HABITATNAGround : int 0 0 0 1 0 0 0 1 1 0 ...  
## $ HABITATNAUnder.stones..bark..twigs : int 0 0 0 0 0 0 0 1 0 0 ...  
## $ HABITATNADecaying.matter : int 1 0 0 1 1 1 1 1 0 1 ...  
## $ HABITATNASubterranean : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ Female.min : num 2 4.02 1.07 5.06 1.05 2 2.09 8.05 7.03 2.05 ...  
## $ Female.max : num 3 5.09 2.01 8.05 1.09 ...  
## $ Female.Avg : Factor w/ 33 levels "0,086805556",..: 17 26 12 29 10 22 5 8 33 21 ...  
## $ Male.min : num 1.08 2.04 1.05 4.06 1.02 1.08 2.06 8.05 8.05 1.07 ...  
## $ Male.max : Factor w/ 28 levels "0","0,09375",..: 12 21 10 25 6 17 16 8 7 14 ...  
## $ Male.Avg : Factor w/ 26 levels "0","0,09375",..: 14 18 2 22 10 15 4 26 25 15 ...  
## $ Dispersal : int 2 1 1 1 2 2 2 0 0 2 ...  
## $ Verticality : Factor w/ 26 levels "0","0,043055556",..: 14 2 NA 1 11 17 NA 1 19 18 ...  
## $ Nocturnality : Factor w/ 22 levels "0","0,042361111",..: 9 20 2 22 14 4 NA NA 22 22 ...  
## $ Capture.web : int 1 0 1 0 1 1 0 0 0 1 ...  
## $ Sensing.web : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ No.web : int 0 1 0 1 0 0 1 1 1 0 ...  
## $ Tube.web : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ Sheet.web : int 1 0 0 0 1 1 0 0 0 1 ...  
## $ Space.web : int 1 0 1 0 1 1 0 0 0 1 ...  
## $ Orb.web : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ Ambush.hunter : int 0 1 0 0 0 0 0 0 0 0 ...  
## $ Active.hunter : int 0 0 0 1 0 0 1 1 1 0 ...  
## $ Stenophagous...Not.Euryphagous : int 0 0 0 0 0 0 0 1 0 0 ...

### Traits matrix - native species

TraitsNat <- read.csv2(here("data","Traits\_Nat\_Fin.csv"), row.names=1, header=TRUE, stringsAsFactors = T, dec = ".")  
TraitsNat <- TraitsNat[,-c(1:3)]   
speciesNat <- rownames(TraitsNat)  
str(Traits)

## 'data.frame': 39 obs. of 27 variables:  
## $ N.E.I : Factor w/ 3 levels "E ","I","N": 3 3 1 1 3 2 2 2 1 1 ...  
## $ IND.NONNAIND : Factor w/ 2 levels "IND","NONNAIND": 1 1 1 1 1 2 2 2 1 1 ...  
## $ HABITATNALeaves..branches..flowers..seeds..fruits..surface.: int 1 1 1 1 1 1 1 0 1 1 ...  
## $ HABITATNAinside.stems..roots..fruits..pods..fungi : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ HABITATNAGround : int 0 0 0 1 0 0 0 1 1 0 ...  
## $ HABITATNAUnder.stones..bark..twigs : int 0 0 0 0 0 0 0 1 0 0 ...  
## $ HABITATNADecaying.matter : int 1 0 0 1 1 1 1 1 0 1 ...  
## $ HABITATNASubterranean : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ Female.min : num 2 4.02 1.07 5.06 1.05 2 2.09 8.05 7.03 2.05 ...  
## $ Female.max : num 3 5.09 2.01 8.05 1.09 ...  
## $ Female.Avg : Factor w/ 33 levels "0,086805556",..: 17 26 12 29 10 22 5 8 33 21 ...  
## $ Male.min : num 1.08 2.04 1.05 4.06 1.02 1.08 2.06 8.05 8.05 1.07 ...  
## $ Male.max : Factor w/ 28 levels "0","0,09375",..: 12 21 10 25 6 17 16 8 7 14 ...  
## $ Male.Avg : Factor w/ 26 levels "0","0,09375",..: 14 18 2 22 10 15 4 26 25 15 ...  
## $ Dispersal : int 2 1 1 1 2 2 2 0 0 2 ...  
## $ Verticality : Factor w/ 26 levels "0","0,043055556",..: 14 2 NA 1 11 17 NA 1 19 18 ...  
## $ Nocturnality : Factor w/ 22 levels "0","0,042361111",..: 9 20 2 22 14 4 NA NA 22 22 ...  
## $ Capture.web : int 1 0 1 0 1 1 0 0 0 1 ...  
## $ Sensing.web : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ No.web : int 0 1 0 1 0 0 1 1 1 0 ...  
## $ Tube.web : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ Sheet.web : int 1 0 0 0 1 1 0 0 0 1 ...  
## $ Space.web : int 1 0 1 0 1 1 0 0 0 1 ...  
## $ Orb.web : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ Ambush.hunter : int 0 1 0 0 0 0 0 0 0 0 ...  
## $ Active.hunter : int 0 0 0 1 0 0 1 1 1 0 ...  
## $ Stenophagous...Not.Euryphagous : int 0 0 0 0 0 0 0 1 0 0 ...

### Traits - Non indigenous species

TraitsNInd <- read.csv2(here("data","Traits\_NInd\_Fin.csv"), row.names=1, header=TRUE, stringsAsFactors = T, dec = ".")  
TraitsNInd <- TraitsNInd[,-c(1:3)]   
SpeciesNInd <- rownames(TraitsNInd)  
str(TraitsNInd)

## 'data.frame': 18 obs. of 27 variables:  
## $ N.E.I : Factor w/ 1 level "I": 1 1 1 1 1 1 1 1 1 1 ...  
## $ IND.NONNAIND : Factor w/ 1 level "NONNAIND": 1 1 1 1 1 1 1 1 1 1 ...  
## $ HABITATNALeaves..branches..flowers..seeds..fruits..surface.: int 1 1 0 1 1 1 1 1 1 1 ...  
## $ HABITATNAinside.stems..roots..fruits..pods..fungi : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ HABITATNAGround : int 0 0 1 0 0 0 0 0 0 0 ...  
## $ HABITATNAUnder.stones..bark..twigs : int 0 0 1 0 0 0 0 0 0 0 ...  
## $ HABITATNADecaying.matter : int 1 1 1 0 0 0 0 1 1 0 ...  
## $ HABITATNASubterranean : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ Female.min : num 2 2.09 8.05 5.06 2 2.04 2.01 1.03 1.03 5.02 ...  
## $ Female.max : num 4.03 3 15 12 4.08 6 3 1.07 2 7 ...  
## $ Female.Avg : num 3.15 0.149 0.51 8.08 3.04 ...  
## $ Male.min : num 1.08 2.06 8.05 4.09 2.05 2 1.05 1.01 1.04 3 ...  
## $ Male.max : num 3.02 3.01 11.01 8 3.02 ...  
## $ Male.Avg : num 2.05 0.142 9.08 6.45 0.142 ...  
## $ Dispersal : Factor w/ 3 levels "F","O","R": 1 1 3 2 3 1 1 1 1 2 ...  
## $ Verticality : num 0.12 NA 0 0.0458 0.32 ...  
## $ Nocturnality : num 0.0437 NA NA 0.0646 0.08 ...  
## $ Capture.web : int 1 0 0 1 0 1 0 0 0 0 ...  
## $ Sensing.web : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ No.web : int 0 1 1 0 1 0 1 1 1 1 ...  
## $ Tube.web : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ Sheet.web : int 1 0 0 0 0 0 0 0 0 0 ...  
## $ Space.web : int 1 0 0 0 0 0 0 0 0 0 ...  
## $ Orb.web : int 0 0 0 1 0 1 0 0 0 0 ...  
## $ Ambush.hunter : int 0 0 0 0 0 0 0 0 0 1 ...  
## $ Active.hunter : int 0 1 1 0 1 0 1 1 1 0 ...  
## $ Stenophagous...Not.Euryphagous : int 0 0 1 0 1 0 0 0 0 0 ...

### All species - abundances

SAAll <- read.csv2(here("data","All\_Fin.csv"),row.names=1, header = TRUE)  
colnames(SAAll) <- species ##Estava assim originalmente, mas parece-me trocado  
sites <- row.names(SAAll)  
sites

## [1] "Guil\_Moniz\_0" "Lagoinha\_0"   
## [3] "Lagoinha\_50" "Lagoinha\_250"   
## [5] "Lagoinha\_Control\_50" "Lagoinha \_Control\_250"   
## [7] "Mist Negros\_0" "Mist Negros\_250"   
## [9] "Mist Negros\_Max" "Mist Negros\_Control\_50"   
## [11] "Mist Negros\_Control\_250" "Sta Barbara\_0"   
## [13] "Sta Barbara\_50" "Sta Barbara\_250"   
## [15] "Sta Barbara\_Max" "Sta Barbara\_Control\_50"   
## [17] "Sta Barbara\_Control\_250" "Malhadas\_0"   
## [19] "Malhadas\_50" "Malhadas\_250"   
## [21] "Malhadas\_Max"

# HEllinger transformation  
#SAAll <- decostand(SAAll, "hellinger")   
#SAAll

### Native species - abundances

SANat <- read.csv2(here("data","Nat\_Fin.csv"),row.names=1, header = TRUE)  
  
colnames(SANat) <- speciesNat   
# HEllinger transformation  
#SANat <- decostand(SANat, "hellinger")   
#SANat

### Non indigenous - abundances

SANInd <- read.csv2(here("data","NInd\_Fin.csv"),row.names=1, header = TRUE)  
colnames(SANInd) <- SpeciesNInd  
  
# HEllinger transformation  
#SANInd <- decostand(SANInd, "hellinger")   
#SANInd

### MDS files

MDSfile <- read.csv2(here("data","MDS\_vectors.csv"))  
trail <- MDSfile[,1]  
trail <- as.vector(trail)  
treatment <- MDSfile[,2]  
treatment <- as.vector(treatment)

### Weight ratios for trails

Weightsfile <- read.csv2(here("data","Weight\_Ratios\_Traits.csv"), header = TRUE, dec=".")  
weights <- Weightsfile[,-c(1:4)]  
weights <- as.vector(weights)

### Data structure verification

str(Variables)  
str(Alpha\_controls)  
str(Traits)  
str(TraitsNat)  
str(TraitsNInd)  
str(SAAll)  
str(SANat)  
str(SANInd)  
str(weights)  
str(treatment)

## Species accumulation curves

Alpha\_controls <- read.csv2(here("data","Control250\_Fin.csv"), header = TRUE)  
  
alphaaccumlist <-list()  
alphaaccumlist

## list()

plotlist <- list()  
par(mfrow=c(2,3))  
pdf('AccumCurvesControls.pdf')  
for(i in unique(Alpha\_controls[,"Trail\_Sampling.Area"])){  
 Alpha\_controlsMatrix <- Alpha\_controls[Alpha\_controls[,"Trail\_Sampling.Area"]== i, -1] #definir a matriz a analisar  
 alphaaccumlist[[i]] <- (alpha.accum(Alpha\_controlsMatrix))  
 alphaaccumlist[[i]]  
   
 #plot(alphaaccumlist[[i]][,1], alphaaccumlist[[i]][,2], xlab="Samples", ylab="Individuals", )  
 plot(alphaaccumlist[[i]][,1], alphaaccumlist[[i]][,3], xlab="Samples", ylab="Individuals",   
 ylim=c(0,50), main = i, col="blue", type = "p")  
   
 lines(alphaaccumlist[[i]][,1], alphaaccumlist[[i]][,4])  
 lines(alphaaccumlist[[i]][,1], alphaaccumlist[[i]][,5], col="yellow")  
 lines(alphaaccumlist[[i]][,1], alphaaccumlist[[i]][,8], col="red")  
 lines(alphaaccumlist[[i]][,1], alphaaccumlist[[i]][,13], col="red", type = "p")  
 lines(alphaaccumlist[[i]][,1], alphaaccumlist[[i]][,17], col="green")  
 lines(alphaaccumlist[[i]][,1], alphaaccumlist[[i]][,19], col="green", type = "p")  
}

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## Calculating functional elements

### Func. tree - all species

dissimAll <- cluster::daisy(Traits, "gower", weights = weights) # Calculating distances between species

## Warning in cluster::daisy(Traits, "gower", weights = weights): binary  
## variable(s) 3, 5, 6, 7, 18, 20, 22, 23, 24, 25, 26, 27 treated as interval  
## scaled

# https://www.rdocumentation.org/packages/cluster/versions/2.0.7-1/topics/daisy  
tree <- hclust(dissimAll, "average")   
par(mfrow=c(1,1))  
dev.copy(device = jpeg, filename = 'Tree.jpeg', width = 1000, height = 500)

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plot(tree, hang = -1) ## PQ O HANG= - 1?  
dev.off()

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## 2

#plot(as.dendrogram(tree))

### Func tree - nat species

dissimNat <- cluster::daisy(TraitsNat, "gower", weights = weights) # Calculating distances between species

## Warning in cluster::daisy(TraitsNat, "gower", weights = weights): binary  
## variable(s) 3, 5, 6, 7, 18, 20, 22, 23, 24, 25, 26, 27 treated as interval  
## scaled

treeNat <- hclust(dissimNat, "average") # building the dendrogrma  
par(mfrow=c(1,1))  
dev.copy(device = jpeg, filename = 'TreeNat.jpeg', width = 1000, height = 500)

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plot(treeNat, hang = -1) ## PQ O HANG= - 1?  
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### Func tree - non ind species

# All Non-Ind tree and FD Alpha ----  
dissimNInd <- cluster::daisy(TraitsNInd, "gower", weights = weights) # Calculating distances between species

## Warning in cluster::daisy(TraitsNInd, "gower", weights = weights): binary  
## variable(s) 3, 5, 6, 7, 18, 20, 22, 23, 24, 25, 26, 27 treated as interval  
## scaled

treeNInd <- hclust(dissimNInd, "average") # building the   
par(mfrow=c(1,1))  
dev.copy(device = jpeg, filename = 'TreeNInd.jpeg', width = 1000, height = 500)

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plot(treeNInd, hang = -1) ## PQ O HANG= - 1?  
dev.off()

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## Calculating Alphas and Betas

### Taxonomical Alpha

Alpha\_All <- alpha(SAAll)  
Alpha\_Nat<- alpha(SANat)  
Alpha\_NInd<- alpha(SANInd)

### Functional Alpha

FDalphaAll <- alpha(SAAll, tree)  
FDalphaNat <- alpha(SANat, treeNat)  
FDalphaNInd <- alpha(SANInd, treeNInd)

### Compiling Alphas

Alphas <- as.data.frame(cbind(Alpha\_All, Alpha\_Nat, Alpha\_NInd, FDalphaAll, FDalphaNat, FDalphaNInd))  
colnames(Alphas) <- cbind("TAlphaAll", "TAlphaNat", "TAlphaNInd","FAlphaAll", "FAlphaNat", "FAlphaNInd" )  
Alphas # Will be printed along with BETAS in the RESULTS file

## TAlphaAll TAlphaNat TAlphaNInd FAlphaAll FAlphaNat  
## Guil\_Moniz\_0 23 12 11 8.636980 2.725734  
## Lagoinha\_0 11 8 3 4.762770 2.033941  
## Lagoinha\_50 7 7 0 3.475044 1.866618  
## Lagoinha\_250 5 5 0 2.507196 1.512323  
## Lagoinha\_Control\_50 10 8 2 4.571896 2.016040  
## Lagoinha \_Control\_250 8 8 0 3.748115 1.917473  
## Mist Negros\_0 17 10 7 7.055960 2.365887  
## Mist Negros\_250 16 11 5 6.188667 2.425721  
## Mist Negros\_Max 11 10 1 4.419375 2.113683  
## Mist Negros\_Control\_50 11 9 2 4.455256 2.150089  
## Mist Negros\_Control\_250 13 10 3 5.157504 2.289209  
## Sta Barbara\_0 12 11 1 4.877473 2.477020  
## Sta Barbara\_50 11 9 2 4.826500 2.196536  
## Sta Barbara\_250 7 6 1 3.438483 1.750469  
## Sta Barbara\_Max 14 11 3 5.248713 2.283214  
## Sta Barbara\_Control\_50 10 9 1 3.913632 1.963638  
## Sta Barbara\_Control\_250 9 9 0 3.839360 1.998621  
## Malhadas\_0 10 8 2 3.662528 1.838051  
## Malhadas\_50 11 9 2 4.669753 2.196536  
## Malhadas\_250 12 11 1 4.320189 2.115858  
## Malhadas\_Max 11 9 2 4.424199 1.998621  
## FAlphaNInd  
## Guil\_Moniz\_0 1.8408466  
## Lagoinha\_0 1.0869209  
## Lagoinha\_50 0.0000000  
## Lagoinha\_250 0.0000000  
## Lagoinha\_Control\_50 1.0353041  
## Lagoinha \_Control\_250 0.0000000  
## Mist Negros\_0 2.1233970  
## Mist Negros\_250 1.1618418  
## Mist Negros\_Max 0.5176521  
## Mist Negros\_Control\_50 0.8228228  
## Mist Negros\_Control\_250 1.0460919  
## Sta Barbara\_0 0.5176521  
## Sta Barbara\_50 1.0353041  
## Sta Barbara\_250 0.5176521  
## Sta Barbara\_Max 0.8525833  
## Sta Barbara\_Control\_50 0.5176521  
## Sta Barbara\_Control\_250 0.0000000  
## Malhadas\_0 0.8228228  
## Malhadas\_50 0.7817502  
## Malhadas\_250 0.5176521  
## Malhadas\_Max 0.8228228

# Taxonomical Beta

BetaAll <- beta(SAAll)  
BetaNat <- beta(SANat)  
BetaNInd <- beta(SANInd)

#Functional Beta

BetaFuncAll <- beta(SAAll, tree, abund = T)  
BetaFuncNat <- beta(SANat, treeNat, abund = T)   
BetaFuncNInd <- beta(SANInd, treeNInd, abund= T)

### Separating Beta Tax fractions

BetaAllTotal <- data.frame(as.matrix(BetaAll[["Btotal"]]), row.names= sites, sep= "tab")  
colnames(BetaAllTotal) <- sites  
BetaAllRich <- data.frame(as.matrix(BetaAll[["Brich"]]), sep= "tab")  
BetaAllRepl <- data.frame(as.matrix(BetaAll[["Brepl"]]), sep= "tab")  
BetaNatTotal <- data.frame(as.matrix(BetaNat[["Btotal"]]), sep= "tab")  
BetaNatRich <- data.frame(as.matrix(BetaNat[["Brich"]]), sep= "tab")  
BetaNatRepl <- data.frame(as.matrix(BetaNat[["Brepl"]]), sep= "tab")  
BetaNIndTotal <- data.frame(as.matrix(BetaNInd[["Btotal"]]), sep= "tab")  
BetaNIndRich <- data.frame(as.matrix(BetaNInd[["Brich"]]), sep= "tab")  
BetaNIndRepl <- data.frame(as.matrix(BetaNInd[["Brepl"]]), sep= "tab")

### Separating Beta Func fractions

BetaFuncAllTotal <- data.frame(as.matrix(BetaFuncAll[["Btotal"]]), sep= "tab")  
BetaFuncAllRich <- data.frame(as.matrix(BetaFuncAll[["Brich"]]), sep= "tab")  
BetaFuncAllRepl <- data.frame(as.matrix(BetaFuncAll[["Brepl"]]), sep= "tab")  
BetaFuncNatTotal <- data.frame(as.matrix(BetaFuncNat[["Btotal"]]), sep= "tab")  
BetaFuncNatRich <- data.frame(as.matrix(BetaFuncNat[["Brich"]]), sep= "tab")  
BetaFuncNatRepl <- data.frame(as.matrix(BetaFuncNat[["Brepl"]]), sep= "tab")  
BetaFuncNIndTotal <- data.frame(as.matrix(BetaFuncNInd[["Btotal"]]), sep= "tab")  
BetaFuncNIndRich <- data.frame(as.matrix(BetaFuncNInd[["Brich"]]), sep= "tab")  
BetaFuncNIndRepl <- as.data.frame(as.matrix(BetaFuncNInd[["Brepl"]]), sep= "tab")

### Controls pairwise separation - taxonomical

A01 <- BetaAllTotal[1,1]  
AA1 <- BetaAllTotal[6,c(2:6)]  
BB1 <- BetaAllTotal[11,c(7:11)]  
CC1 <- BetaAllTotal[17,c(12:17)]  
DD1 <- BetaAllTotal[21,c(18:21)]  
BetaAllTotalVector <- c(A01,AA1, BB1, CC1, DD1)  
  
A02 <- BetaAllRich[1,1]  
AA2 <- BetaAllRich[6,c(2:6)]  
BB2 <- BetaAllRich[11,c(7:11)]  
CC2 <- BetaAllRich[17,c(12:17)]  
DD2<- BetaAllRich[21,c(18:21)]  
BetaAllRichVector <- c(A02,AA2, BB2, CC2, DD2)  
  
A03 <- BetaAllRepl[1,1]  
AA3 <- BetaAllRepl[6,c(2:6)]  
BB3 <- BetaAllRepl[11,c(7:11)]  
CC3 <- BetaAllRepl[17,c(12:17)]  
DD3 <- BetaAllRepl[21,c(18:21)]  
BetaAllReplVector <- c(A03,AA3, BB3, CC3, DD3)  
  
A01 <- BetaNatTotal[1,1]  
AA1 <- BetaNatTotal[6,c(2:6)]  
BB1 <- BetaNatTotal[11,c(7:11)]  
CC1 <- BetaNatTotal[17,c(12:17)]  
DD1 <- BetaNatTotal[21,c(18:21)]  
BetaNatTotalVector <- c(A01,AA1, BB1, CC1, DD1)  
  
A02 <- BetaNatRich[1,1]  
AA2 <- BetaNatRich[6,c(2:6)]  
BB2 <- BetaNatRich[11,c(7:11)]  
CC2 <- BetaNatRich[17,c(12:17)]  
DD2<- BetaNatRich[21,c(18:21)]  
BetaNatRichVector <- c(A02,AA2, BB2, CC2, DD2)  
  
A03 <- BetaNatRepl[1,1]  
AA3 <- BetaNatRepl[6,c(2:6)]  
BB3 <- BetaNatRepl[11,c(7:11)]  
CC3 <- BetaNatRepl[17,c(12:17)]  
DD3 <- BetaNatRepl[21,c(18:21)]  
BetaNatReplVector <- c(A03,AA3, BB3, CC3, DD3)  
  
A01 <- BetaNIndTotal[1,1]  
AA1 <- BetaNIndTotal[6,c(2:6)]  
BB1 <- BetaNIndTotal[11,c(7:11)]  
CC1 <- BetaNIndTotal[17,c(12:17)]  
DD1 <- BetaNIndTotal[21,c(18:21)]  
BetaNIndTotalVector <- c(A01,AA1, BB1, CC1, DD1)  
  
A02 <- BetaNIndRich[1,1]  
AA2 <- BetaNIndRich[6,c(2:6)]  
BB2 <- BetaNIndRich[11,c(7:11)]  
CC2 <- BetaNIndRich[17,c(12:17)]  
DD2<- BetaNIndRich[21,c(18:21)]  
BetaNIndRichVector <- c(A02,AA2, BB2, CC2, DD2)  
  
A03 <- BetaNIndRepl[1,1]  
AA3 <- BetaNIndRepl[6,c(2:6)]  
BB3 <- BetaNIndRepl[11,c(7:11)]  
CC3 <- BetaNIndRepl[17,c(12:17)]  
DD3 <- BetaNIndRepl[21,c(18:21)]  
BetaNIndReplVector <- c(A03,AA3, BB3, CC3, DD3)

### Controls pairwise separation - functional

A01 <- BetaFuncAllTotal[1,1]  
AA1 <- BetaFuncAllTotal[6,c(2:6)]  
BB1 <- BetaFuncAllTotal[11,c(7:11)]  
CC1 <- BetaFuncAllTotal[17,c(12:17)]  
DD1 <- BetaFuncAllTotal[21,c(18:21)]  
BetaFuncAllTotalVector <- c(A01,AA1, BB1, CC1, DD1)  
  
A02 <- BetaFuncAllRich[1,1]  
AA2 <- BetaFuncAllRich[6,c(2:6)]  
BB2 <- BetaFuncAllRich[11,c(7:11)]  
CC2 <- BetaFuncAllRich[17,c(12:17)]  
DD2<- BetaFuncAllRich[21,c(18:21)]  
BetaFuncAllRichVector <- c(A02,AA2, BB2, CC2, DD2)  
  
A03 <- BetaFuncAllRepl[1,1]  
AA3 <- BetaFuncAllRepl[6,c(2:6)]  
BB3 <- BetaFuncAllRepl[11,c(7:11)]  
CC3 <- BetaFuncAllRepl[17,c(12:17)]  
DD3 <- BetaFuncAllRepl[21,c(18:21)]  
BetaFuncAllReplVector <- c(A03,AA3, BB3, CC3, DD3)  
  
A01 <- BetaFuncNatTotal[1,1]  
AA1 <- BetaFuncNatTotal[6,c(2:6)]  
BB1 <- BetaFuncNatTotal[11,c(7:11)]  
CC1 <- BetaFuncNatTotal[17,c(12:17)]  
DD1 <- BetaFuncNatTotal[21,c(18:21)]  
BetaFuncNatTotalVector <- c(A01,AA1, BB1, CC1, DD1)  
  
A02 <- BetaFuncNatRich[1,1]  
AA2 <- BetaFuncNatRich[6,c(2:6)]  
BB2 <- BetaFuncNatRich[11,c(7:11)]  
CC2 <- BetaFuncNatRich[17,c(12:17)]  
DD2<- BetaFuncNatRich[21,c(18:21)]  
BetaFuncNatRichVector <- c(A02,AA2, BB2, CC2, DD2)  
  
A03 <- BetaFuncNatRepl[1,1]  
AA3 <- BetaFuncNatRepl[6,c(2:6)]  
BB3 <- BetaFuncNatRepl[11,c(7:11)]  
CC3 <- BetaFuncNatRepl[17,c(12:17)]  
DD3 <- BetaFuncNatRepl[21,c(18:21)]  
BetaFuncNatReplVector <- c(A03,AA3, BB3, CC3, DD3)  
  
A01 <- BetaFuncNIndTotal[1,1]  
AA1 <- BetaFuncNIndTotal[6,c(2:6)]  
BB1 <- BetaFuncNIndTotal[11,c(7:11)]  
CC1 <- BetaFuncNIndTotal[17,c(12:17)]  
DD1 <- BetaFuncNIndTotal[21,c(18:21)]  
BetaFuncNIndTotalVector <- c(A01,AA1, BB1, CC1, DD1)  
  
A02 <- BetaFuncNIndRich[1,1]  
AA2 <- BetaFuncNIndRich[6,c(2:6)]  
BB2 <- BetaFuncNIndRich[11,c(7:11)]  
CC2 <- BetaFuncNIndRich[17,c(12:17)]  
DD2<- BetaFuncNIndRich[21,c(18:21)]  
BetaFuncNIndRichVector <- c(A02,AA2, BB2, CC2, DD2)  
  
A03 <- BetaFuncNIndRepl[1,1]  
AA3 <- BetaFuncNIndRepl[6,c(2:6)]  
BB3 <- BetaFuncNIndRepl[11,c(7:11)]  
CC3 <- BetaFuncNIndRepl[17,c(12:17)]  
DD3 <- BetaFuncNIndRepl[21,c(18:21)]  
BetaFuncNIndReplVector <- c(A03,AA3, BB3, CC3, DD3)

### Exporting Beta fractions

write.csv(BetaAllTotal,file = here("results", "Control250\_Fin.csv"))  
write.csv(BetaAllRich,file = here("results", "BetaAllRich.csv"))  
write.csv(BetaAllRepl,file = here("results", "BetaAllRepl.csv"))  
write.csv(BetaNatTotal,file = here("results", "BetaNatTotal.csv"))  
write.csv(BetaNatRich,file = here("results", "BetaNatRich.csv"))  
write.csv(BetaNatRepl,file = here("results", "BetaNatRepl.csv"))  
write.csv(BetaNIndTotal,file = here("results", "BetaNIndTotal.csv"))  
write.csv(BetaNIndRich,file = here("results", "BetaNIndRich.csv"))  
write.csv(BetaNIndRepl,file = here("results", "BetaNIndRepl.csv"))  
  
## Exporting FUNCTIONAL beta results to .csv (for the record - it won't be usedin analysis, as the RESULTS   
# file compiles all the useable results )  
  
write.csv(BetaFuncAllTotal,file = here("results", "BetaFuncAllTotal.csv"))  
write.csv(BetaFuncAllRich,file = here("results", "BetaFuncAllRich.csv"))  
write.csv(BetaFuncAllRepl,file = here("results", "BetaFuncAllRepl.csv"))  
write.csv(BetaFuncNatTotal,file = here("results", "BetaFuncNatTotal.csv"))  
write.csv(BetaFuncNatRich,file = here("results", "BetaFuncNatRich.csv"))  
write.csv(BetaFuncNatRepl,file = here("results", "BetaFuncNatRepl.csv"))  
write.csv(BetaFuncNIndTotal,file = here("results", "BetaFuncNIndTotal.csv"))  
write.csv(BetaFuncNIndRich,file = here("results", "BetaFuncNIndRich.csv"))  
write.csv(BetaFuncNIndRepl,file = here("results", "BetaFuncNIndRepl.csv"))

### Compiling betas

Betas <- as.data.frame( t(rbind(  
 BetaAllTotalVector, BetaAllRichVector, BetaAllReplVector,   
 BetaFuncAllTotalVector, BetaFuncAllRichVector, BetaFuncAllReplVector,  
 BetaNatTotalVector, BetaNatRichVector, BetaNatReplVector,   
 BetaFuncNatTotalVector, BetaFuncNatRichVector, BetaFuncNatReplVector,  
 BetaNIndTotalVector, BetaNIndRichVector, BetaNIndReplVector,  
 BetaFuncNIndTotalVector, BetaFuncNIndRichVector, BetaFuncNIndReplVector)))  
  
# converting zero's and one's  
Betas[Betas == 0] <- 0.0001  
Betas[Betas == 1] <- 0.9999

## Results table

Results <- cbind.data.frame(Variables, Alphas, Betas)  
str(Results)

## 'data.frame': 21 obs. of 31 variables:  
## $ ForestID : Factor w/ 5 levels "Guilherme\_Moniz",..: 1 2 2 2 2 2 3 3 3 3 ...  
## $ Dist\_trail : num 0 0 0 0 50 235 0 0 0 50 ...  
## $ Dist\_edge : num 0 0 0 0 293 50 0 0 25 50 ...  
## $ Dist\_trail\_beginning : num 0 50 250 250 250 250 0 200 960 200 ...  
## $ Dist\_trail\_std : num [1:21, 1] 0 0 0 0 0.312 ...  
## ..- attr(\*, "scaled:scale")= num 160  
## $ Dist\_edge\_std : num [1:21, 1] 0 0 0 0 0.963 ...  
## ..- attr(\*, "scaled:scale")= num 304  
## $ Dist\_trail\_beginning\_std: num [1:21, 1] 0 0.0948 0.4741 0.4741 0.4741 ...  
## ..- attr(\*, "scaled:scale")= num 527  
## $ TAlphaAll : num 23 11 7 5 10 8 17 16 11 11 ...  
## $ TAlphaNat : num 12 8 7 5 8 8 10 11 10 9 ...  
## $ TAlphaNInd : num 11 3 0 0 2 0 7 5 1 2 ...  
## $ FAlphaAll : num 8.64 4.76 3.48 2.51 4.57 ...  
## $ FAlphaNat : num 2.73 2.03 1.87 1.51 2.02 ...  
## $ FAlphaNInd : num 1.84 1.09 0 0 1.04 ...  
## $ BetaAllTotalVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 0.643  
## ..$ Lagoinha\_50 : num 0.333  
## ..$ Lagoinha\_250 : num 0.375  
## ..$ Lagoinha\_Control\_50 : num 0.5  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.5  
## ..$ Mist Negros\_250 : num 0.389  
## ..$ Mist Negros\_Max : num 0.588  
## ..$ Mist Negros\_Control\_50 : num 0.5  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 0.5  
## ..$ Sta Barbara\_50 : num 0.571  
## ..$ Sta Barbara\_250 : num 0.545  
## ..$ Sta Barbara\_Max : num 0.562  
## ..$ Sta Barbara\_Control\_50 : num 0.417  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.5  
## ..$ Malhadas\_50 : num 0.533  
## ..$ Malhadas\_250 : num 0.467  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaAllRichVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 0.214  
## ..$ Lagoinha\_50 : num 0.111  
## ..$ Lagoinha\_250 : num 0.375  
## ..$ Lagoinha\_Control\_50 : num 0.167  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.2  
## ..$ Mist Negros\_250 : num 0.167  
## ..$ Mist Negros\_Max : num 0.118  
## ..$ Mist Negros\_Control\_50 : num 0.125  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 0.214  
## ..$ Sta Barbara\_50 : num 0.143  
## ..$ Sta Barbara\_250 : num 0.182  
## ..$ Sta Barbara\_Max : num 0.312  
## ..$ Sta Barbara\_Control\_50 : num 0.0833  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.0714  
## ..$ Malhadas\_50 : num 1e-04  
## ..$ Malhadas\_250 : num 0.0667  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaAllReplVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 0.429  
## ..$ Lagoinha\_50 : num 0.222  
## ..$ Lagoinha\_250 : num 1e-04  
## ..$ Lagoinha\_Control\_50 : num 0.333  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.3  
## ..$ Mist Negros\_250 : num 0.222  
## ..$ Mist Negros\_Max : num 0.471  
## ..$ Mist Negros\_Control\_50 : num 0.375  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 0.286  
## ..$ Sta Barbara\_50 : num 0.429  
## ..$ Sta Barbara\_250 : num 0.364  
## ..$ Sta Barbara\_Max : num 0.25  
## ..$ Sta Barbara\_Control\_50 : num 0.333  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.429  
## ..$ Malhadas\_50 : num 0.533  
## ..$ Malhadas\_250 : num 0.4  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaFuncAllTotalVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 0.494  
## ..$ Lagoinha\_50 : num 0.31  
## ..$ Lagoinha\_250 : num 0.47  
## ..$ Lagoinha\_Control\_50 : num 0.451  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.558  
## ..$ Mist Negros\_250 : num 0.279  
## ..$ Mist Negros\_Max : num 0.525  
## ..$ Mist Negros\_Control\_50 : num 0.315  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 0.526  
## ..$ Sta Barbara\_50 : num 0.657  
## ..$ Sta Barbara\_250 : num 0.527  
## ..$ Sta Barbara\_Max : num 0.587  
## ..$ Sta Barbara\_Control\_50 : num 0.491  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.525  
## ..$ Malhadas\_50 : num 0.64  
## ..$ Malhadas\_250 : num 0.464  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaFuncAllRichVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 0.253  
## ..$ Lagoinha\_50 : num 0.0247  
## ..$ Lagoinha\_250 : num 0.131  
## ..$ Lagoinha\_Control\_50 : num 0.315  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.256  
## ..$ Mist Negros\_250 : num 0.0675  
## ..$ Mist Negros\_Max : num 0.315  
## ..$ Mist Negros\_Control\_50 : num 0.0414  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 0.102  
## ..$ Sta Barbara\_50 : num 0.537  
## ..$ Sta Barbara\_250 : num 0.146  
## ..$ Sta Barbara\_Max : num 0.207  
## ..$ Sta Barbara\_Control\_50 : num 0.219  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.432  
## ..$ Malhadas\_50 : num 0.377  
## ..$ Malhadas\_250 : num 0.357  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaFuncAllReplVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 0.241  
## ..$ Lagoinha\_50 : num 0.286  
## ..$ Lagoinha\_250 : num 0.339  
## ..$ Lagoinha\_Control\_50 : num 0.136  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.302  
## ..$ Mist Negros\_250 : num 0.212  
## ..$ Mist Negros\_Max : num 0.209  
## ..$ Mist Negros\_Control\_50 : num 0.273  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 0.424  
## ..$ Sta Barbara\_50 : num 0.12  
## ..$ Sta Barbara\_250 : num 0.38  
## ..$ Sta Barbara\_Max : num 0.38  
## ..$ Sta Barbara\_Control\_50 : num 0.273  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.0934  
## ..$ Malhadas\_50 : num 0.263  
## ..$ Malhadas\_250 : num 0.107  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaNatTotalVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 0.545  
## ..$ Lagoinha\_50 : num 0.333  
## ..$ Lagoinha\_250 : num 0.375  
## ..$ Lagoinha\_Control\_50 : num 0.4  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.333  
## ..$ Mist Negros\_250 : num 0.385  
## ..$ Mist Negros\_Max : num 0.462  
## ..$ Mist Negros\_Control\_50 : num 0.417  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 0.462  
## ..$ Sta Barbara\_50 : num 0.5  
## ..$ Sta Barbara\_250 : num 0.5  
## ..$ Sta Barbara\_Max : num 0.462  
## ..$ Sta Barbara\_Control\_50 : num 0.364  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.455  
## ..$ Malhadas\_50 : num 0.5  
## ..$ Malhadas\_250 : num 0.333  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaNatRichVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 1e-04  
## ..$ Lagoinha\_50 : num 0.111  
## ..$ Lagoinha\_250 : num 0.375  
## ..$ Lagoinha\_Control\_50 : num 1e-04  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 1e-04  
## ..$ Mist Negros\_250 : num 0.0769  
## ..$ Mist Negros\_Max : num 1e-04  
## ..$ Mist Negros\_Control\_50 : num 0.0833  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 0.154  
## ..$ Sta Barbara\_50 : num 1e-04  
## ..$ Sta Barbara\_250 : num 0.3  
## ..$ Sta Barbara\_Max : num 0.154  
## ..$ Sta Barbara\_Control\_50 : num 1e-04  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.0909  
## ..$ Malhadas\_50 : num 1e-04  
## ..$ Malhadas\_250 : num 0.167  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaNatReplVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 0.545  
## ..$ Lagoinha\_50 : num 0.222  
## ..$ Lagoinha\_250 : num 1e-04  
## ..$ Lagoinha\_Control\_50 : num 0.4  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.333  
## ..$ Mist Negros\_250 : num 0.308  
## ..$ Mist Negros\_Max : num 0.462  
## ..$ Mist Negros\_Control\_50 : num 0.333  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 0.308  
## ..$ Sta Barbara\_50 : num 0.5  
## ..$ Sta Barbara\_250 : num 0.2  
## ..$ Sta Barbara\_Max : num 0.308  
## ..$ Sta Barbara\_Control\_50 : num 0.364  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.364  
## ..$ Malhadas\_50 : num 0.5  
## ..$ Malhadas\_250 : num 0.167  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaFuncNatTotalVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 0.531  
## ..$ Lagoinha\_50 : num 0.371  
## ..$ Lagoinha\_250 : num 0.547  
## ..$ Lagoinha\_Control\_50 : num 0.437  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.63  
## ..$ Mist Negros\_250 : num 0.361  
## ..$ Mist Negros\_Max : num 0.359  
## ..$ Mist Negros\_Control\_50 : num 0.409  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 0.488  
## ..$ Sta Barbara\_50 : num 0.65  
## ..$ Sta Barbara\_250 : num 0.54  
## ..$ Sta Barbara\_Max : num 0.593  
## ..$ Sta Barbara\_Control\_50 : num 0.48  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.556  
## ..$ Malhadas\_50 : num 0.695  
## ..$ Malhadas\_250 : num 0.456  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaFuncNatRichVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 0.307  
## ..$ Lagoinha\_50 : num 0.0238  
## ..$ Lagoinha\_250 : num 0.125  
## ..$ Lagoinha\_Control\_50 : num 0.334  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.0965  
## ..$ Mist Negros\_250 : num 0.00716  
## ..$ Mist Negros\_Max : num 0.0912  
## ..$ Mist Negros\_Control\_50 : num 0.206  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 0.128  
## ..$ Sta Barbara\_50 : num 0.566  
## ..$ Sta Barbara\_250 : num 0.0973  
## ..$ Sta Barbara\_Max : num 0.125  
## ..$ Sta Barbara\_Control\_50 : num 0.233  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.494  
## ..$ Malhadas\_50 : num 0.409  
## ..$ Malhadas\_250 : num 0.372  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaFuncNatReplVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 0.225  
## ..$ Lagoinha\_50 : num 0.347  
## ..$ Lagoinha\_250 : num 0.423  
## ..$ Lagoinha\_Control\_50 : num 0.103  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.534  
## ..$ Mist Negros\_250 : num 0.354  
## ..$ Mist Negros\_Max : num 0.268  
## ..$ Mist Negros\_Control\_50 : num 0.203  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 0.36  
## ..$ Sta Barbara\_50 : num 0.084  
## ..$ Sta Barbara\_250 : num 0.443  
## ..$ Sta Barbara\_Max : num 0.468  
## ..$ Sta Barbara\_Control\_50 : num 0.247  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.0618  
## ..$ Malhadas\_50 : num 0.286  
## ..$ Malhadas\_250 : num 0.0843  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaNIndTotalVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 1  
## ..$ Lagoinha\_50 : num 1e-04  
## ..$ Lagoinha\_250 : num 1e-04  
## ..$ Lagoinha\_Control\_50 : num 1  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.75  
## ..$ Mist Negros\_250 : num 0.4  
## ..$ Mist Negros\_Max : num 1  
## ..$ Mist Negros\_Control\_50 : num 0.75  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 1  
## ..$ Sta Barbara\_50 : num 1  
## ..$ Sta Barbara\_250 : num 1  
## ..$ Sta Barbara\_Max : num 1  
## ..$ Sta Barbara\_Control\_50 : num 1  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.667  
## ..$ Malhadas\_50 : num 0.667  
## ..$ Malhadas\_250 : num 1  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaNIndRichVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 1  
## ..$ Lagoinha\_50 : num 1e-04  
## ..$ Lagoinha\_250 : num 1e-04  
## ..$ Lagoinha\_Control\_50 : num 1  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.5  
## ..$ Mist Negros\_250 : num 0.4  
## ..$ Mist Negros\_Max : num 0.5  
## ..$ Mist Negros\_Control\_50 : num 0.25  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 1  
## ..$ Sta Barbara\_50 : num 1  
## ..$ Sta Barbara\_250 : num 1  
## ..$ Sta Barbara\_Max : num 1  
## ..$ Sta Barbara\_Control\_50 : num 1  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 1e-04  
## ..$ Malhadas\_50 : num 1e-04  
## ..$ Malhadas\_250 : num 0.333  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaNIndReplVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 1e-04  
## ..$ Lagoinha\_50 : num 1e-04  
## ..$ Lagoinha\_250 : num 1e-04  
## ..$ Lagoinha\_Control\_50 : num 1e-04  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.25  
## ..$ Mist Negros\_250 : num 1e-04  
## ..$ Mist Negros\_Max : num 0.5  
## ..$ Mist Negros\_Control\_50 : num 0.5  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 1e-04  
## ..$ Sta Barbara\_50 : num 1e-04  
## ..$ Sta Barbara\_250 : num 1e-04  
## ..$ Sta Barbara\_Max : num 1e-04  
## ..$ Sta Barbara\_Control\_50 : num 1e-04  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.667  
## ..$ Malhadas\_50 : num 0.667  
## ..$ Malhadas\_250 : num 0.667  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaFuncNIndTotalVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 1  
## ..$ Lagoinha\_50 : num 1e-04  
## ..$ Lagoinha\_250 : num 1e-04  
## ..$ Lagoinha\_Control\_50 : num 1  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.799  
## ..$ Mist Negros\_250 : num 0.297  
## ..$ Mist Negros\_Max : num 0.989  
## ..$ Mist Negros\_Control\_50 : num 0.585  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 1  
## ..$ Sta Barbara\_50 : num 1  
## ..$ Sta Barbara\_250 : num 1  
## ..$ Sta Barbara\_Max : num 1  
## ..$ Sta Barbara\_Control\_50 : num 1  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.858  
## ..$ Malhadas\_50 : num 0.836  
## ..$ Malhadas\_250 : num 0.78  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaFuncNIndRichVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 1  
## ..$ Lagoinha\_50 : num 1e-04  
## ..$ Lagoinha\_250 : num 1e-04  
## ..$ Lagoinha\_Control\_50 : num 1  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.695  
## ..$ Mist Negros\_250 : num 0.287  
## ..$ Mist Negros\_Max : num 0.967  
## ..$ Mist Negros\_Control\_50 : num 0.575  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 1  
## ..$ Sta Barbara\_50 : num 1  
## ..$ Sta Barbara\_250 : num 1  
## ..$ Sta Barbara\_Max : num 1  
## ..$ Sta Barbara\_Control\_50 : num 1  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.761  
## ..$ Malhadas\_50 : num 0.699  
## ..$ Malhadas\_250 : num 0.244  
## ..$ Malhadas\_Max : num 1e-04  
## $ BetaFuncNIndReplVector :List of 21  
## ..$ : num 1e-04  
## ..$ Lagoinha\_0 : num 1e-04  
## ..$ Lagoinha\_50 : num 1e-04  
## ..$ Lagoinha\_250 : num 1e-04  
## ..$ Lagoinha\_Control\_50 : num 1e-04  
## ..$ Lagoinha \_Control\_250 : num 1e-04  
## ..$ Mist Negros\_0 : num 0.104  
## ..$ Mist Negros\_250 : num 0.00989  
## ..$ Mist Negros\_Max : num 0.0224  
## ..$ Mist Negros\_Control\_50 : num 0.00982  
## ..$ Mist Negros\_Control\_250: num 1e-04  
## ..$ Sta Barbara\_0 : num 1e-04  
## ..$ Sta Barbara\_50 : num 1e-04  
## ..$ Sta Barbara\_250 : num 1e-04  
## ..$ Sta Barbara\_Max : num 1e-04  
## ..$ Sta Barbara\_Control\_50 : num 1e-04  
## ..$ Sta Barbara\_Control\_250: num 1e-04  
## ..$ Malhadas\_0 : num 0.0971  
## ..$ Malhadas\_50 : num 0.137  
## ..$ Malhadas\_250 : num 0.536  
## ..$ Malhadas\_Max : num 1e-04

#MAKING THE RESULTS EXPORTABLE INTO CSV  
Results <- apply(Results, 2 , as.character)  
  
#NAMING THE TRAIL SEGMENTS  
rownames(Results) <- rownames(Alphas)  
  
#PASSING RESULTS TO FILE  
write.csv(Results, file = here("results","RESULTS.csv"), row.names = TRUE)  
  
Results2 <- read.csv2(here("results","RESULTS.CSV"), header=TRUE, row.names = 1, stringsAsFactors = T,sep = ",", dec = ".")  
Results2

## ForestID Dist\_trail Dist\_edge  
## Guil\_Moniz\_0 Guilherme\_Moniz 0 0  
## Lagoinha\_0 Lagoinha 0 0  
## Lagoinha\_50 Lagoinha 0 0  
## Lagoinha\_250 Lagoinha 0 0  
## Lagoinha\_Control\_50 Lagoinha 50 293  
## Lagoinha \_Control\_250 Lagoinha 235 50  
## Mist Negros\_0 Mist\xe9rios\_Negros 0 0  
## Mist Negros\_250 Mist\xe9rios\_Negros 0 0  
## Mist Negros\_Max Mist\xe9rios\_Negros 0 25  
## Mist Negros\_Control\_50 Mist\xe9rios\_Negros 50 50  
## Mist Negros\_Control\_250 Mist\xe9rios\_Negros 600 600  
## Sta Barbara\_0 Santa\_Barbara 0 510  
## Sta Barbara\_50 Santa\_Barbara 0 481  
## Sta Barbara\_250 Santa\_Barbara 0 436  
## Sta Barbara\_Max Santa\_Barbara 0 404  
## Sta Barbara\_Control\_50 Santa\_Barbara 50 441  
## Sta Barbara\_Control\_250 Santa\_Barbara 300 600  
## Malhadas\_0 Pico\_Vara 0 0  
## Malhadas\_50 Pico\_Vara 0 0  
## Malhadas\_250 Pico\_Vara 0 0  
## Malhadas\_Max Pico\_Vara 0 0  
## Dist\_trail\_beginning Dist\_trail\_std Dist\_edge\_std  
## Guil\_Moniz\_0 0 0.000000 0.00000000  
## Lagoinha\_0 50 0.000000 0.00000000  
## Lagoinha\_50 250 0.000000 0.00000000  
## Lagoinha\_250 250 0.000000 0.00000000  
## Lagoinha\_Control\_50 250 0.312279 0.96318857  
## Lagoinha \_Control\_250 250 1.467711 0.16436665  
## Mist Negros\_0 0 0.000000 0.00000000  
## Mist Negros\_250 200 0.000000 0.00000000  
## Mist Negros\_Max 960 0.000000 0.08218333  
## Mist Negros\_Control\_50 200 0.312279 0.16436665  
## Mist Negros\_Control\_250 1880 3.747348 1.97239980  
## Sta Barbara\_0 0 0.000000 1.67653983  
## Sta Barbara\_50 50 0.000000 1.58120718  
## Sta Barbara\_250 250 0.000000 1.43327719  
## Sta Barbara\_Max 401 0.000000 1.32808253  
## Sta Barbara\_Control\_50 401 0.312279 1.44971386  
## Sta Barbara\_Control\_250 401 1.873674 1.97239980  
## Malhadas\_0 0 0.000000 0.00000000  
## Malhadas\_50 50 0.000000 0.00000000  
## Malhadas\_250 250 0.000000 0.00000000  
## Malhadas\_Max 400 0.000000 0.00000000  
## Dist\_trail\_beginning\_std TAlphaAll TAlphaNat  
## Guil\_Moniz\_0 0.00000000 23 12  
## Lagoinha\_0 0.09482271 11 8  
## Lagoinha\_50 0.47411353 7 7  
## Lagoinha\_250 0.47411353 5 5  
## Lagoinha\_Control\_50 0.47411353 10 8  
## Lagoinha \_Control\_250 0.47411353 8 8  
## Mist Negros\_0 0.00000000 17 10  
## Mist Negros\_250 0.37929082 16 11  
## Mist Negros\_Max 1.82059594 11 10  
## Mist Negros\_Control\_50 0.37929082 11 9  
## Mist Negros\_Control\_250 3.56533373 13 10  
## Sta Barbara\_0 0.00000000 12 11  
## Sta Barbara\_50 0.09482271 11 9  
## Sta Barbara\_250 0.47411353 7 6  
## Sta Barbara\_Max 0.76047810 14 11  
## Sta Barbara\_Control\_50 0.76047810 10 9  
## Sta Barbara\_Control\_250 0.76047810 9 9  
## Malhadas\_0 0.00000000 10 8  
## Malhadas\_50 0.09482271 11 9  
## Malhadas\_250 0.47411353 12 11  
## Malhadas\_Max 0.75858164 11 9  
## TAlphaNInd FAlphaAll FAlphaNat FAlphaNInd  
## Guil\_Moniz\_0 11 8.636980 2.725734 1.8408466  
## Lagoinha\_0 3 4.762770 2.033941 1.0869209  
## Lagoinha\_50 0 3.475044 1.866618 0.0000000  
## Lagoinha\_250 0 2.507196 1.512323 0.0000000  
## Lagoinha\_Control\_50 2 4.571896 2.016040 1.0353041  
## Lagoinha \_Control\_250 0 3.748115 1.917473 0.0000000  
## Mist Negros\_0 7 7.055960 2.365887 2.1233970  
## Mist Negros\_250 5 6.188667 2.425721 1.1618418  
## Mist Negros\_Max 1 4.419375 2.113683 0.5176521  
## Mist Negros\_Control\_50 2 4.455256 2.150089 0.8228228  
## Mist Negros\_Control\_250 3 5.157504 2.289209 1.0460919  
## Sta Barbara\_0 1 4.877473 2.477020 0.5176521  
## Sta Barbara\_50 2 4.826500 2.196536 1.0353041  
## Sta Barbara\_250 1 3.438483 1.750469 0.5176521  
## Sta Barbara\_Max 3 5.248713 2.283214 0.8525833  
## Sta Barbara\_Control\_50 1 3.913632 1.963638 0.5176521  
## Sta Barbara\_Control\_250 0 3.839360 1.998621 0.0000000  
## Malhadas\_0 2 3.662528 1.838051 0.8228228  
## Malhadas\_50 2 4.669753 2.196536 0.7817502  
## Malhadas\_250 1 4.320189 2.115858 0.5176521  
## Malhadas\_Max 2 4.424199 1.998621 0.8228228  
## BetaAllTotalVector BetaAllRichVector  
## Guil\_Moniz\_0 0.0001000 0.00010000  
## Lagoinha\_0 0.6428571 0.21428571  
## Lagoinha\_50 0.3333333 0.11111111  
## Lagoinha\_250 0.3750000 0.37500000  
## Lagoinha\_Control\_50 0.5000000 0.16666667  
## Lagoinha \_Control\_250 0.0001000 0.00010000  
## Mist Negros\_0 0.5000000 0.20000000  
## Mist Negros\_250 0.3888889 0.16666667  
## Mist Negros\_Max 0.5882353 0.11764706  
## Mist Negros\_Control\_50 0.5000000 0.12500000  
## Mist Negros\_Control\_250 0.0001000 0.00010000  
## Sta Barbara\_0 0.5000000 0.21428571  
## Sta Barbara\_50 0.5714286 0.14285714  
## Sta Barbara\_250 0.5454545 0.18181818  
## Sta Barbara\_Max 0.5625000 0.31250000  
## Sta Barbara\_Control\_50 0.4166667 0.08333333  
## Sta Barbara\_Control\_250 0.0001000 0.00010000  
## Malhadas\_0 0.5000000 0.07142857  
## Malhadas\_50 0.5333333 0.00010000  
## Malhadas\_250 0.4666667 0.06666667  
## Malhadas\_Max 0.0001000 0.00010000  
## BetaAllReplVector BetaFuncAllTotalVector  
## Guil\_Moniz\_0 0.0001000 0.0001000  
## Lagoinha\_0 0.4285714 0.4936784  
## Lagoinha\_50 0.2222222 0.3104295  
## Lagoinha\_250 0.0001000 0.4703047  
## Lagoinha\_Control\_50 0.3333333 0.4510427  
## Lagoinha \_Control\_250 0.0001000 0.0001000  
## Mist Negros\_0 0.3000000 0.5584348  
## Mist Negros\_250 0.2222222 0.2792181  
## Mist Negros\_Max 0.4705882 0.5247621  
## Mist Negros\_Control\_50 0.3750000 0.3148084  
## Mist Negros\_Control\_250 0.0001000 0.0001000  
## Sta Barbara\_0 0.2857143 0.5260492  
## Sta Barbara\_50 0.4285714 0.6572888  
## Sta Barbara\_250 0.3636364 0.5266739  
## Sta Barbara\_Max 0.2500000 0.5870997  
## Sta Barbara\_Control\_50 0.3333333 0.4914517  
## Sta Barbara\_Control\_250 0.0001000 0.0001000  
## Malhadas\_0 0.4285714 0.5250878  
## Malhadas\_50 0.5333333 0.6401026  
## Malhadas\_250 0.4000000 0.4641417  
## Malhadas\_Max 0.0001000 0.0001000  
## BetaFuncAllRichVector BetaFuncAllReplVector  
## Guil\_Moniz\_0 0.00010000 0.00010000  
## Lagoinha\_0 0.25316330 0.24051505  
## Lagoinha\_50 0.02466526 0.28576424  
## Lagoinha\_250 0.13145819 0.33884650  
## Lagoinha\_Control\_50 0.31515581 0.13588692  
## Lagoinha \_Control\_250 0.00010000 0.00010000  
## Mist Negros\_0 0.25627825 0.30215660  
## Mist Negros\_250 0.06748164 0.21173649  
## Mist Negros\_Max 0.31531803 0.20944404  
## Mist Negros\_Control\_50 0.04135440 0.27345396  
## Mist Negros\_Control\_250 0.00010000 0.00010000  
## Sta Barbara\_0 0.10235769 0.42369155  
## Sta Barbara\_50 0.53708446 0.12020438  
## Sta Barbara\_250 0.14647102 0.38020285  
## Sta Barbara\_Max 0.20743412 0.37966555  
## Sta Barbara\_Control\_50 0.21871146 0.27274028  
## Sta Barbara\_Control\_250 0.00010000 0.00010000  
## Malhadas\_0 0.43168162 0.09340618  
## Malhadas\_50 0.37683904 0.26326358  
## Malhadas\_250 0.35717635 0.10696535  
## Malhadas\_Max 0.00010000 0.00010000  
## BetaNatTotalVector BetaNatRichVector  
## Guil\_Moniz\_0 0.0001000 0.00010000  
## Lagoinha\_0 0.5454545 0.00010000  
## Lagoinha\_50 0.3333333 0.11111111  
## Lagoinha\_250 0.3750000 0.37500000  
## Lagoinha\_Control\_50 0.4000000 0.00010000  
## Lagoinha \_Control\_250 0.0001000 0.00010000  
## Mist Negros\_0 0.3333333 0.00010000  
## Mist Negros\_250 0.3846154 0.07692308  
## Mist Negros\_Max 0.4615385 0.00010000  
## Mist Negros\_Control\_50 0.4166667 0.08333333  
## Mist Negros\_Control\_250 0.0001000 0.00010000  
## Sta Barbara\_0 0.4615385 0.15384615  
## Sta Barbara\_50 0.5000000 0.00010000  
## Sta Barbara\_250 0.5000000 0.30000000  
## Sta Barbara\_Max 0.4615385 0.15384615  
## Sta Barbara\_Control\_50 0.3636364 0.00010000  
## Sta Barbara\_Control\_250 0.0001000 0.00010000  
## Malhadas\_0 0.4545455 0.09090909  
## Malhadas\_50 0.5000000 0.00010000  
## Malhadas\_250 0.3333333 0.16666667  
## Malhadas\_Max 0.0001000 0.00010000  
## BetaNatReplVector BetaFuncNatTotalVector  
## Guil\_Moniz\_0 0.0001000 0.0001000  
## Lagoinha\_0 0.5454545 0.5311598  
## Lagoinha\_50 0.2222222 0.3708089  
## Lagoinha\_250 0.0001000 0.5473470  
## Lagoinha\_Control\_50 0.4000000 0.4372679  
## Lagoinha \_Control\_250 0.0001000 0.0001000  
## Mist Negros\_0 0.3333333 0.6303940  
## Mist Negros\_250 0.3076923 0.3610143  
## Mist Negros\_Max 0.4615385 0.3592383  
## Mist Negros\_Control\_50 0.3333333 0.4093626  
## Mist Negros\_Control\_250 0.0001000 0.0001000  
## Sta Barbara\_0 0.3076923 0.4882130  
## Sta Barbara\_50 0.5000000 0.6500609  
## Sta Barbara\_250 0.2000000 0.5399822  
## Sta Barbara\_Max 0.3076923 0.5925594  
## Sta Barbara\_Control\_50 0.3636364 0.4802903  
## Sta Barbara\_Control\_250 0.0001000 0.0001000  
## Malhadas\_0 0.3636364 0.5555806  
## Malhadas\_50 0.5000000 0.6951840  
## Malhadas\_250 0.1666667 0.4564614  
## Malhadas\_Max 0.0001000 0.0001000  
## BetaFuncNatRichVector BetaFuncNatReplVector  
## Guil\_Moniz\_0 0.000100000 0.00010000  
## Lagoinha\_0 0.306540571 0.22461919  
## Lagoinha\_50 0.023783812 0.34702505  
## Lagoinha\_250 0.124837365 0.42250966  
## Lagoinha\_Control\_50 0.334383730 0.10288415  
## Lagoinha \_Control\_250 0.000100000 0.00010000  
## Mist Negros\_0 0.096451128 0.53394286  
## Mist Negros\_250 0.007157143 0.35385714  
## Mist Negros\_Max 0.091153427 0.26808489  
## Mist Negros\_Control\_50 0.206418588 0.20294406  
## Mist Negros\_Control\_250 0.000100000 0.00010000  
## Sta Barbara\_0 0.127756647 0.36045636  
## Sta Barbara\_50 0.566103493 0.08395741  
## Sta Barbara\_250 0.097334518 0.44264771  
## Sta Barbara\_Max 0.124920764 0.46763862  
## Sta Barbara\_Control\_50 0.233363668 0.24692659  
## Sta Barbara\_Control\_250 0.000100000 0.00010000  
## Malhadas\_0 0.493818608 0.06176196  
## Malhadas\_50 0.409461098 0.28572287  
## Malhadas\_250 0.372157528 0.08430387  
## Malhadas\_Max 0.000100000 0.00010000  
## BetaNIndTotalVector BetaNIndRichVector  
## Guil\_Moniz\_0 0.0001000 0.0001000  
## Lagoinha\_0 0.9999000 0.9999000  
## Lagoinha\_50 0.0001000 0.0001000  
## Lagoinha\_250 0.0001000 0.0001000  
## Lagoinha\_Control\_50 0.9999000 0.9999000  
## Lagoinha \_Control\_250 0.0001000 0.0001000  
## Mist Negros\_0 0.7500000 0.5000000  
## Mist Negros\_250 0.4000000 0.4000000  
## Mist Negros\_Max 0.9999000 0.5000000  
## Mist Negros\_Control\_50 0.7500000 0.2500000  
## Mist Negros\_Control\_250 0.0001000 0.0001000  
## Sta Barbara\_0 0.9999000 0.9999000  
## Sta Barbara\_50 0.9999000 0.9999000  
## Sta Barbara\_250 0.9999000 0.9999000  
## Sta Barbara\_Max 0.9999000 0.9999000  
## Sta Barbara\_Control\_50 0.9999000 0.9999000  
## Sta Barbara\_Control\_250 0.0001000 0.0001000  
## Malhadas\_0 0.6666667 0.0001000  
## Malhadas\_50 0.6666667 0.0001000  
## Malhadas\_250 0.9999000 0.3333333  
## Malhadas\_Max 0.0001000 0.0001000  
## BetaNIndReplVector BetaFuncNIndTotalVector  
## Guil\_Moniz\_0 0.0001000 0.0001000  
## Lagoinha\_0 0.0001000 0.9999000  
## Lagoinha\_50 0.0001000 0.0001000  
## Lagoinha\_250 0.0001000 0.0001000  
## Lagoinha\_Control\_50 0.0001000 0.9999000  
## Lagoinha \_Control\_250 0.0001000 0.0001000  
## Mist Negros\_0 0.2500000 0.7991101  
## Mist Negros\_250 0.0001000 0.2973494  
## Mist Negros\_Max 0.5000000 0.9892372  
## Mist Negros\_Control\_50 0.5000000 0.5847644  
## Mist Negros\_Control\_250 0.0001000 0.0001000  
## Sta Barbara\_0 0.0001000 0.9999000  
## Sta Barbara\_50 0.0001000 0.9999000  
## Sta Barbara\_250 0.0001000 0.9999000  
## Sta Barbara\_Max 0.0001000 0.9999000  
## Sta Barbara\_Control\_50 0.0001000 0.9999000  
## Sta Barbara\_Control\_250 0.0001000 0.0001000  
## Malhadas\_0 0.6666667 0.8582503  
## Malhadas\_50 0.6666667 0.8357918  
## Malhadas\_250 0.6666667 0.7804025  
## Malhadas\_Max 0.0001000 0.0001000  
## BetaFuncNIndRichVector BetaFuncNIndReplVector  
## Guil\_Moniz\_0 0.0001000 0.000100000  
## Lagoinha\_0 0.9999000 0.000100000  
## Lagoinha\_50 0.0001000 0.000100000  
## Lagoinha\_250 0.0001000 0.000100000  
## Lagoinha\_Control\_50 0.9999000 0.000100000  
## Lagoinha \_Control\_250 0.0001000 0.000100000  
## Mist Negros\_0 0.6952520 0.103858104  
## Mist Negros\_250 0.2874605 0.009888885  
## Mist Negros\_Max 0.9668166 0.022420679  
## Mist Negros\_Control\_50 0.5749395 0.009824927  
## Mist Negros\_Control\_250 0.0001000 0.000100000  
## Sta Barbara\_0 0.9999000 0.000100000  
## Sta Barbara\_50 0.9999000 0.000100000  
## Sta Barbara\_250 0.9999000 0.000100000  
## Sta Barbara\_Max 0.9999000 0.000100000  
## Sta Barbara\_Control\_50 0.9999000 0.000100000  
## Sta Barbara\_Control\_250 0.0001000 0.000100000  
## Malhadas\_0 0.7611665 0.097083853  
## Malhadas\_50 0.6985249 0.137266826  
## Malhadas\_250 0.2439195 0.536483020  
## Malhadas\_Max 0.0001000 0.000100000

Results3 <- read.csv(here("results","RESULTS.csv"), header = TRUE, row.names = 1, sep = ",", dec = ".")  
ResultsWithoutControls <- Results3[-c(5,6,10,11,16,17),-c(1:2)]

## GLMM testing

### Checking for colinearity on ind. var.

results.variables <- Results2[,5:7] # selecting the variables relevant to the test  
  
numeric.results.variables <- Results2[,5:7] # selecting the variables relevant to the test  
cor(numeric.results.variables) #isto ontem funcionava, nÃ£o sei o que se passa

## Dist\_trail\_std Dist\_edge\_std  
## Dist\_trail\_std 1.0000000 0.5038650  
## Dist\_edge\_std 0.5038650 1.0000000  
## Dist\_trail\_beginning\_std 0.7667594 0.3780011  
## Dist\_trail\_beginning\_std  
## Dist\_trail\_std 0.7667594  
## Dist\_edge\_std 0.3780011  
## Dist\_trail\_beginning\_std 1.0000000

### Alpha Taxonomic - All Species

gm1 <- glmmTMB(TAlphaAll ~ Dist\_edge\_std + Dist\_trail\_std + Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = poisson)  
options(na.action = "na.fail")  
dredge(gm1)

## Global model call: glmmTMB(formula = TAlphaAll ~ Dist\_edge\_std + Dist\_trail\_std +   
## Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2,   
## family = poisson, ziformula = ~0, dispformula = ~1)  
## ---  
## Model selection table   
## cnd((Int)) dsp((Int)) cnd(Dst\_edg\_std) cnd(Dst\_trl\_bgn\_std)  
## 1 2.481 +   
## 3 2.517 + -0.06859  
## 5 2.493 +   
## 2 2.508 + -0.058030   
## 7 2.520 + -0.08736  
## 4 2.515 + 0.007253 -0.07182  
## 6 2.502 + -0.030400   
## 8 2.523 + -0.011770 -0.08596  
## cnd(Dst\_trl\_std) df logLik AICc delta weight  
## 1 2 -54.915 114.5 0.00 0.469  
## 3 3 -54.610 116.6 2.14 0.161  
## 5 -0.03570 3 -54.797 117.0 2.51 0.134  
## 2 3 -54.804 117.0 2.52 0.133  
## 7 0.02084 4 -54.594 119.7 5.19 0.035  
## 4 4 -54.610 119.7 5.22 0.034  
## 6 -0.02216 4 -54.784 120.1 5.57 0.029  
## 8 0.02513 5 -54.593 123.2 8.69 0.006  
## Models ranked by AICc(x)   
## Random terms (all models):   
## 'cond(1 | ForestID)'

### Alpha Taxonomic - Native Species

gm2 <- glmmTMB(TAlphaNat ~ Dist\_edge\_std +Dist\_trail\_std + Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = poisson)  
dredge(gm2)

## Global model call: glmmTMB(formula = TAlphaNat ~ Dist\_edge\_std + Dist\_trail\_std +   
## Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2,   
## family = poisson, ziformula = ~0, dispformula = ~1)  
## ---  
## Model selection table   
## cnd((Int)) dsp((Int)) cnd(Dst\_edg\_std) cnd(Dst\_trl\_bgn\_std)  
## 1 2.203 +   
## 3 2.189 + 0.02293  
## 2 2.191 + 0.01826   
## 5 2.199 +   
## 4 2.185 + 0.01076 0.01894  
## 7 2.187 + 0.03437  
## 6 2.191 + 0.01632   
## 8 2.179 + 0.01686 0.03483  
## cnd(Dst\_trl\_std) df logLik AICc delta weight  
## 1 2 -45.956 96.6 0.00 0.512  
## 3 3 -45.924 99.3 2.68 0.134  
## 2 3 -45.937 99.3 2.71 0.132  
## 5 0.010220 3 -45.948 99.3 2.73 0.131  
## 4 4 -45.919 102.3 5.76 0.029  
## 7 -0.012870 4 -45.919 102.3 5.76 0.029  
## 6 0.003244 4 -45.936 102.4 5.80 0.028  
## 8 -0.020380 5 -45.907 105.8 9.24 0.005  
## Models ranked by AICc(x)   
## Random terms (all models):   
## 'cond(1 | ForestID)'

### Alpha Taxonomic - Nind species

gm3 <- glmmTMB(TAlphaNInd ~ Dist\_edge\_std + Dist\_trail\_std + Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = poisson)  
dredge(gm3)

## Global model call: glmmTMB(formula = TAlphaNInd ~ Dist\_edge\_std + Dist\_trail\_std +   
## Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2,   
## family = poisson, ziformula = ~0, dispformula = ~1)  
## ---  
## Model selection table   
## cnd((Int)) dsp((Int)) cnd(Dst\_edg\_std) cnd(Dst\_trl\_bgn\_std)  
## 1 0.8873 +   
## 3 1.0240 + -0.3052  
## 5 0.9374 +   
## 2 1.0070 + -0.26650   
## 4 0.9902 + 0.12500 -0.3560  
## 7 1.0280 + -0.3394  
## 6 0.9306 + 0.02091   
## 8 0.9868 + 0.13430 -0.3526  
## cnd(Dst\_trl\_std) df logLik AICc delta weight  
## 1 2 -40.953 86.6 0.00 0.318  
## 3 3 -39.775 87.0 0.39 0.261  
## 5 -0.187200 3 -40.362 88.1 1.56 0.145  
## 2 3 -40.547 88.5 1.93 0.121  
## 4 4 -39.741 90.0 3.41 0.058  
## 7 0.042300 4 -39.765 90.0 3.46 0.056  
## 6 -0.196900 4 -40.361 91.2 4.65 0.031  
## 8 -0.008777 5 -39.741 93.5 6.91 0.010  
## Models ranked by AICc(x)   
## Random terms (all models):   
## 'cond(1 | ForestID)'

### Alpha Fuctional - All Species

gm4 <- glmmTMB(FAlphaAll ~ Dist\_edge\_std + Dist\_trail\_std + Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = Gamma)  
dredge(gm4)

## Global model call: glmmTMB(formula = FAlphaAll ~ Dist\_edge\_std + Dist\_trail\_std +   
## Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2,   
## family = Gamma, ziformula = ~0, dispformula = ~1)  
## ---  
## Model selection table   
## cnd((Int)) dsp((Int)) cnd(Dst\_edg\_std) cnd(Dst\_trl\_bgn\_std)  
## 1 0.2074 +   
## 3 0.2002 + 0.01470  
## 5 0.2053 +   
## 2 0.2039 + 0.007620   
## 4 0.2045 + -0.017960 0.02264  
## 7 0.1993 + 0.02097  
## 6 0.2073 + -0.006271   
## 8 0.2041 + -0.016910 0.02303  
## cnd(Dst\_trl\_std) df logLik AICc delta weight  
## 1 3 -31.476 70.4 0.00 0.453  
## 3 4 -30.711 71.9 1.56 0.208  
## 5 0.0067250 4 -31.253 73.0 2.64 0.121  
## 2 4 -31.381 73.3 2.90 0.106  
## 4 5 -30.485 75.0 4.61 0.045  
## 7 -0.0070860 5 -30.610 75.2 4.86 0.040  
## 6 0.0095620 5 -31.233 76.5 6.10 0.021  
## 8 -0.0009545 6 -30.484 79.0 8.60 0.006  
## Models ranked by AICc(x)   
## Random terms (all models):   
## 'cond(1 | ForestID)'

### Alpha Functional - Native Species

gm5 <- glmmTMB(FAlphaNat ~ Dist\_edge\_std + Dist\_trail\_std + Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = Gamma)  
dredge(gm5)

## Global model call: glmmTMB(formula = FAlphaNat ~ Dist\_edge\_std + Dist\_trail\_std +   
## Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2,   
## family = Gamma, ziformula = ~0, dispformula = ~1)  
## ---  
## Model selection table   
## cnd((Int)) dsp((Int)) cnd(Dst\_edg\_std) cnd(Dst\_trl\_bgn\_std)  
## 1 0.4686 +   
## 3 0.4632 + 0.009359  
## 2 0.4707 + -0.004285   
## 5 0.4680 +   
## 4 0.4684 + -0.025890 0.021420  
## 7 0.4614 + 0.019420  
## 6 0.4727 + -0.014770   
## 8 0.4675 + -0.023440 0.022710  
## cnd(Dst\_trl\_std) df logLik AICc delta weight  
## 1 3 -0.934 9.3 0.00 0.535  
## 3 4 -0.728 12.0 2.68 0.140  
## 2 4 -0.911 12.3 3.04 0.117  
## 5 0.001529 4 -0.926 12.4 3.07 0.115  
## 4 5 -0.323 14.6 5.37 0.037  
## 7 -0.010890 5 -0.557 15.1 5.83 0.029  
## 6 0.008125 5 -0.814 15.6 6.35 0.022  
## 8 -0.002625 6 -0.316 18.6 9.35 0.005  
## Models ranked by AICc(x)   
## Random terms (all models):   
## 'cond(1 | ForestID)'

### FAILED Alpha Functional - N/Ind Species

{r, warning=FALSE} gm6 <- glmmTMB(FAlphaNInd ~ Dist\_edge\_std + Dist\_trail\_std + Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = Gamma) dredge(gm6) FAILED - Error in eval(family$initialize, rho) : non-positive values not allowed for the ‘gamma’ family

### Beta Taxonomic - All Species

gm7 <- glmmTMB(BetaAllTotalVector ~ Dist\_edge\_std + Dist\_trail\_std + Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
dredge(gm7)

## Global model call: glmmTMB(formula = BetaAllTotalVector ~ Dist\_edge\_std + Dist\_trail\_std +   
## Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2,   
## family = beta\_family, ziformula = ~0, dispformula = ~1)  
## ---  
## Model selection table   
## cnd((Int)) dsp((Int)) cnd(Dst\_edg\_std) cnd(Dst\_trl\_bgn\_std)  
## 5 -0.8334 +   
## 6 -1.2500 + 1.13200   
## 7 -0.9170 + 0.2623  
## 8 -1.2770 + 1.08800 0.1329  
## 1 -0.9398 +   
## 3 -0.6597 + -0.4729  
## 2 -0.8049 + -0.22160   
## 4 -0.6868 + 0.07433 -0.5085  
## cnd(Dst\_trl\_std) df logLik AICc delta weight  
## 5 -1.255 4 20.944 -31.4 0.00 0.442  
## 6 -1.704 5 22.585 -31.2 0.22 0.396  
## 7 -1.325 5 21.071 -28.1 3.25 0.087  
## 8 -1.732 6 22.618 -27.2 4.15 0.055  
## 1 3 15.419 -23.4 7.96 0.008  
## 3 4 16.783 -23.1 8.32 0.007  
## 2 4 15.671 -20.8 10.55 0.002  
## 4 5 16.805 -19.6 11.78 0.001  
## Models ranked by AICc(x)   
## Random terms (all models):   
## 'cond(1 | ForestID)'

gm7.5 <- glmmTMB(BetaAllTotalVector ~ Dist\_trail\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
summary(gm7.5)

## Family: beta ( logit )  
## Formula: BetaAllTotalVector ~ Dist\_trail\_std + (1 | ForestID)  
## Data: Results2  
##   
## AIC BIC logLik deviance df.resid   
## -33.9 -29.7 20.9 -41.9 17   
##   
## Random effects:  
##   
## Conditional model:  
## Groups Name Variance Std.Dev.  
## ForestID (Intercept) 0.8608 0.9278   
## Number of obs: 21, groups: ForestID, 5  
##   
## Overdispersion parameter for beta family (): 3   
##   
## Conditional model:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -0.8334 0.4983 -1.673 0.09443 .   
## Dist\_trail\_std -1.2546 0.4024 -3.118 0.00182 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

gm7.6 <- glmmTMB(BetaAllTotalVector ~ Dist\_edge\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
summary(gm7.6)

## Family: beta ( logit )  
## Formula: BetaAllTotalVector ~ Dist\_edge\_std + (1 | ForestID)  
## Data: Results2  
##   
## AIC BIC logLik deviance df.resid   
## -23.3 -19.2 15.7 -31.3 17   
##   
## Random effects:  
##   
## Conditional model:  
## Groups Name Variance Std.Dev.   
## ForestID (Intercept) 4.05e-10 2.013e-05  
## Number of obs: 21, groups: ForestID, 5  
##   
## Overdispersion parameter for beta family (): 1.27   
##   
## Conditional model:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -0.8049 0.3528 -2.282 0.0225 \*  
## Dist\_edge\_std -0.2216 0.3125 -0.709 0.4783   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

gm7.7 <- glmmTMB(BetaAllTotalVector ~ Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
summary(gm7.7)

## Family: beta ( logit )  
## Formula:   
## BetaAllTotalVector ~ Dist\_trail\_beginning\_std + (1 | ForestID)  
## Data: Results2  
##   
## AIC BIC logLik deviance df.resid   
## -25.6 -21.4 16.8 -33.6 17   
##   
## Random effects:  
##   
## Conditional model:  
## Groups Name Variance Std.Dev.   
## ForestID (Intercept) 1.243e-09 3.526e-05  
## Number of obs: 21, groups: ForestID, 5  
##   
## Overdispersion parameter for beta family (): 1.39   
##   
## Conditional model:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -0.6597 0.3378 -1.953 0.0508 .  
## Dist\_trail\_beginning\_std -0.4729 0.3143 -1.505 0.1324   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

### Beta Taxonomic - Nat Species

gm8 <- glmmTMB(BetaNatTotalVector ~ Dist\_edge\_std + Dist\_trail\_std + Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
dredge(gm8)

## Global model call: glmmTMB(formula = BetaNatTotalVector ~ Dist\_edge\_std + Dist\_trail\_std +   
## Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2,   
## family = beta\_family, ziformula = ~0, dispformula = ~1)  
## ---  
## Model selection table   
## cnd((Int)) dsp((Int)) cnd(Dst\_edg\_std) cnd(Dst\_trl\_bgn\_std)  
## 5 -1.0380 +   
## 6 -1.4310 + 1.07300   
## 7 -1.1110 + 0.2243  
## 8 -1.4600 + 1.03900 0.1259  
## 1 -1.1020 +   
## 3 -0.8268 + -0.4723  
## 2 -0.9729 + -0.21320   
## 4 -0.8586 + 0.08783 -0.5152  
## cnd(Dst\_trl\_std) df logLik AICc delta weight  
## 5 -1.265 4 22.720 -34.9 0.00 0.444  
## 6 -1.662 5 24.365 -34.7 0.21 0.400  
## 7 -1.318 5 22.819 -31.6 3.30 0.085  
## 8 -1.691 6 24.398 -30.8 4.14 0.056  
## 1 3 16.909 -26.4 8.53 0.006  
## 3 4 18.332 -26.2 8.78 0.006  
## 2 4 17.158 -23.8 11.12 0.002  
## 4 5 18.364 -22.7 12.21 0.001  
## Models ranked by AICc(x)   
## Random terms (all models):   
## 'cond(1 | ForestID)'

gm8.6 <- glmmTMB(BetaNatTotalVector ~ Dist\_edge\_std + Dist\_trail\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
summary(gm8.6)

## Family: beta ( logit )  
## Formula:   
## BetaNatTotalVector ~ Dist\_edge\_std + Dist\_trail\_std + (1 | ForestID)  
## Data: Results2  
##   
## AIC BIC logLik deviance df.resid   
## -38.7 -33.5 24.4 -48.7 16   
##   
## Random effects:  
##   
## Conditional model:  
## Groups Name Variance Std.Dev.  
## ForestID (Intercept) 0.7393 0.8598   
## Number of obs: 21, groups: ForestID, 5  
##   
## Overdispersion parameter for beta family (): 4.14   
##   
## Conditional model:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.4310 0.5293 -2.704 0.006859 \*\*   
## Dist\_edge\_std 1.0727 0.6115 1.754 0.079376 .   
## Dist\_trail\_std -1.6624 0.4307 -3.859 0.000114 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

gm8.7 <- glmmTMB(BetaNatTotalVector ~ Dist\_trail\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
summary(gm8.7)

## Family: beta ( logit )  
## Formula: BetaNatTotalVector ~ Dist\_trail\_std + (1 | ForestID)  
## Data: Results2  
##   
## AIC BIC logLik deviance df.resid   
## -37.4 -33.3 22.7 -45.4 17   
##   
## Random effects:  
##   
## Conditional model:  
## Groups Name Variance Std.Dev.  
## ForestID (Intercept) 0.8423 0.9177   
## Number of obs: 21, groups: ForestID, 5  
##   
## Overdispersion parameter for beta family (): 3.69   
##   
## Conditional model:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.0376 0.4926 -2.106 0.03518 \*   
## Dist\_trail\_std -1.2646 0.3991 -3.168 0.00153 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

### Beta Taxonomic - NInd Species

gm9 <- glmmTMB(BetaNIndTotalVector ~ Dist\_edge\_std + Dist\_trail\_std + Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
dredge(gm9)

## Global model call: glmmTMB(formula = BetaNIndTotalVector ~ Dist\_edge\_std + Dist\_trail\_std +   
## Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2,   
## family = beta\_family, ziformula = ~0, dispformula = ~1)  
## ---  
## Model selection table   
## cnd((Int)) dsp((Int)) cnd(Dst\_edg\_std) cnd(Dst\_trl\_bgn\_std)  
## 6 -0.03587 + 0.9071   
## 1 0.14330 +   
## 5 0.38820 +   
## 2 -0.05676 + 0.3343   
## 3 0.30980 + -0.2725  
## 8 -0.24970 + 0.9554 0.5862  
## 7 0.24040 + 0.4746  
## 4 0.09743 + 0.5312 -0.4927  
## cnd(Dst\_trl\_std) df logLik AICc delta weight  
## 6 -0.9786 5 81.695 -149.4 0.00 0.278  
## 1 3 78.261 -149.1 0.28 0.242  
## 5 -0.5428 4 79.614 -148.7 0.66 0.200  
## 2 4 78.588 -146.7 2.72 0.072  
## 3 4 78.530 -146.6 2.83 0.068  
## 8 -1.4030 6 82.261 -146.5 2.87 0.066  
## 7 -0.8633 5 79.982 -146.0 3.43 0.050  
## 4 5 79.252 -144.5 4.89 0.024  
## Models ranked by AICc(x)   
## Random terms (all models):   
## 'cond(1 | ForestID)'

gm9.5 <- glmmTMB(BetaNIndTotalVector ~ Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
summary(gm9.5)

## Family: beta ( logit )  
## Formula:   
## BetaNIndTotalVector ~ Dist\_trail\_beginning\_std + (1 | ForestID)  
## Data: Results2  
##   
## AIC BIC logLik deviance df.resid   
## -149.1 -144.9 78.5 -157.1 17   
##   
## Random effects:  
##   
## Conditional model:  
## Groups Name Variance Std.Dev.   
## ForestID (Intercept) 5.135e-09 7.166e-05  
## Number of obs: 21, groups: ForestID, 5  
##   
## Overdispersion parameter for beta family (): 0.295   
##   
## Conditional model:  
## Estimate Std. Error z value Pr(>|z|)  
## (Intercept) 0.3098 0.3787 0.818 0.413  
## Dist\_trail\_beginning\_std -0.2725 0.3633 -0.750 0.453

### Beta Functional - All

gm10 <- glmmTMB(BetaFuncAllTotalVector ~ Dist\_edge\_std +Dist\_trail\_std + Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
dredge(gm10)

## Global model call: glmmTMB(formula = BetaFuncAllTotalVector ~ Dist\_edge\_std + Dist\_trail\_std +   
## Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2,   
## family = beta\_family, ziformula = ~0, dispformula = ~1)  
## ---  
## Model selection table   
## cnd((Int)) dsp((Int)) cnd(Dst\_edg\_std) cnd(Dst\_trl\_bgn\_std)  
## 5 -0.8169 +   
## 6 -1.2040 + 1.0580   
## 7 -0.9079 + 0.3016  
## 8 -1.2490 + 0.9810 0.2440  
## 1 -0.9474 +   
## 3 -0.6636 + -0.4804  
## 2 -0.8303 + -0.1924   
## 4 -0.7083 + 0.1222 -0.5392  
## cnd(Dst\_trl\_std) df logLik AICc delta weight  
## 5 -1.169 4 20.725 -30.9 0.00 0.416  
## 6 -1.596 5 22.457 -30.9 0.03 0.409  
## 7 -1.247 5 20.887 -27.8 3.18 0.085  
## 8 -1.634 6 22.555 -27.1 3.84 0.061  
## 1 3 15.685 -24.0 6.99 0.013  
## 3 4 17.081 -23.7 7.29 0.011  
## 2 4 15.874 -21.2 9.70 0.003  
## 4 5 17.139 -20.3 10.67 0.002  
## Models ranked by AICc(x)   
## Random terms (all models):   
## 'cond(1 | ForestID)'

gm10.5 <- glmmTMB(BetaFuncAllTotalVector ~ Dist\_trail\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
summary(gm10.5)

## Family: beta ( logit )  
## Formula: BetaFuncAllTotalVector ~ Dist\_trail\_std + (1 | ForestID)  
## Data: Results2  
##   
## AIC BIC logLik deviance df.resid   
## -33.4 -29.3 20.7 -41.4 17   
##   
## Random effects:  
##   
## Conditional model:  
## Groups Name Variance Std.Dev.  
## ForestID (Intercept) 0.6208 0.7879   
## Number of obs: 21, groups: ForestID, 5  
##   
## Overdispersion parameter for beta family (): 2.66   
##   
## Conditional model:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -0.8169 0.4538 -1.800 0.07186 .   
## Dist\_trail\_std -1.1691 0.4214 -2.775 0.00553 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

gm10.6 <- glmmTMB(BetaFuncAllTotalVector ~ Dist\_edge\_std +Dist\_trail\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
summary(gm10.6)

## Family: beta ( logit )  
## Formula:   
## BetaFuncAllTotalVector ~ Dist\_edge\_std + Dist\_trail\_std + (1 |   
## ForestID)  
## Data: Results2  
##   
## AIC BIC logLik deviance df.resid   
## -34.9 -29.7 22.5 -44.9 16   
##   
## Random effects:  
##   
## Conditional model:  
## Groups Name Variance Std.Dev.  
## ForestID (Intercept) 0.5002 0.7072   
## Number of obs: 21, groups: ForestID, 5  
##   
## Overdispersion parameter for beta family (): 3.03   
##   
## Conditional model:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.2038 0.4923 -2.445 0.01448 \*   
## Dist\_edge\_std 1.0580 0.6150 1.720 0.08536 .   
## Dist\_trail\_std -1.5955 0.4718 -3.382 0.00072 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

### Beta Functional - Nat

gm11 <- glmmTMB(BetaFuncNatTotalVector ~ Dist\_edge\_std + Dist\_trail\_std + Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
dredge(gm11)

## Global model call: glmmTMB(formula = BetaFuncNatTotalVector ~ Dist\_edge\_std + Dist\_trail\_std +   
## Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2,   
## family = beta\_family, ziformula = ~0, dispformula = ~1)  
## ---  
## Model selection table   
## cnd((Int)) dsp((Int)) cnd(Dst\_edg\_std) cnd(Dst\_trl\_bgn\_std)  
## 5 -0.7555 +   
## 6 -1.1000 + 0.94760   
## 7 -0.7907 + 0.1323  
## 8 -1.1050 + 0.93430 0.0367  
## 1 -0.9078 +   
## 3 -0.6049 + -0.5114  
## 2 -0.7745 + -0.21890   
## 4 -0.6392 + 0.09243 -0.5541  
## cnd(Dst\_trl\_std) df logLik AICc delta weight  
## 5 -1.145 4 20.221 -29.9 0.00 0.479  
## 6 -1.523 5 21.649 -29.3 0.64 0.347  
## 7 -1.168 5 20.248 -26.5 3.45 0.086  
## 8 -1.526 6 21.651 -25.3 4.64 0.047  
## 1 3 15.313 -23.2 6.73 0.017  
## 3 4 16.857 -23.2 6.73 0.017  
## 2 4 15.554 -20.6 9.33 0.005  
## 4 5 16.890 -19.8 10.16 0.003  
## Models ranked by AICc(x)   
## Random terms (all models):   
## 'cond(1 | ForestID)'

### Exploring best ranked models

gm11.5 <- glmmTMB(BetaFuncNatTotalVector ~ Dist\_trail\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
summary(gm11.5)

## Family: beta ( logit )  
## Formula: BetaFuncNatTotalVector ~ Dist\_trail\_std + (1 | ForestID)  
## Data: Results2  
##   
## AIC BIC logLik deviance df.resid   
## -32.4 -28.3 20.2 -40.4 17   
##   
## Random effects:  
##   
## Conditional model:  
## Groups Name Variance Std.Dev.  
## ForestID (Intercept) 0.5708 0.7555   
## Number of obs: 21, groups: ForestID, 5  
##   
## Overdispersion parameter for beta family (): 2.48   
##   
## Conditional model:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -0.7555 0.4443 -1.701 0.08903 .   
## Dist\_trail\_std -1.1455 0.4259 -2.690 0.00715 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

gm11.6 <- glmmTMB(BetaFuncNatTotalVector ~ Dist\_edge\_std + Dist\_trail\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
summary(gm11.6)

## Family: beta ( logit )  
## Formula:   
## BetaFuncNatTotalVector ~ Dist\_edge\_std + Dist\_trail\_std + (1 |   
## ForestID)  
## Data: Results2  
##   
## AIC BIC logLik deviance df.resid   
## -33.3 -28.1 21.6 -43.3 16   
##   
## Random effects:  
##   
## Conditional model:  
## Groups Name Variance Std.Dev.  
## ForestID (Intercept) 0.4731 0.6878   
## Number of obs: 21, groups: ForestID, 5  
##   
## Overdispersion parameter for beta family (): 2.74   
##   
## Conditional model:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.0996 0.4853 -2.266 0.02345 \*   
## Dist\_edge\_std 0.9476 0.6052 1.566 0.11739   
## Dist\_trail\_std -1.5235 0.4747 -3.209 0.00133 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

### Beta Functional - NInd

gm12 <- glmmTMB(BetaFuncNIndTotalVector ~ Dist\_edge\_std + Dist\_trail\_std + Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
dredge(gm12)

## Global model call: glmmTMB(formula = BetaFuncNIndTotalVector ~ Dist\_edge\_std + Dist\_trail\_std +   
## Dist\_trail\_beginning\_std + (1 | ForestID), data = Results2,   
## family = beta\_family, ziformula = ~0, dispformula = ~1)  
## ---  
## Model selection table   
## cnd((Int)) dsp((Int)) cnd(Dst\_edg\_std) cnd(Dst\_trl\_bgn\_std)  
## 6 -0.224400 + 1.1160   
## 1 0.071840 +   
## 5 0.310600 +   
## 8 -0.365200 + 1.1390 0.3851  
## 2 -0.200700 + 0.4577   
## 3 0.286000 + -0.3483  
## 4 -0.007551 + 0.7583 -0.6790  
## 7 0.218400 + 0.2931  
## cnd(Dst\_trl\_std) df logLik AICc delta weight  
## 6 -1.0830 5 73.187 -132.4 0.00 0.462  
## 1 3 68.811 -130.2 2.16 0.157  
## 5 -0.5319 4 70.150 -129.8 2.57 0.127  
## 8 -1.3520 6 73.417 -128.8 3.54 0.079  
## 2 4 69.406 -128.3 4.06 0.061  
## 3 4 69.265 -128.0 4.34 0.053  
## 4 5 70.668 -127.3 5.04 0.037  
## 7 -0.7285 5 70.282 -126.6 5.81 0.025  
## Models ranked by AICc(x)   
## Random terms (all models):   
## 'cond(1 | ForestID)'

gm12.6 <- glmmTMB(BetaFuncNIndTotalVector ~ Dist\_edge\_std + Dist\_trail\_std + (1 | ForestID), data = Results2 , family = beta\_family)  
summary(gm12.6)

## Family: beta ( logit )  
## Formula:   
## BetaFuncNIndTotalVector ~ Dist\_edge\_std + Dist\_trail\_std + (1 |   
## ForestID)  
## Data: Results2  
##   
## AIC BIC logLik deviance df.resid   
## -136.4 -131.2 73.2 -146.4 16   
##   
## Random effects:  
##   
## Conditional model:  
## Groups Name Variance Std.Dev.   
## ForestID (Intercept) 1.254e-09 3.541e-05  
## Number of obs: 21, groups: ForestID, 5  
##   
## Overdispersion parameter for beta family (): 0.468   
##   
## Conditional model:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -0.2244 0.3775 -0.594 0.55231   
## Dist\_edge\_std 1.1157 0.4471 2.496 0.01258 \*   
## Dist\_trail\_std -1.0829 0.4067 -2.663 0.00775 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1