

GDM :

Generalized Dissimilarity Modelling

Anusha Bishop & Anne Chambers (2024)



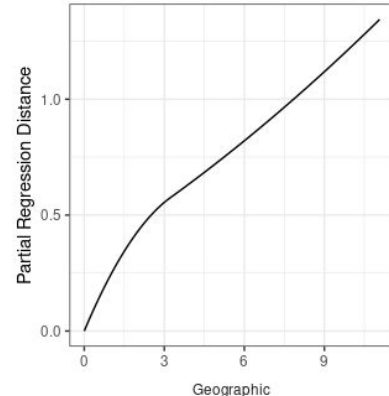
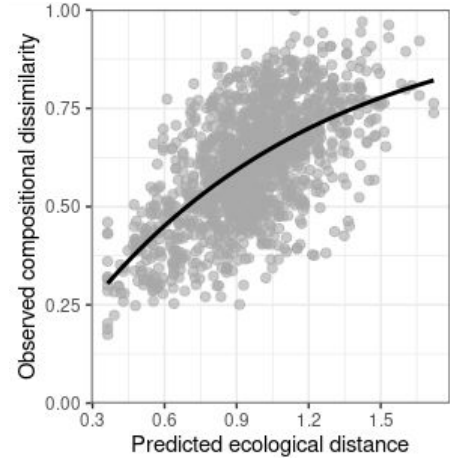
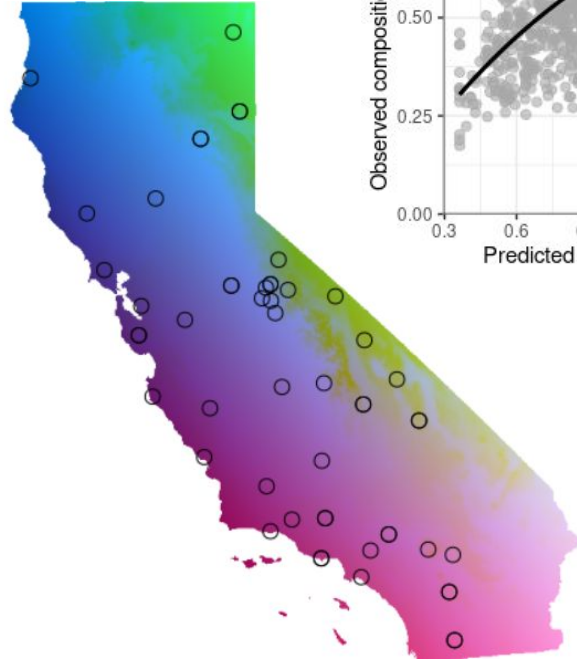
Generalized Dissimilarity Modelling

Goal: Determine how environmental and geographic distance (ecological distance) drive dissimilarity

dissimilarity = genetic distance

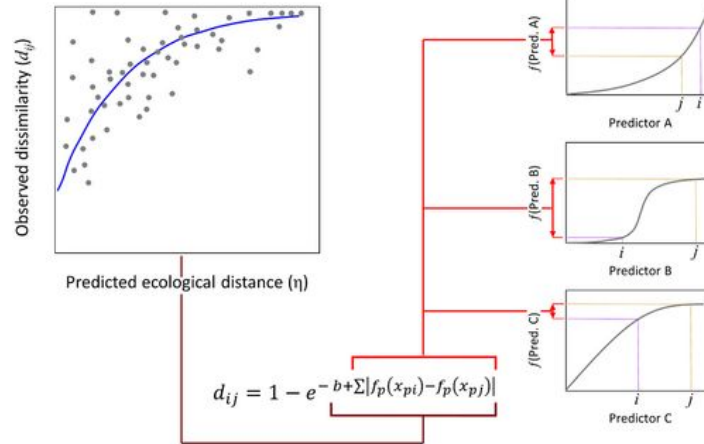
What's special? nonlinear relationships

Why? Understand the drivers of biodiversity (specifically, turnover in genetic diversity)



GDM explained

A. GDM models dissimilarity as a function of predicted ecological distance

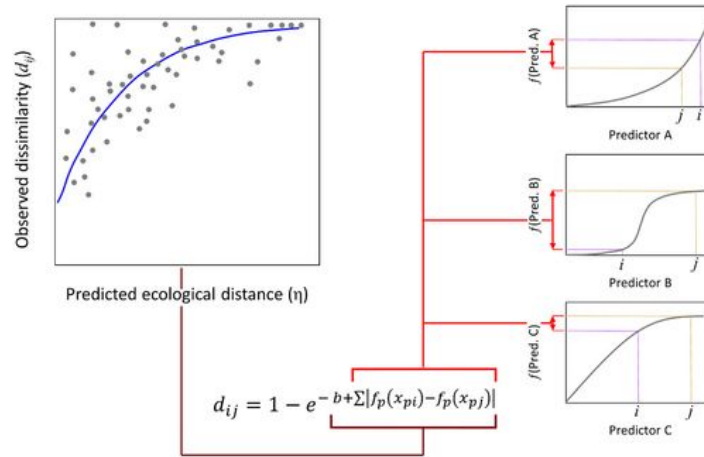


B. It fits the best estimate of predicted ecological distance by transforming predictors using I-splines

C. The summed difference in the I-spline transformed predictor values = the predicted ecological distance

GDM explained

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GDM explained

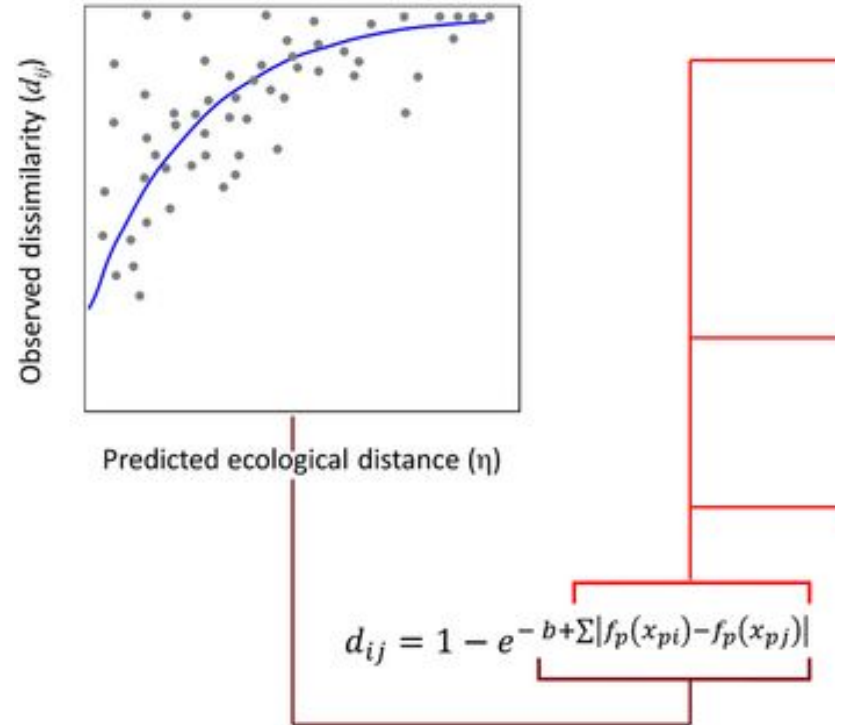
GDM model link function
(**negative exponential**):

$$d_{ij} = 1 - e^{\eta}$$

d_{ij} = dissimilarity between sites i and j

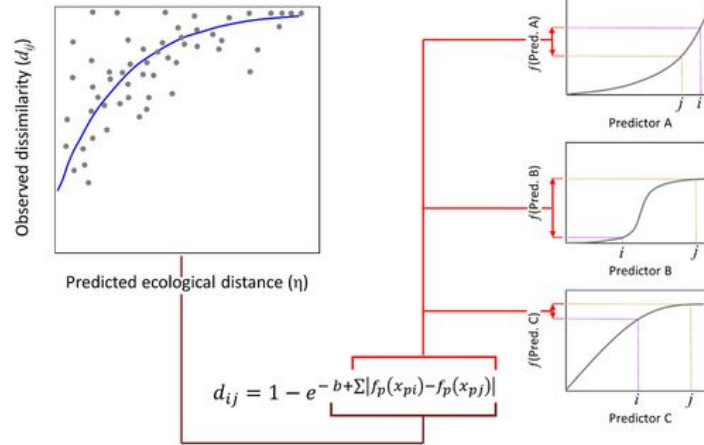
η = transformed ecological distance
between sites i and j (predicted
ecological distance)

Assumes: dissimilarity **increases and saturates** with increasing ecological distance and is bound between 0 and 1



GDM explained

A. GDM models dissimilarity as a function of predicted ecological distance



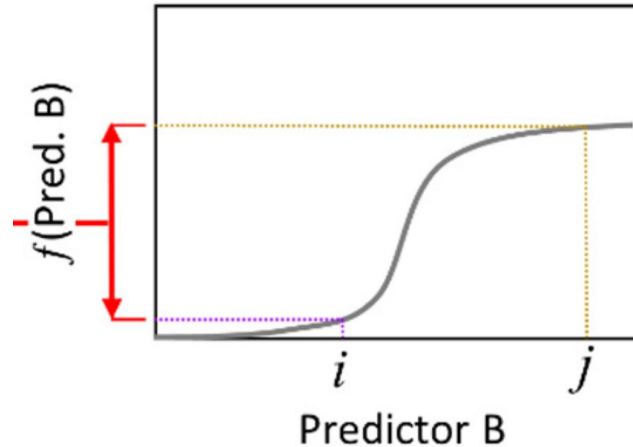
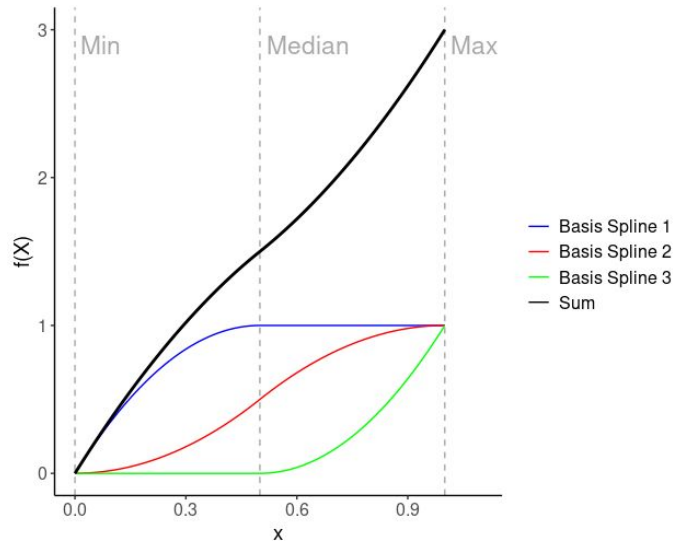
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GDM explained

By default three I-splines are fit with **three knots positioned at the minimum, median and maximum** of the observed predictor values

Example I-splines:



$$f_B(i) = f_B(4) = 0.5$$

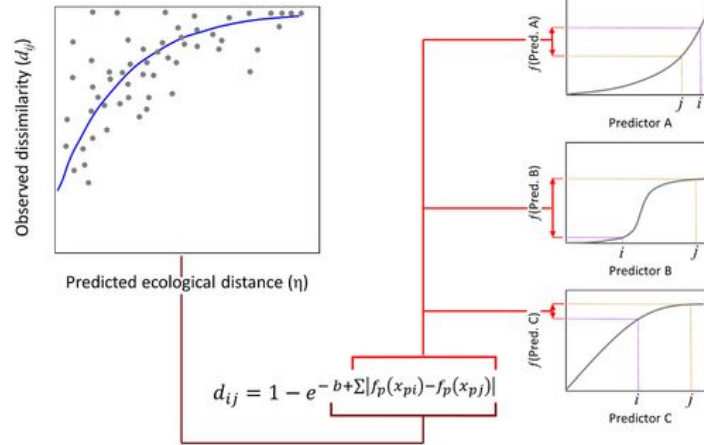
$$f_B(j) = f_B(11) = 3$$

$$|f_B(i) - f_B(j)| = 2.5$$

Partial predicted
ecological distance

GDM explained

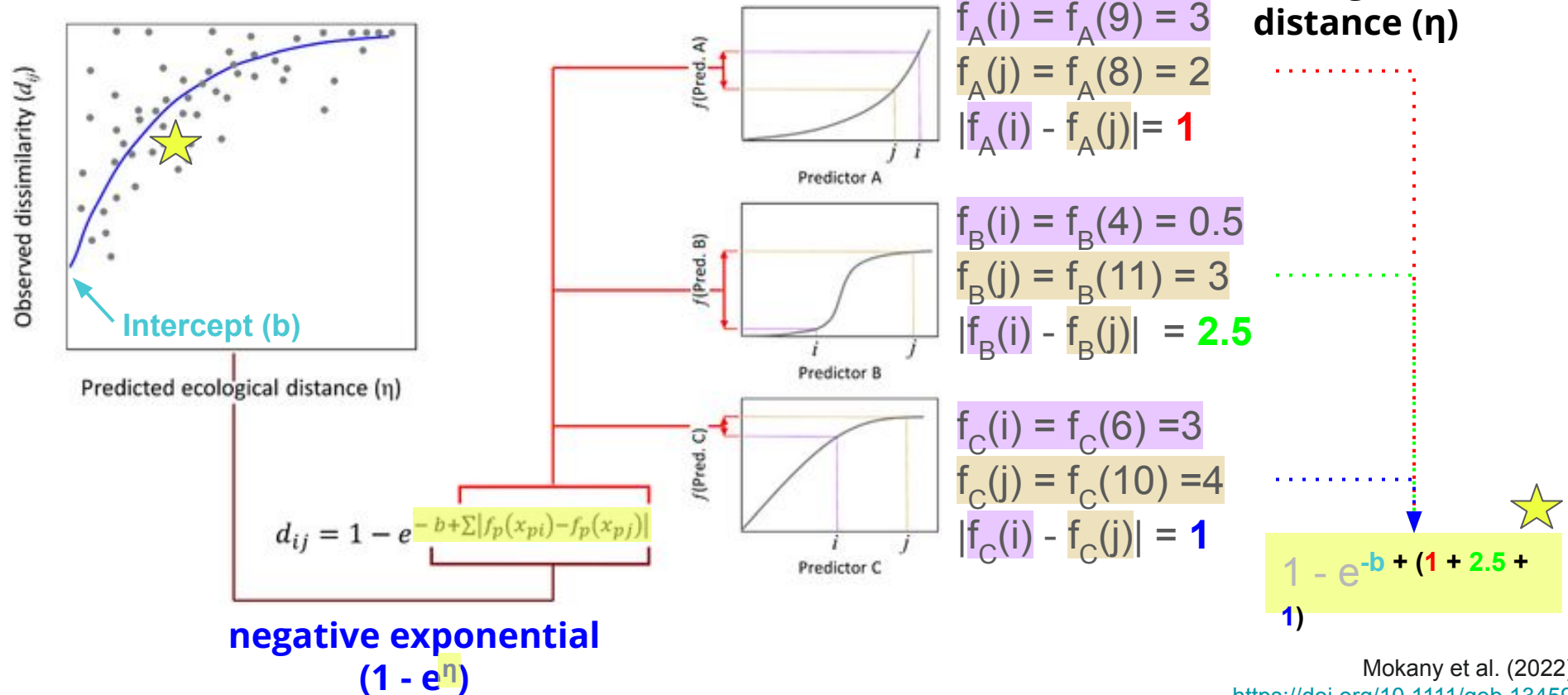
A. GDM models dissimilarity as a function of predicted ecological distance



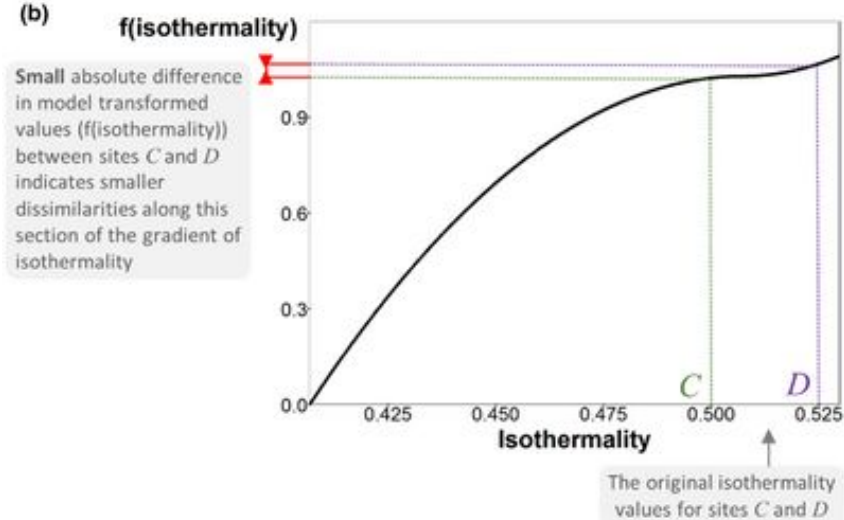
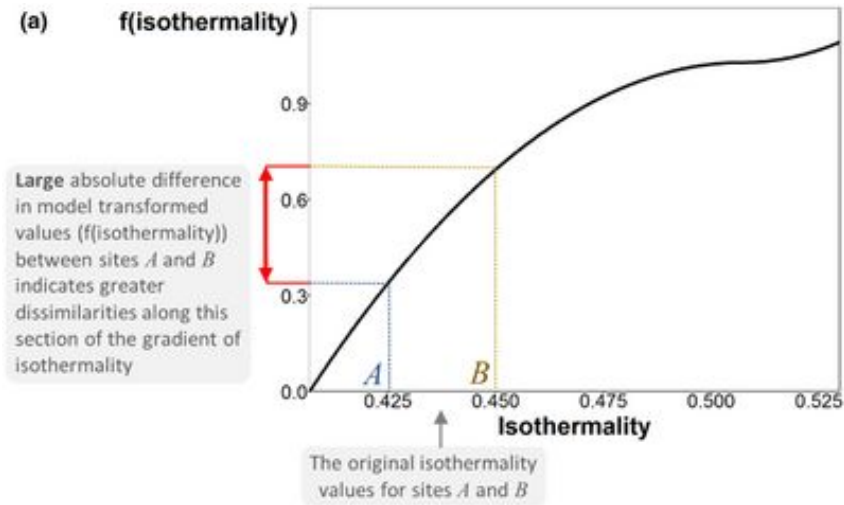
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GDM explained



GDM explained



EXERCISE

Run GDM

gdm_run() fits a generalized dissimilarity model

```
1 gdm_full <- gdm_run(  
2   gendist = liz_gendist,  
3   coords = liz_coords,  
4   env = env,  
5   model = "full",  
6   scale_gendist = TRUE  
7 )
```

gendist = genetic distances

coords = coordinates

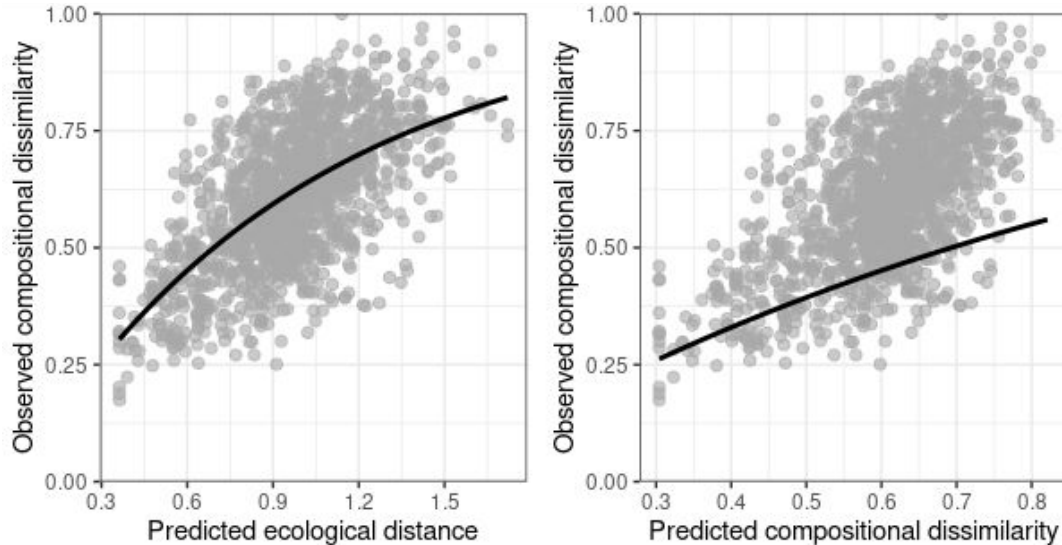
env = environmental raster stack (must be continuous)

model = whether to run a “full” model with all variables or find the “best” model by performing variable selection

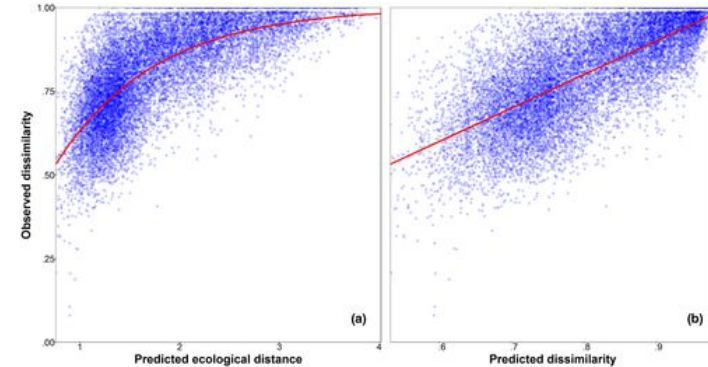
scale_gendist = whether to scale the genetic distances from 0 to 1 (values of genetic distance must be between 0 and 1)

Interpret and plot GDM

```
1 gdm_plot_diss(gdm_full$model)
```

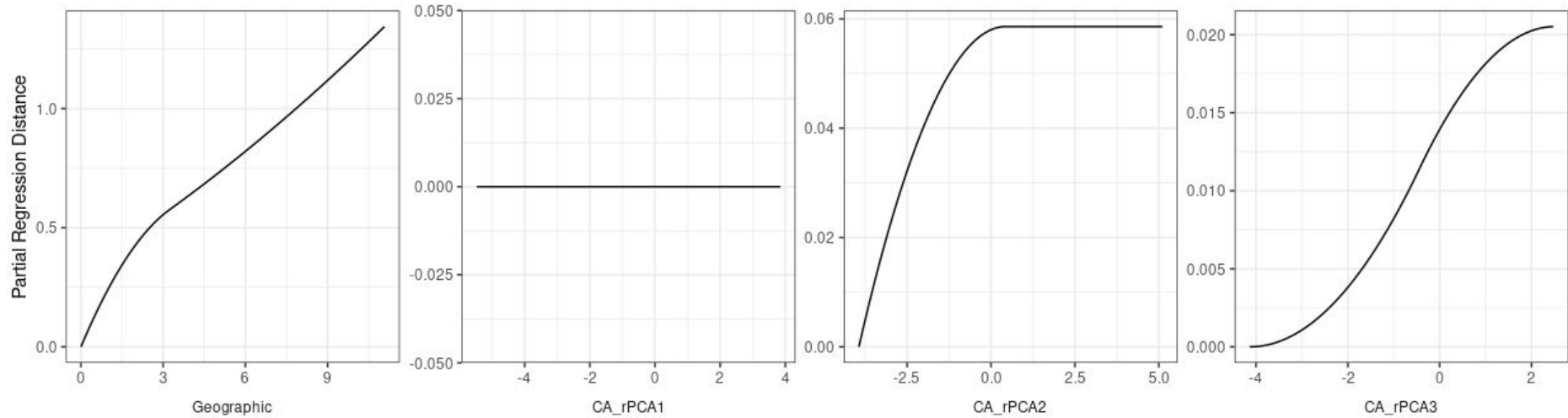


What we want it to look like:



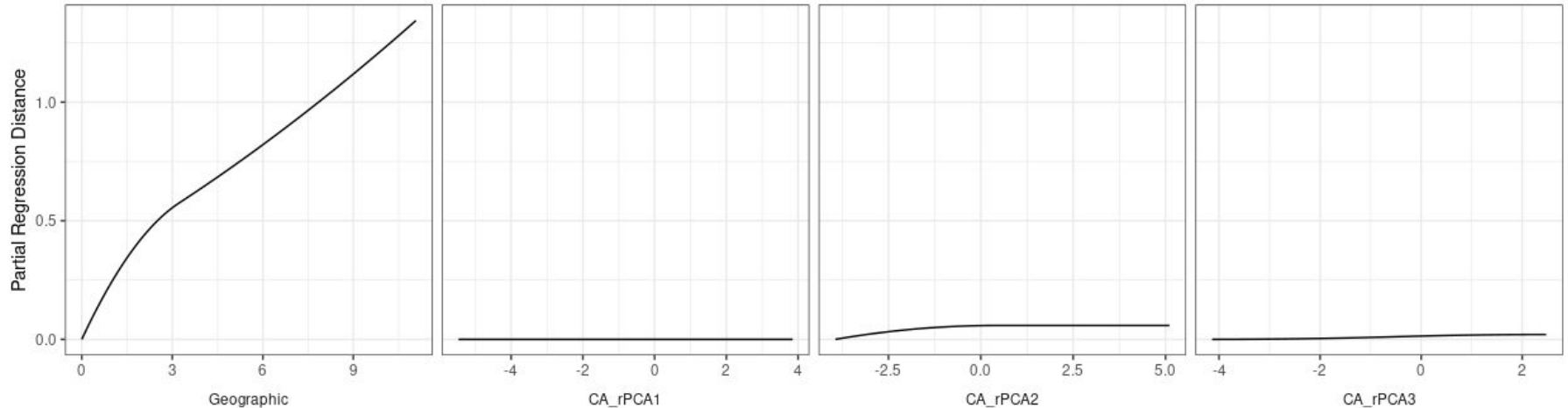
Interpret and plot GDM

```
1 gdm_plot_isplines(gdm_full$model)
```



Interpret and plot GDM

```
1 # Plot the I-splines with a free x-axis and a fixed y-axis
2 # This allows for visualization of relative importance (i.e., the height of the I-splines)
3 gdm_plot_isplines(gdm_full$model, scales = "free_x")
```



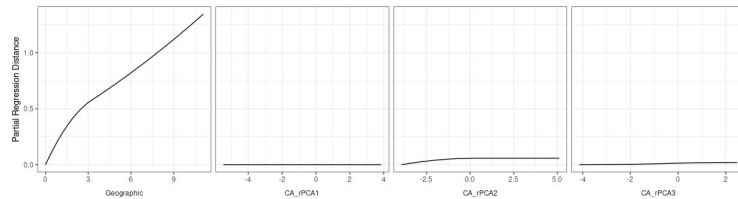
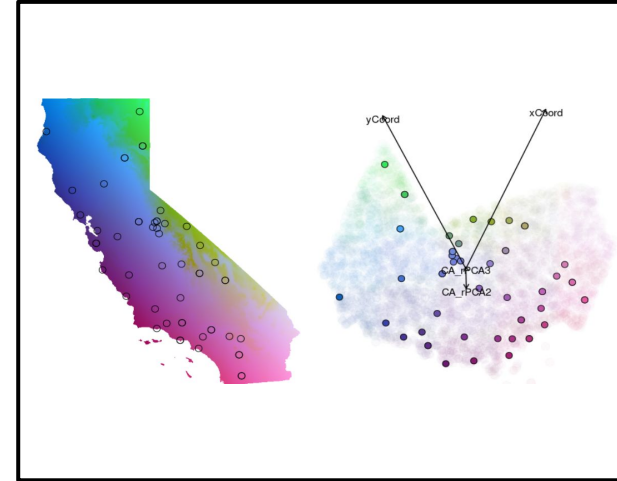
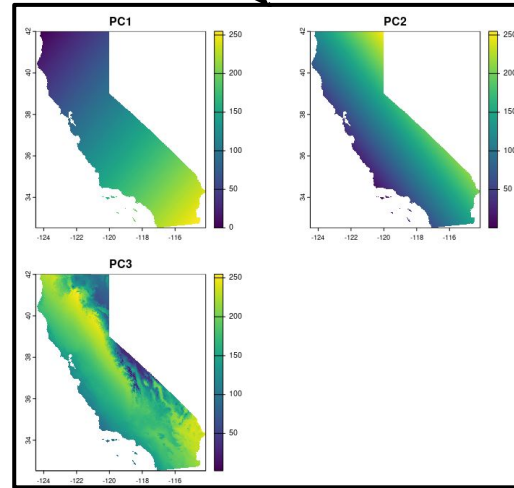
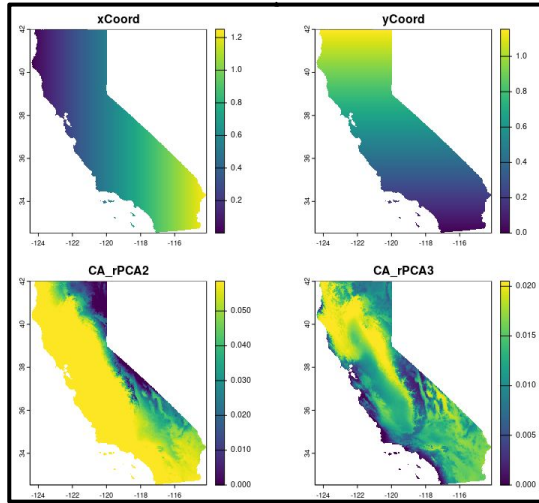
Interpret and plot GDM

```
1 gdm_table(gdm_full)
```

predictor	coefficient
Geographic	1.35
CA_rPCA1	0.00
CA_rPCA2	0.06
CA_rPCA3	0.02
% Explained:	36.89[†]

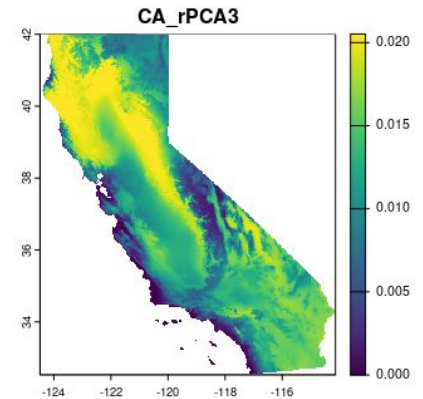
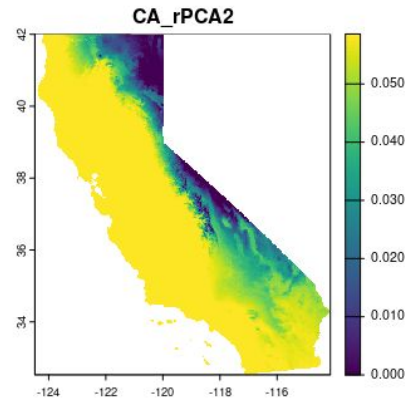
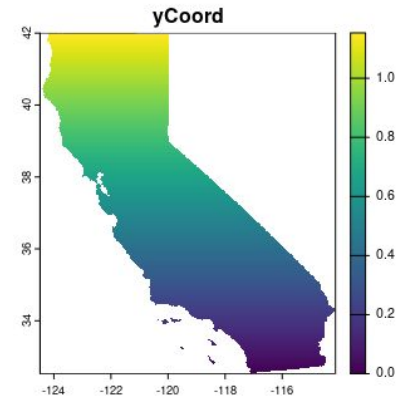
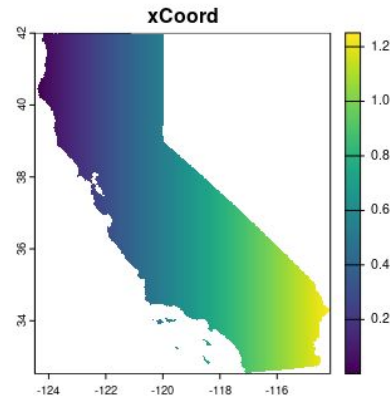
[†] The percentage of null deviance explained by the fitted GDM model.

INTERLUDE



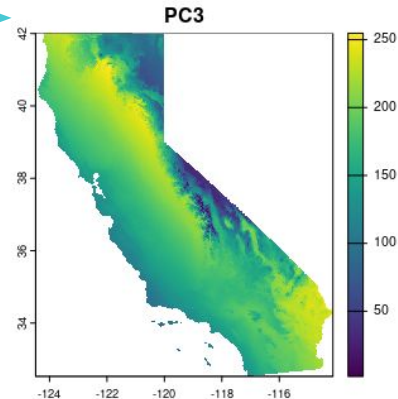
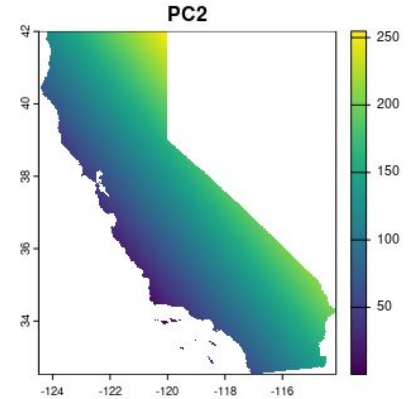
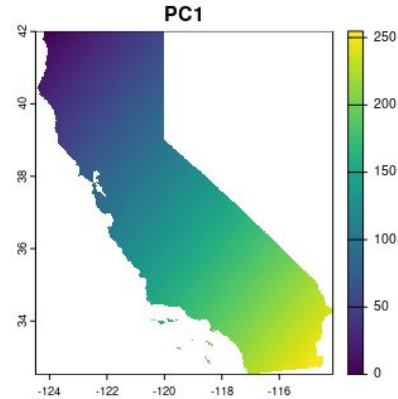
Interpret and plot GDM

```
> summary(map)
      Length Class      Mode
rastTrans 1    SpatRaster S4
pcaRastRGB 1    SpatRaster S4
```



Interpret and plot GDM

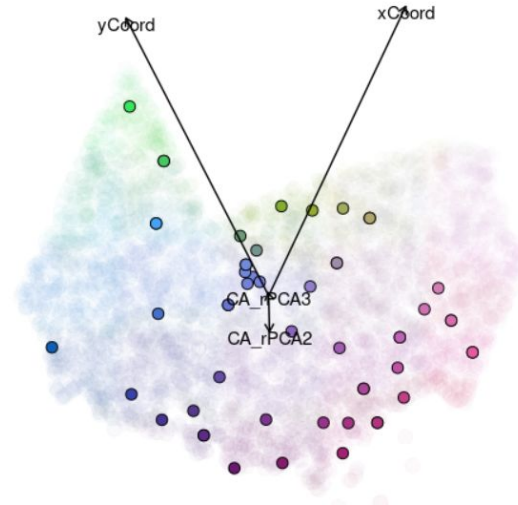
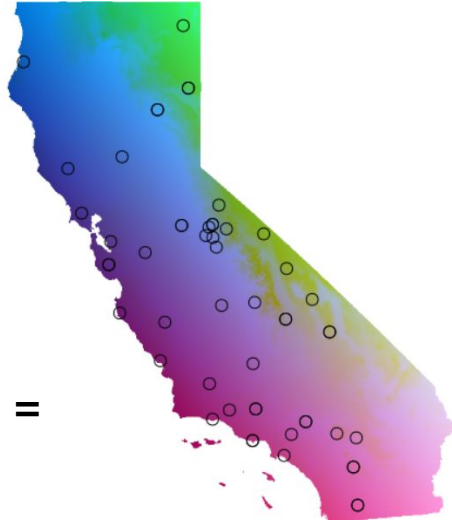
```
> summary(map)
      Length Class      Mode
rastTrans 1      SpatRaster S4
pcaRastRGB 1      SpatRaster S4
```



Interpret and plot GDM

```
1 map <- gdm_map(gdm_full$model, CA_env, liz_coords)
```

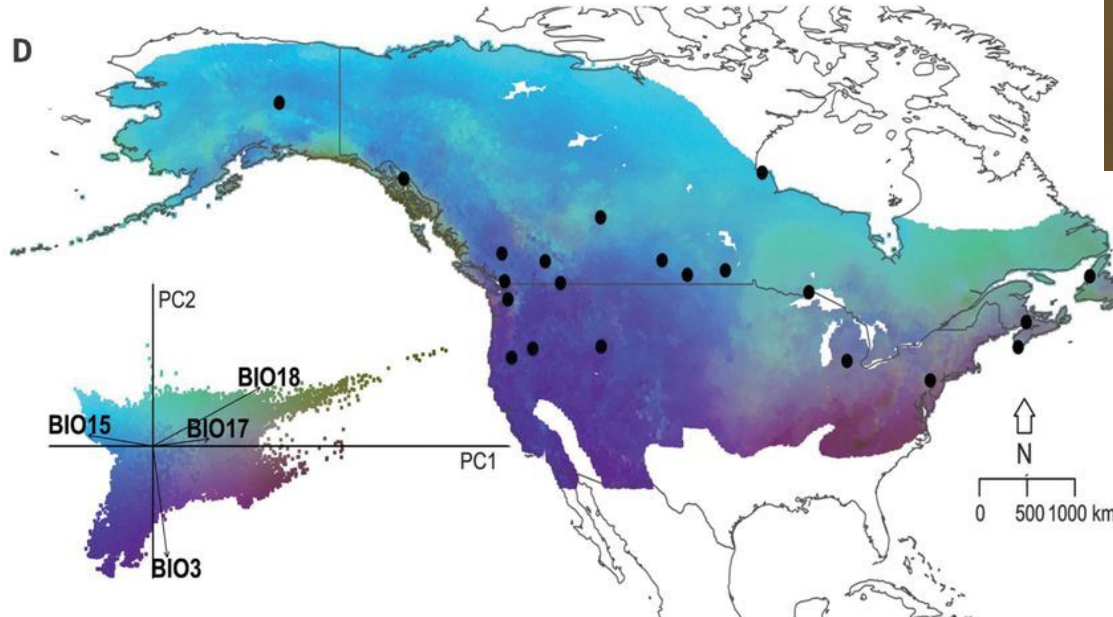
More similar colors =
More similar composition =
More similar genetically



Genomic signals of selection predict climate-driven population declines in a migratory bird

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Exercise

1. Run GDM using `gdm_run()`
2. Plot observed versus predicted dissimilarity and predicted ecological distances vs dissimilarity using `gdm_plot_diss()`
3. Plot I-splines using `gdm_plot_isplines()`
4. Get coefficient table using `gdm_table()`
5. Create GDM raster map using `gdm_map()`