Appendix 2. Bibliographic sources.

|  |  |
| --- | --- |
| Reference | Species |
| GBIF: https://www.gbif.org/ | All |
| iNaturalist: <https://www.inaturalist.org/Testudo> marginata | 1. *marginata*
 |
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Table 2. Best Maxent models selected by Akaike criterion (AICc), after evaluating several candidate models combining different features (L: linear; Q: Quadratic; H: Hinge; P: Product; T: Threshold) and regularization multipliers (RM). AUC, area under the curve. wAICc, Akaike weights. The best supported models are those with delta AICc equal to 0 and wAICc close to 1.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Features | RM | AUC | AICc | Delta AICc | wAICc |
| *T. graeca* | LQHPT | 2.5 | 0.925 | 5926.347 | 0.00 | 0.823 |
| *T. hermanni* | LQHPT | 2 | 0.975 | 2089.313 | 0.00 | 0.963 |
| *T. horsfieldii* | LQLQHP | 0.51.0 | 0.9560.966 | 1628.9651631.268 | 0.002.30 | 0.6670.211 |
| *T. marginata* | LQ | 0.5 | 0.980 | 1156.233 | 0.00 | 0.999 |

Table 3. Permutation importance of environmental variables modelling the fundamental niche of *Testudo* species, using Maxent.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *T. graeca* | *T. hermanni* | *T. horsfieldii* | *T. marginata* |
| Temperature warmest quarter | 13.6 | 5.2 | 6.5 | 16.5 |
| Temperature coldest quarter | 1.3 | 1.5 | 2.7 | 10.1 |
| Temperature wettest quarter | 6.0 | 4.5 | **29.1** | 6.4 |
| Temperature driest quarter | 2.8 | 1.6 | 2.2 | 7.0 |
| Annual Precipitation | **39.8** | **77.9** | 25.0 | 17.7 |
| Precipitation seasonality | 14.1 | 1.5 | 5.4 | 10.0 |
| Precipitation warmest quarter | 22.3 | 7.7 | **29.1** | **32.3** |

**R. script for niche models**

**a) model evaluation**

library("ENMeval")

sitx<-read.table("MARGINATA.txt")

data(wrld\_simpl)

plot(sitx, pch=21, cex=1, col = "red")

plot(wrld\_simpl,add=T)

bio <- raster::getData("worldclim", var = "bio", res=5)#

bio <- bio[[c(10,11,8,9,12,13,18)]]

env\_vars <- stack(bio)

e <- extent(-15, 80, 25, 50)

env\_vars <- crop(env\_vars, e)

dir.create('~/MaxEnt\_Default')

xm <- maxent(env\_vars, sitx, path='MaxEnt\_Default')

r <- predict(xm, env\_vars, progress='text')

plot(r)

def.results <- getFEATUs(paste('MaxEnt\_Default',"/maxent.html",sep=''))

def.results <- strsplit(def.results, " ")[[1]]

def.results <- lapply(def.results, function(x) gsub("hinge", "H", x))

def.results <- lapply(def.results, function(x) gsub("linear", "L", x))

def.results <- lapply(def.results, function(x) gsub("product", "P", x))

def.results <- lapply(def.results, function(x) gsub("threshold", "T", x))

def.results <- lapply(def.results, function(x) gsub("quadratic", "Q", x))

def.results <- lapply(def.results, function(x) paste(x, collapse = ""))

def.results <- paste(unlist(def.results),collapse='')

def.results

dir.create(ENMeval')

eval.results <- ENMevaluate(sitx=sitx, env=env\_vars, RMvalues=seq(0.5, 4, 0.5),

 featu=c("L", "LQ", "H", "LQH", "LQHP", "LQHPT"), method='block', algorithm='maxent.jar')

aicmods <- which(eval.results@results$AICc == min(na.omit(eval.results@results$AICc)))

eval.results@results[aicmods,]

aicmods <- which(eval.results@results$AICc == min(na.omit(eval.results@results$AICc)))[1]

aicmods <- eval.results@results[aicmods,]

FEATU\_best <- as.character(aicmods$features[1])

rm\_best <- aicmods$rm

maxent.args <- make.args(RMvalues = rm\_best, featu = FEATU\_best)

 mx\_best <- maxent(env\_vars, sitx, args=maxent.args[[1]],

 overight=T)

r\_best <- predict(mx\_best, env\_vars, overwrite=TRUE, progress = 'text')

**b) niche tests**

library(ENMTools)

env <- raster::getData('worldclim', var='bio', res= 5)

env <- crop(env, extent(-15, 80, 25, 50))

graeca <- enmtools.species()

env <- env[[c("bio8", "bio9", "bio10", "bio11", "bio12", "bio15","bio18")]]

id.glm <- identity.test(species.1 = graeca, env = env, type = "glm", nreps = 500)