A person in a dark suit is pointing with a blue pen at a line graph on a clipboard. The graph shows a fluctuating line with a general upward trend. The background is a blurred office setting.

Incorporating decision priorities into forecasts: A case study using species distribution models

Colin Daniel & Alex Filazzola

ApexRMS

July 27, 2023

Providing forecast models

A model needs to be:

- 1) Credible
- 2) Reliable
- 3) Relevant
- 4) Accessible

Identify an audience for model results

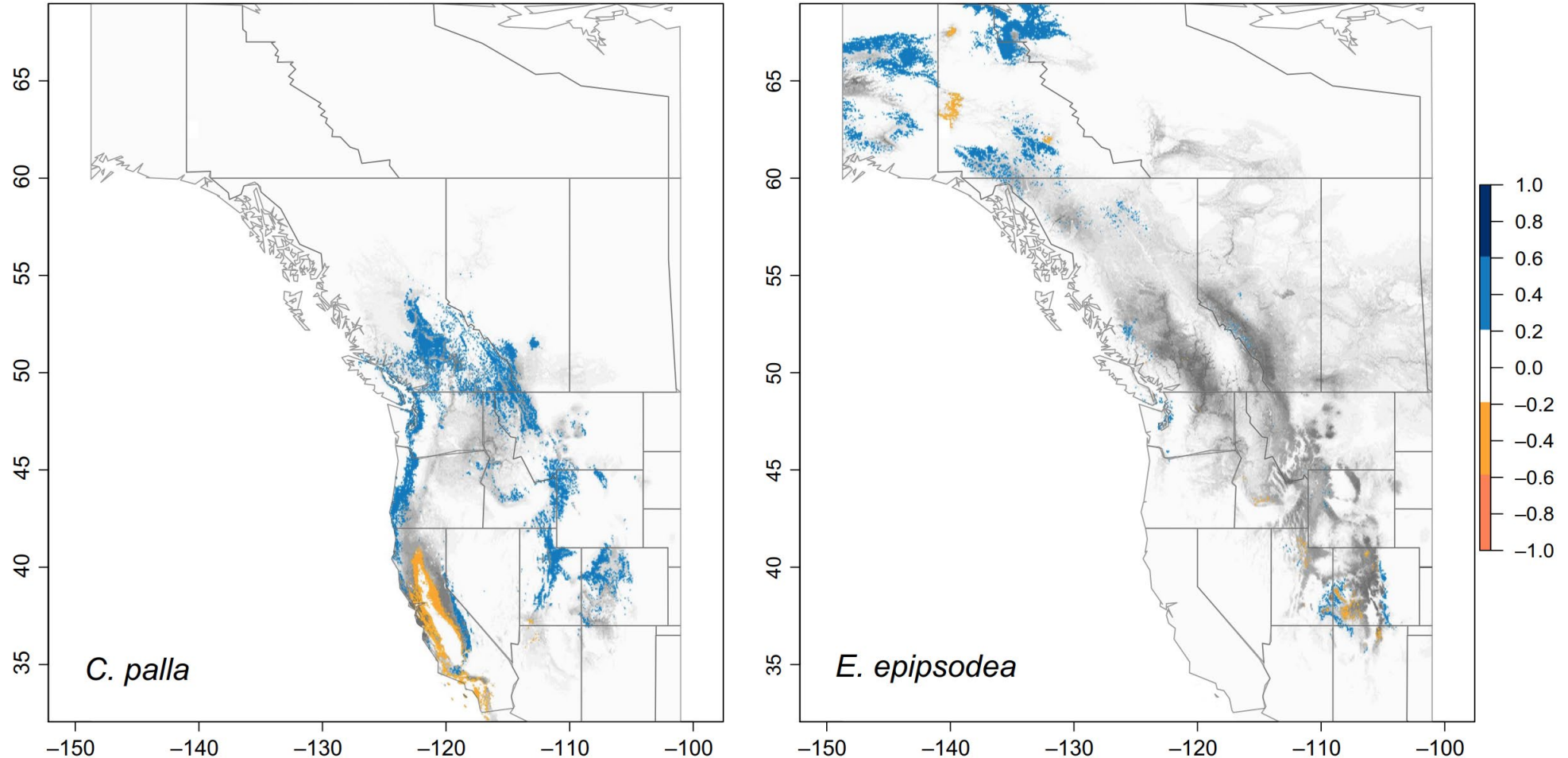


Forecasting species responses to climate

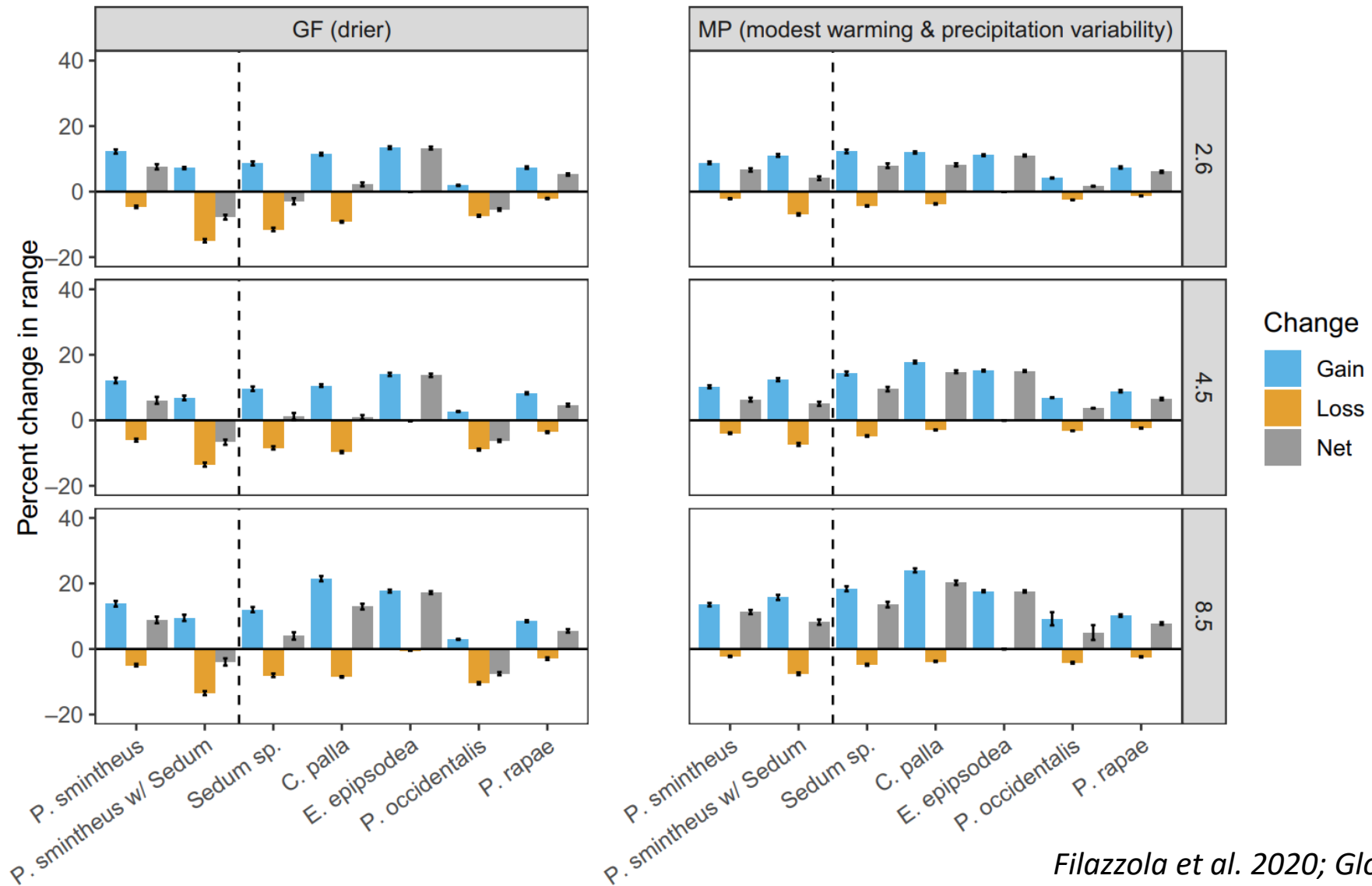
How will this species change in an area of interest with climate change?



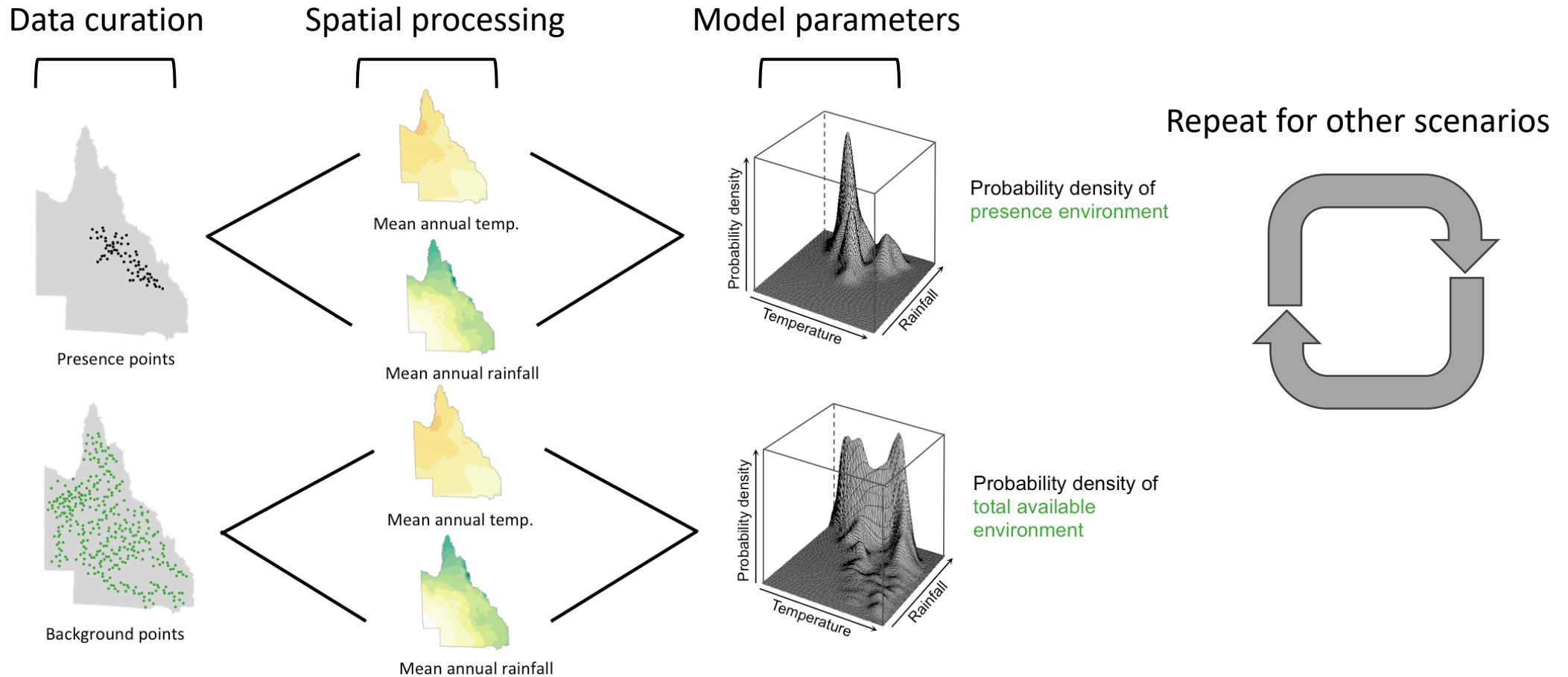
Forecasting species responses to climate



Forecasting species responses to climate

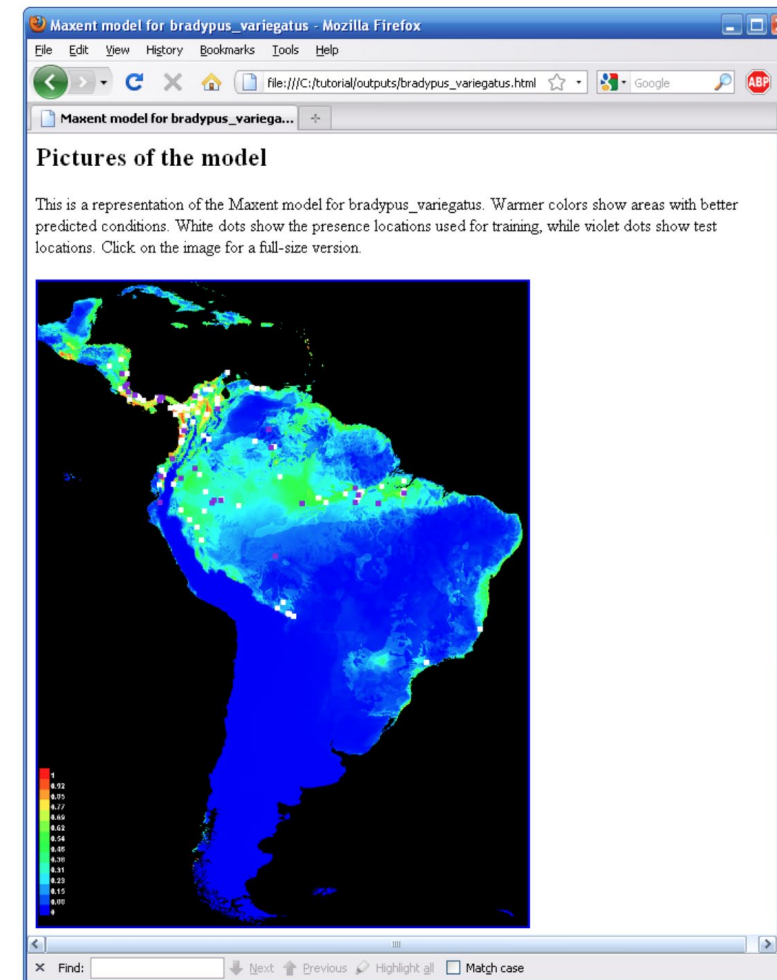
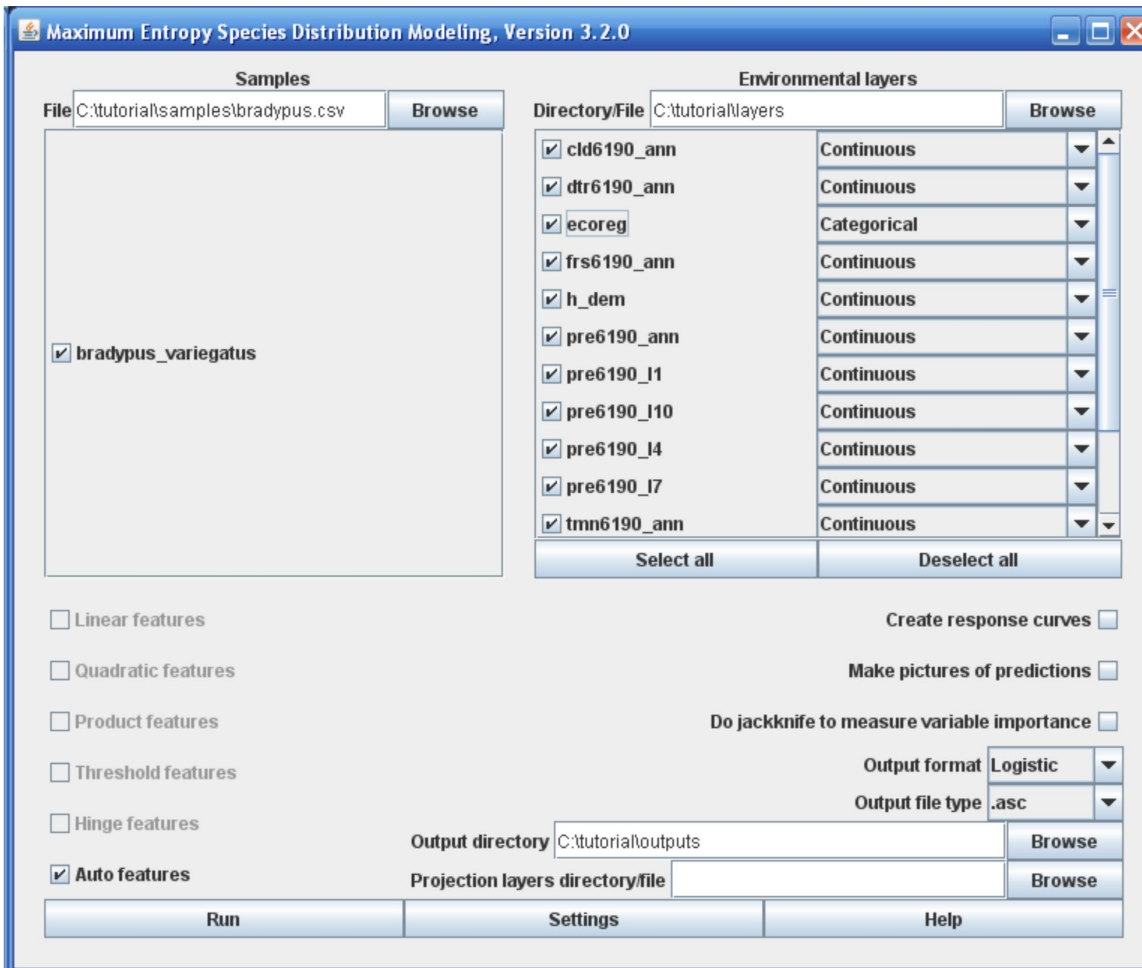


Forecasting species responses to climate



Adapted from Elith et al. (2011) *A statistical explanation of MaxEnt for ecologists*. Diversity and Distributions, 17, 43-57.

Methods for predicting species change: MaxEnt



Credible



Reliable



Relevant

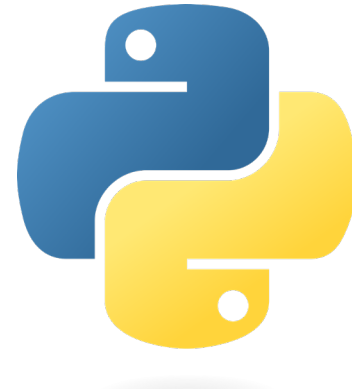
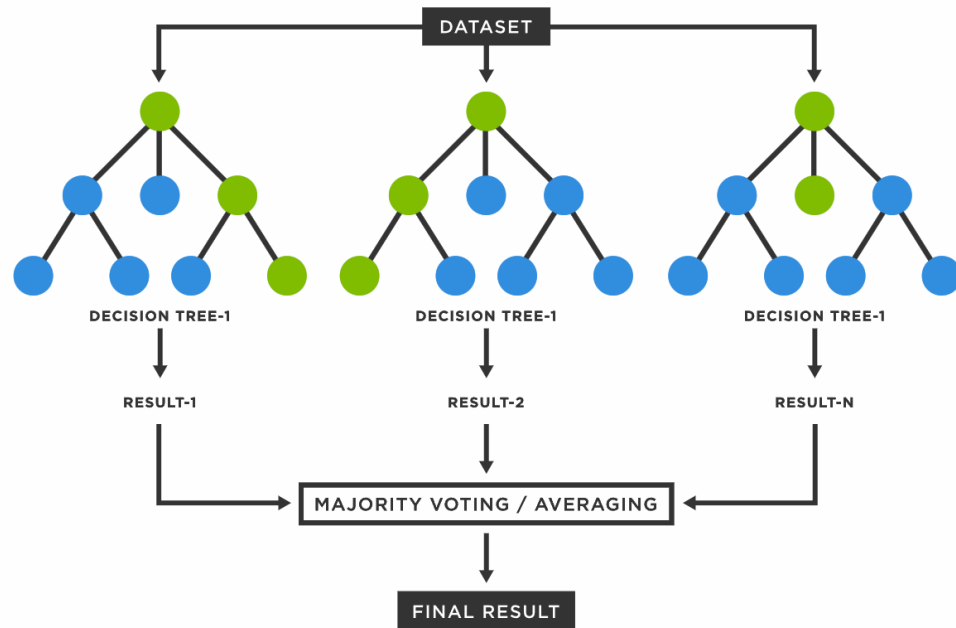


Accessible



Methods for predicting species change:

Random forest



Credible



Reliable



Relevant



Accessible



Delivery SDM results to decision makers

- 1) Credibility – No shortage of good statistical models
- 2) Reliability – Models should dynamic (e.g., Shiny, Jupyter, custom applications)
- 3) Relevant – Deliver models, not reports
- 4) Accessibility – Models must be digestible and useable by target audience

A tale of three MaxEnt models

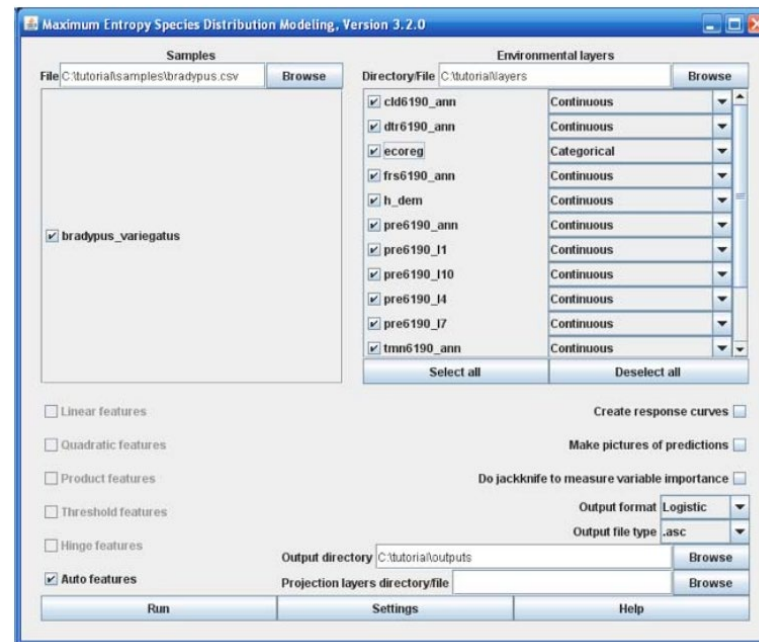
R stats - ENMeval

```

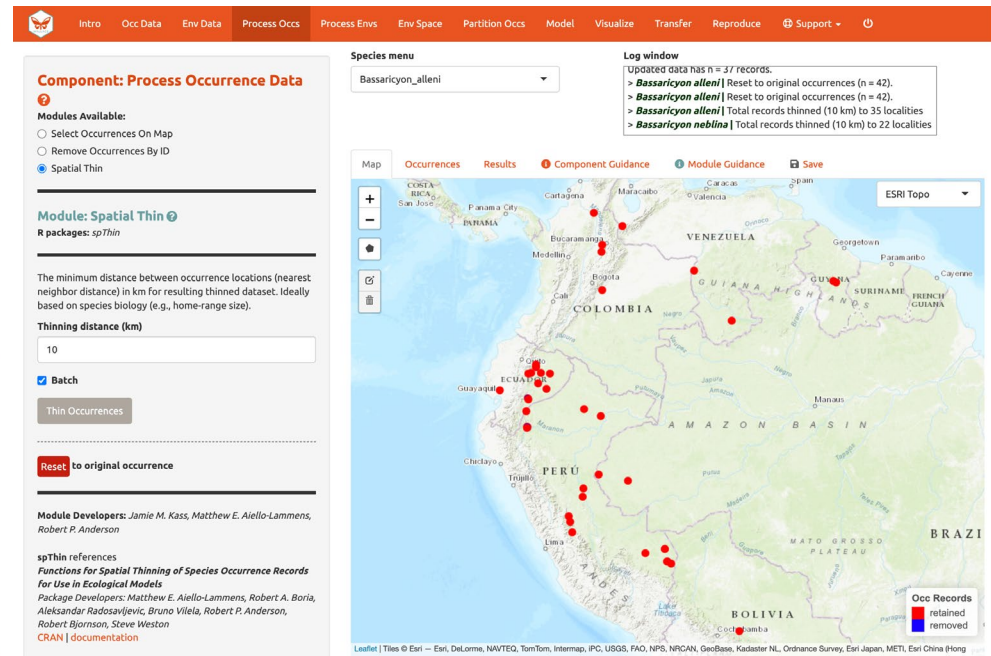
10 #####
11 ##### Climate layers
12 #####
13
14 # List all species
15 speciesList <- sort(as.character(unique(bombus$species)))
16
17 # List remaining species to be processed
18 completed <- list.files("output", pattern="BMDout.csv",
19                        full.names=T)
20 completed <- gsub("BMDout.csv", "", completed)
21 speciesList <- speciesList[!speciesList %in% completed]
22
23 BMDout<-function(spp, sppOf, biasFile) {
24   ## Load current climate
25   climate=current
26
27   ## Data set up
28   tempSpp <- subset(sppOf, species == spp)
29   nrowSpp <- nrow(tempSpp)+1
30
31   ## Load buffer - last input extent
32   sppBuffer <- readRDS(dnorm("~/buffer", layer=paste0(spp,"buffer")))
33
34   ## Mask climate to extent
35   climate <- mask(climate, sppBuffer)
36
37   ## Checking for collinearity among the climate variables using vifcor
38   #<- c( sampleRandomClimate, background, gyr2) feeding random background points for comparison. 100
39   x <- random <- cbind(data.frame(longitude=runif(1),latitude=runif(1)), coordinates(tempSpp) #<= 100
40   #<- 100
41   vifcor <- vifcorTest(vif)
42   vifcor <- vifcorTest(vif)
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99   vifcor <- vifcorTest(vif)
100  vifcor <- vifcorTest(vif)

```

MaxEnt - Java

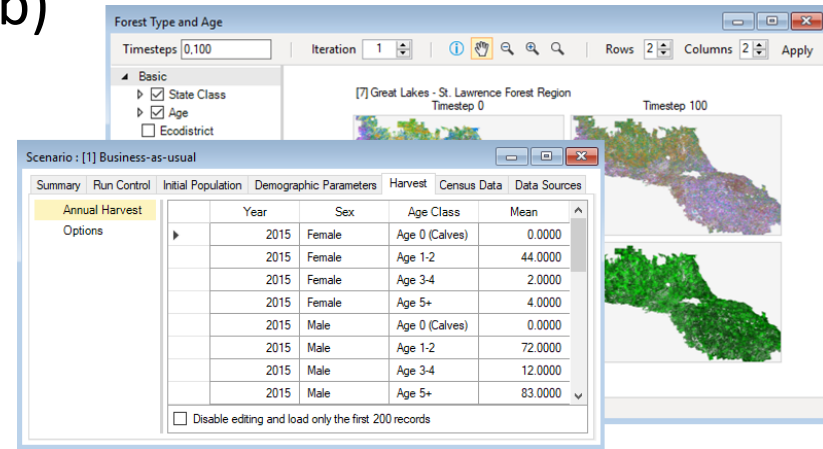
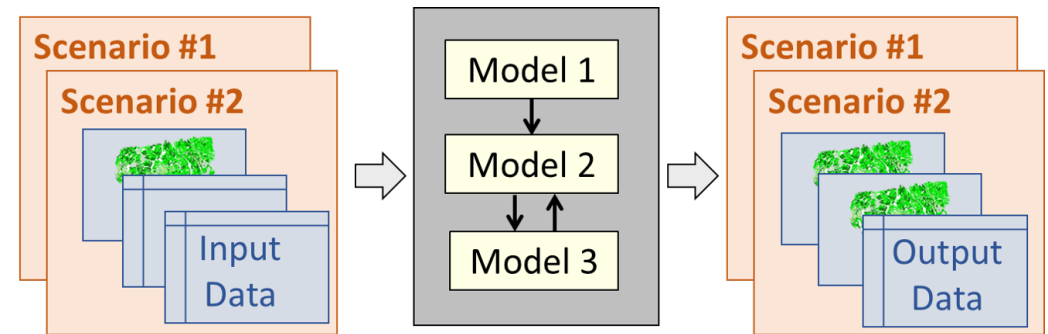


Custom Shiny App



SyncroSim – A tool for delivering models to decision makers

- Automatically structures data
- Model pipelining or chaining
- Multiple interfaces (R/Python, Desktop, Web)
- Supports R, Python, or C#
- Multi-processing



Different deliverables to different audiences

| | SyncroSim Package | SyncroSim Library |
|------------------|---------------------|--------------------------|
| Description | Template for models | Series of models |
| When to use | Need a new model | A package already exists |
| Model parameters | Customizable | Adjustable |
| Interface | Customizable | Static |
| Target audience | Research Scientists | Analysts/Decision Makers |

Different deliverables to different audiences



Requirements

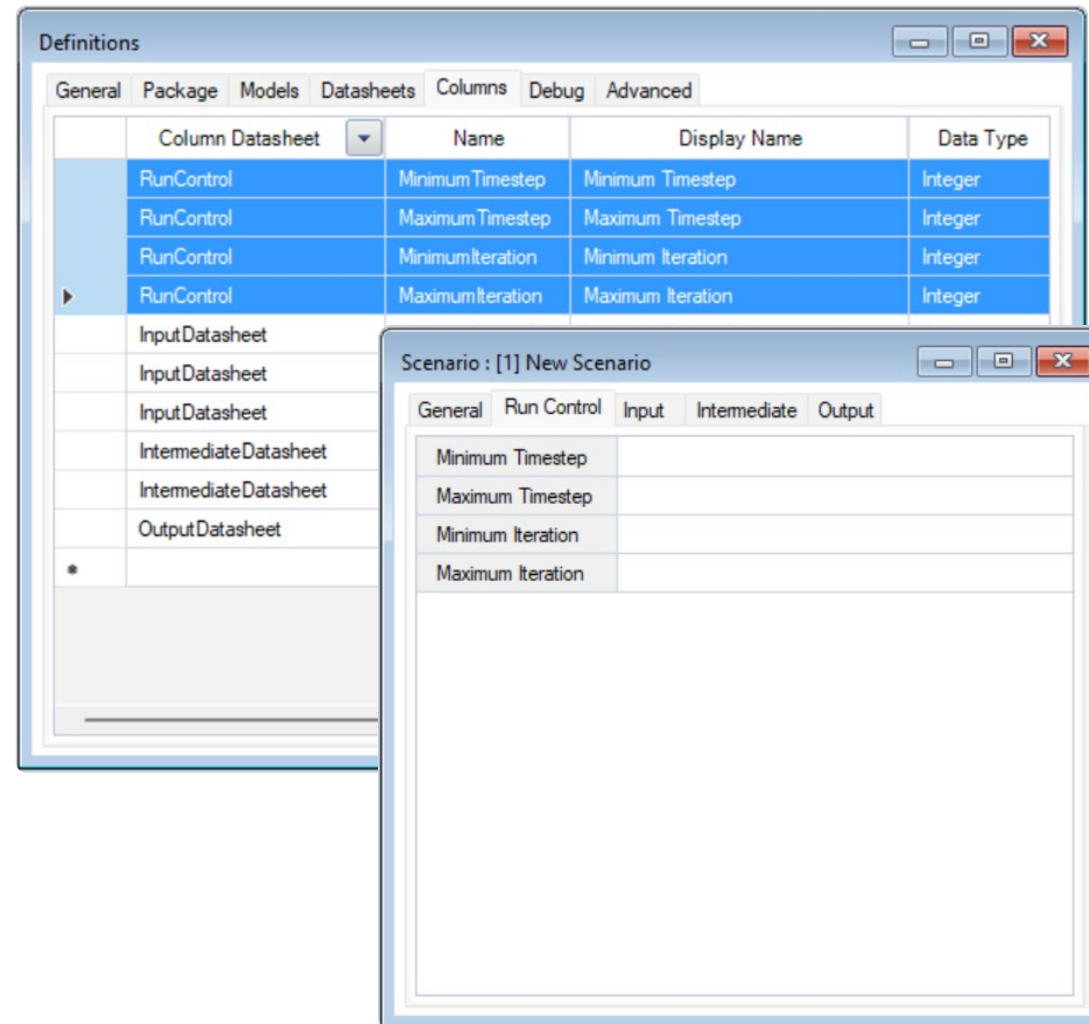
- A flexible tool for conducting SDMs
- Specific model settings
- Pre-model data processing
- Customized data output
- Research scientists



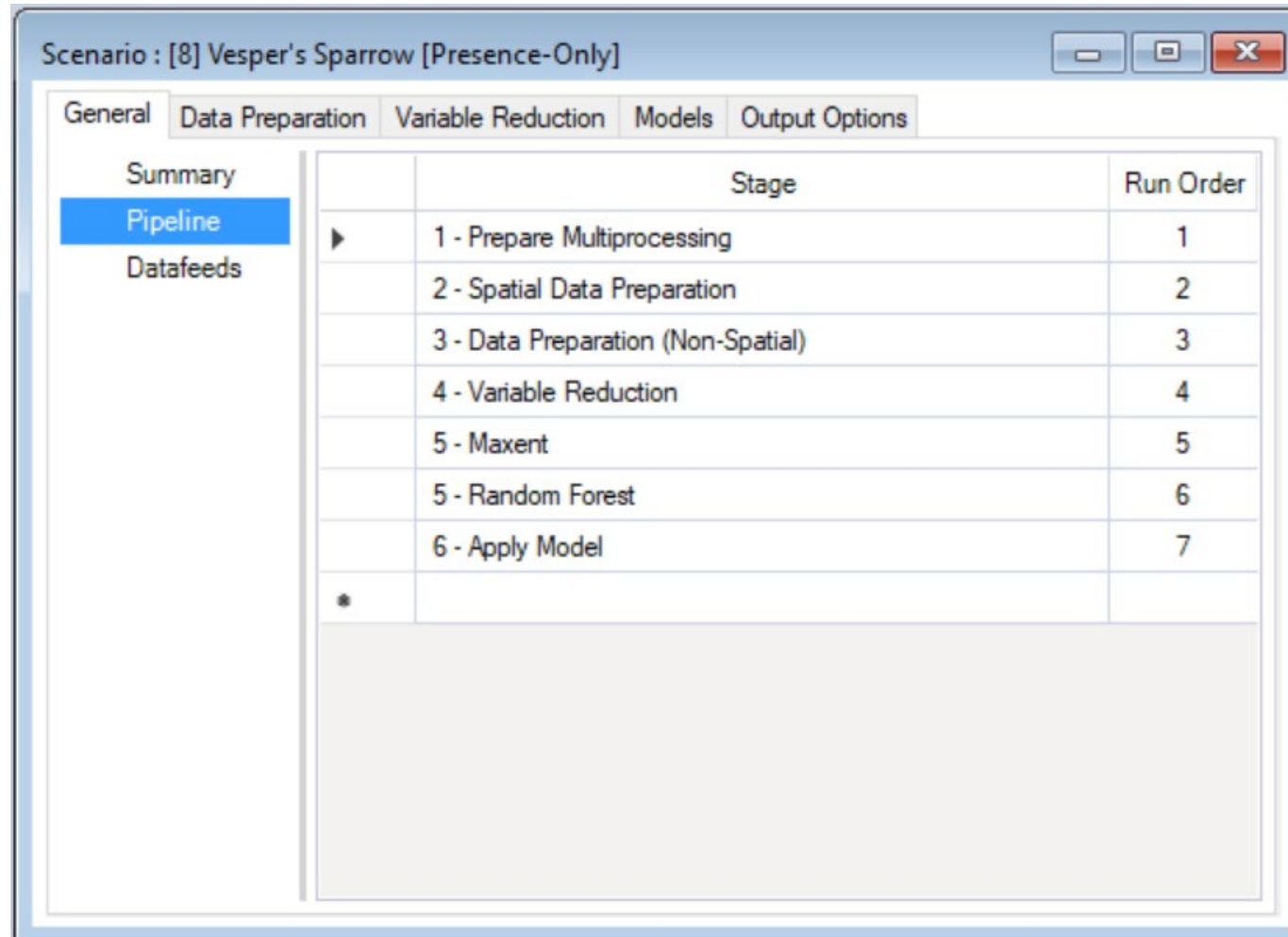
Requirements

- SDM for a select set of species
- Control over model settings
- Pre-model data processing
- Reproducible data output
- Analysts and decision makers

Creating a package: the package designer



Creating a package for SDMs - USGS



Creating a package for SDMs - USGS

Scenario : [8] Vesper's Sparrow [Presence-Only]

General Data Preparation Variable Reduction Models Output Options

Template Raster
Covariate Data
▶ Field Data
Validation Options
Spatial Multiprocessing

| | |
|---|--------|
| Split data for model training and testing | Yes |
| Proportion of data used for model training | 0.5000 |
| Use cross validation for model selection | Yes |
| Stratify cross-validation folds by the response | Yes |
| Number of cross-validation folds | 5 |

Creating a library for SDMs - CVC

The screenshot displays the CVC (Covariate Variable Compiler) software interface, which is used for creating libraries for Species Distribution Models (SDMs). The interface is divided into several panels:

- Scenario : [8] Vesper's Sparrow [Presence-Only]**: The main window title.
- General**: The active tab, showing a list of covariates and their corresponding raster files.
- Covariate Data**: A table with two columns: **Covariate** and **Raster File**. The table lists the following covariates and their files:

| Covariate | Raster File |
|--------------------|-------------|
| annual_mean_temp | bio1.tif |
| annual_precip | bio12.tif |
| conifer_forest | |
| max_temp | |
| min_temp | |
| mixed_shrub | |
| ndvi | |
| precip_wet_quarter | |
| road_density | |
| sagebrush | |
| tri | |
- Model Outputs**: A panel showing the results of the model runs. It includes a tree view with the following structure:
 - WISDM - Maxent Example
 - Definitions
 - publish
 - [1] Brewer's Sparrow [Presence-Absence]
 - Results
 - [7] Brewer's Sparrow
 - [8] Vesper's Sparrow [Presence-Only]
 - Results
 - [9] Vesper's Sparrow [Presence-Only]
- Model Outputs**: A panel showing the results of the model runs. It includes a tree view with the following structure:
 - Model Outputs
 - Covariate Maps
 - Covariate Correlations
 - Map Outputs
 - Probability
 - Generalized Linear Model
 - Maxent
- Model Outputs**: A panel showing the results of the model runs. It includes a tree view with the following structure:
 - Model Outputs
 - Covariate Maps
 - Covariate Correlations
 - Map Outputs
 - Probability
 - Generalized Linear Model
 - Maxent

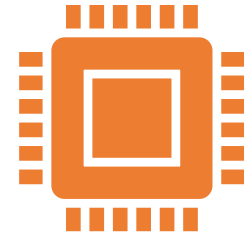
Benefits of this approach



Simplified scenario management
for different models







Database control of
uncertainty



Efficient – both
computationally and labour

Using SyncroSim to deliver to decision makers

- 1) Credibility – Uses models based on leading research 
- 2) Reliability – Models can be easily updated 
- 3) Relevant – Deliverable is not static and be adjusted 
- 4) Accessibility – Requires a technical expert or analyst 

Increasing the accessibility of models

SyncroSim

?

A

Libraries

SDM Brewer's Sparrow

ApexRMS

Modelling Brewer's Sparrow distributions in the Wyoming Basins, USA.

2023-05-06 10:31 AM | 1 MB | wisdm1.0.9

SDM Red Winged Blackbird

ApexRMS

Modelling Red Winged Blackbird distributions in the Wyoming Basins, USA.

2023-05-06 10:31 AM | 1 MB | wisdm1.0.9

SDM Sage Grouse

ApexRMS

Modelling Sage Grouse distributions in the Wyoming Basins, USA.

2023-05-06 10:31 AM | 1 MB | wisdm1.0.9

SDM Vesper's Sparrow

ApexRMS

Modelling Vesper's Sparrow distributions in the Wyoming Basins, USA.

2023-05-06 10:31 AM | 1 MB | wisdm1.0.9

DOWNLOAD LIBRARY

Libraries / SDM Vesper's Sparrow / Scenarios

UPLOAD

DELETE

MANAGE UPLOADS

MAKE PUBLIC

Scenarios

Name

MaxEnt - RCP 2.6

Simulation of the distribution of Vesper's Sparrow under a MaxEnt model using the RCP 2.6 climate change scenario.

2022-08-18 at 8:22 AM

MaxEnt - RCP 8.5

Random Forest - RCP 2.6

Random Forest - RCP 8.5

Maps

Probability of Occurrence

Climate

Land Cover

All Maps

Charts

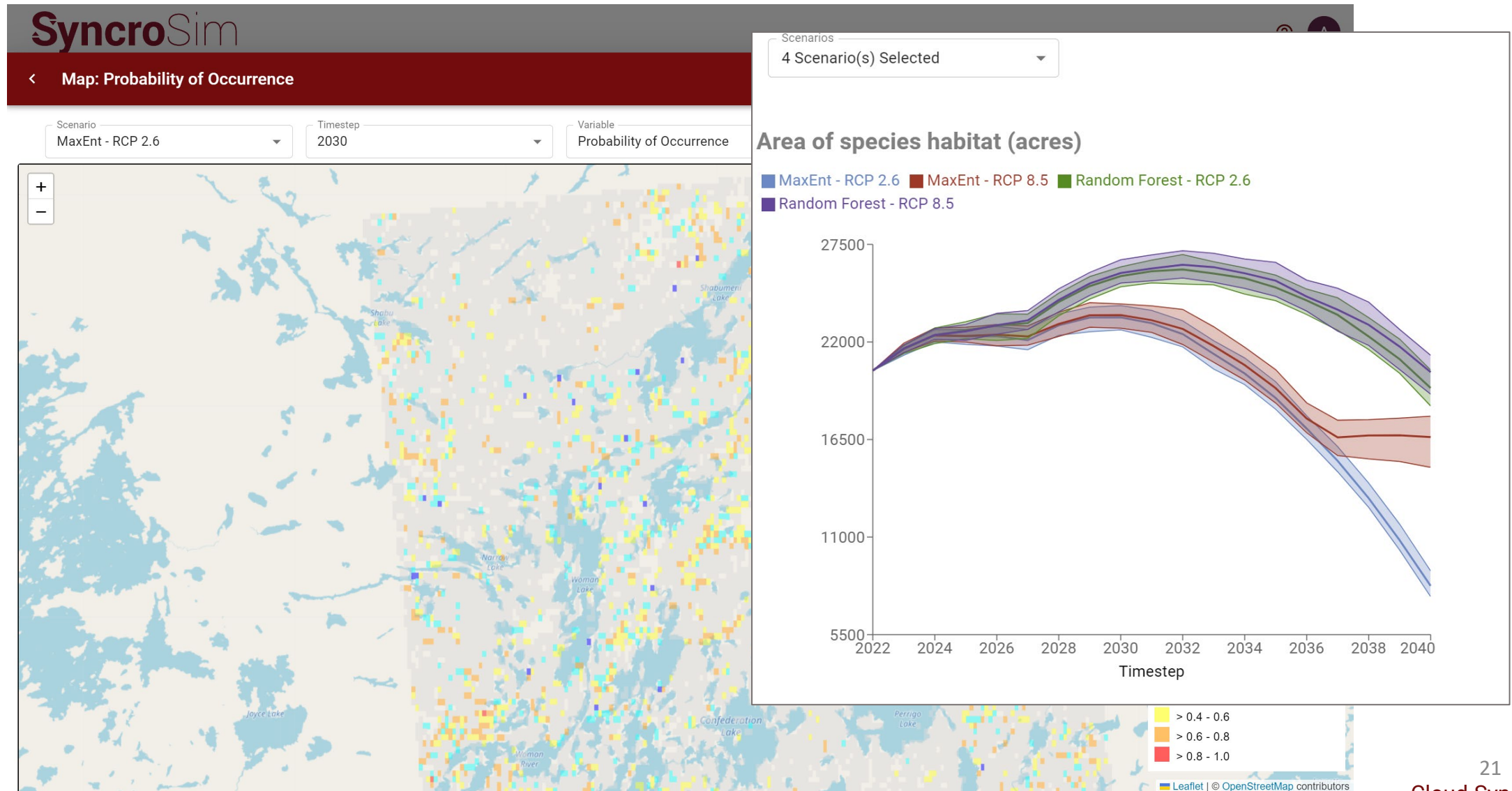
Land Cover

Area of species habitat

20

Cloud.SyncroSim.com

Increasing the accessibility of models



Questions

Colin Daniel

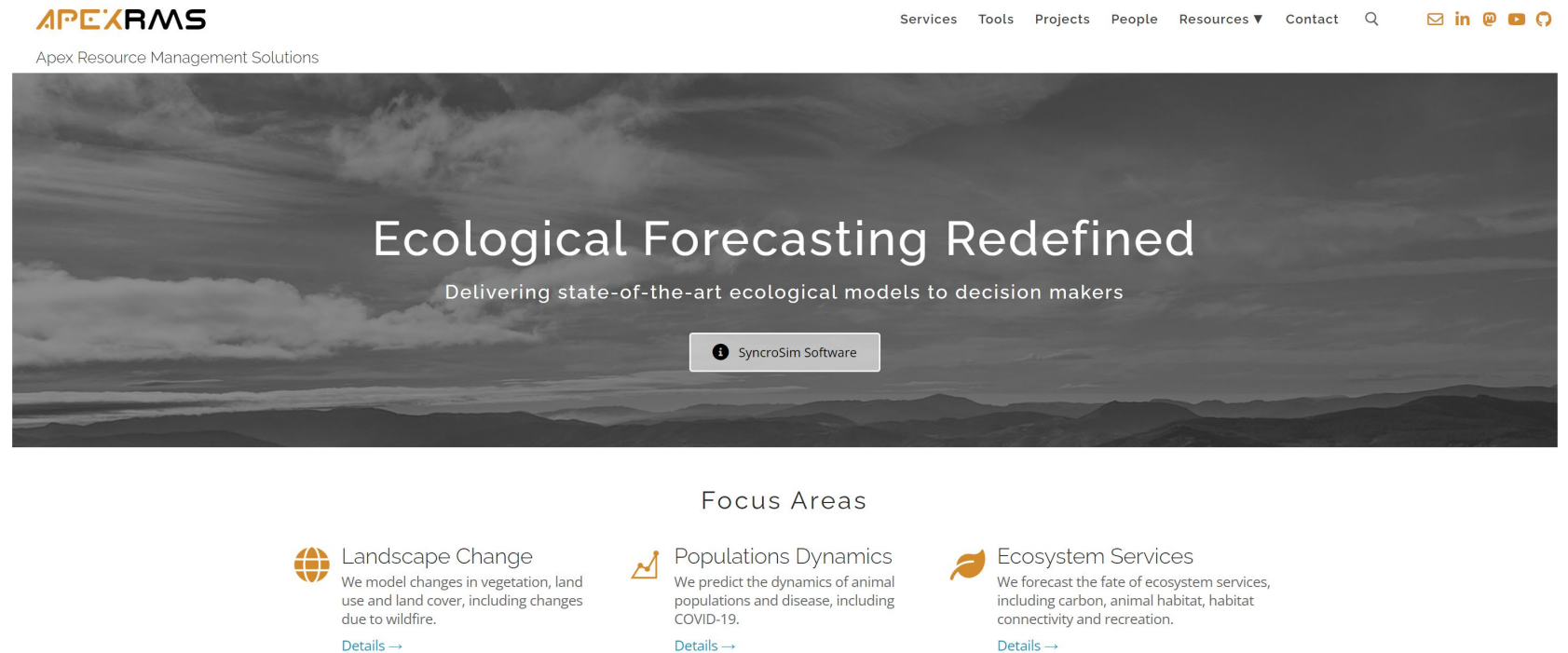
President, Systems Ecologist

ApexRMS

Alessandro Filazzola

Data Scientist, ApexRMS

Adjunct Faculty, WesternU



Company: <https://apexrms.com/>

Software: <https://syncrosim.com/>