Foundation for Research and Technology Hellas
Institute of Applied and Computational Mathematics
Remote Sensing Lab

Mountain biodiversity as a sentinel of environmental change

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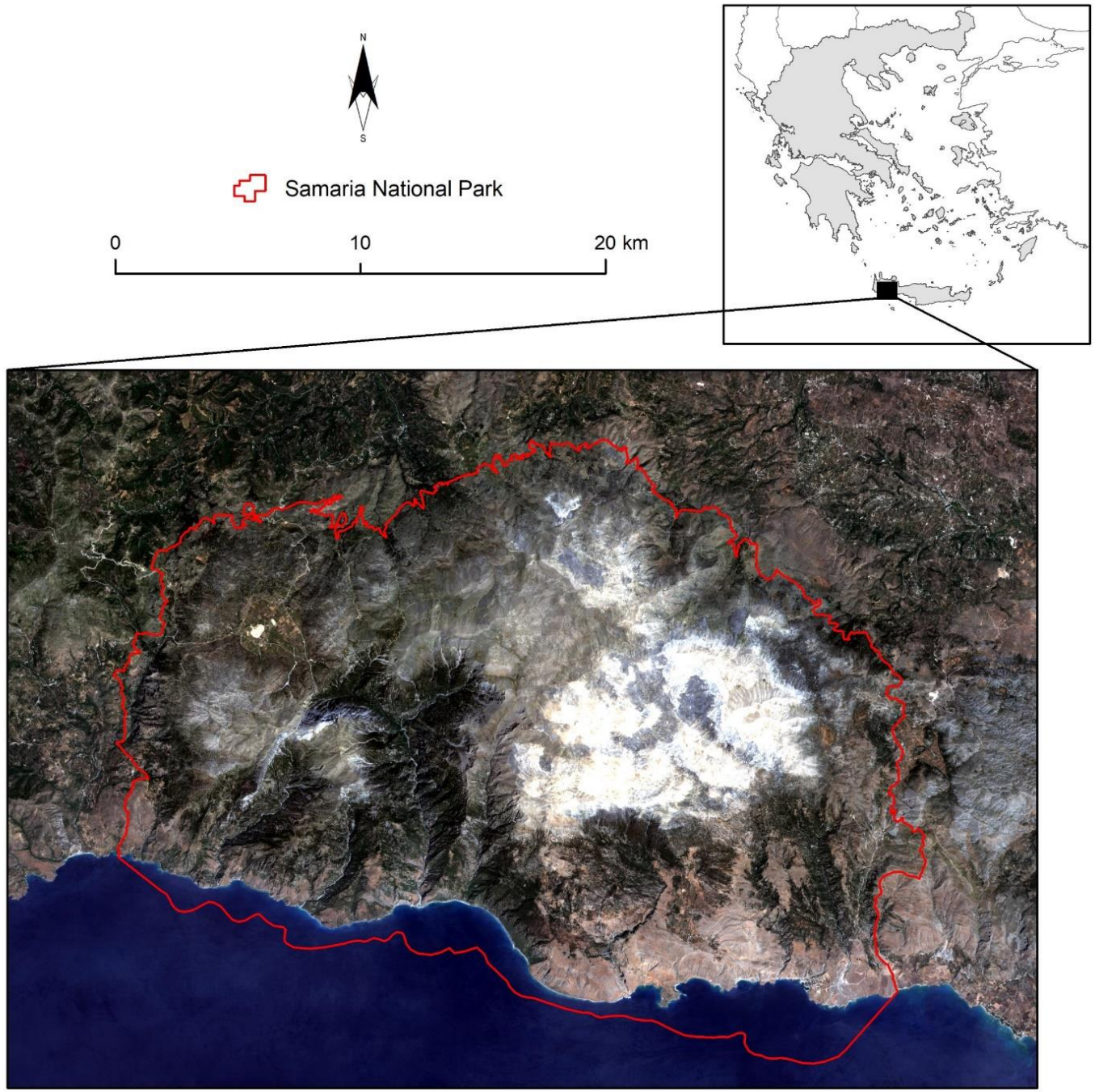
Copernicus Sentinel data for local scale conservation activities

- Mountain habitats support some of the world's most rare and fragile ecosystems.
- Mountain environments are especially sensitive to climate and environmental change.
- Biodiversity in mountain areas can be severely affected by environmental change.

GOAL

The use of Sentinel-2 data, combined with geodiversity essential variables for the modelling and the connectivity of the distribution of the endemic lizard *Podarcis cretensis* in Samaria National Park using machine learning tools and methods.

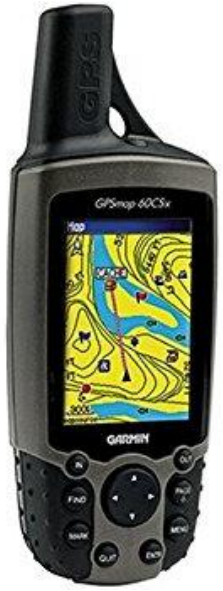
Samaria National Park

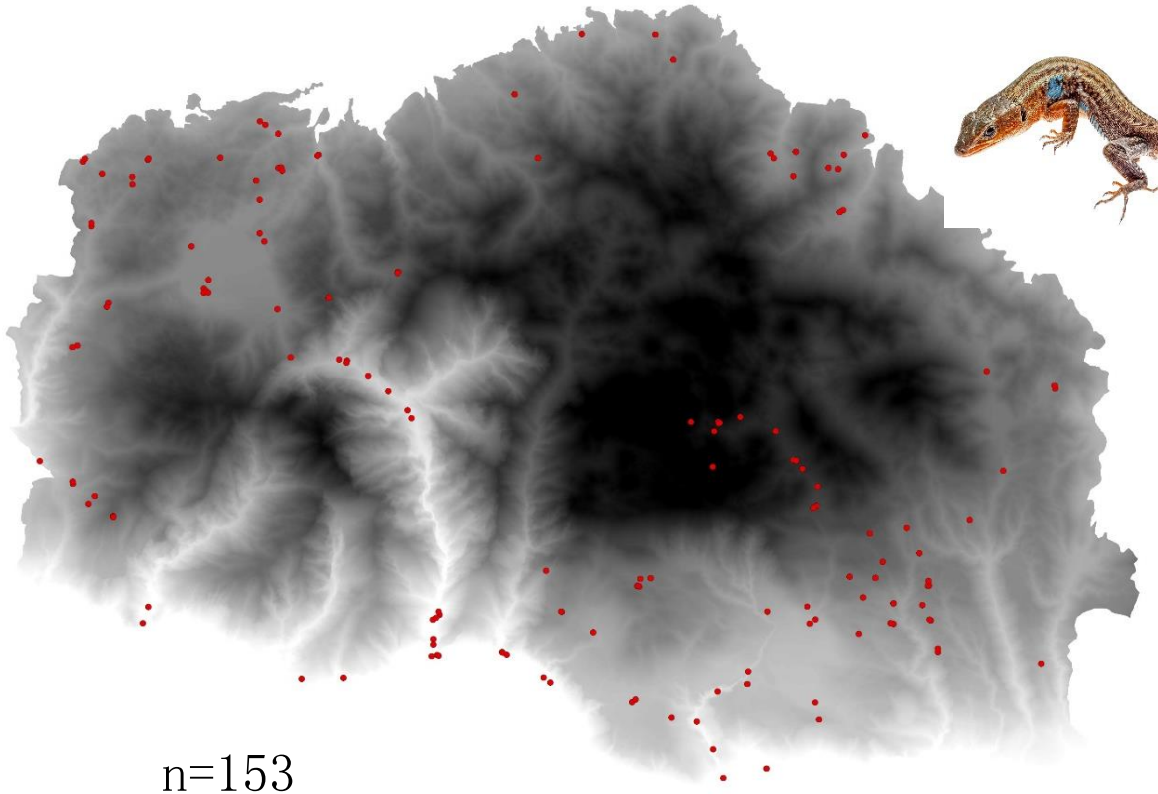


Sampling design and methodology

- A vast proportion of the Samaria NP is inaccessible by car and even on foot due to the steep slopes and the loose ground.
- Thus sampling is concentrated at areas that are accessible from dirt roads and on close distances by them or at sites that accessible by boat from the sea.
- Safety first is the rule that define the sampling in the National Park
- The sampling was curried out during a 3-years monitoring scheme for the collection of biodiversity data for the needs of reporting in EEA

In situ DATA: The endemic Cretan lizard





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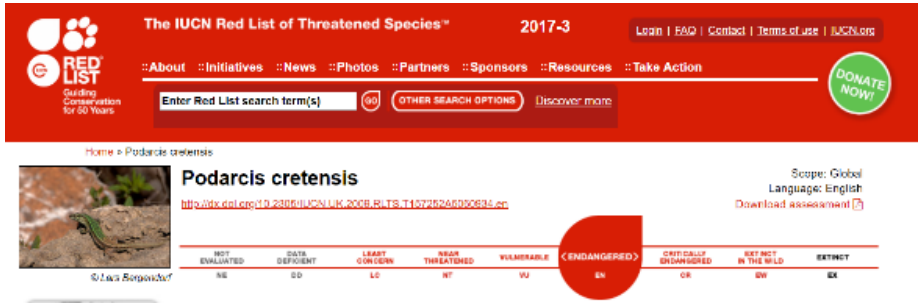


Cretan wall lizard

Cretan wall lizard in Elafonisi, Crete

Conservation status

Extinct | Threatened | Least Concern

EX EW CR EN VU NT LC

Endangered (IUCN 3.1)[1]

Scientific classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Reptilia
Order:	Squamata
Family:	Lacertidae
Genus:	*Podarcis*
Species:	***P. cretensis***

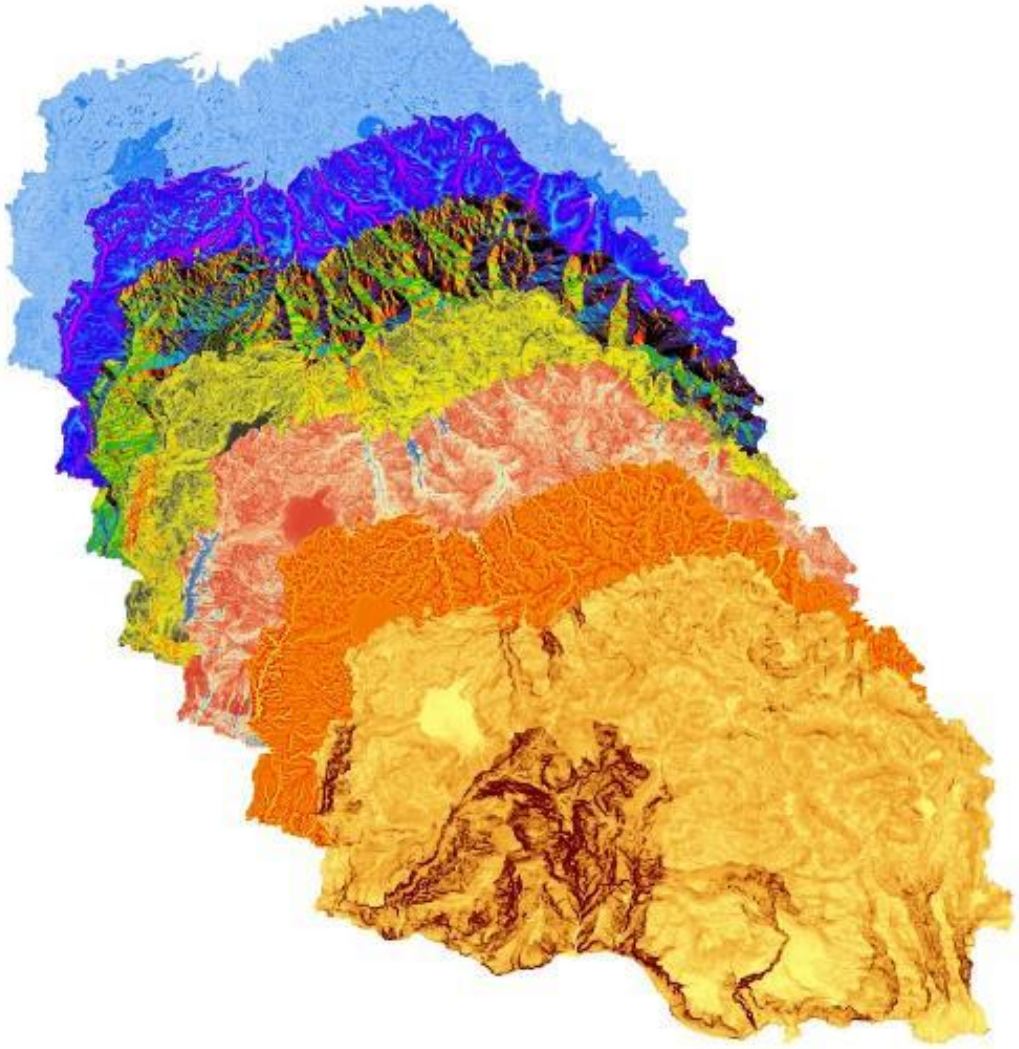
Binomial name

Podarcis cretensis
(Wettstein, 1952)

Synonyms

Lacerta erhardii cretensis Wettstein, 1952

Environmental Dataset – I



Remote Sensing based Geodiversity

Land surface related parameters based on high resolution DSM (10m)

- Slope – Aspect
- Topographic Roughness Index
- Topographic Wetness Index
- Sky View Factor
- Topographic Position Index
- Wind Exposition
- Diffuse and Direct Insolation

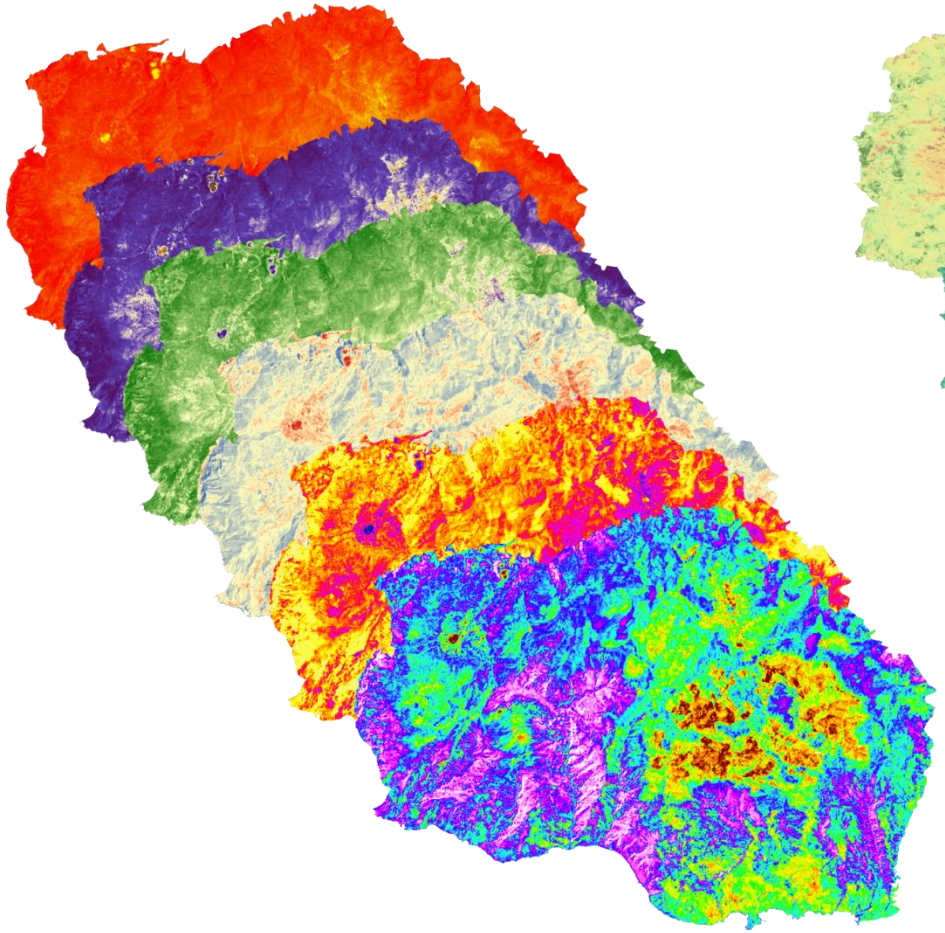
Environmental Dataset – II

Remote Sensing based

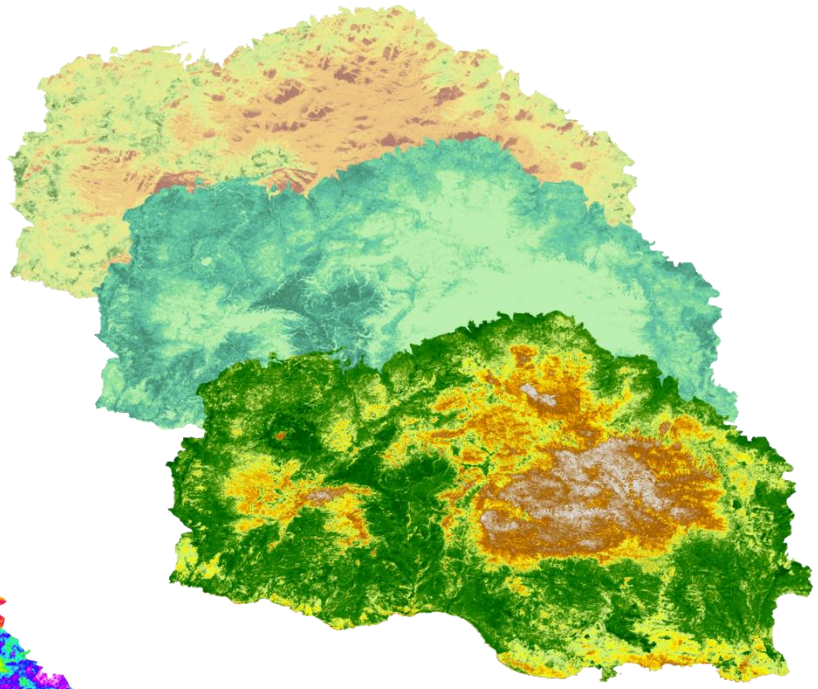
Spectral Diversity

Copernicus Sentinel 2 spectral bands (min/max/median)

- Blue
- Green
- Red
- Near Infrared
- Red Edge
- Shortwave Infrared



and Copernicus Sentinel 2 based Spectral indices (e.c. NDVI)



- Min
- Max
- Median

Species Distribution Modelling

Maximum Entropy approach using Wallace R package

Intro | About

What is *Wallace*?

Welcome to *Wallace*, a flexible application for reproducible ecological modeling, built for community expansion. The current version of *Wallace* (v1.0.6) steps the user through a full niche/distribution modeling analysis, from data acquisition to visualizing results.

The application is written in `R` with the web app development package `shiny`. Please find the stable version of *Wallace* on CRAN, and the development version on Github. We also maintain a *Wallace* website that has some basic info, links, and will be updated with tutorial materials in the near future.

Wallace is designed to facilitate spatial biodiversity research, and currently concentrates on modeling species niches and distributions using occurrence datasets and environmental predictor variables. These models provide an estimate of the species' response to environmental conditions, and can be used to generate maps that indicate suitable areas for the species (i.e. its potential geographic distribution; Guisan & Thuiller 2005; Elith & Leathwick 2009; Franklin 2010a; Peterson et al. 2011). This research area has grown tremendously over the past two decades, with applications to pressing environmental issues such as conservation biology (Franklin 2010b), invasive species (Ficetola et al. 2007), zoonotic diseases (González et al. 2010), and climate-change impacts (Kearney et al. 2010).

Also, for more detail, please see our paper in Methods in Ecology and Evolution.

Kass J. M., Vilela B., Aiello-Lammens M. E., Muscarella R., Merow C., Anderson R. P. (2018). Wallace: A flexible platform for reproducible modeling of species niches and distributions built for community expansion. *Methods Ecol Evol.* 2018. 9: 1151-1156. https://doi.org/10.1111/2041-210X.12945

Who is *Wallace* for?

We engineered *Wallace* to be used by a broad audience that includes graduate students, ecologists, conservation practitioners, natural resource managers, educators, and programmers. Anyone, regardless of programming ability, can use *Wallace* to perform an analysis, learn about the methods, and share the results. Additionally, those who want to disseminate a technique can author a module for *Wallace*.

WORKFLOW

Wallace (v1.0.6) currently includes the following components and modules:

1: *Obtain Occurrence Data*

- Query Database
- User-specified Occurrences

2: *Process Occurrence Data*

- Select Occurrences on Map
- Remove Occurrences by ID
- Spatial Thin

3: *Obtain Environmental Data*

- WorldClim
- User-specified Environmental Data

4: *Process Environmental Data*

- Select Study Region
- User-specified Study Region

5: *Partition Occurrence Data*

- Non-spatial Partition
- Spatial Partition

6: *Build and Evaluate Niche Model*

- BIOCLIM
- Maxent

7: *Visualize Model Results*

- BIOCLIM Envelope Plot
- Maxent Evaluation Plots
- Plot Response Curves
- Map Prediction

8: *Project Model*

- Project to New Area
- Project to New Time
- Calculate Environmental Similarity

Download Session Code

› Why Wallace ?

Attributes of *Wallace*

- **open**: the code is free to use and modify (GPL 3.0), and it gives users access to some of the largest public online biodiversity databases
- **expandible**: users can author and contribute modules that enable new methodological options
- **flexible**: options for user uploads and downloads of results
- **interactive**: includes an embedded zoomable `leaflet` map, sortable `DF` data tables, and visualizations of results
- **instructive**: features guidance text that educates users about theoretical and analytical aspects of each step in the workflow
- **reproducible**: users can download an `rmarkdown` .Rmd file that when run reproduces the analysis

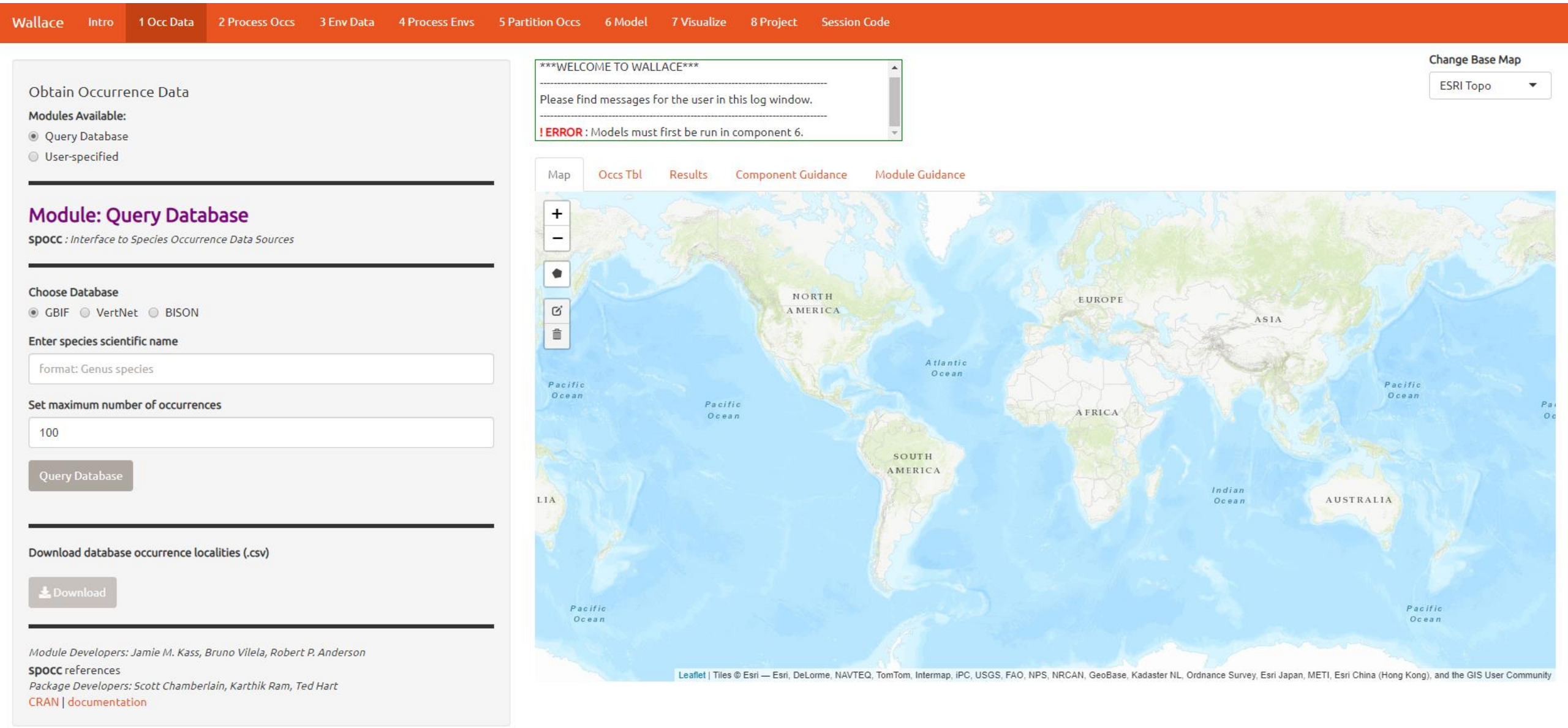
› Protected Area personnel don't know R

› Wallace has a nice GUI - thus more attractive to them

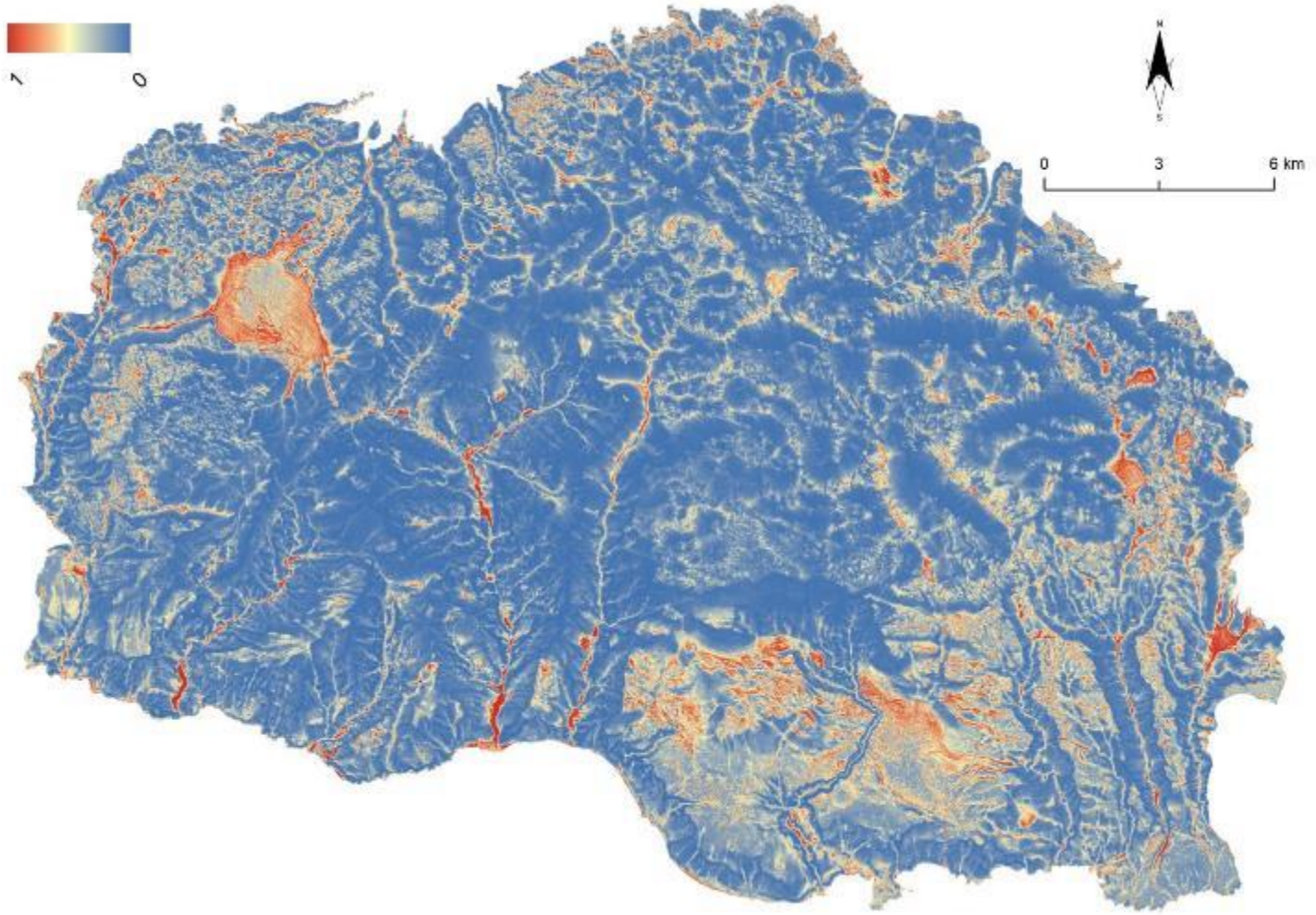
› Provide at the end the R code - you can read it and understand it

› And can be shared to experts for corrections, suggestions, etc.

The interface



Some results



AUC > 0.89
TSS > 0.7
Boyce index > 0.81

› Tune up the model for optimization

› Use an ensemble approach by including machine learning algorithms such as Support Vector Machines, Random Forests and Boosted Regression Trees

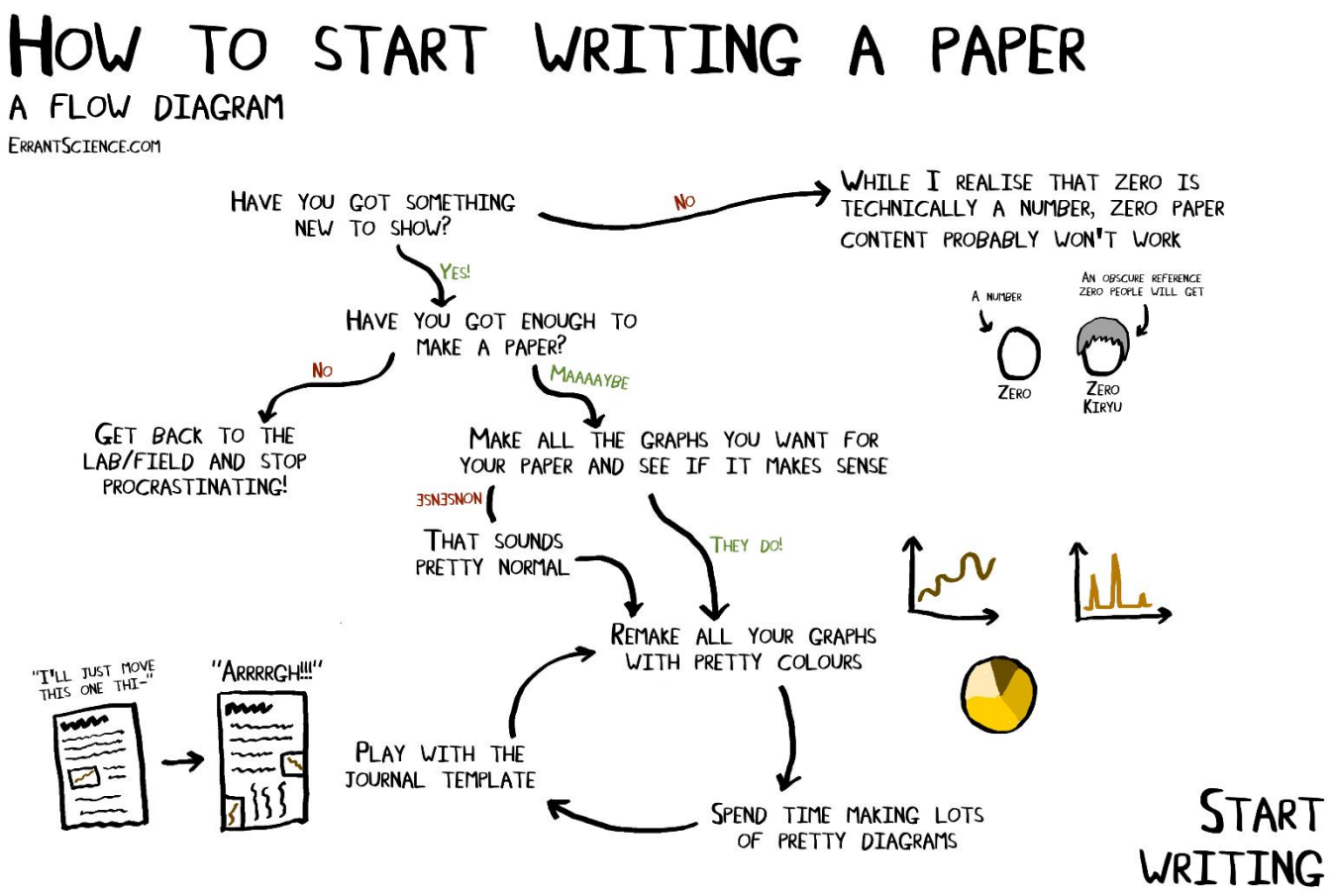
› Add landscape metric - fragmentation indices

› Use model results in connectivity analysis

Use the final results in the conservation plan

of the Cretan lizard

till the end of the project a manuscript will be ready for publication



People involved in this work

- the personnel of the park that provide essential help in the field work
- the students and collaborators that collect the field data
- the Cretan lizard that make us happy
- the experts that judge the model results

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