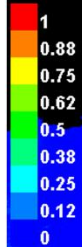


Modeli povoljnosti staništa u istraživanjima flore



izv. prof. Martina Temunović
Zavod za šumarsku genetiku, dendrologiju i botaniku
Sveučilište u Zagrebu, Fakultet šumarstva i drvne tehnologije

Ecological niche modeling (ENM)

Species distribution modeling (SDM)

Habitat suitability modeling

and many other minor variants

Koncept i teorija ekoloških niša

Za razmišljanje ...

- Zašto ima toliko vrsta?
- Gdje dolazi neka vrsta?
- Zašto su neke vrste češće od ostalih?
- Kako se vrste odnose međusobno/ u kakvim su interakcijama?
- Kako okoliš ograničava vrste?

Ekološki čimbenici

fizikalne, kemijske ili biološke varijable koje mogu pozitivno ili negativno djelovati na životne funkcije, rast, razmnožavanje i gustoću populacije i na koje se organizam mora prilagoditi da bi preživio

Biotički

Neutralizam 0/0

Kompeticija -/-

Amenzalizam -/0

Mutualizam +/+

Parazitizam +/-

Predatorstvo +/-

Komenzalizam +/0

Abiotički

Temperatura

Vlaga

Svjetlost




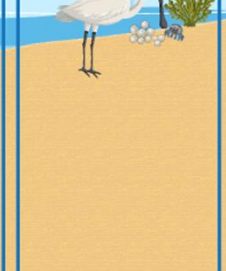

Tlak zraka

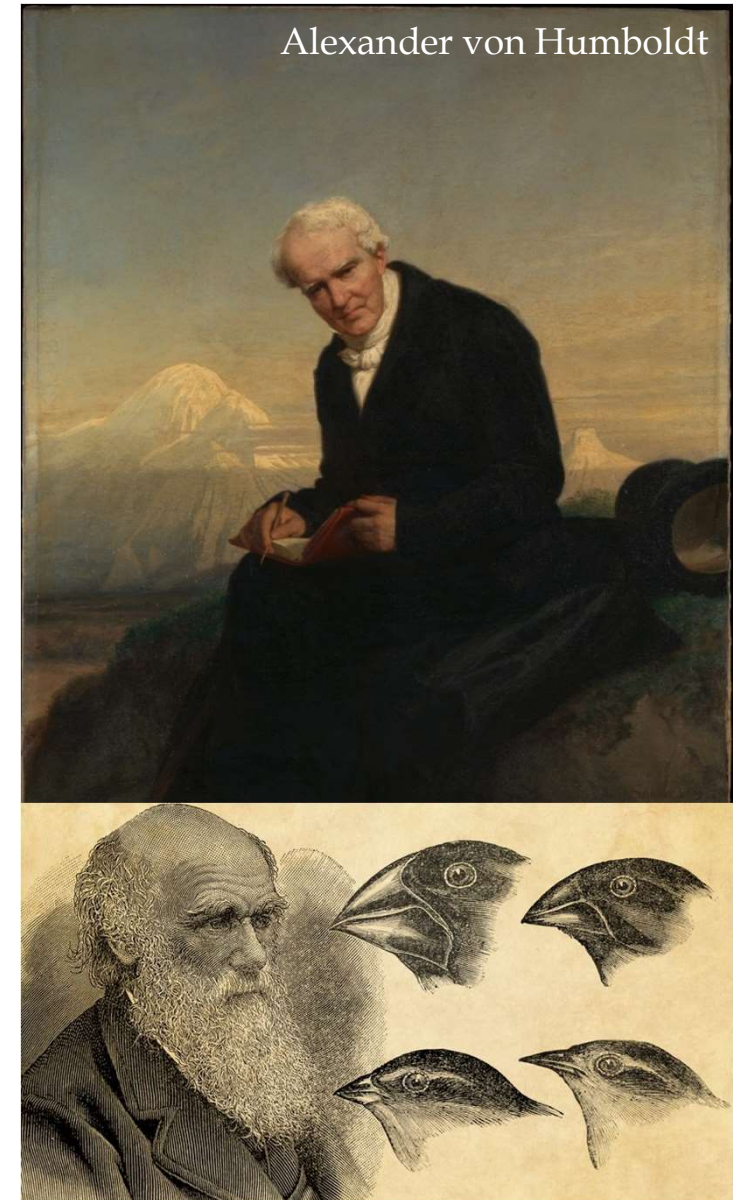
Salinitet

Reljef

- Rani biogeografi (Von Humboldt / Darwin) primijetili su da ista vrsta može nastanjivati lokacije s različitim uvjetima okoliša, pri čemu svaka pojedina kombinacija predstavlja različito stanište, i tako zauzimati niz različitih staništa
- ipak, većina vrsta ima **ograničenu geografsku distribuciju** hmm



Flamingos	Ducks	Avocets	Oyster catchers	Plovers
Flamingos feed on small molluscs, crustaceans, and vegetable matter strained from mud pumped through their bills by their powerful tongues	Dabbling ducks feed by tipping, tail up, to reach aquatic plants, seeds, snails, and insects	Avocets feed on insects, small marine invertebrates, and seeds by sweeping their bills from side to side in shallow water.	Oystercatchers pry open bivalve shells with their knife like bills and probe sand for worms and crabs.	Plovers dart around on beaches and grasslands hunting for insects and small
				

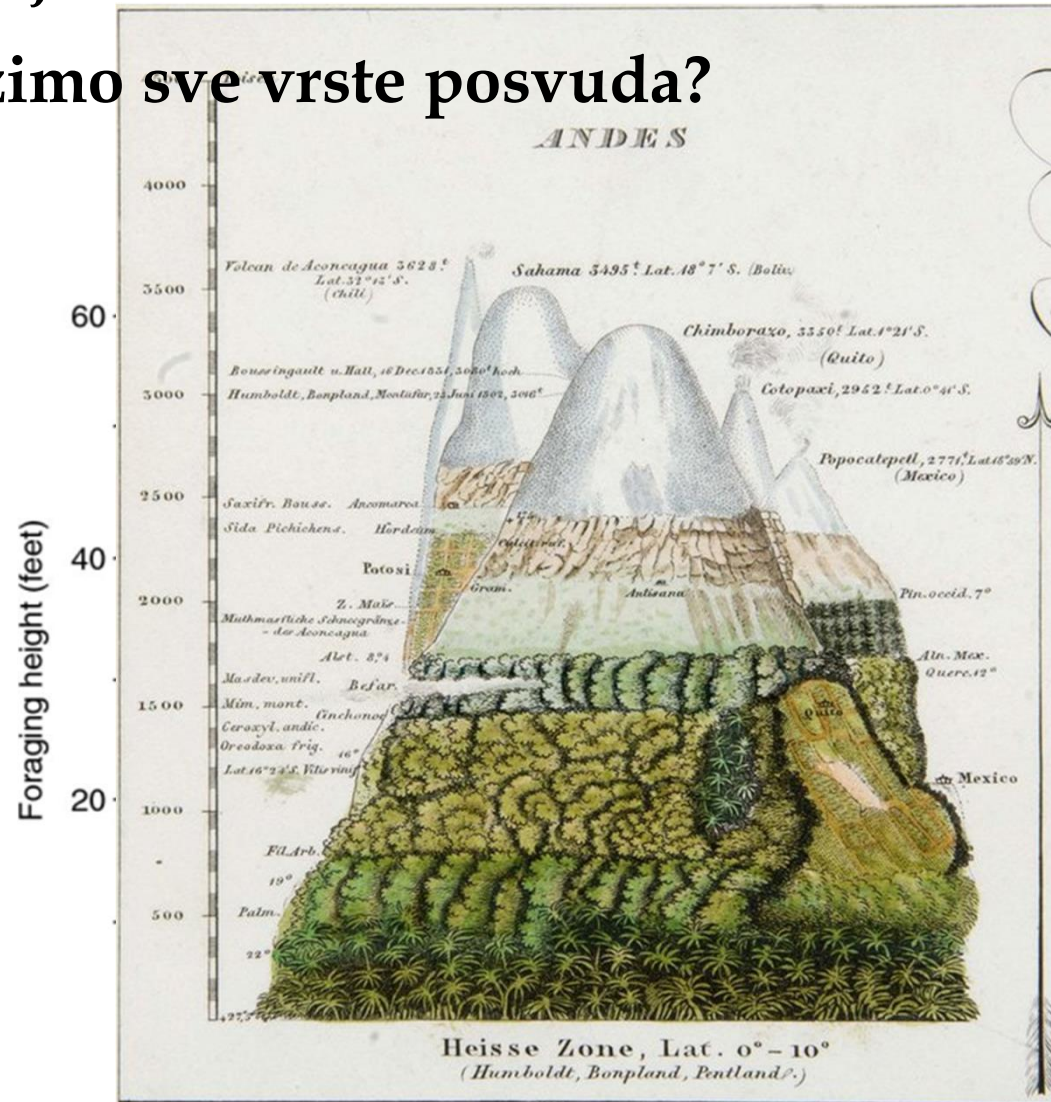


Alexander von Humboldt

- Zašto je tome tako?

- Zašto ne nalazimo sve vrste posvuda?

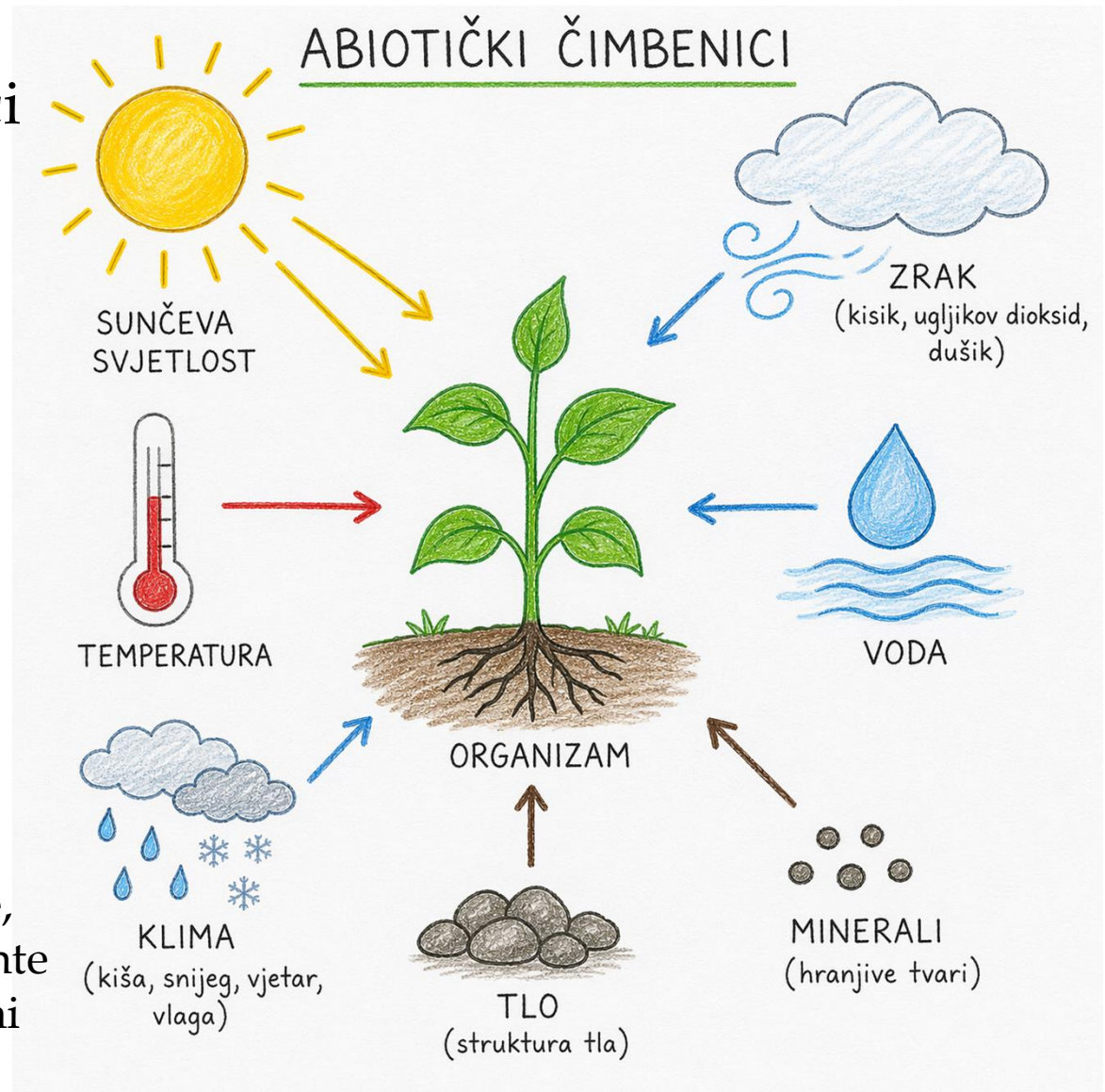
- vrsta zauzima samo ograničeni geografski i ekološki raspon gdje su ispunjeni svi specifični uvjeti
- u većini slučajeva taj raspon zauzima samo dio svih mogućih okolišnih uvjeta



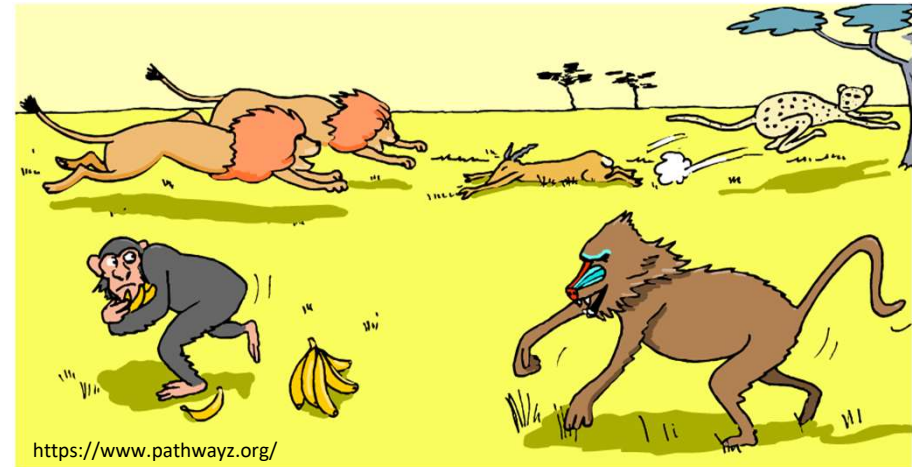
Kako **abiotički** čimbenici utječu na distribuciju organizama ?

Kako više čimbenika/ varijabli zajedno određuje geografsku distribuciju vrste?

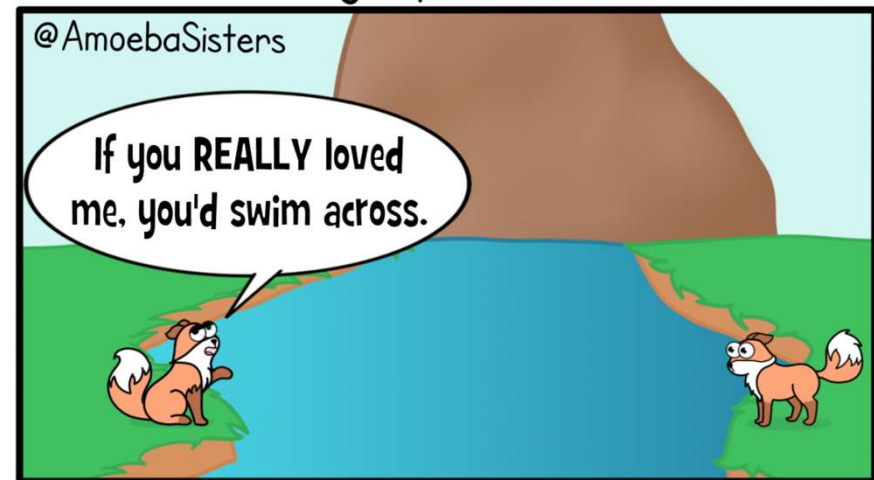
- uključuju klimatske, pedološke, fizikalne, kemijske... komponente ekološkog sustava + drugi razni neživi ekološki čimbenici



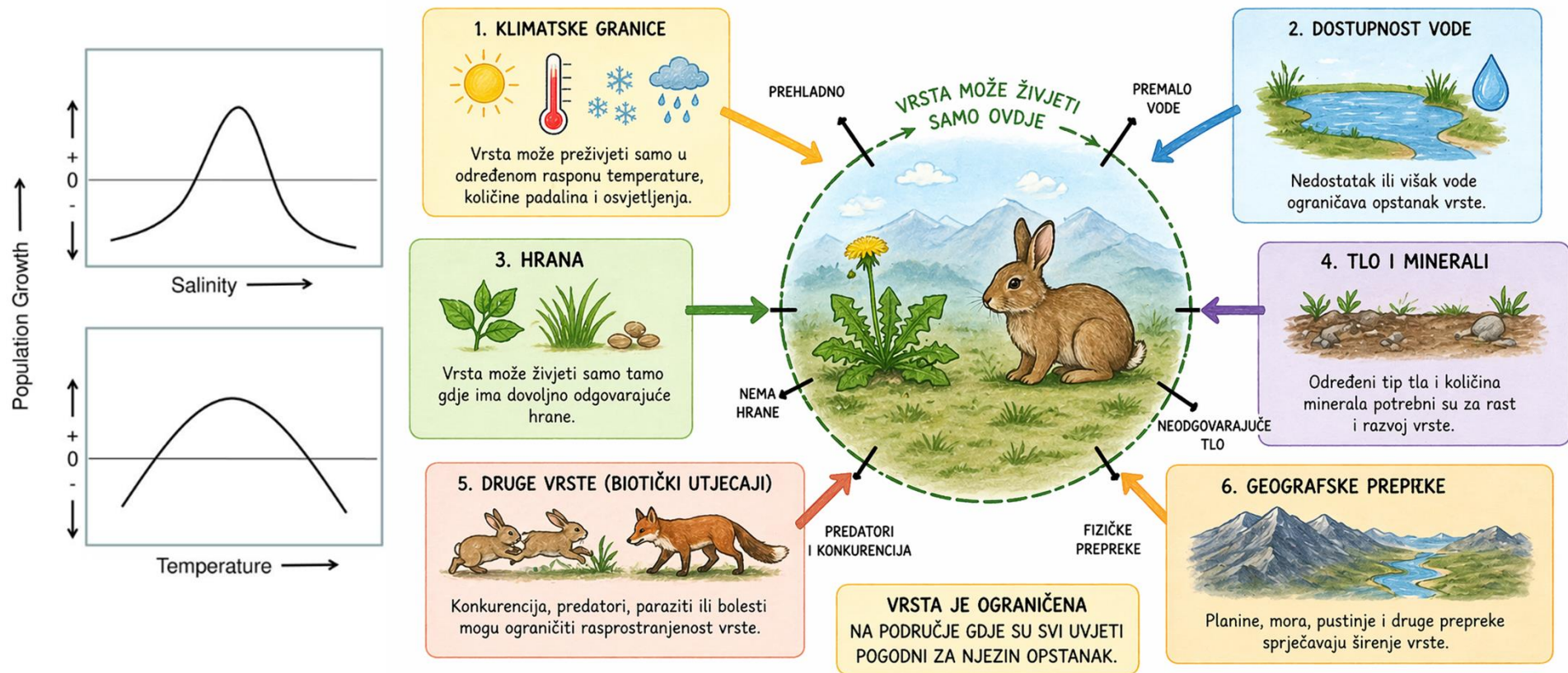
- **Ekološke specifičnosti** - svaka vrsta ima svoje jedinstvene ekološke potrebe - ne može preživjeti ili reproducirati se u svim okolišnim uvjetima
- **Konkurencija:** može ograničiti rasprostranjenost vrsta jer se ne mogu sve vrste uspješno natjecati sa svim drugima
- **Barijere za disperziju:** fizičke prepreke (oceani, planine ili pustinje) mogu ograničiti širenje vrsta izvan određenih geografskih područja



Geographic Isolation

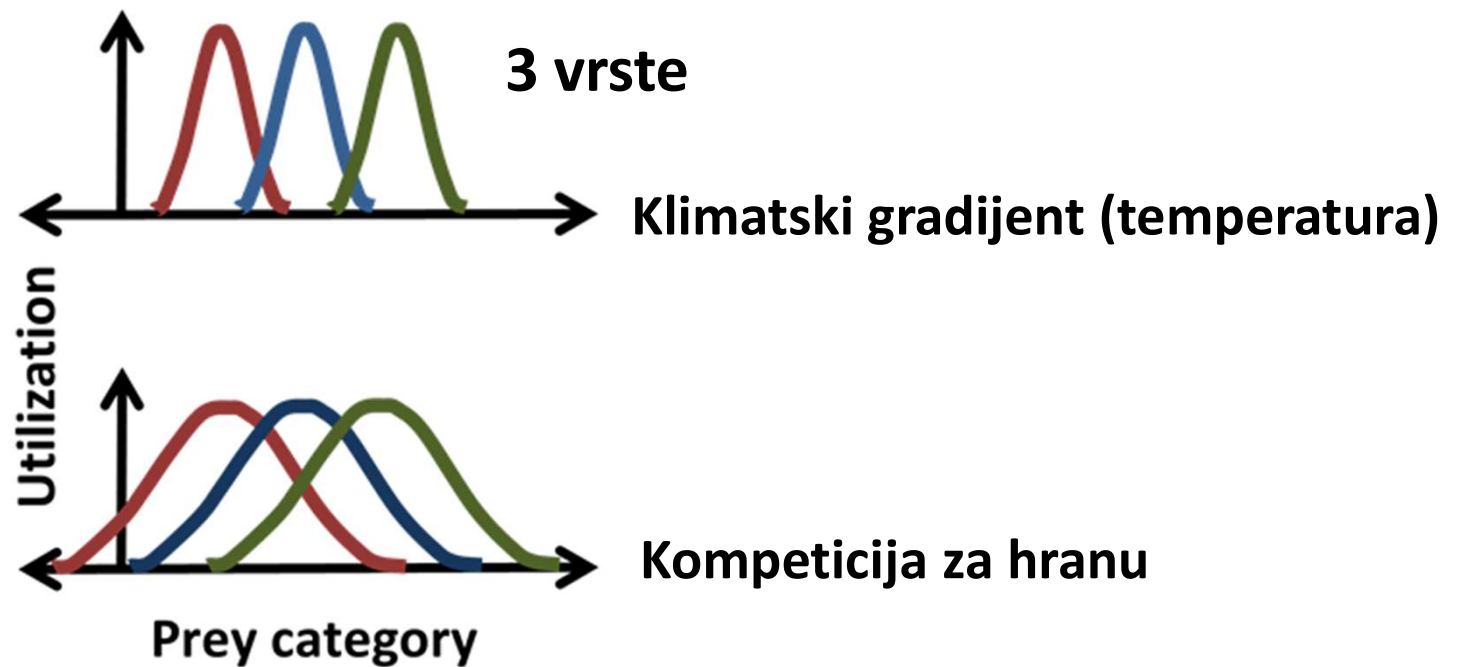


- sve ove čimbenike treba uzeti u obzir kako bismo razumjeli zašto sve vrste nisu prisutne svugdje i zašto imaju ograničene geografske distribucije

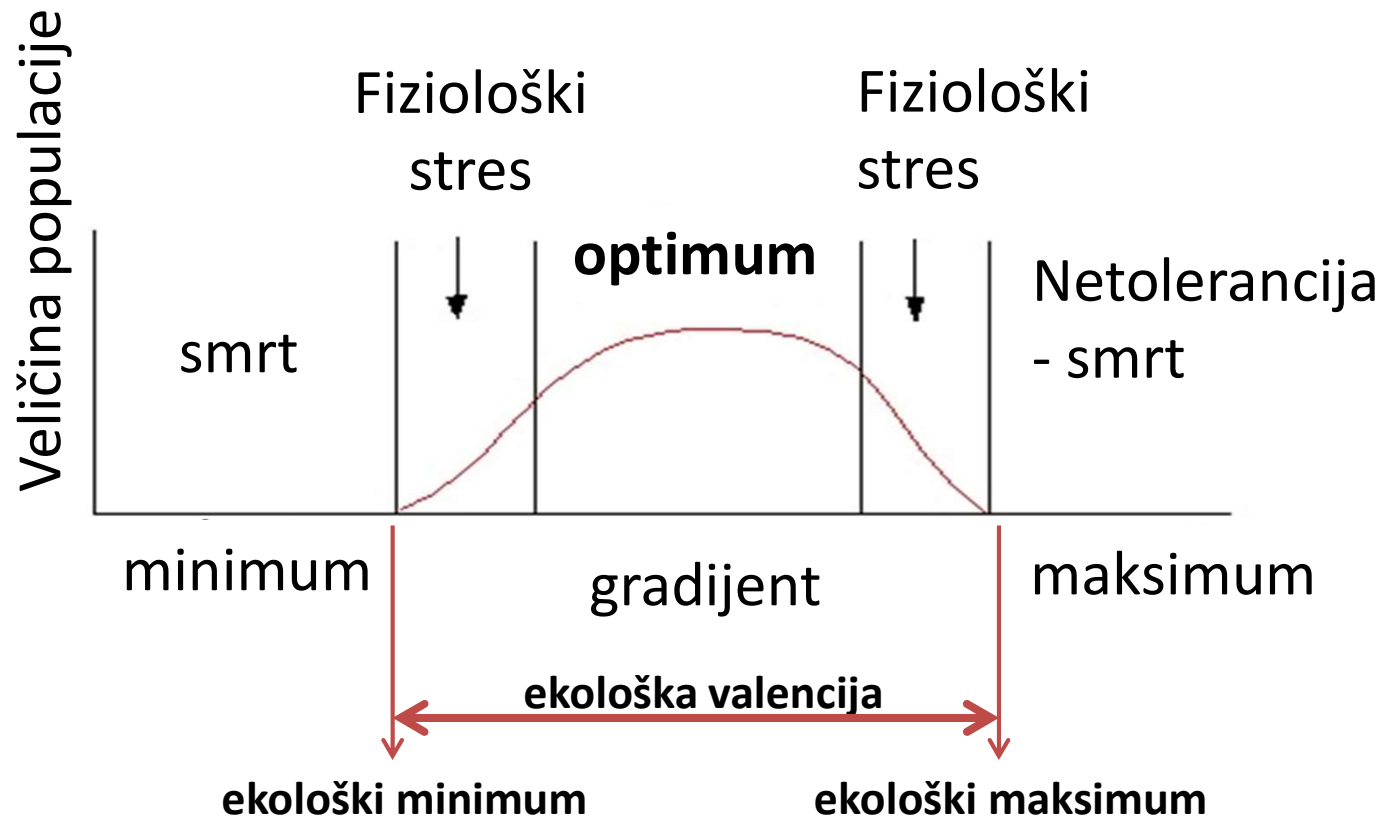


Odgovor vrste na ekološke čimbenike - gradijent

- Gradijent okoliša – os
- Distribucija vrste – raspon duž osi

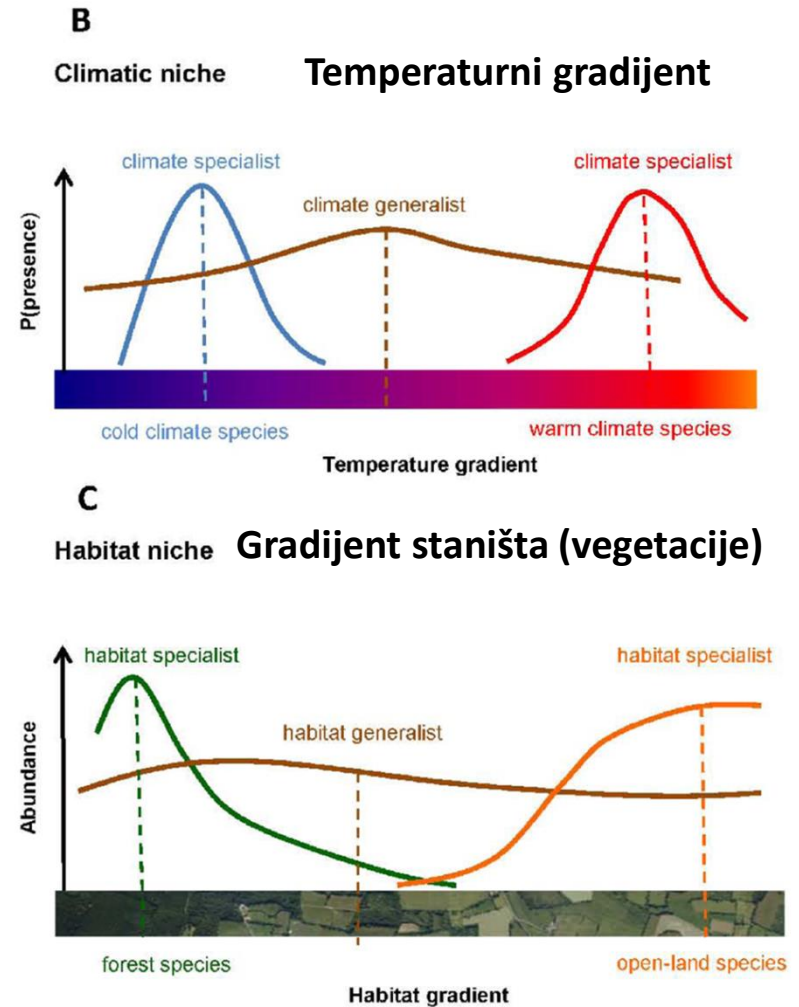
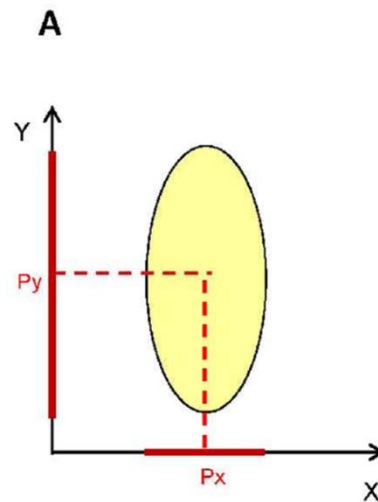


Odgovor vrste na ekološke čimbenike - gradijent



Odgovor vrste na ekološke čimbenike

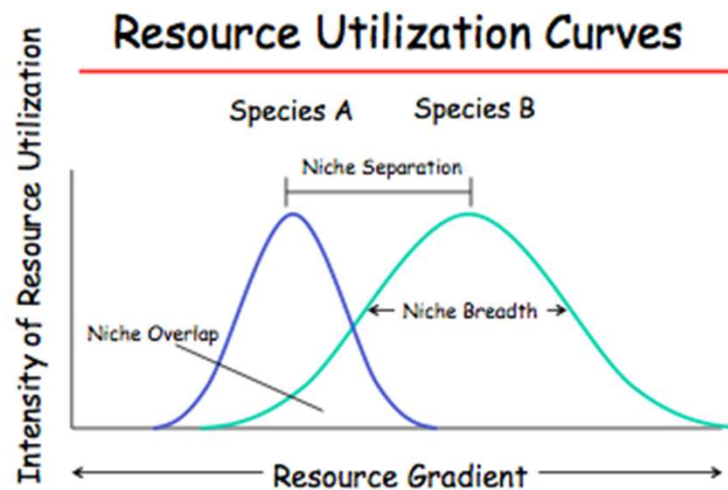
- temperatura, padaline, nadmorska visina, vlaga tla, pH, salinitet, ...



Širina ekološke niše (ekološke valencija)

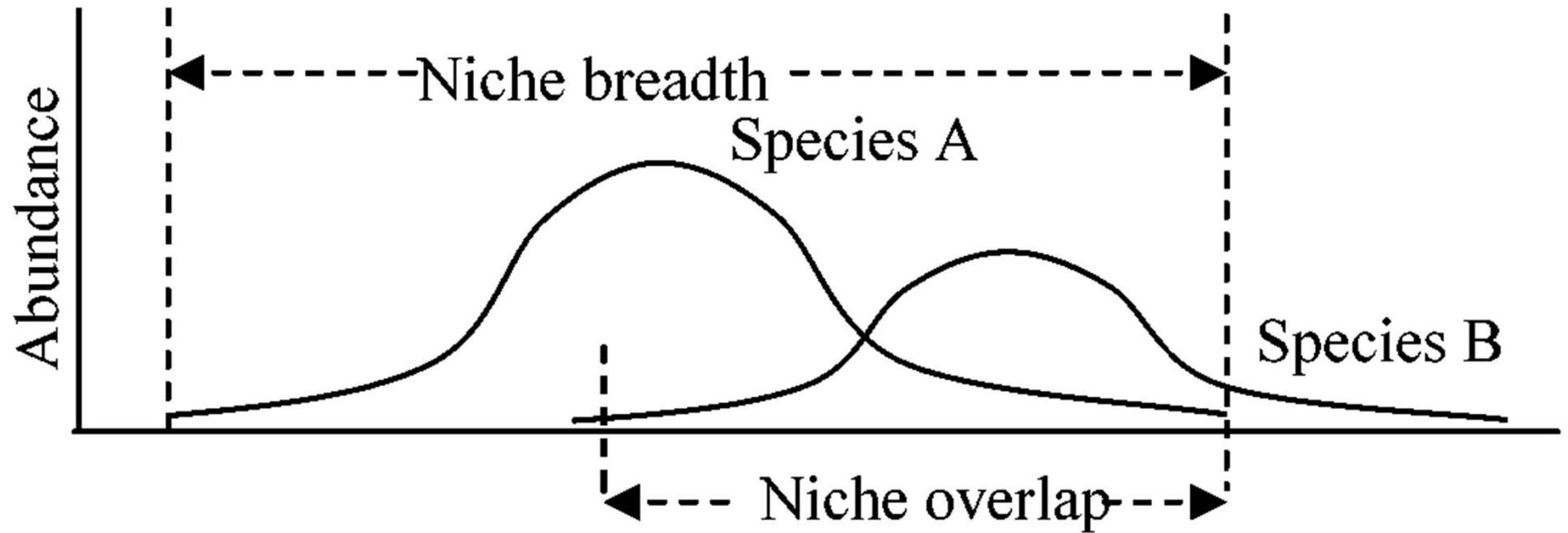
- ✓ Eurivalentne vrste - široke ekološke valencije
- ✓ Stenovalentne vrste - uske ekološke valencije

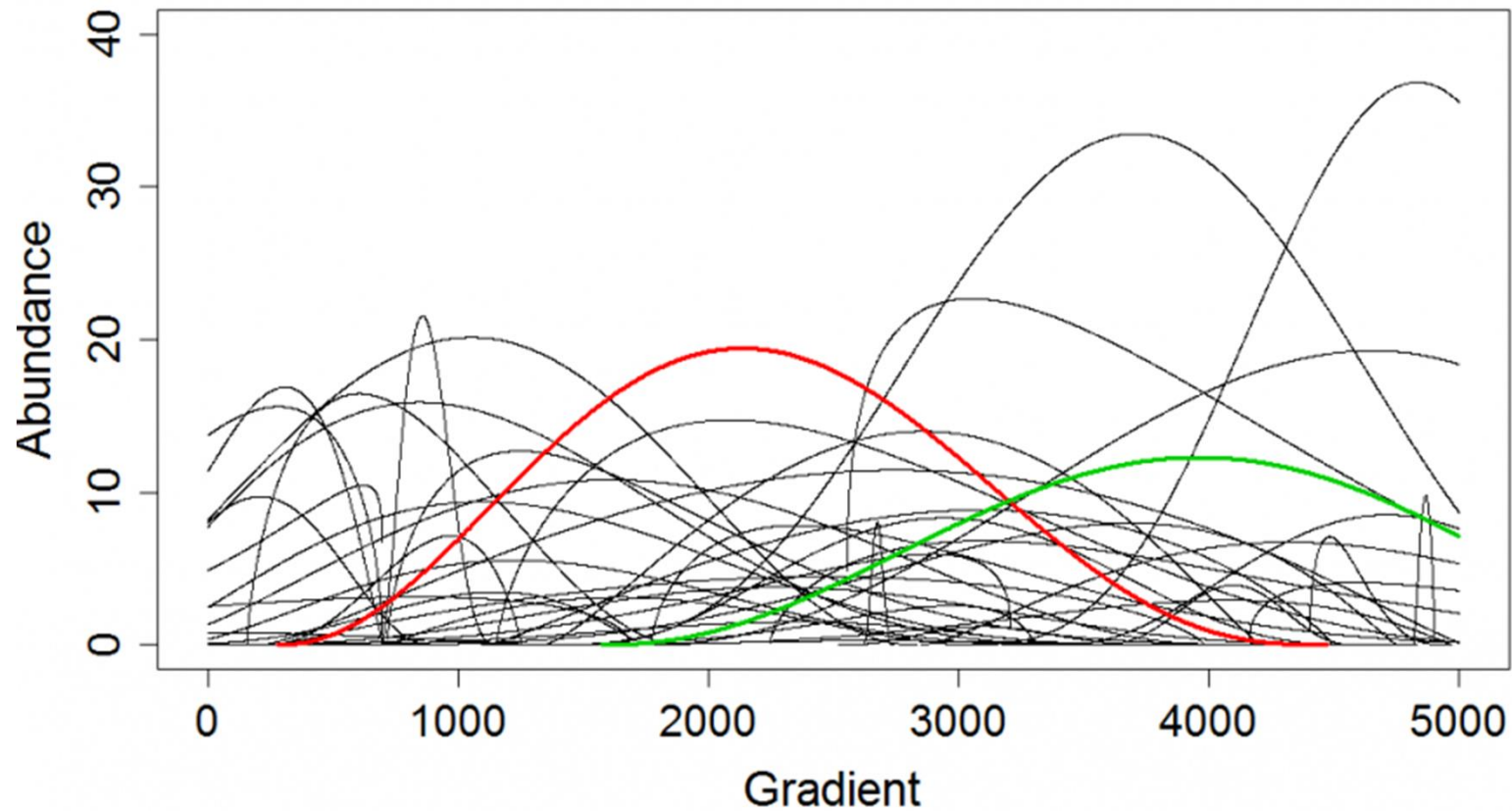
SPECIJALIZACIJA – smanjenje širine ekološke niše



Species A has a narrow niche breadth and is a **specialist**
Species B has a wide niche breadth and is a **generalist**

Širina ekološke niše (ekološke valencija)



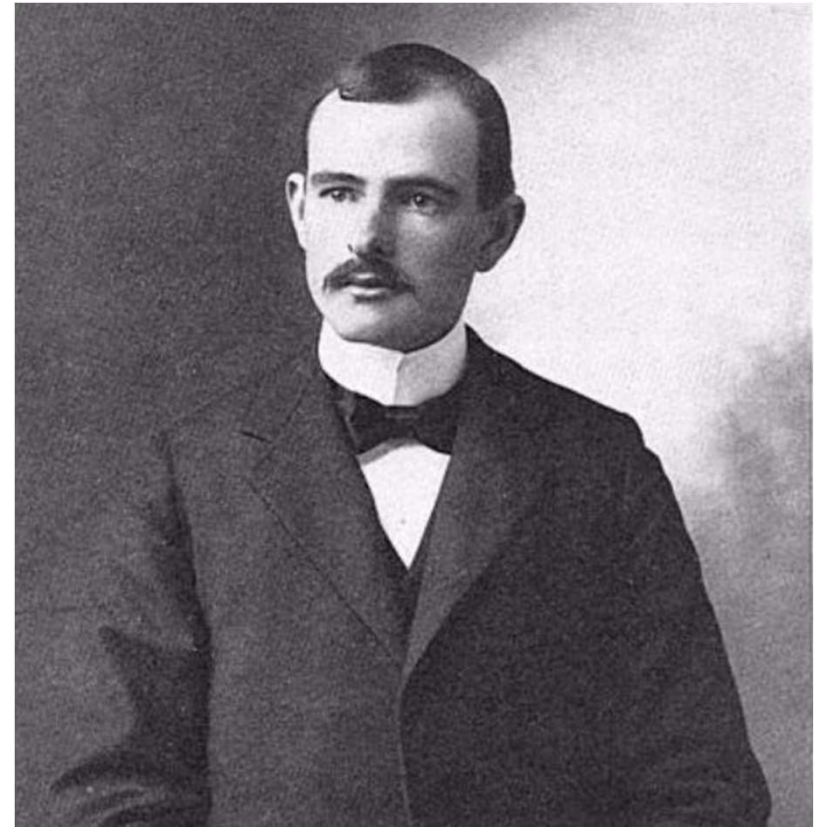


- Koliko osi/dimenzija možemo imati? ... n

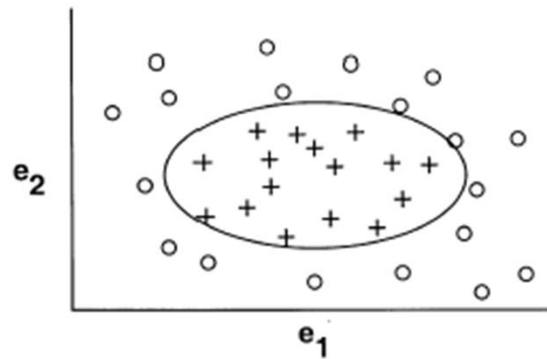
- Kada se promatra učinak svake okolišne varijable neovisno, može se propustiti identificiranje zajedničkog učinka (interakcija) nekih od ovih varijabli, pri čemu jedna može umanjivati ili pojačavati učinak druge

- Stoga bi sve važne varijable trebale biti zajedno uzete u obzir u analizi kako bi se definiralo ono što se naziva **ekološkim nišama vrsta**

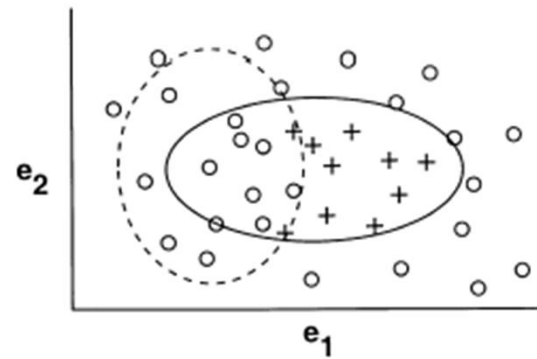
- izraz koji je prvotno skovao **Grinnell (1917)**



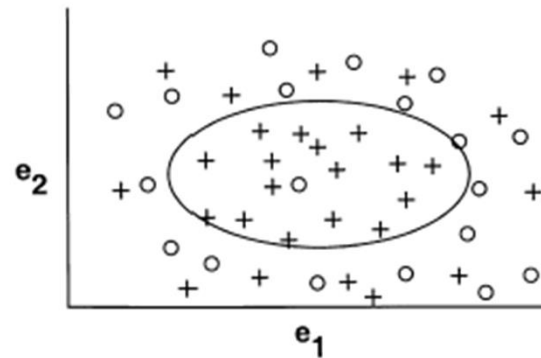
Koncept i Teorija ekološke niše



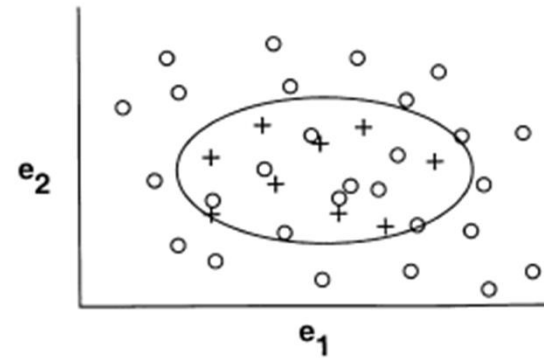
A. Grinnellian Niche



B. Hutchinsonian Realized Niche

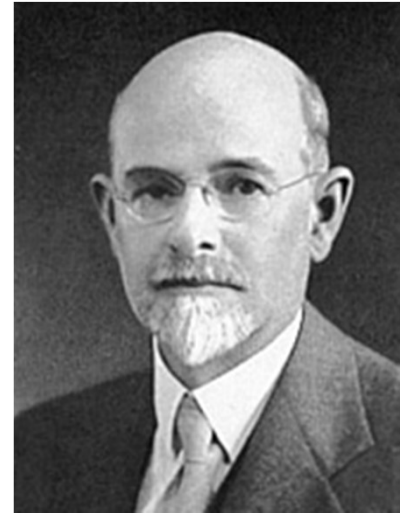


C. Source-Sink Dynamics



D. Dispersal Limitation

Koncept ekološke niše



Grinnell (1917)

definira ekološku nišu kao mjesto koje određena vrsta zauzima na nekom staništu

odn. kao skup/raspon ekoloških čimbenika u kojima neka vrsta može opstati i stvarati potomstvo

**Grinnellan niche
(abiotic)**



Eltonian niche (functional)

1927 Charles Sutherland Elton, a British ecologist, defined a niche as follows:

„The 'niche' of an animal means its place in the **biotic** environment, its relations to food and enemies,,

Pojam 'niše' vrste označava njezino mjesto u **biotskom** okolišu i njezine odnose prema hrani i neprijateljima (**funkcija u zajednici**)

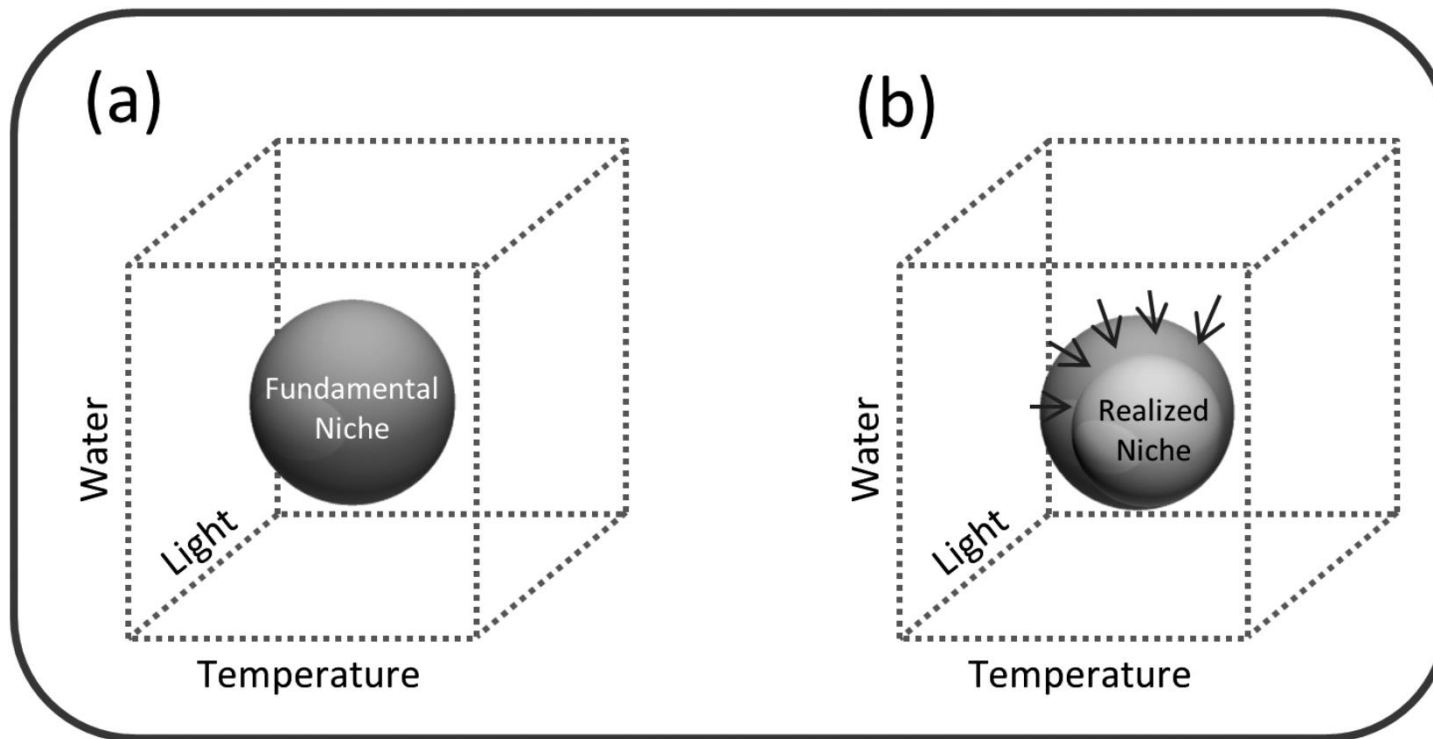
fundamentalna vs. realizirana niša



Hutchinson (1957) uvodi dva nova termina:

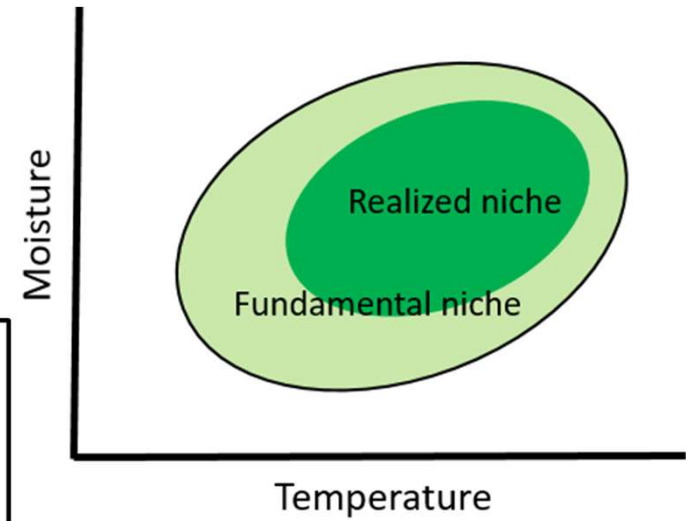
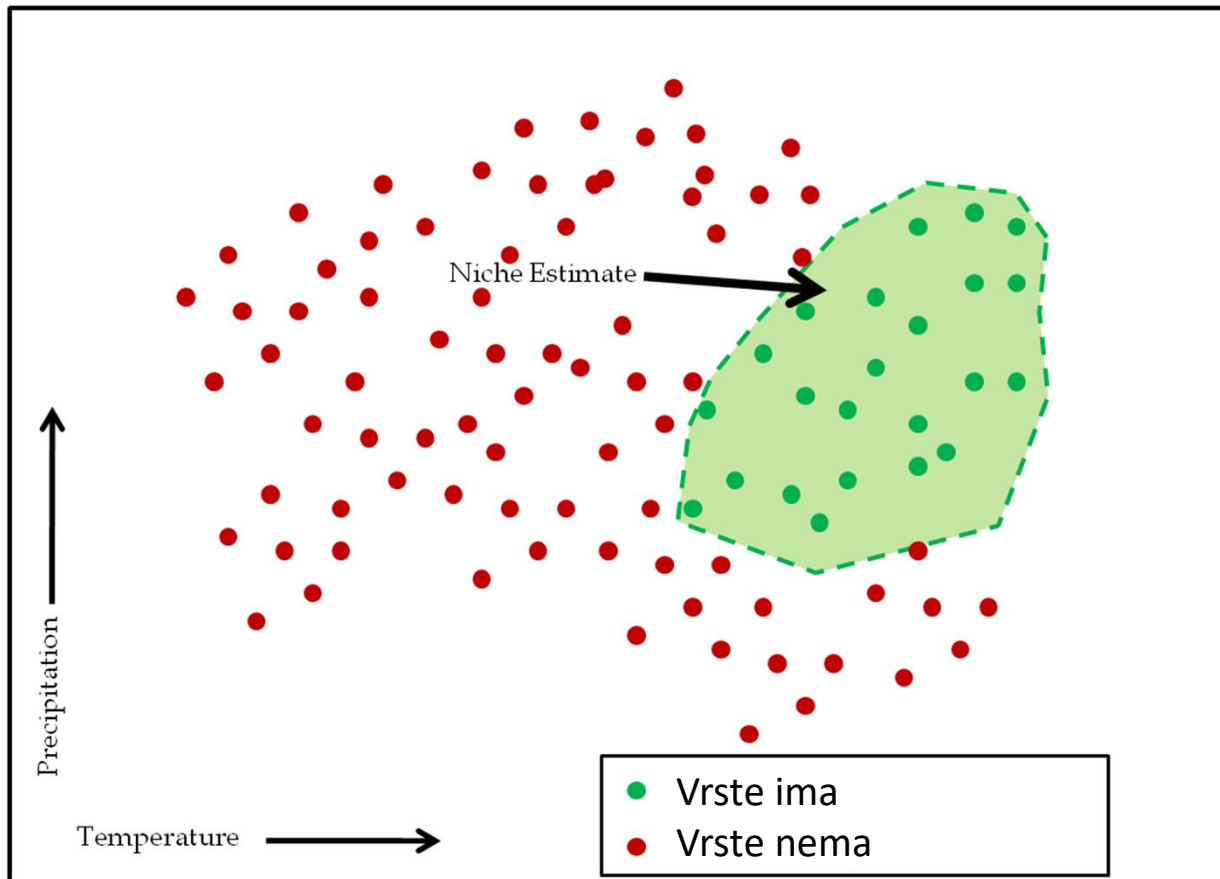
- **Fundamentalna (temeljna) niša** - „*n-dimensional hypervolume*“
 - cjelovit raspon okolišnih uvjeta (**biotički i abiotički**) pod kojima neki organizam može postojati
 - stanje okoliša u kojem bi neka populacija mogla egzistirati neograničeno dugo vremena (**bez biotičkih interakcija**)
- **Realizirana niša**
 - manji dio fundamentalne niše kao rezultat mnogobrojnih pritisaka i interakcija s drugim organizmima (**biotički čimbenici** : kompeticija, ...)

fundamentalna vs. realizirana niša

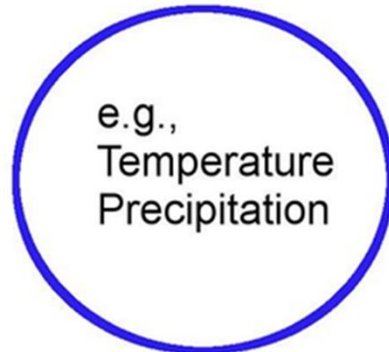


$n > 3$ dimensions = n- dimensional hypervolume

fundamentalna vs. realizirana niša



Grinnellian niche



e.g.,
Temperature
Precipitation

Abiotic

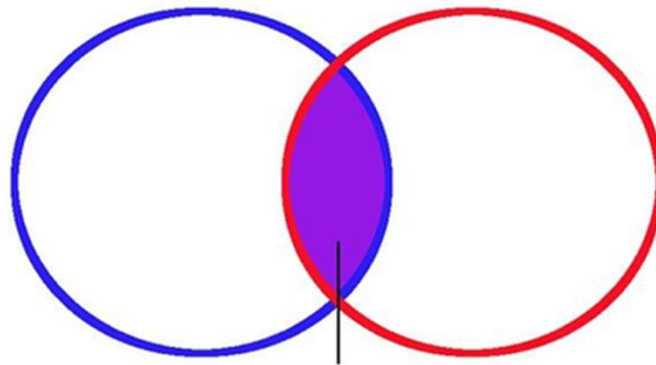
Eltonian niche



e.g.,
Depredation
Parasitism

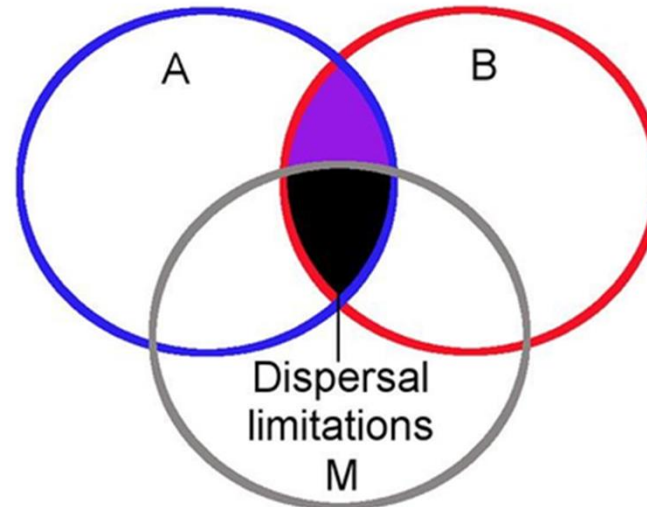
Biotic

Hutchinsonian niche



Biotic interactions limit
the use of Abiotic

Soberón and Peterson framework

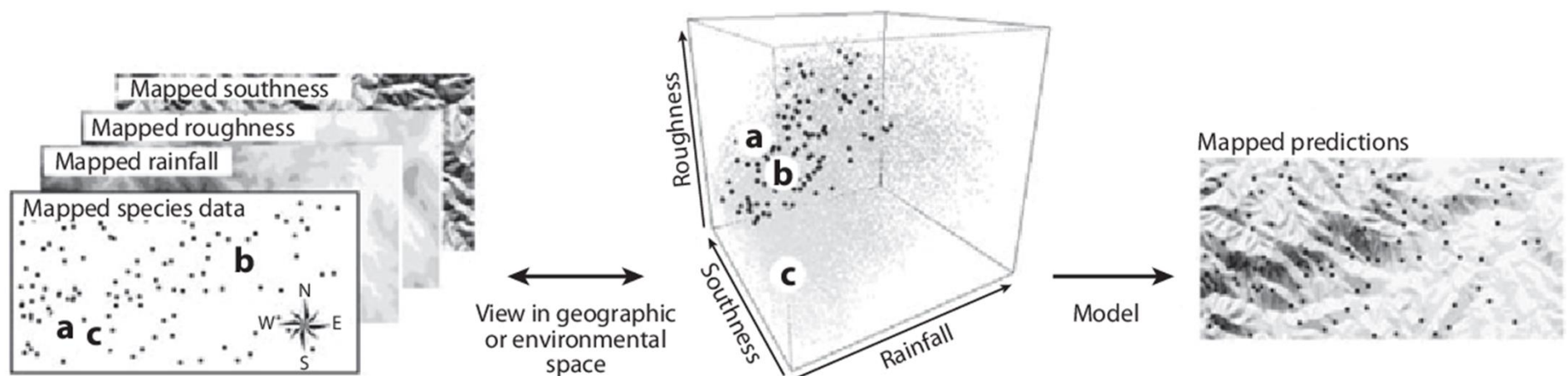


Dispersal
limitations
M

Movement

„Geografski prostor“ i "okolišni prostor"

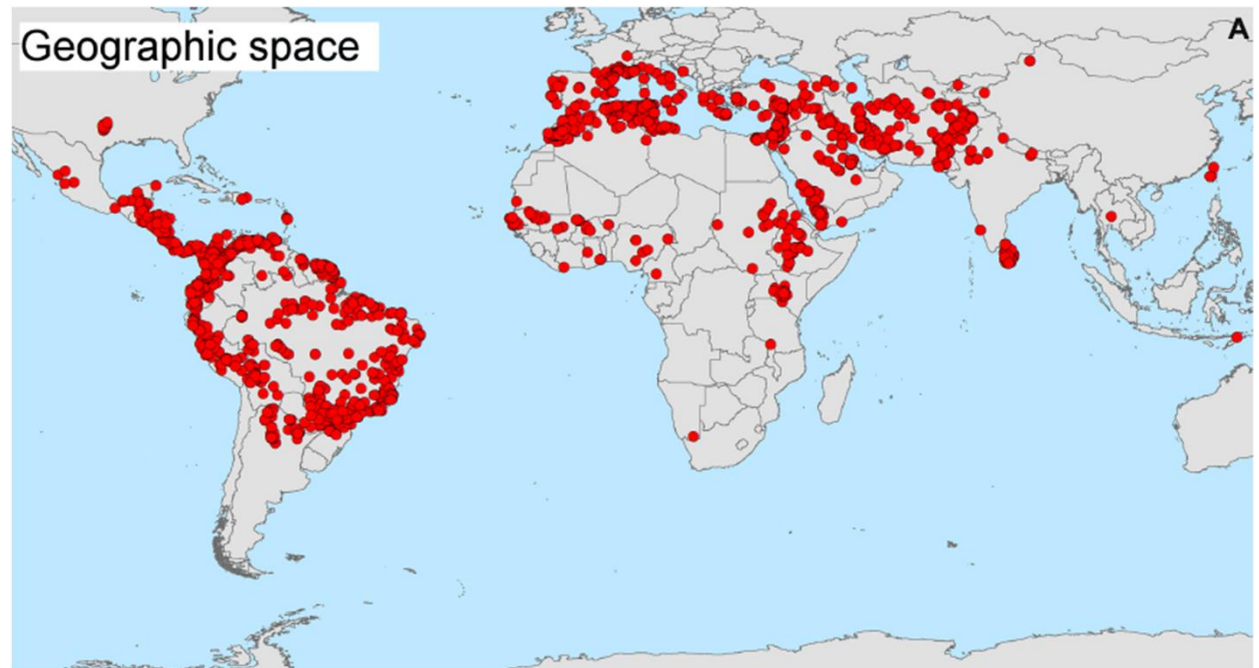
- dva različita koncepta koja se koriste u ekologiji i biogeografiji kako bi se razumjela distribucija organizama



Geografski prostor

- Ovaj prostor se odnosi na stvarnu **fizičku površinu planeta Zemlje**
- prostor koji se može kartirati i odnosi se na geografske koordinate, topografiju, geološke karakteristike, klimu i sve ostale fizičke aspekte okoliša

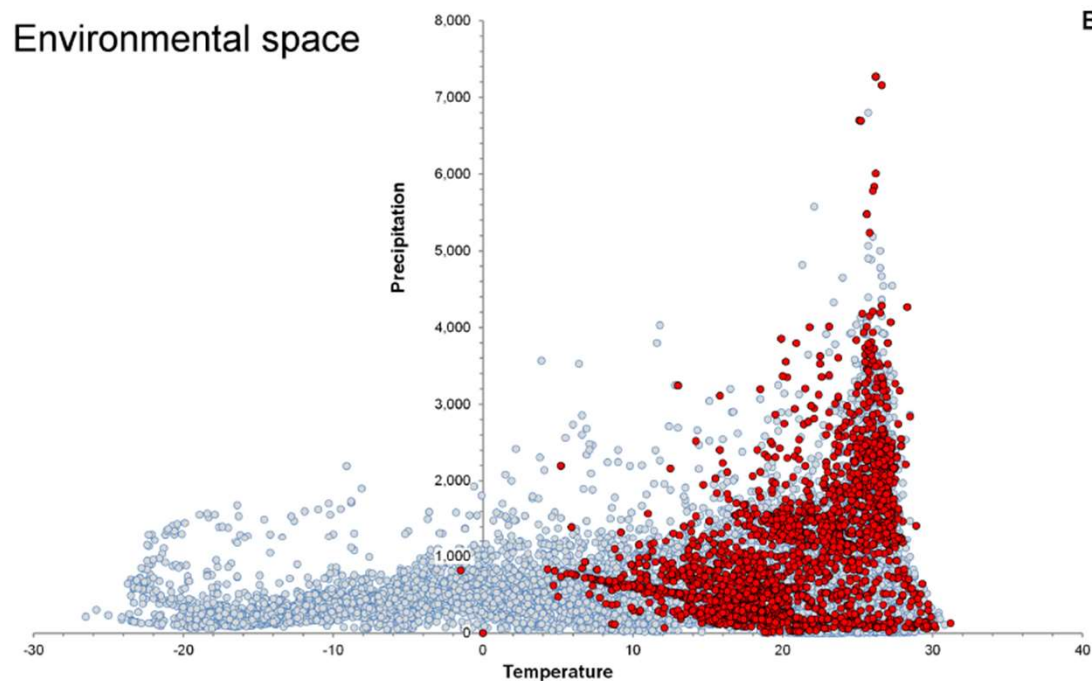
Rasprostranjenost
vrsta prikazana
na karti.

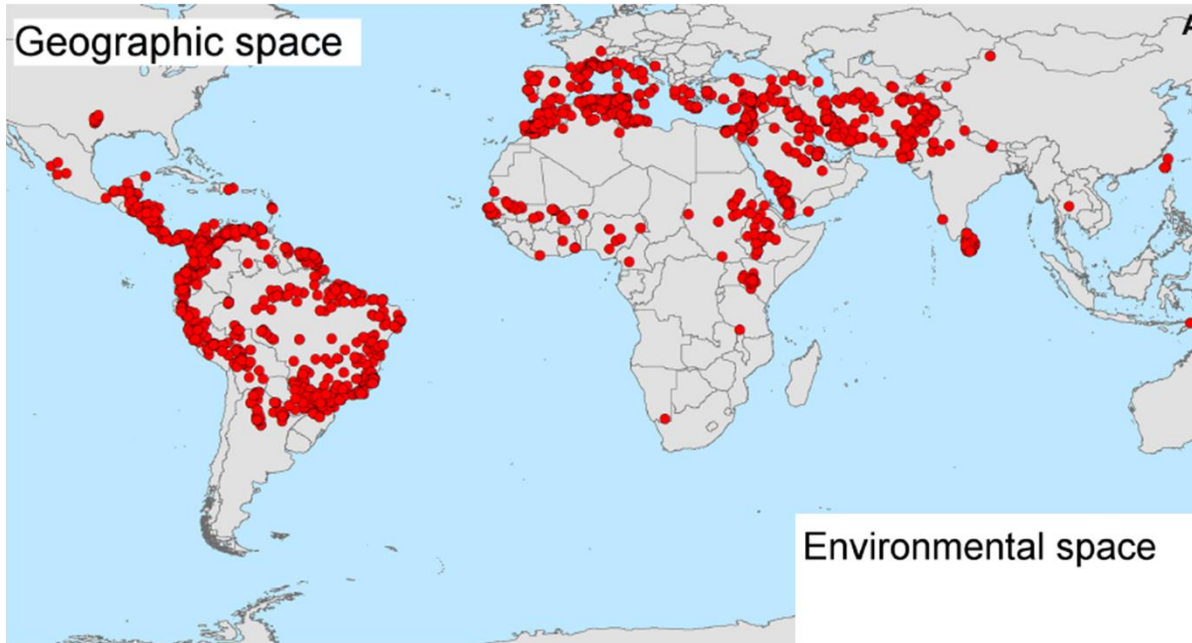


Okolišni / Ekološki prostor

- odnosi se na ekološke uvjete i faktore u okolišu koji utječu na organizme
- temperatura, vlažnost, raspoloživost hrane, konkurencija s drugim organizmima i drugi ekološki faktori koji utječu na sposobnost organizma da prežive i reproduciraju se

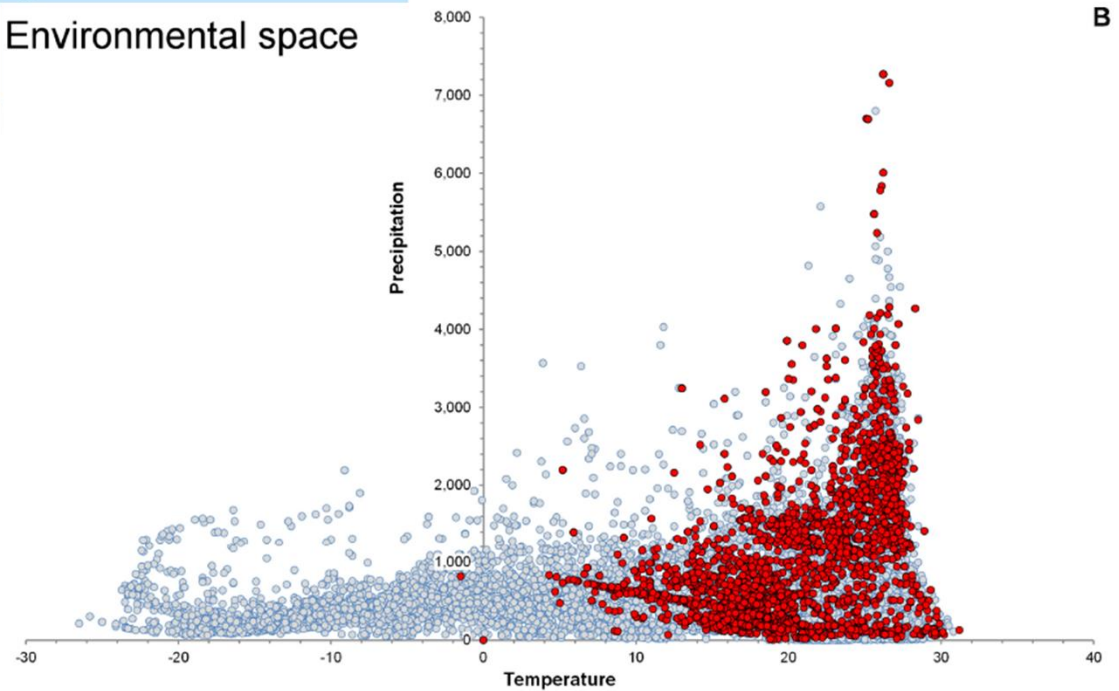
apstraktan koncept i
često se koristi za
modeliranje kako bi se
razumjeli obrasci
distribucije
organizama



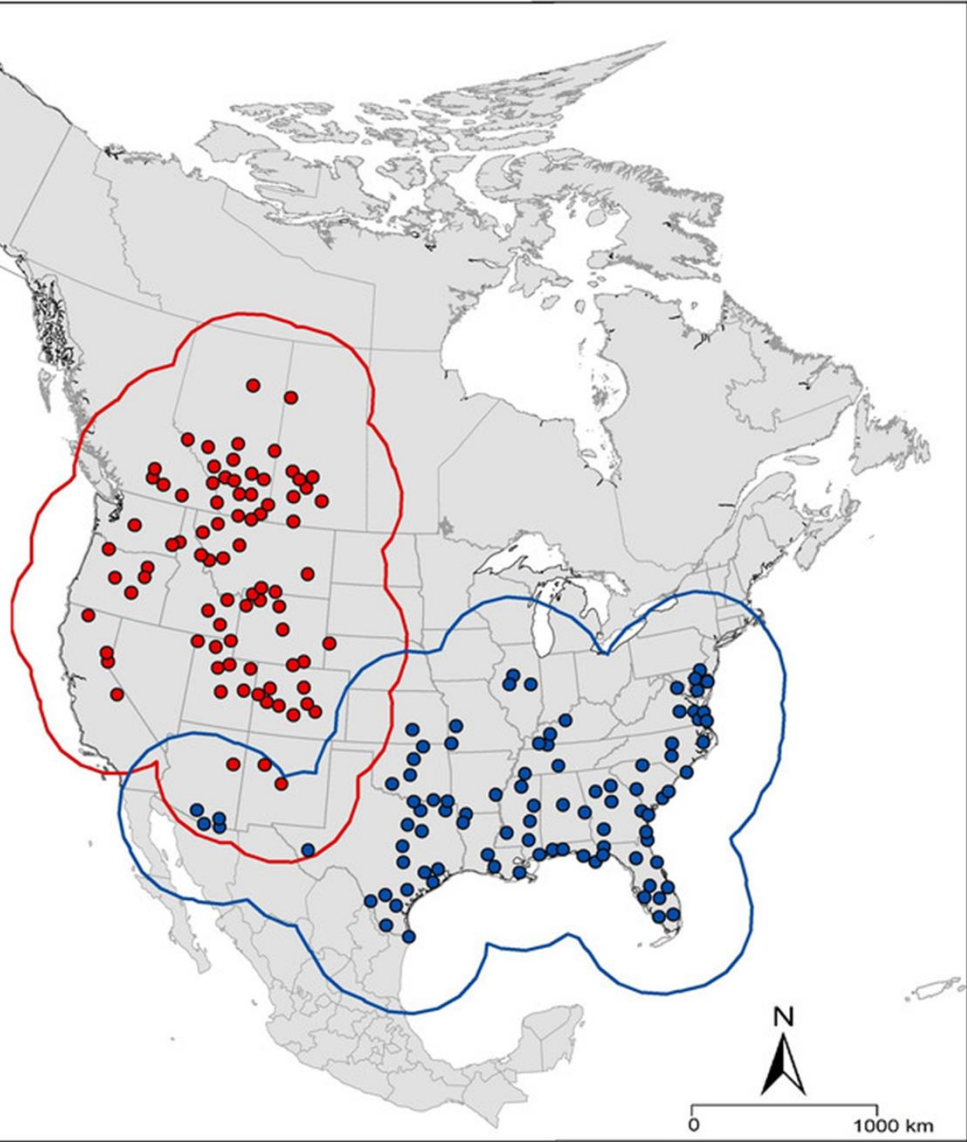
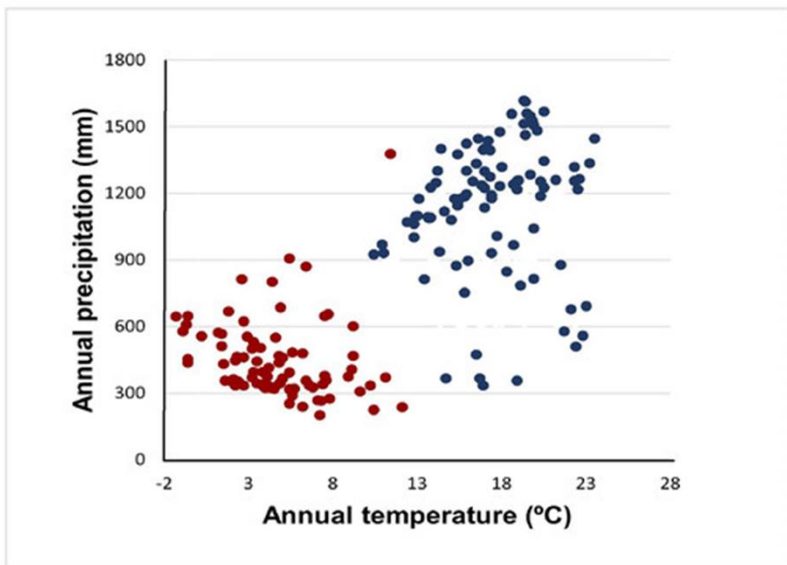


✓ to understand species' distribution models it is important to think about species occurring in environmental space

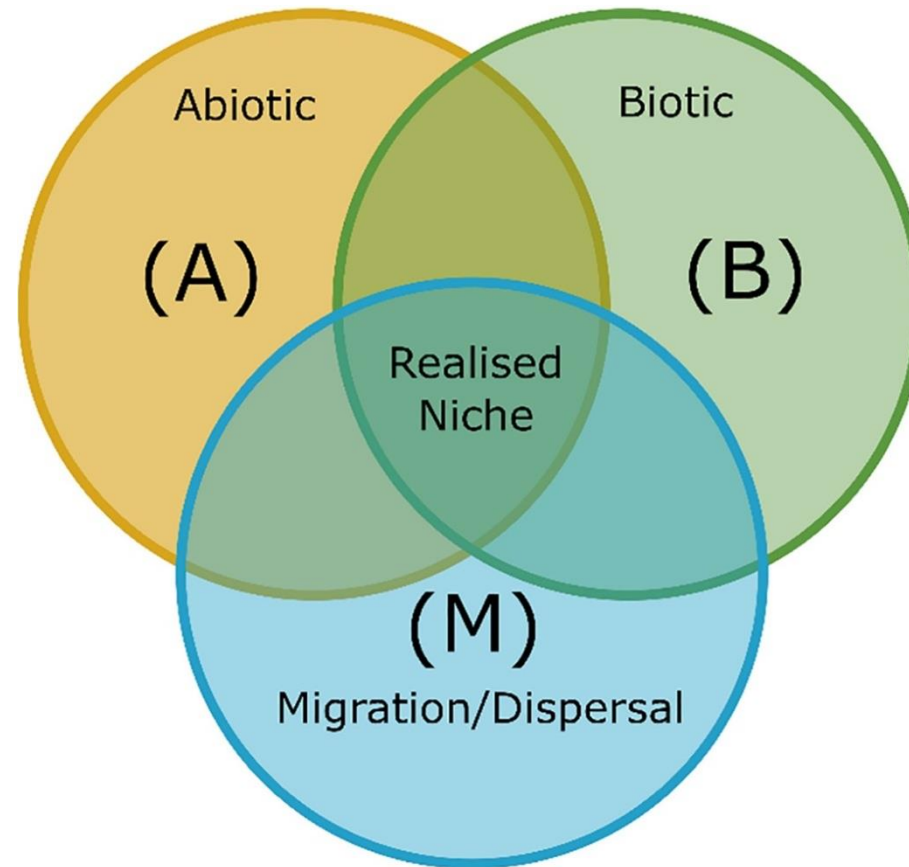
✓ okolišni prostor definiraju osi n-dimenzionalnog hiperprostora



- *Dermacentor andersoni*
- *Amblyomma maculatum*



The “BAM” Framework



**IDEA AND
PERSPECTIVE**

Grinnellian and Eltonian niches and geographic distributions of species

Jorge Soberón*

*Biodiversity Research Center
and Museum of Natural History,
University of Kansas Dyche Hall,
1345 Jayhawk Blvd, Lawrence,
KS 66045, USA*

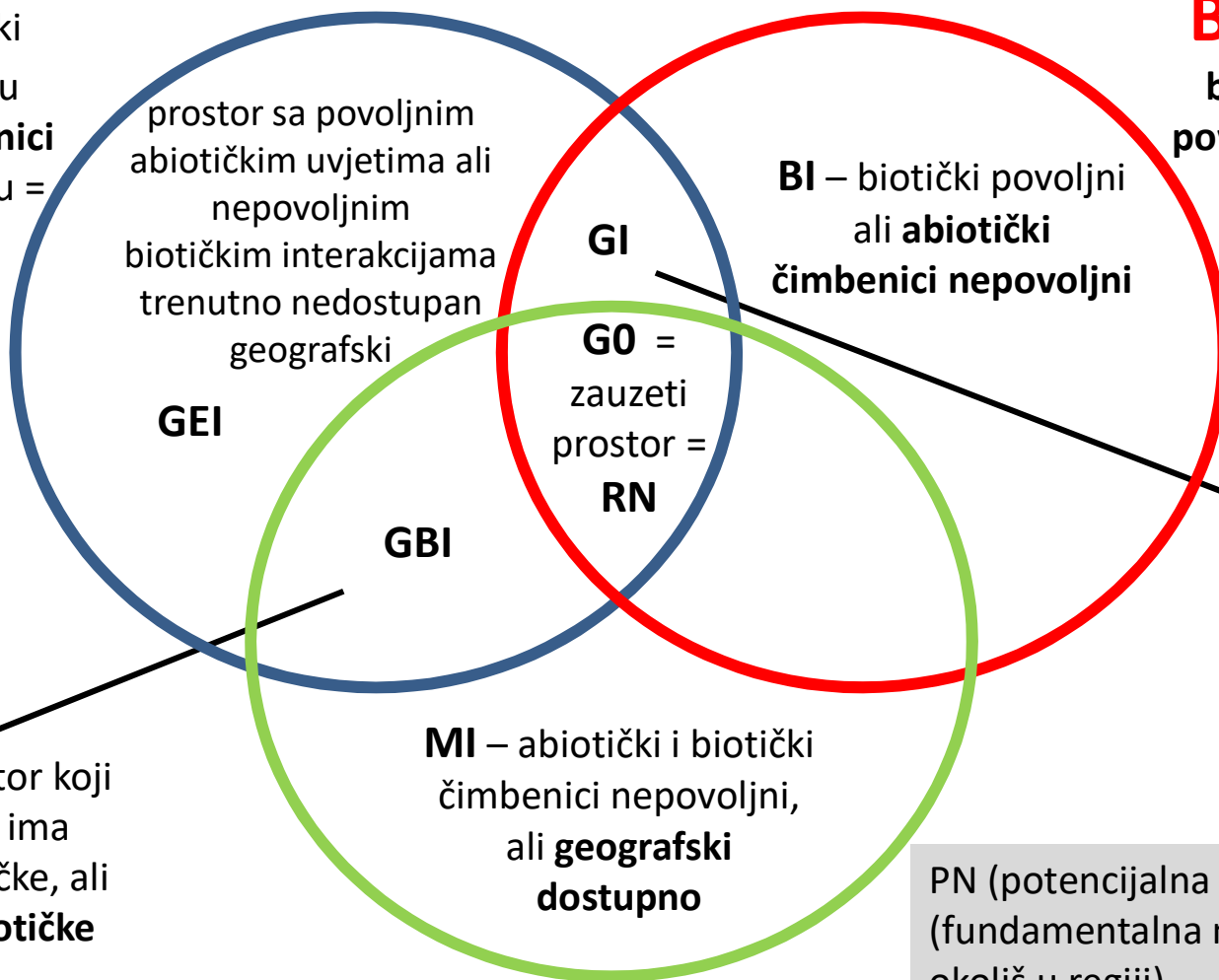
**Correspondence: E-mail:
jsoberon@ku.edu*

Abstract

In the recent past, availability of large data sets of species presences has increased by orders of magnitude. This, together with developments in geographical information systems and statistical methods, has enabled scientists to calculate, for thousands of species, the environmental conditions of their distributional areas. The profiles thus obtained are obviously related to niche concepts in the Grinnell tradition, and separated from those in Elton's tradition. I argue that it is useful to define Grinnellian and Eltonian niches on the basis of the types of variables used to calculate them, the natural spatial scale at which they can be measured, and the dispersal of the individuals over the environment. I use set theory notation and analogies derived from population ecology theory to obtain formal definitions of areas of distribution and several types of niches. This brings clarity to several practical and fundamental questions in macroecology and biogeography.

A – geografski prostor gdje su **abiotički čimbenici** povoljni za vrstu = **PN**

B – prostor gdje su **biotički čimbenici** povoljni za život vrste



prostor sa povoljnim abiotičkim uvjetima ali nepovoljnim biotičkim interakcijama trenutno nedostupan geografski

BI – biotički povoljni ali **abiotički čimbenici nepovoljni**

GI
GO =
zauzeti
prostor =
RN

geografski prostor koji ima povoljne biotičke i abiotičke uvjete ali nije zauzet
 $GI = A \cap B$ bez M

geografski prostor koji je dostupan i ima povoljne abiotičke, ali **nepovoljne biotičke** uvjete

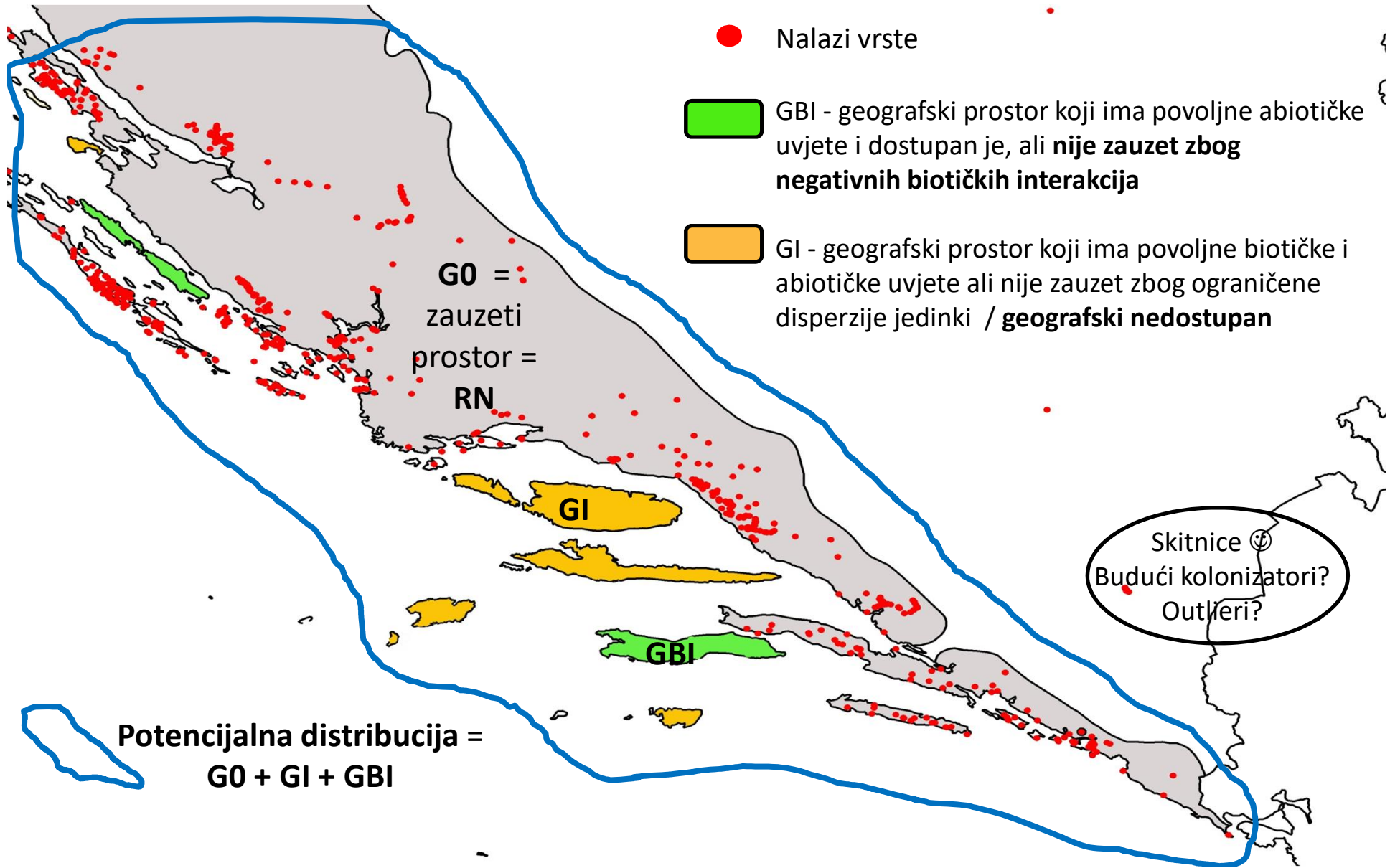
MI – abiotički i biotički čimbenici nepovoljni, ali **geografski dostupno**

PN (potencijalna niša) = FN (fundamentalna niša) \cap E (postojeći okoliš u regiji)

M – geografski prostor koji je dostupan vrsti

Potencijalna distribucija = $GO + GI + GBI$

RN (realizirana niša) = $A \cap B \cap M$



● Nalazi vrste

■ GBI - geografski prostor koji ima povoljne abiotičke uvjete i dostupan je, ali **nije zauzet zbog negativnih biotičkih interakcija**

■ GI - geografski prostor koji ima povoljne biotičke i abiotičke uvjete ali nije zauzet zbog ograničene disperzije jedinki / **geografski nedostupan**

GO =
zauzeti
prostor =
RN

Skitnice ☹️
Budući kolonizatori?
Outlier?

Potencijalna distribucija =
GO + GI + GBI

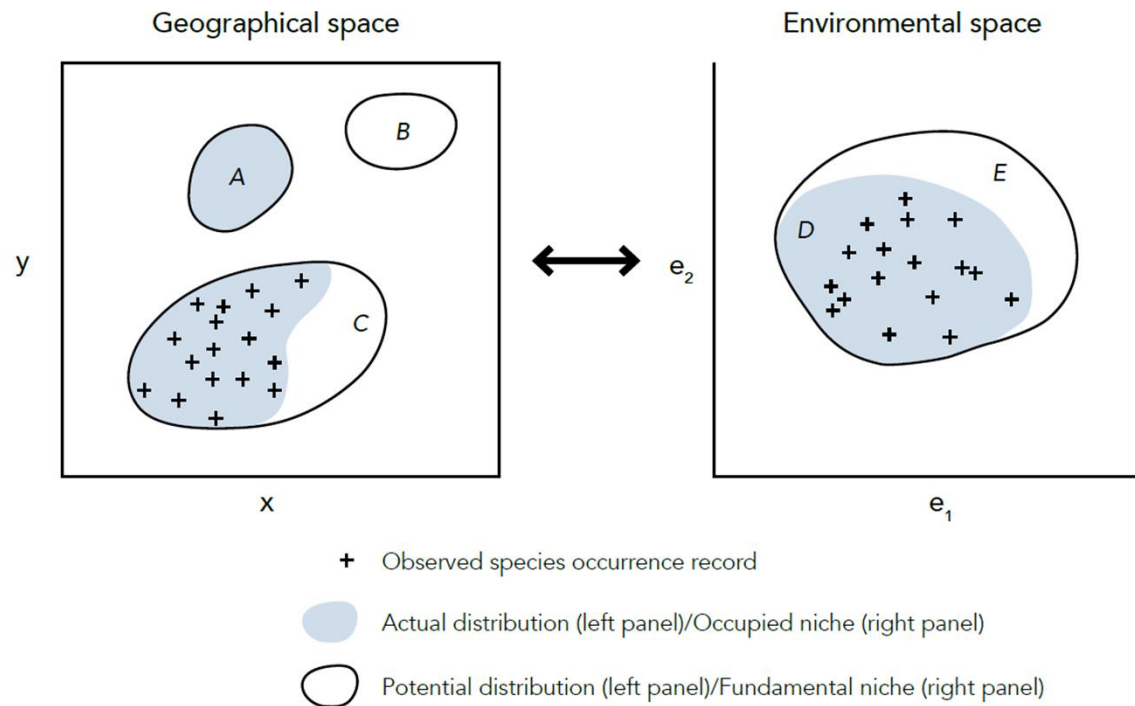
- **Potencijalna niša** se stoga malo razlikuje od Hutchinsonove niše jer je ograničena onime **što je stvarno dostupno vrsti** u određenom području
- „Realizirani okoliš“ opisuje kombinaciju svih postojećih okolišnih uvjeta u istraživanom području (Guisan et al., 2014).
- „Available environment“

Modeli rasprostranjenosti vrsta

- matematički i statistički alati koji predviđaju gdje određena vrsta može živjeti
- temelje se na povezanosti između okolišnih varijabli i poznatih podataka o prisutnosti vrsta
- kako bi se identificirali okolišni uvjeti unutar kojih se populacije mogu održavati....
- **Cilj** ...opisati ekološku nišu vrste i predvidjeti njezinu potencijalnu rasprostranjenost

Modeli rasprostranjenosti vrsta

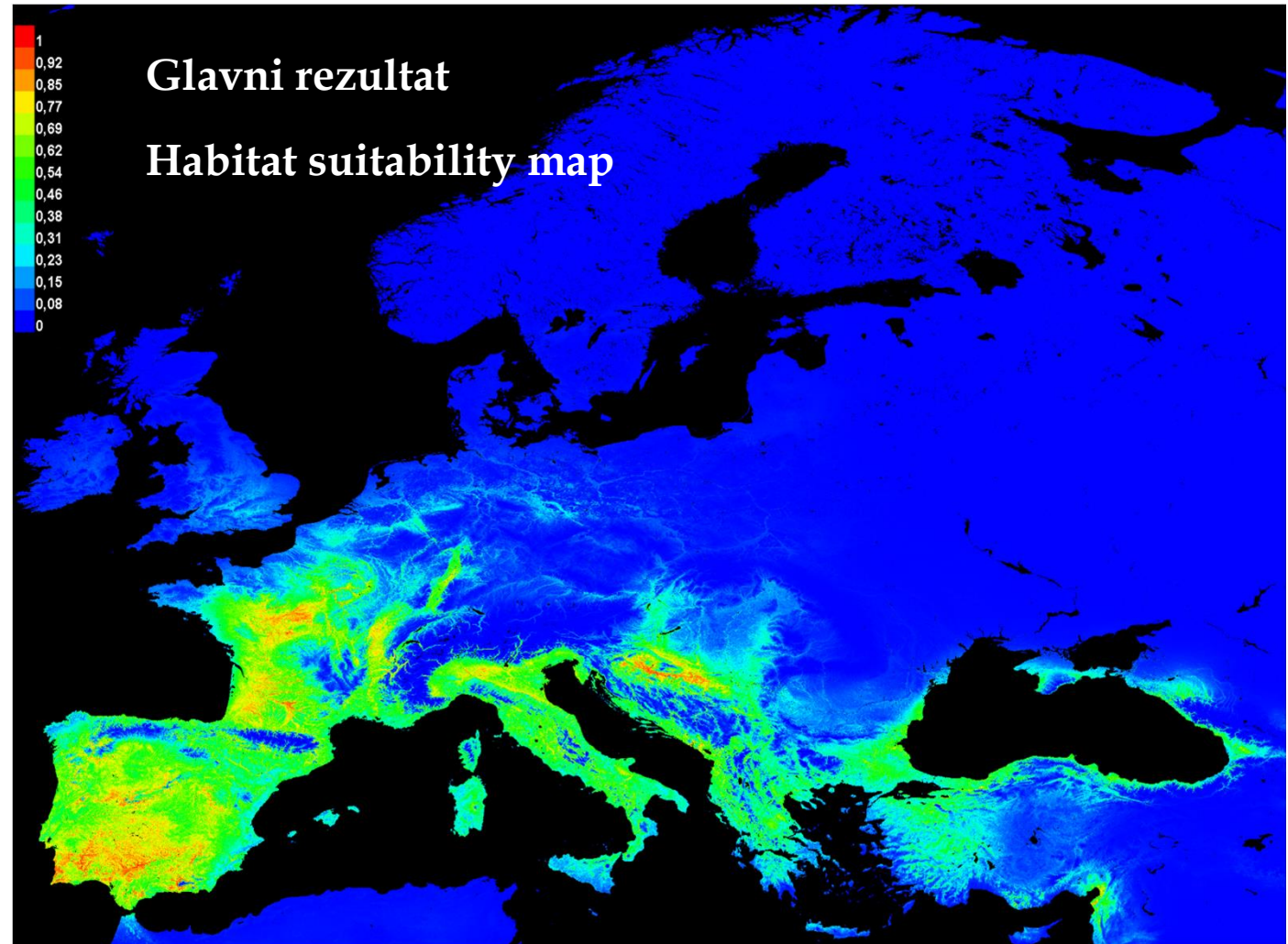
- ✓ temelje se na principu interakcije vrsta-okoliš
- ✓ pomoću poznatih podataka o prisutnosti/ili odsutnosti vrste i niza okolišnih varijabli pokušavamo predvidjeti distribuciju vrste u ekološkom prostoru, te je zatim projicirati u geografski prostor



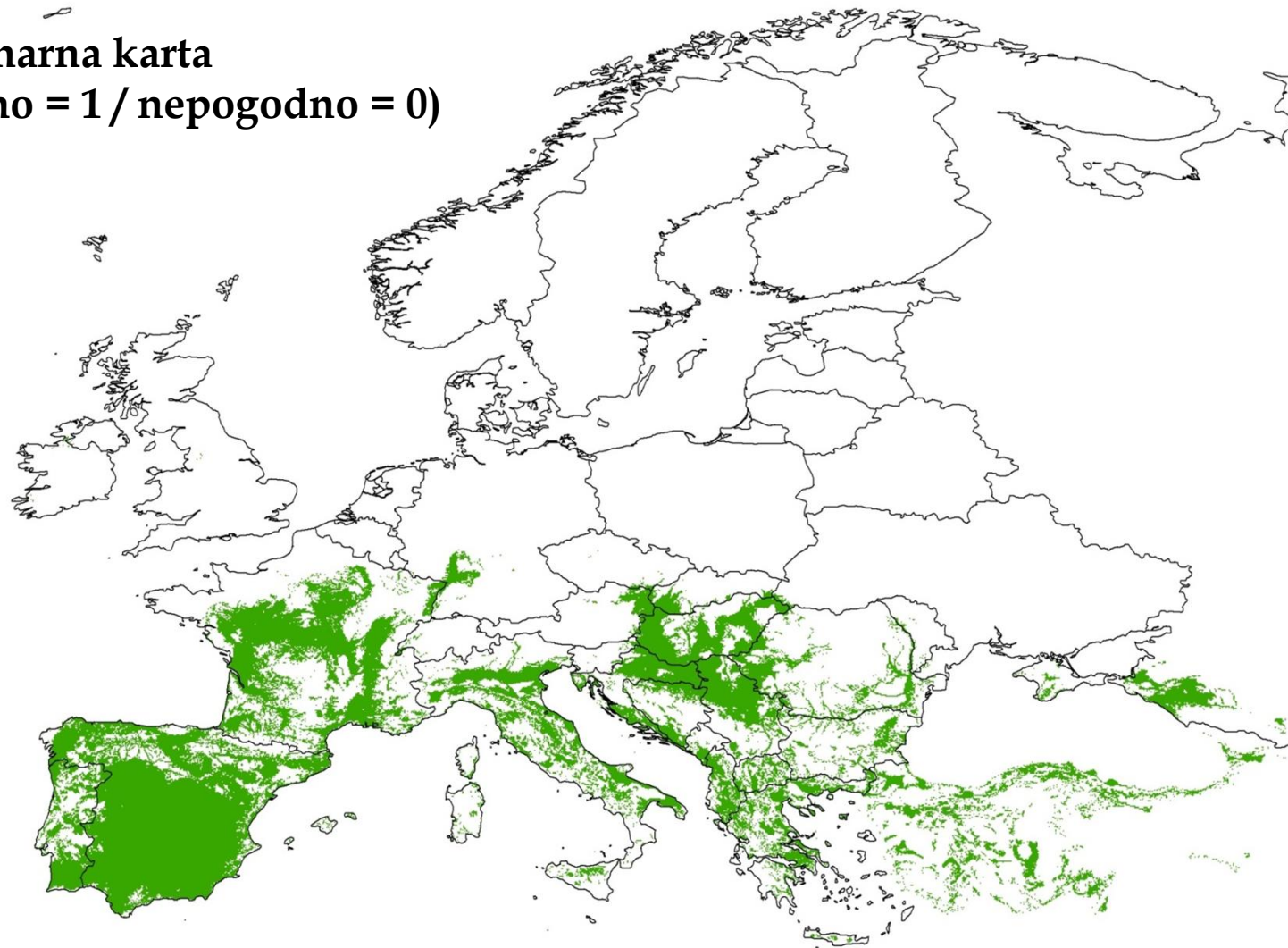
Modeli rasprostranjenosti vrsta

Rezultat modela je:

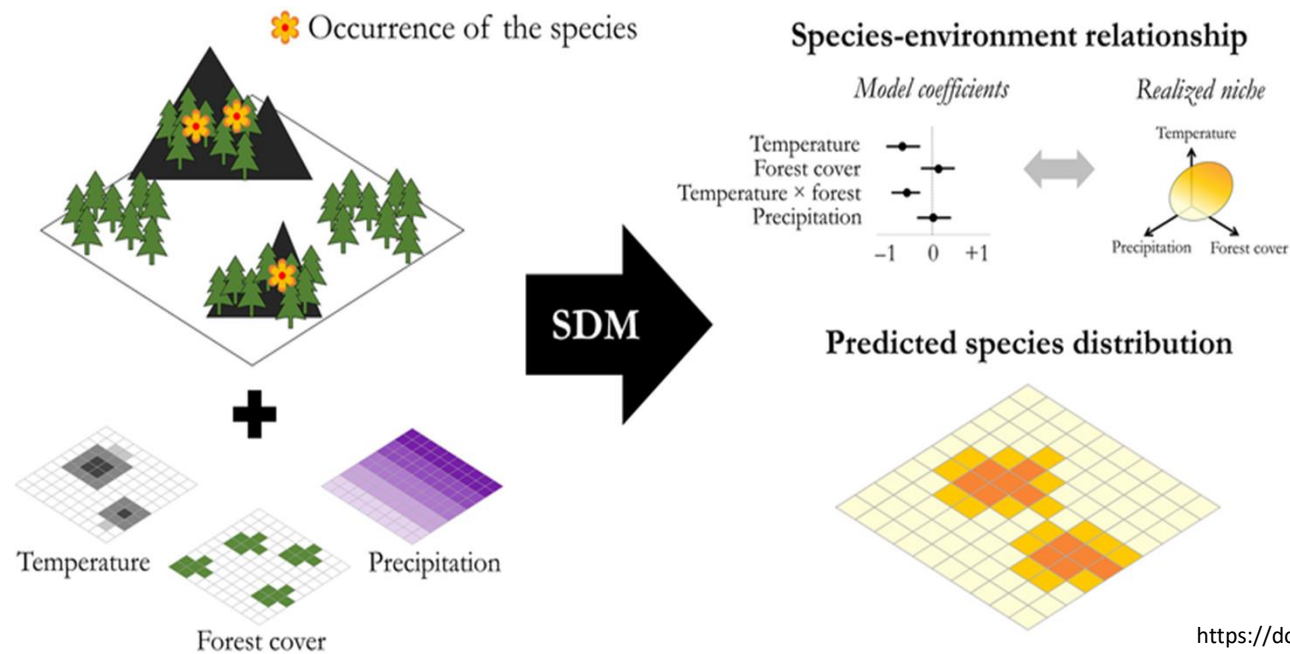
- karta potencijalne distribucije
- karta potencijalne povoljnosti staništa
- prikazuje gdje postoje povoljni okolišni uvjeti za neku vrstu
- od 0 – 1 (kontinuirana)



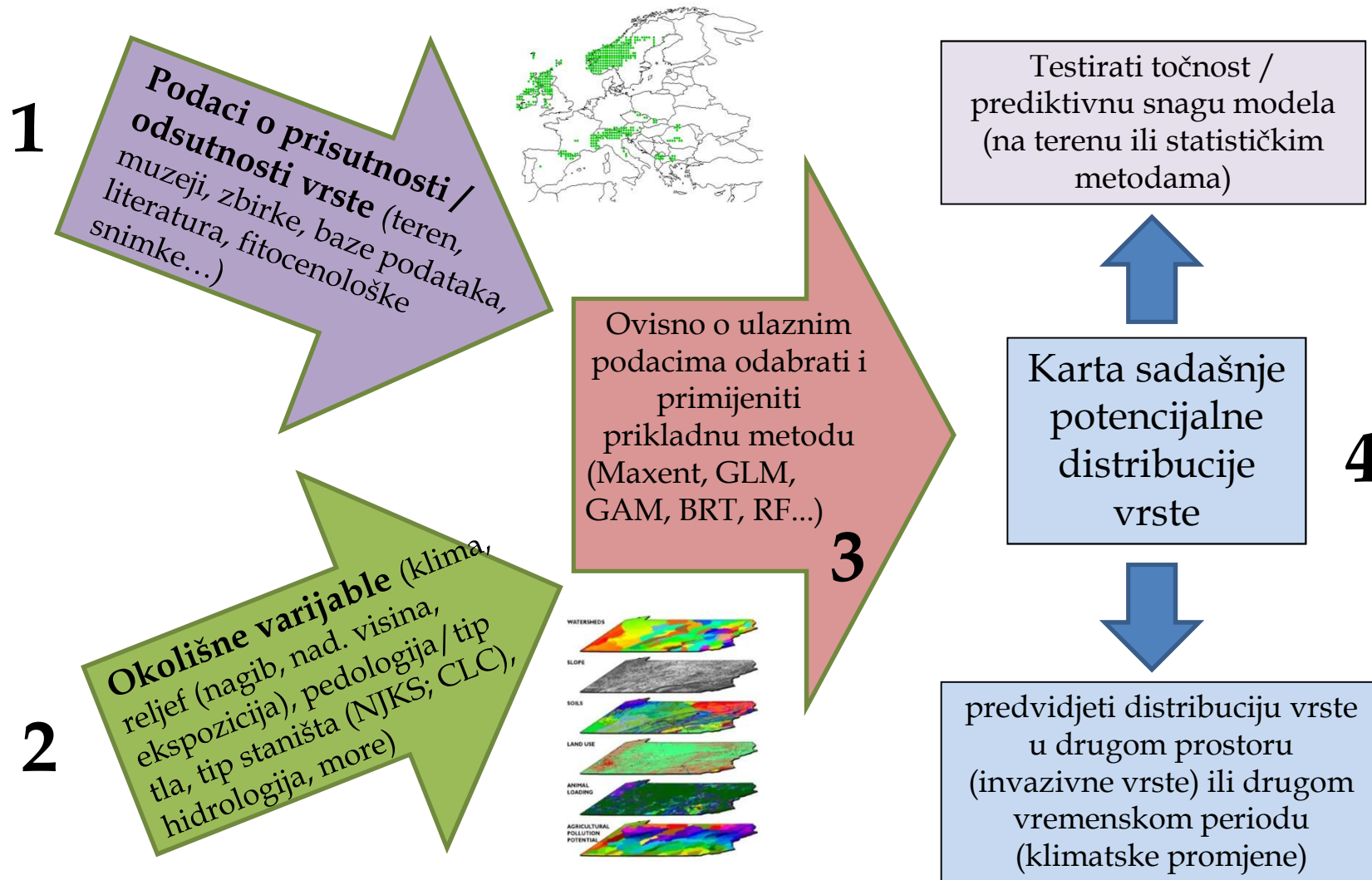
- ili binarna karta
(pogodno = 1 / nepogodno = 0)



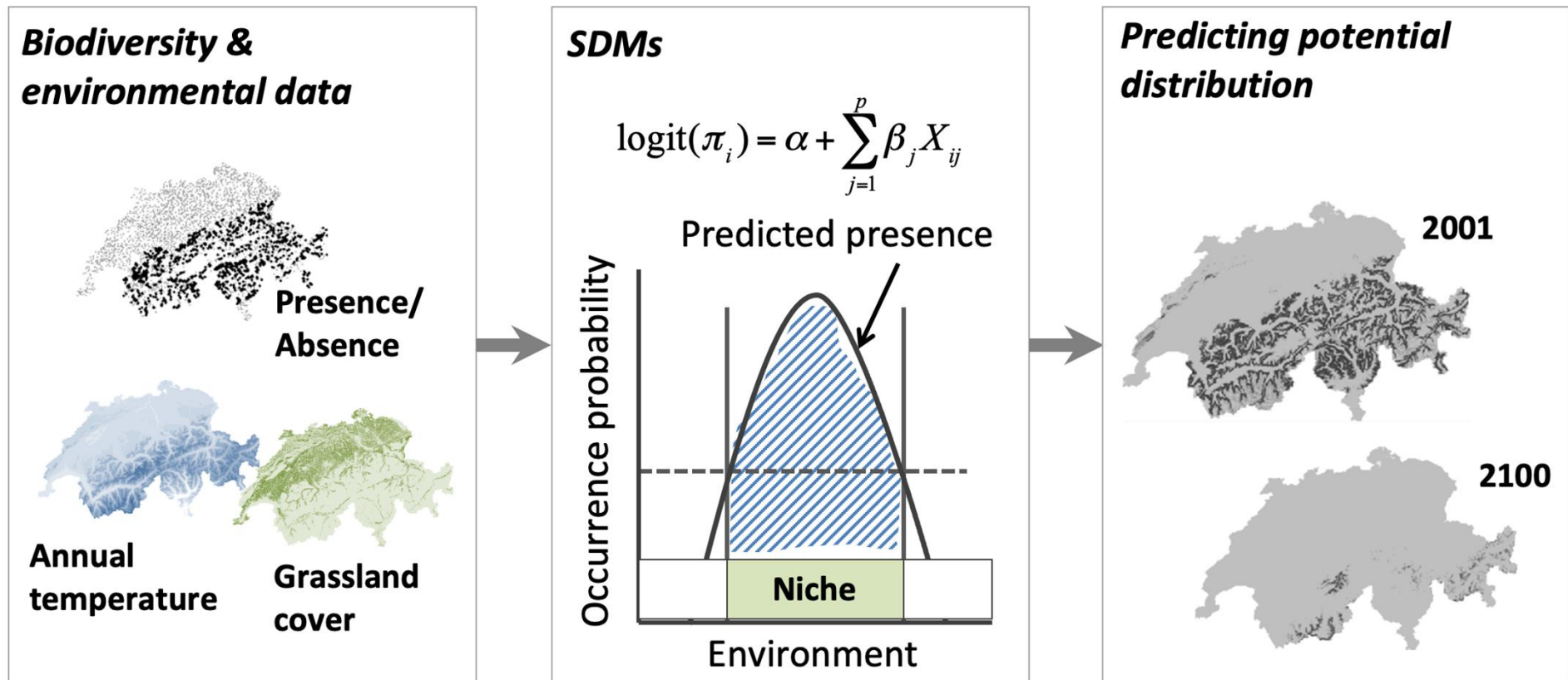
Osnovni principi i koraci u modeliranju rasprostranjenosti vrsta

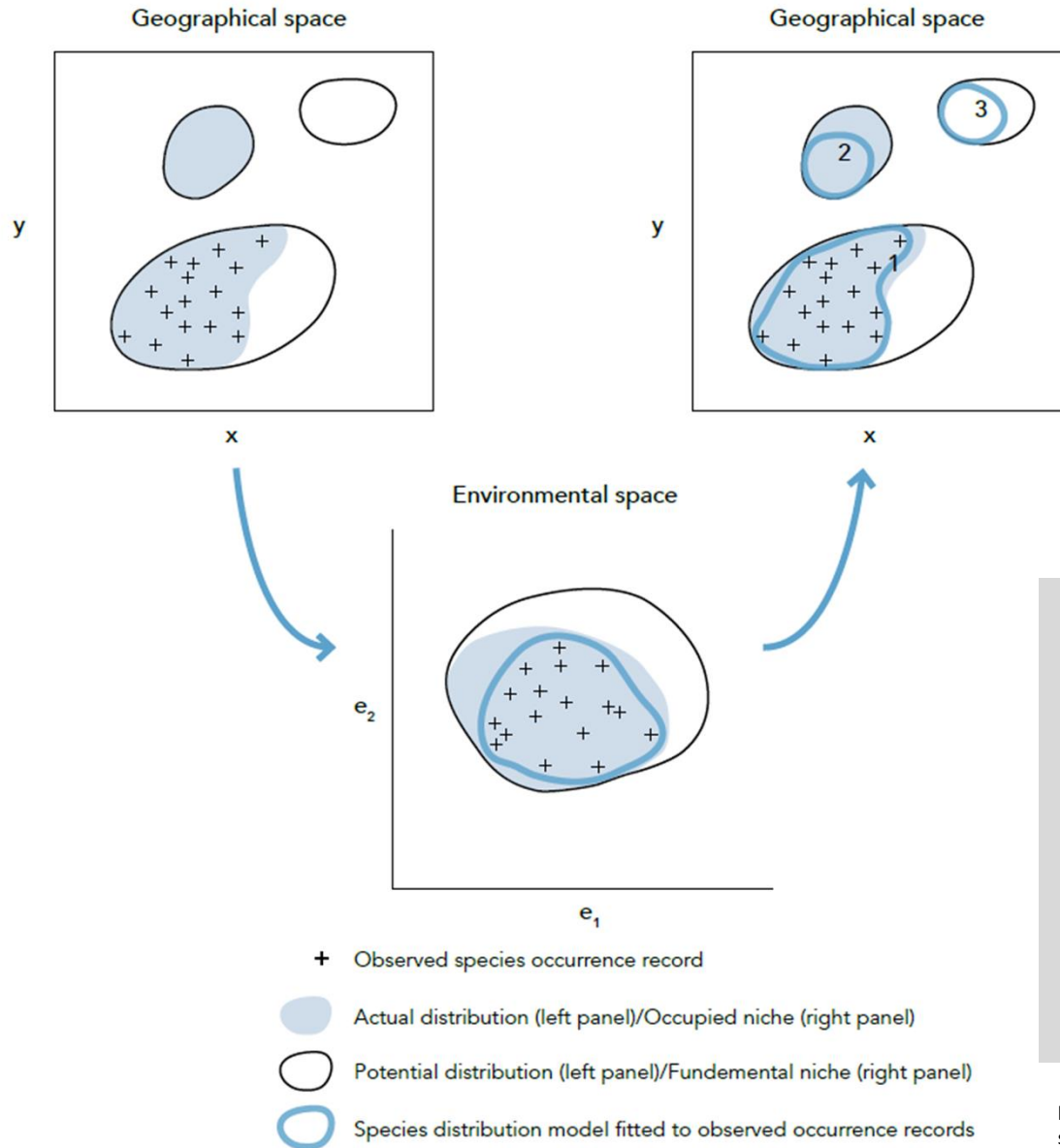


Modeliranje ekološke niše - Osnovni Princip



projected distribution of a species is the “potential distribution”





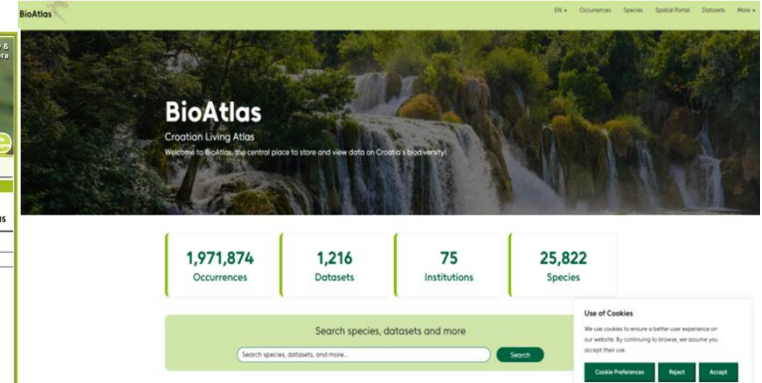
Model obično nikada ne identificira cijelu fundamentalnu ili cijelu realiziranu nišu

model uglavnom identificira dio niše koji je definiran ulaznim podacima!!

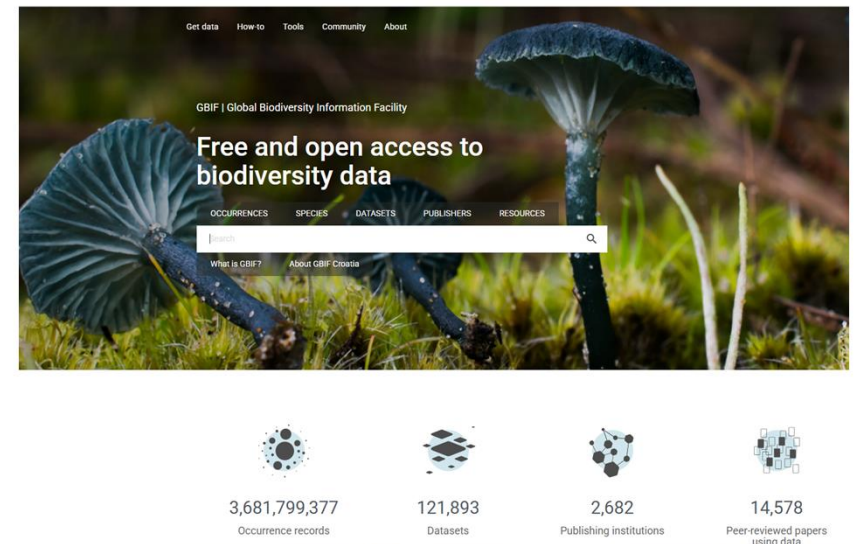
kada model projiciramo natrag u geografski prostor najčešće će identificirati dio realizirane ali i dio potencijalne distribucije

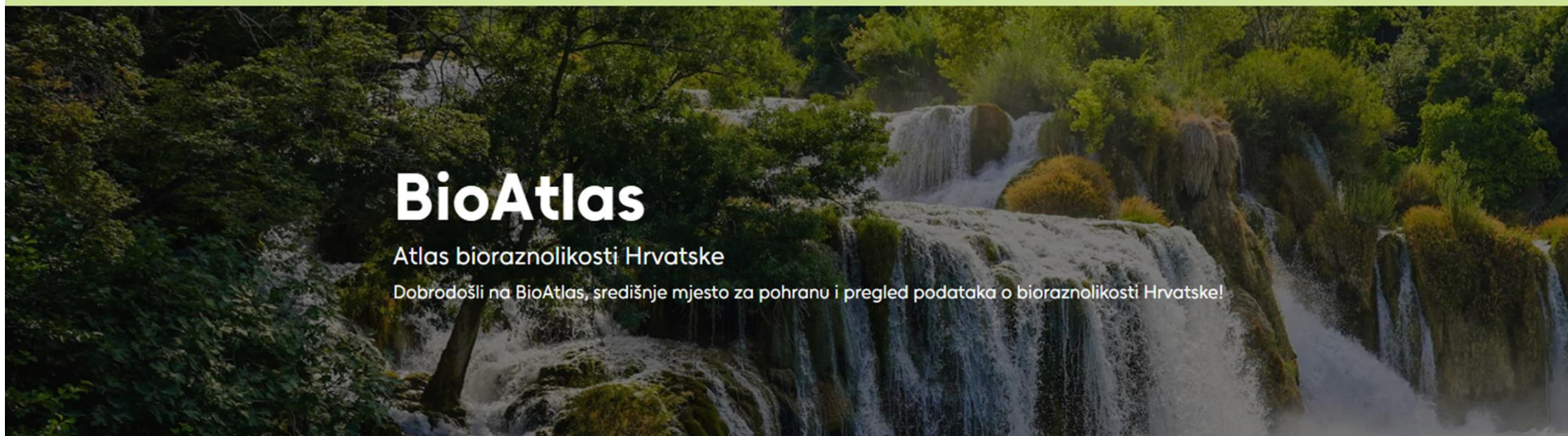
Izvori podataka o prisutnosti vrsta

- iz literature
- tereni/istraživanja
- nacionalne inventure šuma
- zbirke / herbari
- razne on-line baza podataka:



- GBIF database (<http://data.gbif.org>)
- Bioatlas (<https://bioatlas.bioportal.hr>)
- fitocenološke snimke iz Europske vegetacijske arhive (<http://euroveg.org/eva-database>)
- Inaturalist (<https://www.inaturalist.org/>)
- EUFORGEN (<http://www.euforgen.org>)
- Flora Croatica Database (<http://hirc.botanic.hr/fcd>)





BioAtlas

Atlas bioraznolikosti Hrvatske

Dobrodošli na BioAtlas, središnje mjesto za pohranu i pregled podataka o bioraznolikosti Hrvatske!

1,971,874

Opažanja

1,277

Skupovi podataka

76

Institucije

25,859

Vrste

Pretraži vrste, skupove podataka i više

Unesite pojam za pretraživanje...

Traži

- Bioportal HR <https://bioportal.hr>

bioportal.hr

GIS preglednik FCD IAS CroSpeleo Crveni popis HR IPT Georef BioAtlas HR EN

bioportal
Web portal
Informacijskog sustava zaštite prirode

O sustavu Istraži prirodu Uključi se! GBIF HR Otvoreni podaci Izvješća Novosti Kontakt

Bioportal - web portal Informacijskog sustava zaštite prirode

Dobrodošli na Bioportal, web portal Informacijskog sustava
zaštite prirode!

Saznaj više

25,859

vrsta zabilježenih u Atlasu
bioraznolikosti Hrvatske

1,971,874

opažanja u Atlasu
bioraznolikosti Hrvatske

3,269

važeci procjena
ugroženosti u Crvenom
popisu divljih vrsta RH

4,559

objekata u Katastru
speleoloških objekata RH

Izvori podataka ekološke / okolišne varijable (podloge) za sadašnjost

Ekološke varijable preuzeti u obliku rasterskih slojeva iz različitih baza podataka:

1. Klimatske varijable:

- ✓ WorldClim – globalna klima (rasteri) rezolucije cca 1km za cijeli svijet <http://www.worldclim.org/>
- ✓ CHELSA (Climatologies at High Resolution for the Earth's Land Surface Areas) <https://www.chelsa-climate.org/>

2. Topografske varijable

- ✓ digitalni model reljefa - DEM (nadmorska visina, nagib, ekspozicija)

(Svijet 90 m: <https://portal.opentopography.org/raster?opentopoID=OTSRTM.042013.4326.1>)

ili (EU 25 m: <http://land.copernicus.eu/>)

- ✓ <https://www.earthenv.org/topography>

3. Stanišne i pedološke varijable

- ✓ European Soil Data Centre (ESDAC), European Soil Database (<https://esdac.jrc.ec.europa.eu/>)
- ✓ SoilGrids250m <https://soilgrids.org/>
- ✓ Pokrov zemljišta - Corine Land Cover (CLC) za EU <https://land.copernicus.eu/en/products/corine-land-cover>
- ✓ Vodotoci/hidrologija - HydroSHEDS (<https://www.hydrosheds.org> ; <http://land.copernicus.eu/>
- ✓ Karta staništa Hrvatske (<https://bioportal.hr/gis/>)

WorldClim

Maps, graphs, tables, and data of the global climate

Download

<https://www.worldclim.org/>



Klima



Climate Data Store

Datasets User guide Applications Forum Live status

Dive into this wealth of information about the Earth's past, present and future climate

Search

<https://www.chelsa-climate.org/>

CHELSEA

Datasets Models Tutorials About Download

CHELSEA

Providing high resolution climate data for all

Climate data since the last glacial maximum



Explore the data behind the increasing occurrence of multi-year drought



Climate data for the Canary Islands at unprecedented resolution...



IMPORTANT: Some datasets are still showing gaps especially in recent years. We are updating these at the moment, so please bear with us for the moment. We will announce the completion as soon as we finished it...

Meet the team behind CHELSEA...



API

Access the full data store catalogue, with search and availability features



Training

Copernicus Climate Change Service (C3S) data tutorials



earthkit

Open-source Python tools simplifying data access, processing, analysis,



JupyterHub

Access and process data within the Data Stores Common Cloud Infrastructure (CCI)

<https://cds.climate.copernicus.eu/>

Klimatske varijable za budućnost



Future climate data

The data available here are [CMIP6](#) downscaled future climate projections. The [downscaling](#) and calibration (bias correction) was done with WorldClim v2.1 as baseline climate.

Monthly values of minimum temperature, maximum temperature, and precipitation were processed for 23 global climate models (GCMs), and for four [Shared Socio-economic Pathways](#) (SSPs): 126, 245, 370 and 585.

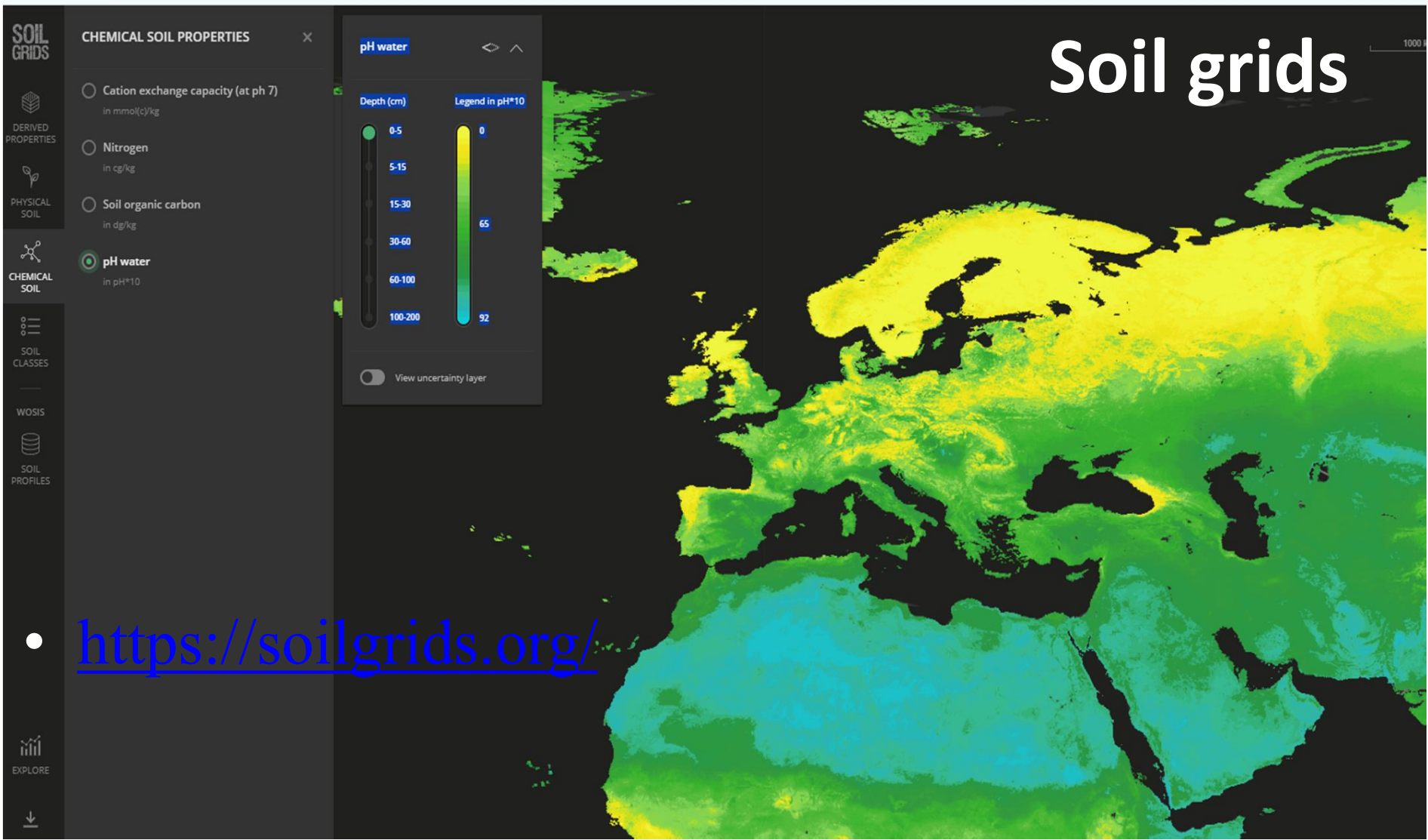
The monthly values were averages over 20 year periods (2021-2040, 241-2060, 2061-2080, 2081-2100). The following spatial resolutions are available (expressed as minutes of a degree of longitude and latitude): [10 minutes](#), [5 minutes](#), [2.5 minutes](#), and [30 seconds](#).

You can look at maps of the climate anomalies [here](#).

CMIP6 [terms of use and citation information](#).

The now obsolete downscaled CMIP5 data is still available [here](#).

The screenshot shows the CHELSA website interface. At the top, there is a navigation bar with 'Datasets', 'Models', 'Tutorials', 'About', and a 'Download' button. The main content area is divided into a search sidebar and a results section. The search sidebar includes a search box, a 'Model' filter with options for CHELSA TraCE21k, V1.2, V2.1, V2.0, and Ach-highres, a 'Coverage' filter with 'Temporal' (Past, Present, Future) and 'Spatial' (Canaries, Europe, Global, Switzerland) options, and a 'Frequency' filter. The results section shows two datasets: 'CHELSA-climatologies' and 'CHELSA-bioclim', both generated with CHELSA V2.1. Each result includes a description, a 'Download' button, and a small globe icon labeled 'Daily Mean Near-Surface Air Temperature'.



- [CLC \(2018\): http://land.copernicus.eu/pan-european/corine-land-cover](http://land.copernicus.eu/pan-european/corine-land-cover)

The screenshot displays the Copernicus Land Monitoring Service (CLMS) website interface. At the top, there is a navigation bar with links for 'Help & support', 'Production updates', 'News and Events', 'Register/Login', and a search box. Below this, the Copernicus logo and 'Land Monitoring Service' are visible, along with a menu for 'CLMS portfolio', 'Dataset catalogue', 'Data viewer', 'Use cases', and 'About'. The main content area shows a map of Europe with a legend on the left titled 'Products and datasets' and 'Active layers'. The legend lists five CORINE Land Cover datasets, with the 2018 version selected. The map itself shows a detailed land cover classification of Europe, with various colors representing different land use types. A sidebar on the right contains map navigation tools like zoom in/out, pan, and print. The bottom of the page features a footer with a Creative Commons license notice and a small icon in the bottom right corner.

land.copernicus.eu/en/map-viewer?dataset=a5ee71470be04d66bcff498f94ceb5dc

Help & support Production updates News and Events Register/Login Search Site

Copernicus Europe's eyes on Earth Land Monitoring Service

CLMS portfolio Dataset catalogue Data viewer Use cases About

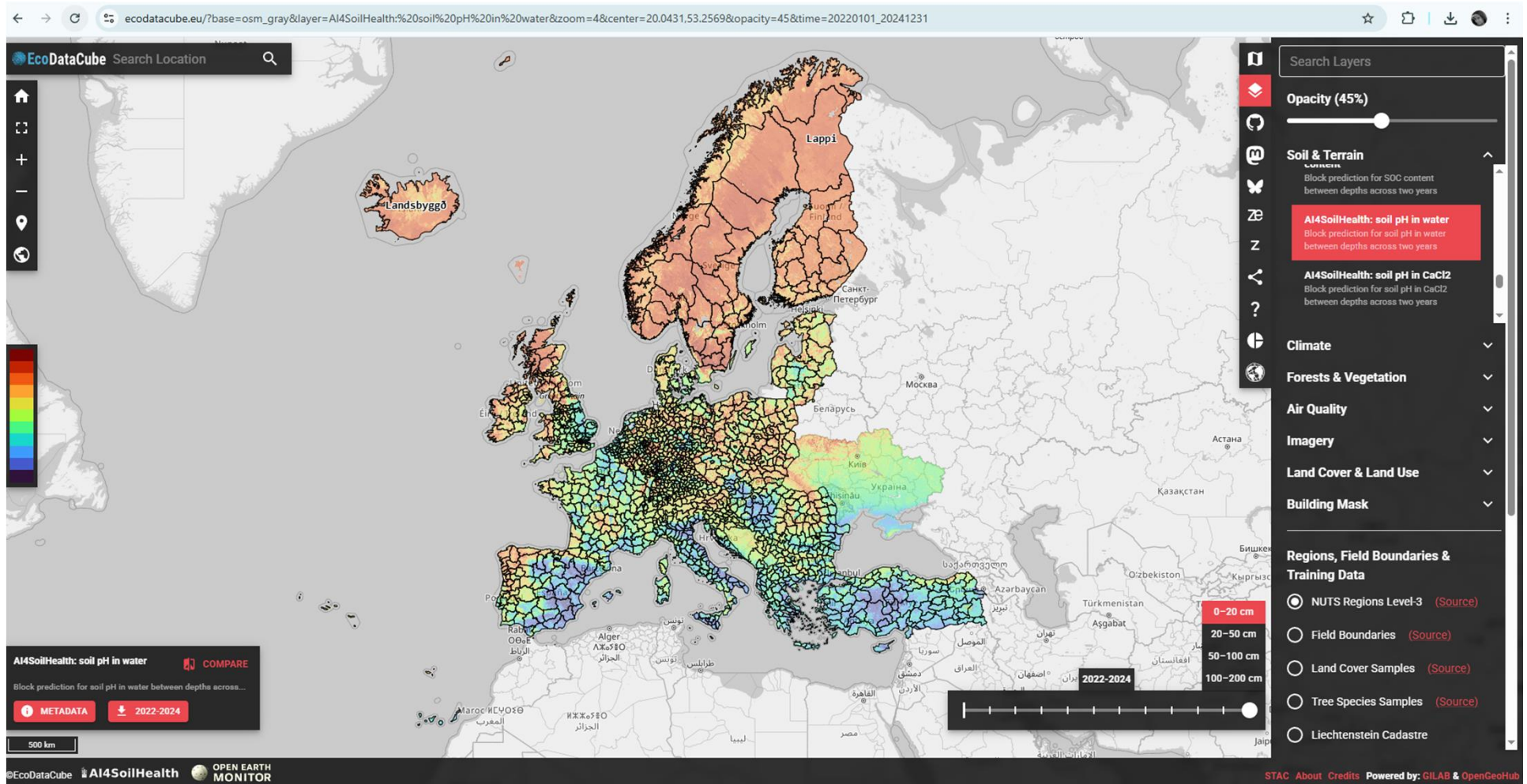
Home > Data viewer

Products and datasets Active layers

- CORINE Land Cover 2018 (vector/raster 100 m), Europe, 6-yearly
- CORINE Land Cover 2012 (vector/raster 100 m), Europe, 6-yearly
- CORINE Land Cover 2006 (vector/raster 100 m), Europe, 6-yearly
- CORINE Land Cover 2000 (vector/raster 100 m), Europe, 6-yearly
- CORINE Land Cover 1990 (vector/raster 100 m), Europe, 6-yearly

OpenStreetMap (and) contributors, CC-BY-SA | No Limitation

<https://ecodatacube.eu/>





The HydroSHEDS database offers a suite of global digital data layers in support of hydro-ecological research and applications worldwide. Its various hydrographic data products include catchment boundaries, river networks, and lakes at multiple resolutions and scales. HydroSHEDS data are freely available in standard GIS formats and form the geospatial framework for a broad range of assessments including hydrological, environmental, conservation, socioeconomic, and human health applications.



Karta staništa RH, zasticena podrucja ... <http://www.biportal.hr/gis/>

The screenshot displays the biportal GIS web application interface. The main map shows the geographical outline of Croatia, with various protected areas and habitats overlaid in different colors and patterns. The layer list on the left includes categories such as Podloge, Zašticena podrucja, Ekološka mreža Natura 2000, Staništa i biotopi, and Rasprostranjenost vrsta. The toolbar at the top provides navigation and interaction tools. The search bar at the top right contains the text "Google Places pretraga". The map includes a scale bar (100km) and a coordinate system (HTRS96/TM) with the position coordinates (-53450.133, 4945050.005). The footer contains the biportal logo, the text "Web portal Informacijskog sustava zaštite prirode", the copyright notice "© 2015 Hrvatska agencija za okoliš i prirodu", and a help icon.

bioportal Web portal Informacijskog sustava zaštite prirode

© 2015 Hrvatska agencija za okoliš i prirodu

Mjerilo 1: 2.500.000
Pozicija (HTRS96/TM): -53450.133, 4945050.005

Ekološke varijable u GIS-u

- Npr. klimatske varijable
- Rasterski slojevi

Temperatura



Padaline



Potencijalni problemi/poteškoće

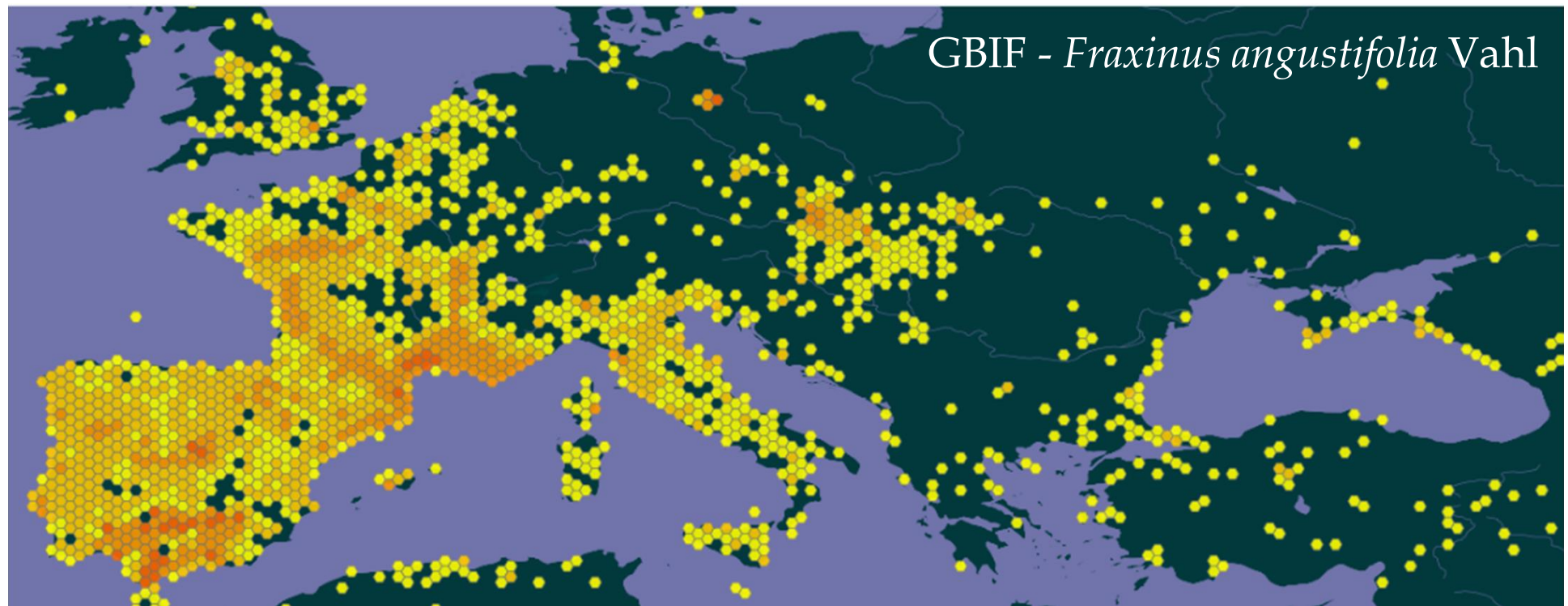
1. Samplig ili spatial bias/prostorna pristranost podataka

- u geografskom prostoru
- u ekološkom prostoru

- podaci o pojavljivanju vrste nisu ravnomjerno raspoređeni u prostoru
- ne odražavaju točno rasprostranjenost vrste
- lakša dostupnost terena (uz ceste, staze, naselja)
- zaštićena područja (više istraživanja u parkovima prirode i nacionalnim parkovima)
- istraživački interesi (dugogodišnja istraživanja na istim lokacijama, istim vrstama)

- leads to biases in the estimated environmental distribution of a species
- model uči gdje su ljudi tražili/našli vrstu, a ne gdje vrsta stvarno može živjeti

prostorna pristranost podataka



Potencijalni problemi/poteškoće

2. Odabir okolišnih varijabli

- Postoji jako punoooo dostupnih varijabli ... kako odabrati ?
- Nikad ne koristimo sve varijable...bolje manje varijabli čije značenje možemo interpretirati i koje su bitne za biologiju/ekologiju vrste - birati ekološki smislen skup varijabli
- Broj varijabli proporcionalan broju točaka...
U pravilu min. 5 : 1 (5 točaka po svakoj varijabli ili 20:1)
- Izbjegavati korelirane variable ! Varijable međusobno nebi smjele biti korelirane (potrebno testirati nekom od metoda npr. pearson r, PCA, vif) **korelacija ≠ uzročnost**

Kako odabrati SDM metodu?

Method(s)¹
Gower Metric
Ecological Niche Factor Analysis (ENFA)
Maximum Entropy
Genetic algorithm (GA)
Artificial Neural Network (ANN)
Regression: generalized linear model (GLM), generalized additive model (GAM), boosted regression trees (BRT), multivariate adaptive regression splines (MARS)
Multiple methods
Multiple methods



Ecological Modelling
Volume 476, February 2023, 110242



A curated list of R packages for ecological niche modelling

Neftalí Sillero ^a, João Carlos Campos ^a, Salvador Arenas-Castro ^b, A.Márcia Barbosa ^a

[Show more](#) ▾

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<https://doi.org/10.1016/j.ecolmodel.2022.110242> ↗

[Get rights and content](#) ↗

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[● Open access](#)

Highlights

- We present a curated list of R packages useful in ecological niche models.
- We compiled 60 R packages, organised by the four main modelling stages.

[cs/ ref/research tools/dom](#)

[er/](#)

[/~schapire/maxent/](#)

[esktopgarp/](#)

[orge.net/](#)

(Elith J, Graham C, Anderson

a. *Ecography*, 29, 129–151.)

Kako odabrati SDM metodu?

Ovisi o:

- dostupnim podacima (prisutnost vs. odsutnost)
 - veličini uzorka
 - cilju istraživanja
 - razini interpretabilnosti
-
- Ensemble modeli - kombiniraju više SDM metoda u jedan rezultat



https://github.com/helixcn/sdm_r_packages

<https://wallaceecomod.github.io/>

<https://wallaceecomod.github.io/wallace/articles/tutorial-v1.html>

Wallace Ecological Modeling App

About Applications Resources Dev Team Acknowledgments

Wallace Intro 1 Occ Data 2 Process Occs 3 Env Data 4 Process Envs 5 Partition Occs 6 Model 7 Visualize 8 Project Session Code

Process Occurrence Data

Modules Available:

- Select Occurrences On Map
- Remove Occurrences By ID
- Spatial Thin

Module: Spatial Thin

spThin : Spatial Thinning of Species Occurrence Records

Thinning distance (km)

10

Thin Occurrences

Reset to original occurrences

Reset

Download processed occurrence localities (.csv)

Download

Module Developers: Jamie M. Kass, Matthew E. Aiello-Lammens, Robert P. Anderson

spThin references

Package Developers: Matthew E. Aiello-Lammens, Rob A. Borla, Alex Radosavljevic, Bruno Vilela, Robert P. Anderson

> Removed occurrence with ID = 147 . Updated data has n = 57 records.

> Removed occurrence with ID = 159 . Updated data has n = 56 records.

> Total records thinned to [44] localities.

Change Base Map

ESRI Topo

Map Occs Tbl Results Component Guidance Module Guidance

Occ Records

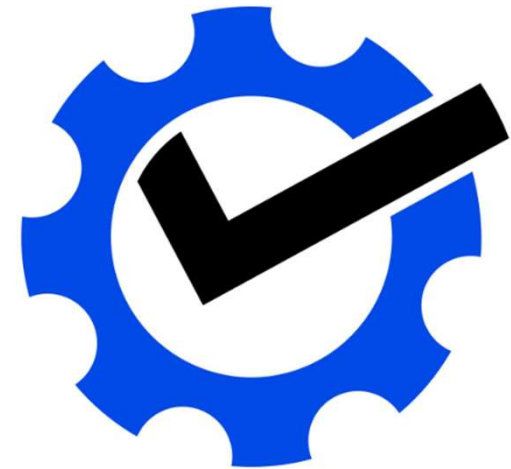
- retained
- removed

Leaflet | Tiles © Esri — Esri, DeLorme, NAVTEQ, TomTom, Intermap, IPC, USGS, FAO, NPS, NRCAN, GeoBase, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

Modeli rasprostranjenosti vrsta

Primjena:

- ✓ Predviđanje potencijalne rasprostranjenosti/ prepoznavanje pogodnih staništa vrsta
- ✓ Otkrivanje novih populacija
- ✓ Taksonomija - određivanje granica između vrsta
- ✓ Procjena utjecaja klimatskih promjena
- ✓ Širenje invazivnih vrsta
- ✓ Identifikacija područja za reintrodukcije/ translokacije
- ✓ Planiranje očuvanja biološke raznolikosti / planiranje zaštićenih područja



Primjena modela: Otkrivanje novih populacija

Maxent-directed field surveys identify new populations of narrowly endemic habitat specialists

Research Article Biogeography Conservation Biology Environmental Sciences
Natural Resource Management

Cody M. Rhoden¹, William E. Peterman², Christopher A. Taylor¹

Published July 31, 2017



Full Access

Using species distribution models to predict new occurrences for rare plants

John N. Williams, Changwan Seo, James Thorne, Julie K. Nelson, Susan Erwin, Joshua M. O'Brien, Mark W. Schwartz

First published: 10 June 2009 | <https://doi.org/10.1111/j.1472-4642.2009.00567.x> | VIEW METRICS

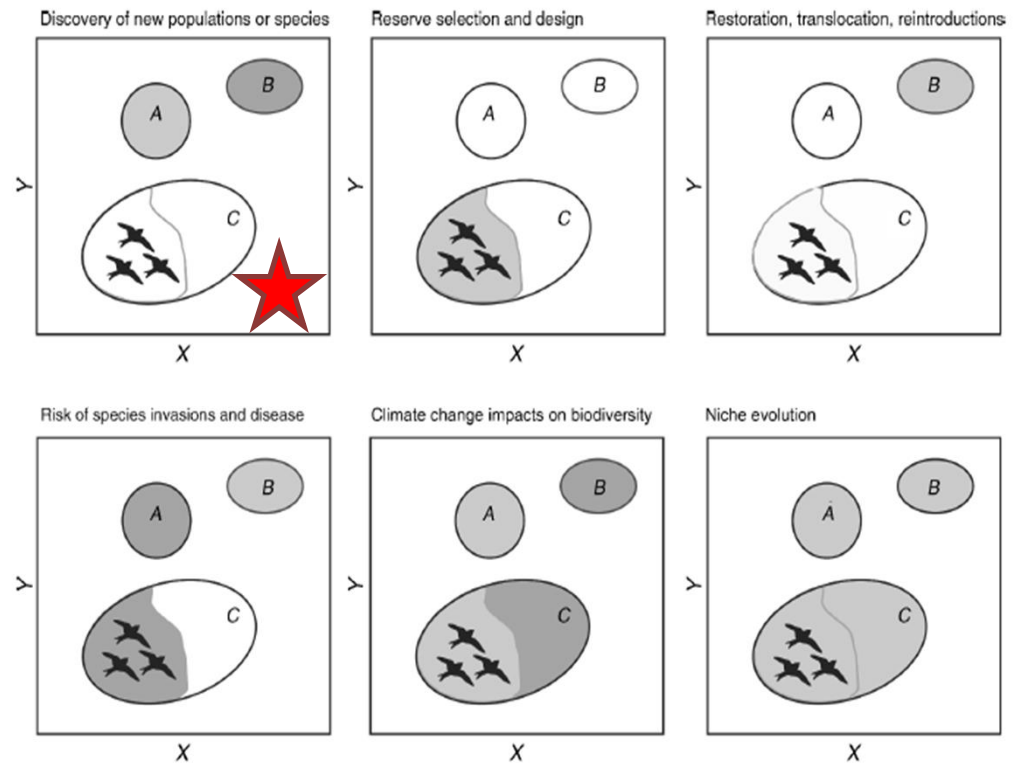
Received: 21 September 2021 | Revised: 26 March 2022 | Accepted: 6 April 2022
DOI: 10.1111/ddi.13536

RESEARCH ARTICLE

Diversity and Distributions WILEY

Finding what you don't know: Testing SDM methods for poorly known species

Tom Radomski¹, David Beamer², Alan Babineau³, Christa Wilson⁴, Joseph Pechmann^{4,5}, Kenneth H. Kozak⁶



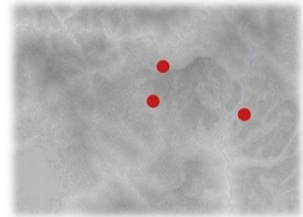
- Known species occurrence record
- Abiotically suitable area; fundamental niche
- Alternative model predictions
- Area A: Occupied but species not yet detected
- Area B: Suitable but not colonized due to dispersal limitation
- Area C: Suitable but not colonized due to biotic interaction (e.g., competition)

Primjena modela: Otkrivanje novih populacija

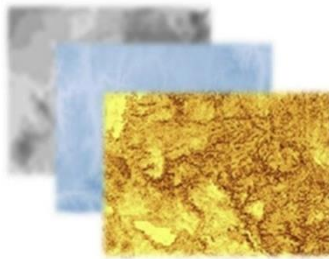
Searching for a rare species...



...correlating...



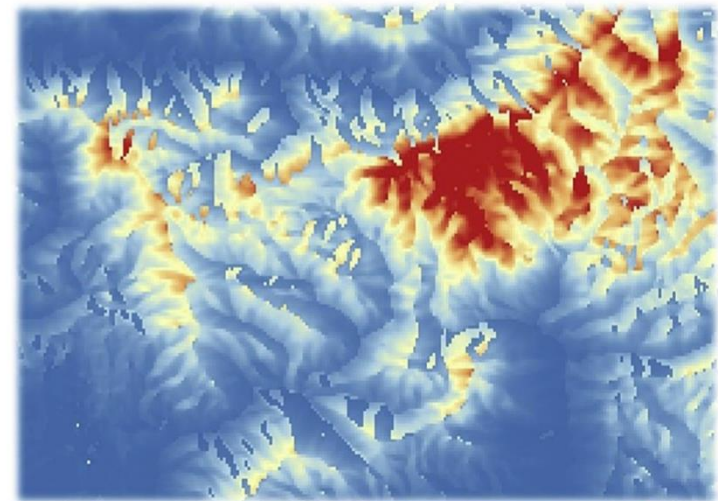
Limited information on species occurrence



Environmental factors



Using distribution models' outputs to guide field surveys



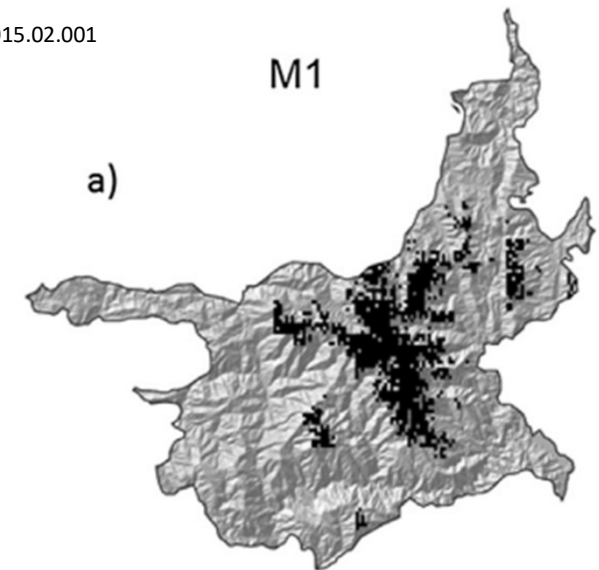
0  1
Probability of occurrence

A practical method to speed up the discovery of unknown populations using Species Distribution Models

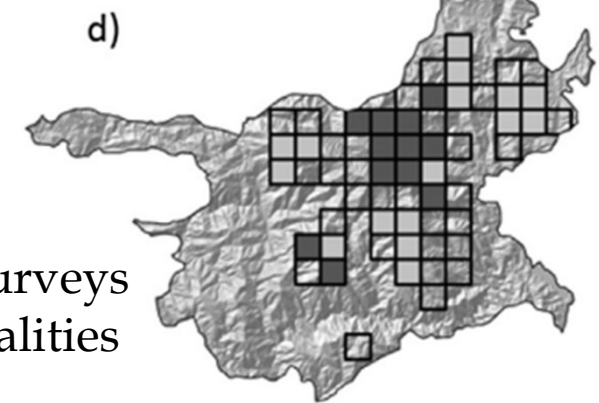
Mauro Fois ^a ✉, Giuseppe Fenu ^b ✉, Alba Cuena Lombraña ^a ✉, Donatella Cogoni ^a ✉, Gianluigi Bacchetta ^a ✉



- ✓ *Gentiana lutea* L.
- ✓ Prilog V Direktive o staništima
- ✓ SDM successful at guiding field surveys
- ✓ discovery of 16 unknown new localities



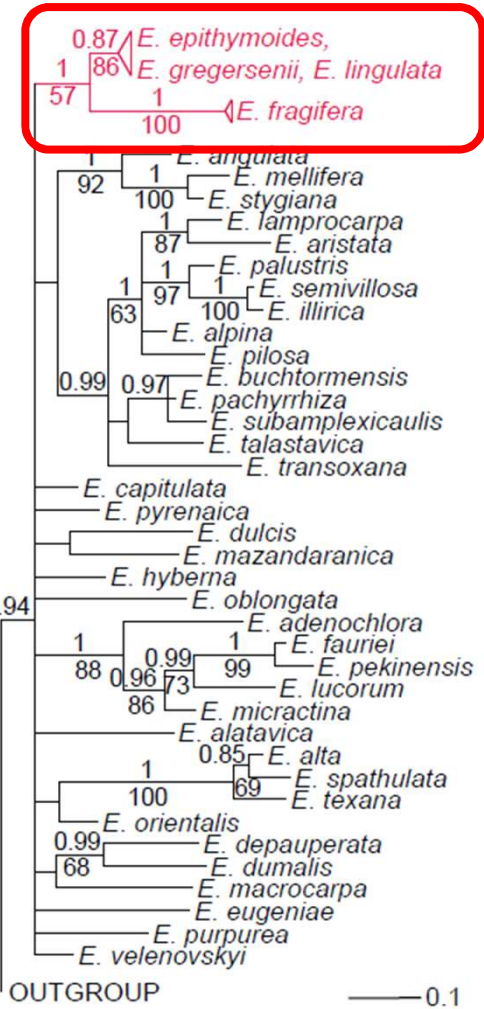
- black grids (2x2 km) - potential distribution areas
- dark gray - current presences
- light gray - confirmed extinct localities



Primjena modela: Taksonomija, evolucija niše



E. epithymoides
Group



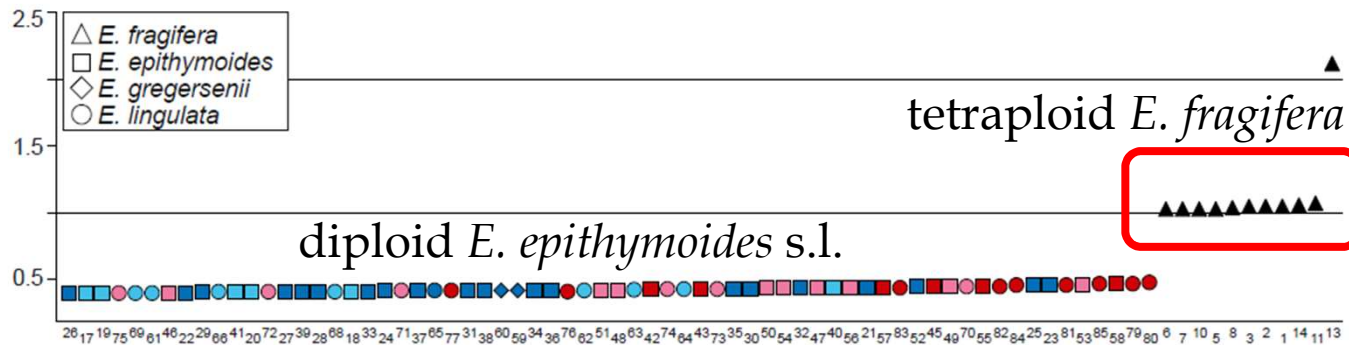
Polyploidisation and niche differentiation drive the diversification of the *Euphorbia epithymoides* group (Euphorbiaceae) in southeastern Europe

Sanja Z. Đurović^{a,1,2}, Martina Temunović^{b,2,3}, Peter Schönswetter^{c,4}, Božo Frajman^{c,*,5}

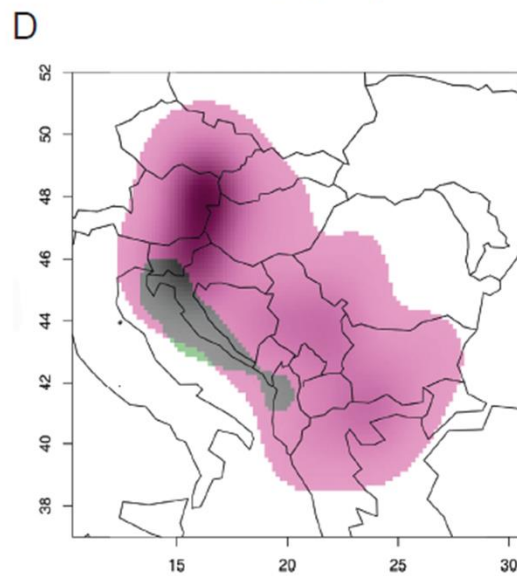
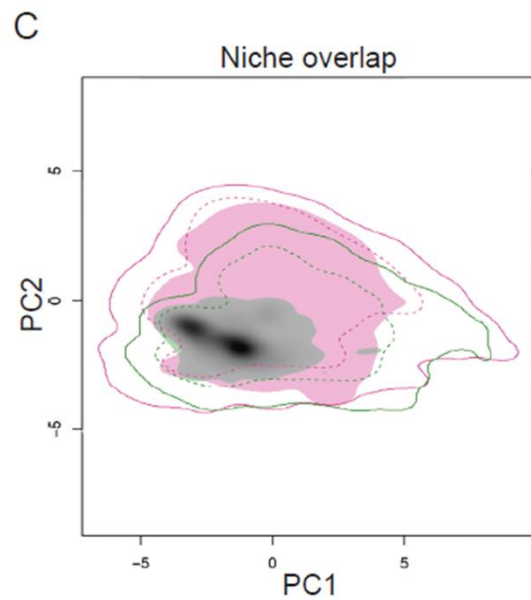
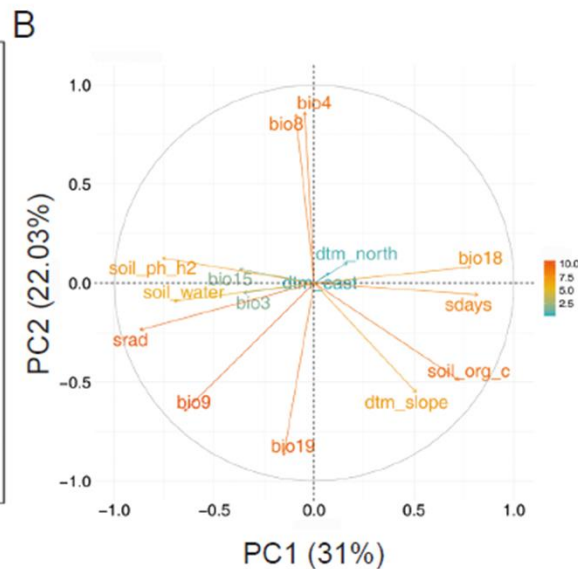
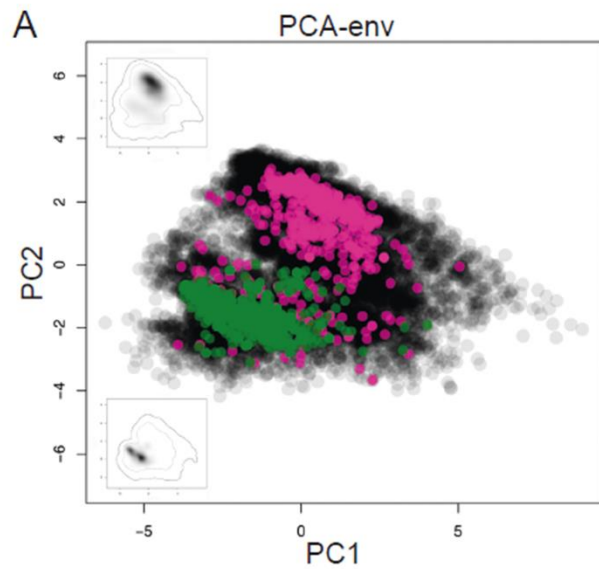
^a University of Niš, Faculty of Agriculture, Kruševac, Serbia

^b University of Zagreb, Faculty of Forestry and Wood Technology, Department of Forest Genetics, Dendrology and Botany, Zagreb, Croatia.

^c University of Innsbruck, Department of Botany, Innsbruck, Austria.



Relative genome size (RGS) variation in the *E. epithymoides* group

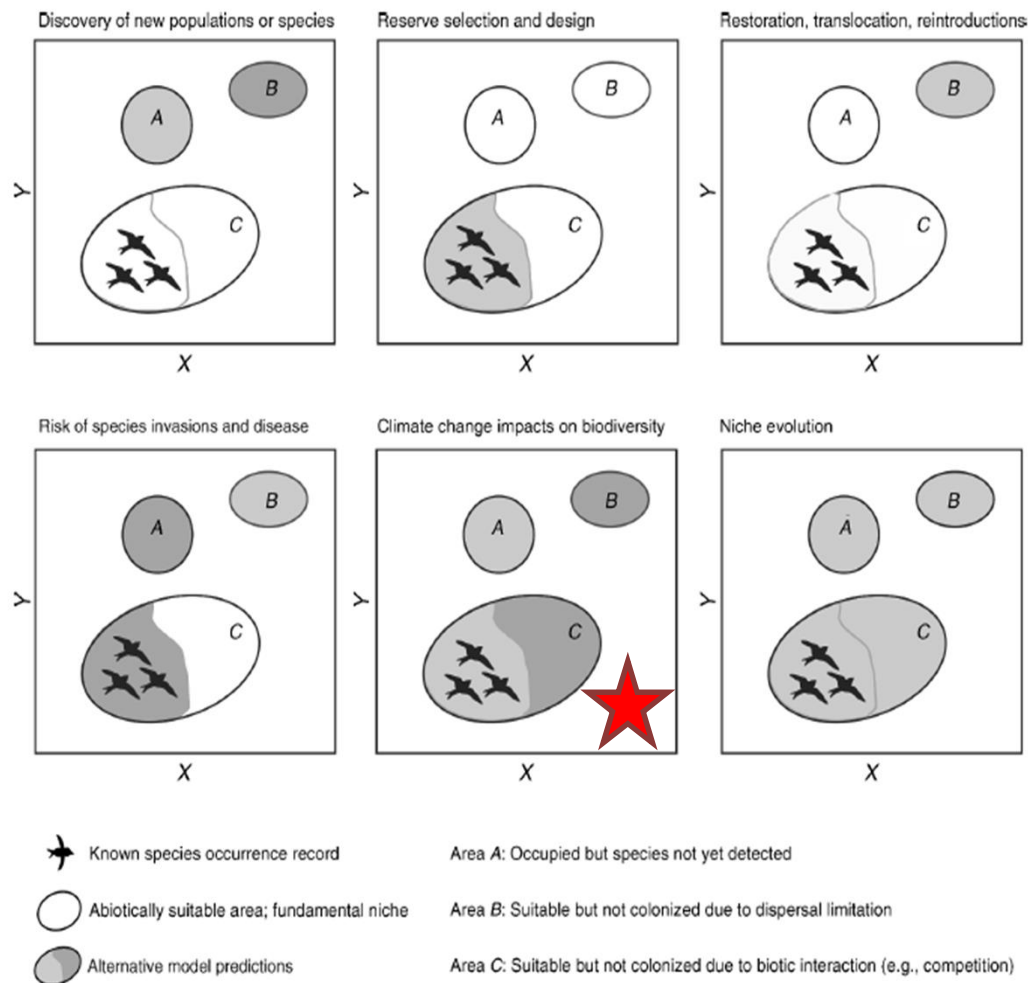
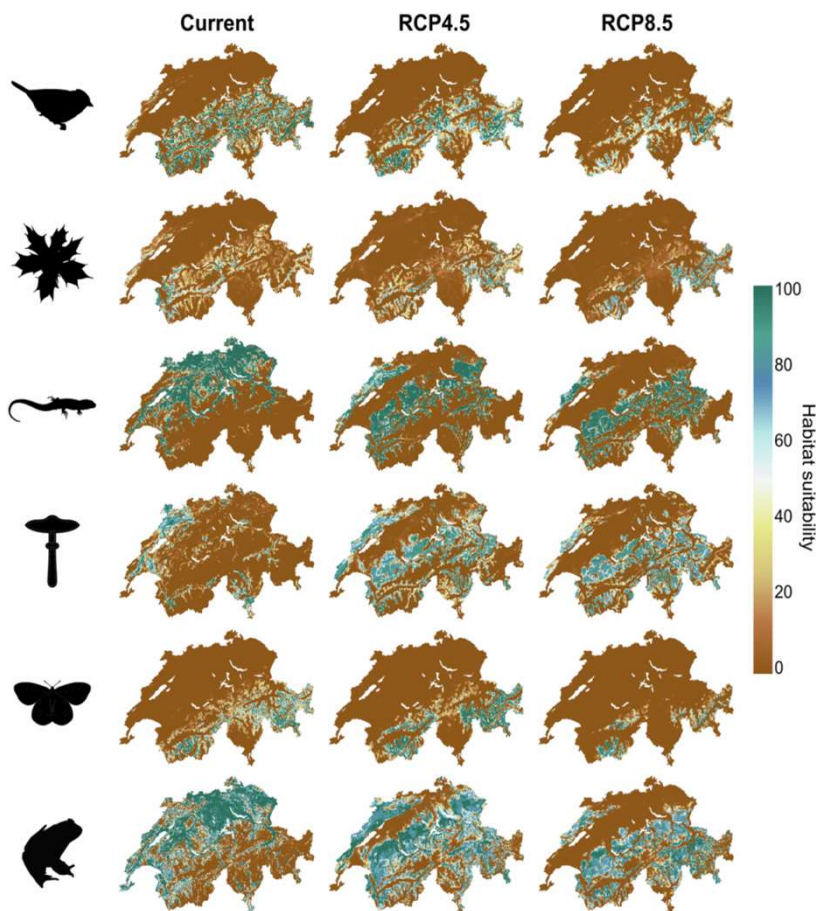


Comparison of environmental niches between diploid *E. epithymoides* s.l. (pink) & tetraploid *E. fragifera* (green) groups

E. fragifera

- ✓ shift towards areas with higher summer temperatures ...typical mediterranean climate
- ✓ niche contraction

Primjena modela: utjecaj klimatskih promjena



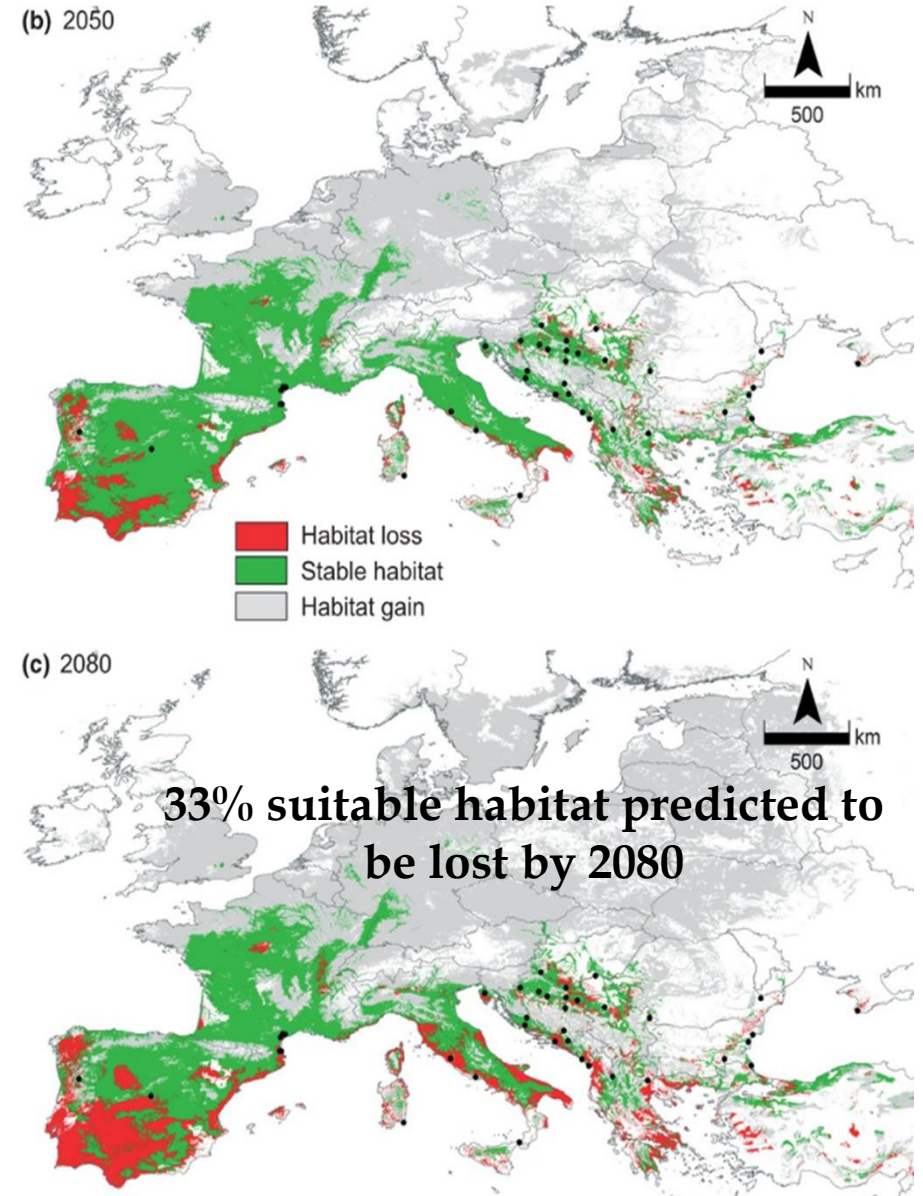
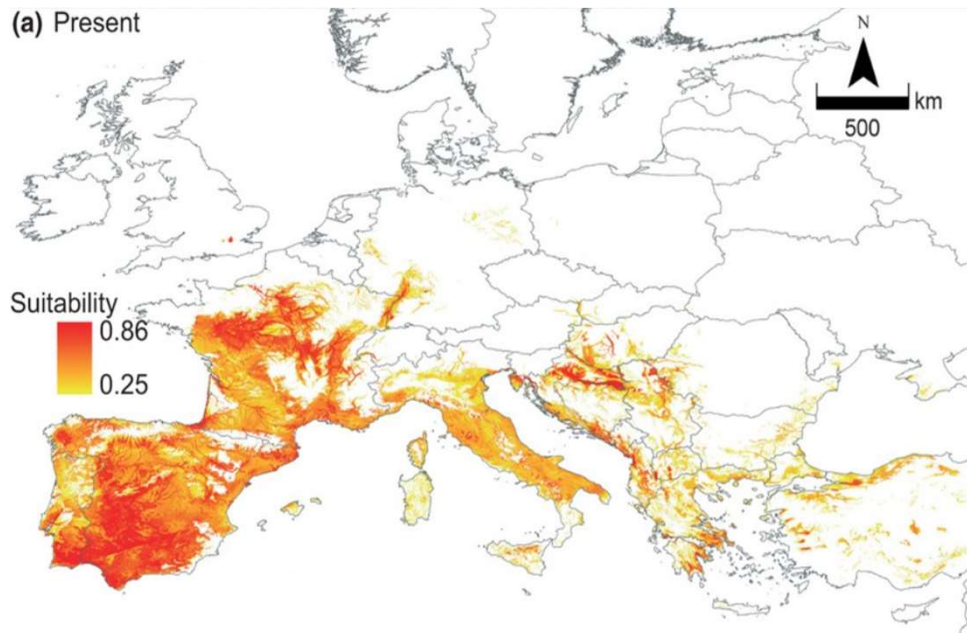
MOLECULAR ECOLOGY

Original Article | [Full Access](#)

Identifying refugia from climate change using coupled ecological and genetic data in a transitional Mediterranean-temperate tree species

M. Temunović  N. Frascaria-Lacoste, J. Franjić, Z. Satovic, J. F. Fernández-Manjarrés

First published: 27 February 2013 | <https://doi.org/10.1111/mec.12252> | [VIEW METRICS](#)





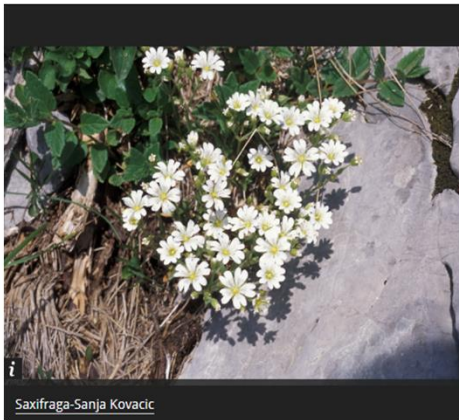
RESEARCH ARTICLE | [Open Access](#) | [CC](#) | [i](#) | [S](#)

Impact of Quaternary climatic oscillations on phylogeographic patterns of three habitat-segregated *Cerastium* taxa endemic to the Dinaric Alps

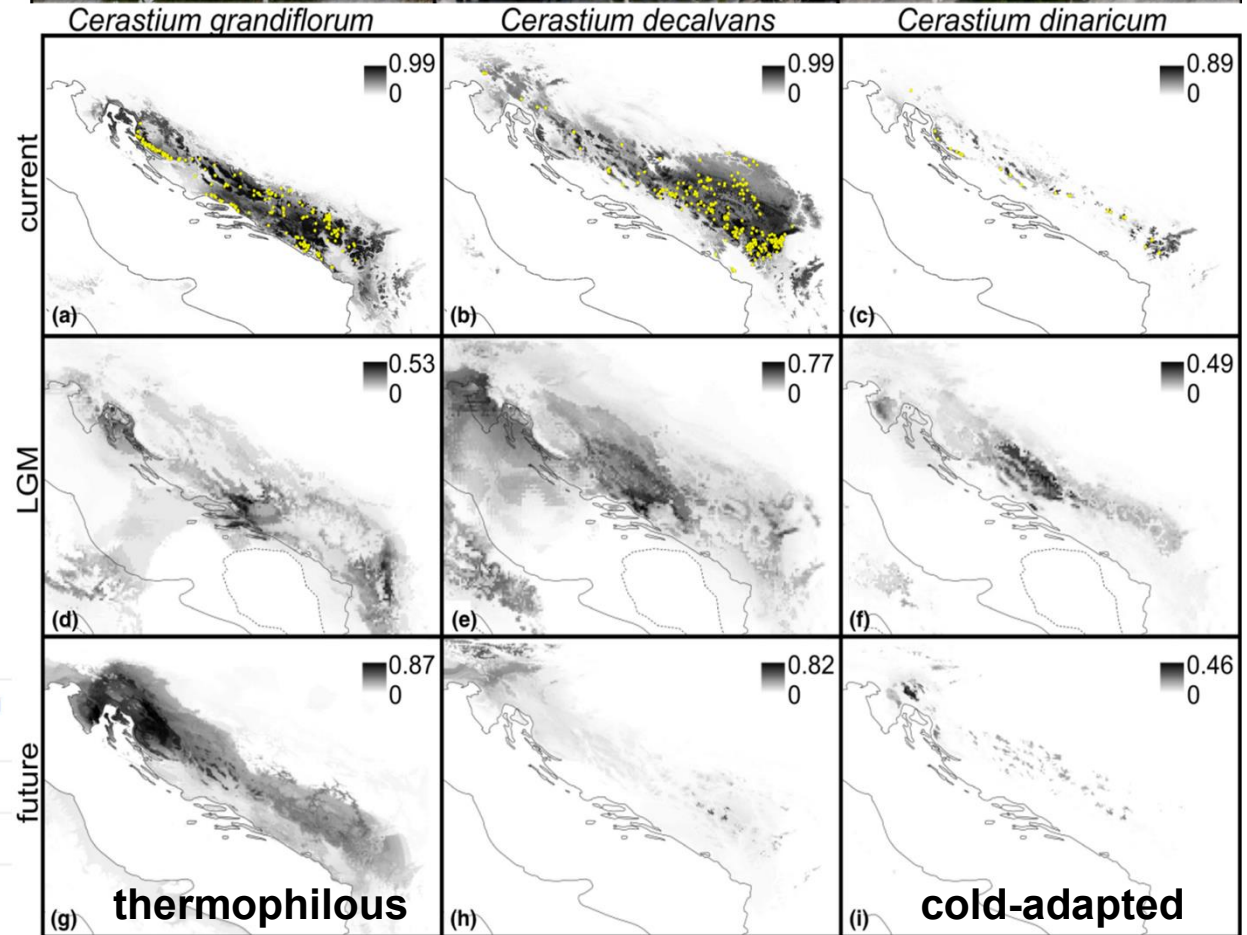
[Sanja Z. Đurović](#) [Martina Temunović](#) [Marjan Niketić](#) [Gordana Tomović](#) [Peter Schönswetter](#) [Božo Frajman](#)

First published: 04 June 2021 | <https://doi.org/10.1111/jbi.14133> | [VIEW METRICS](#)

Cerastium dinaricum Beck & Szyszylł.



Threat status Europe	Vulnerable (IUCN)
Protected by	EU Habitats Directive and 1 other international agreement
Natura 2000 sites	4 are designated for this species
Most preferred habitats	sparsely vegetated land
Natura 2000 species code	4072



Primjena modela: širenje alohtonih / invazivnih vrsta

Diversity and Distributions

A Journal of Conservation Biogeography

RESEARCH ARTICLE | [Open Access](#) |

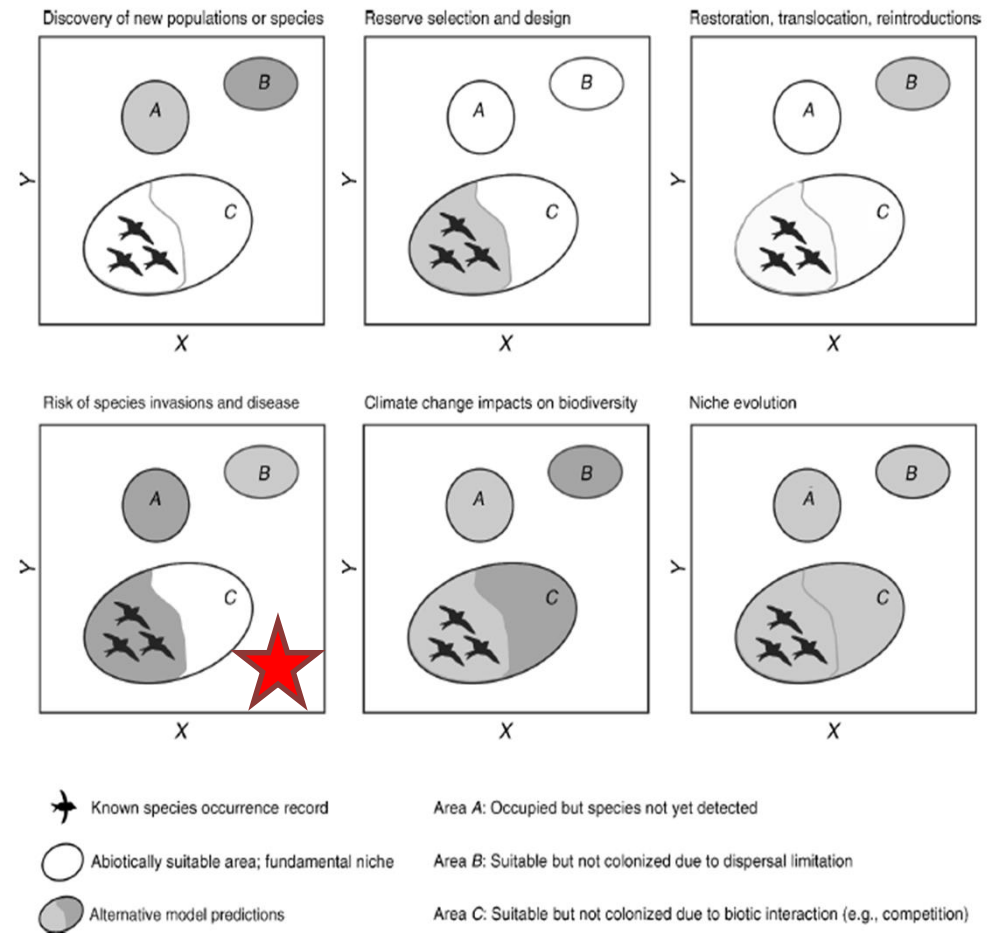
Europe Under Siege? Predicting Fall Armyworm (*Spodoptera frugiperda*) Invasion Risk Based on Climatic Niche Shift and Species Distribution Models

Martina Kadoić Balaško, Filip Varga, Martina Temunović

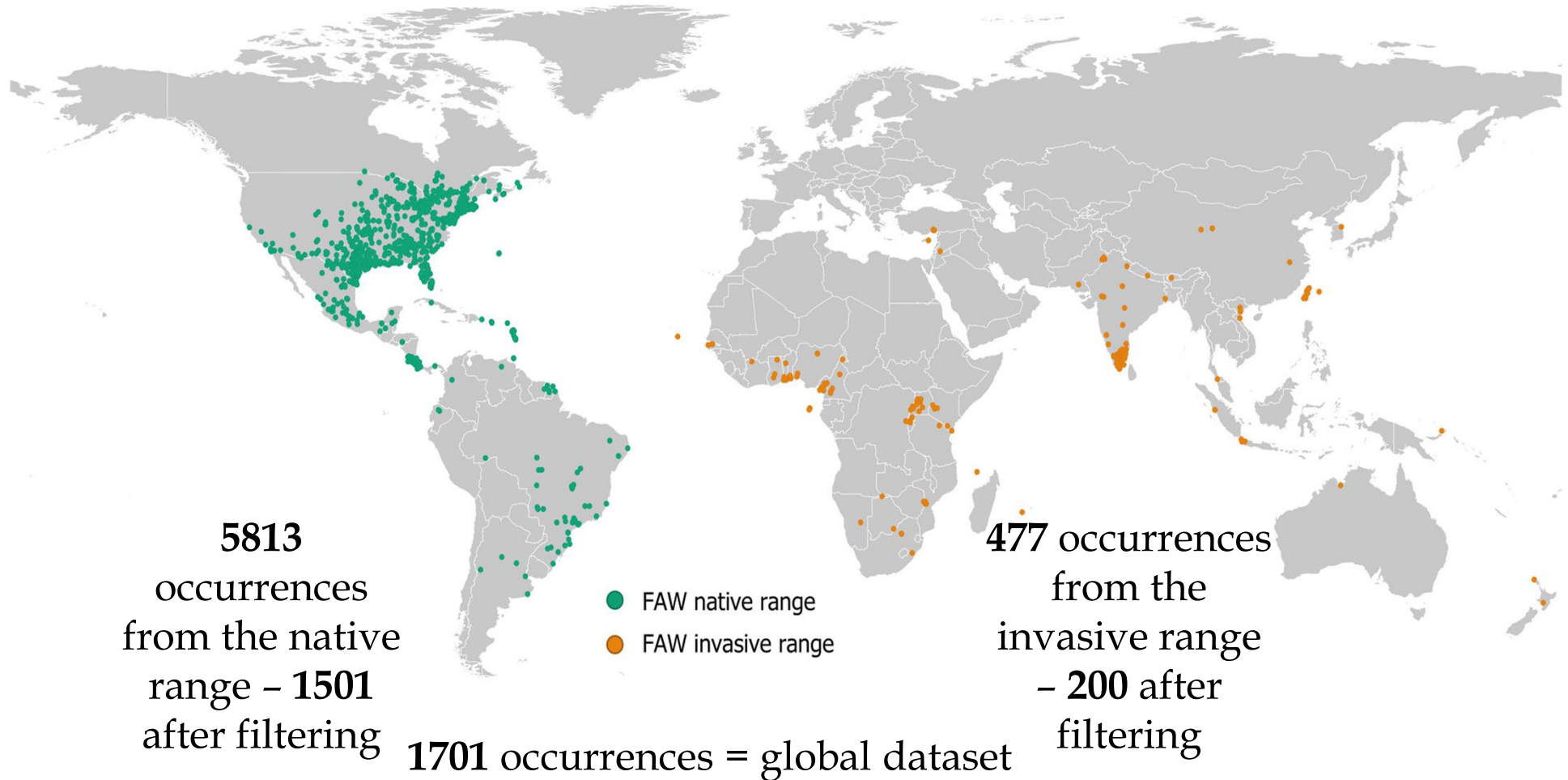
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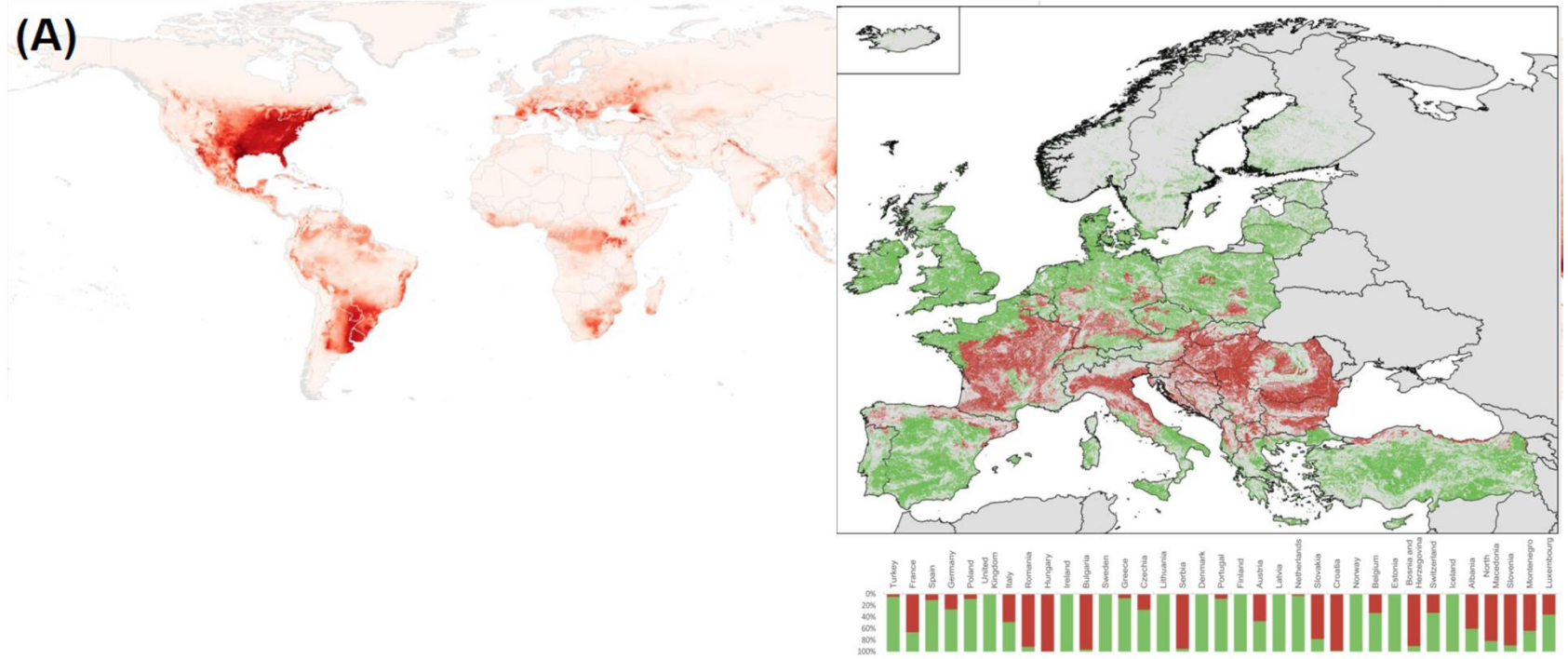
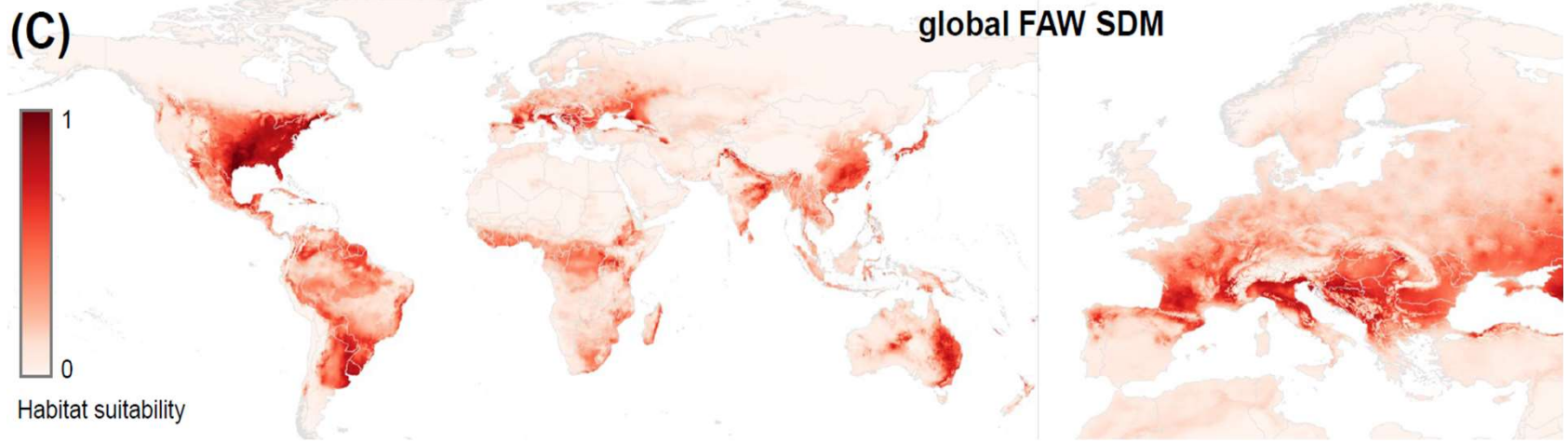


<https://www.cabdigitallibrary.org/product/qi/portal/fallarmyworm>

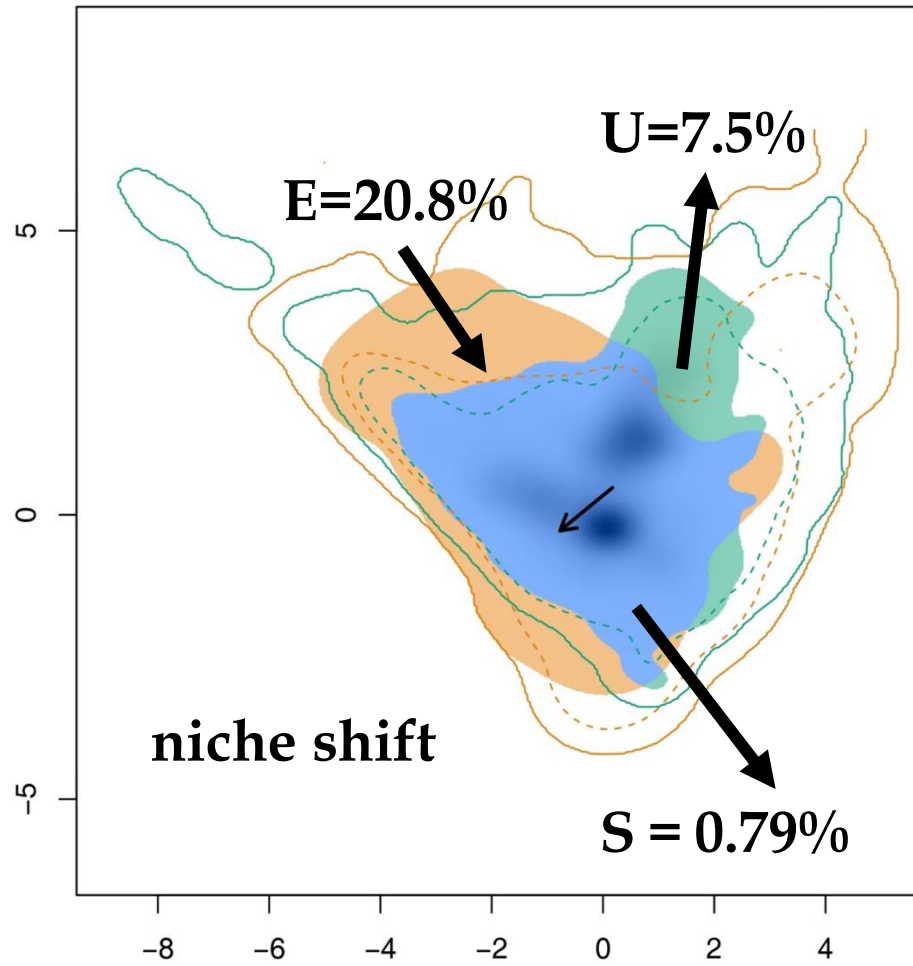


FAW Occurrence Data



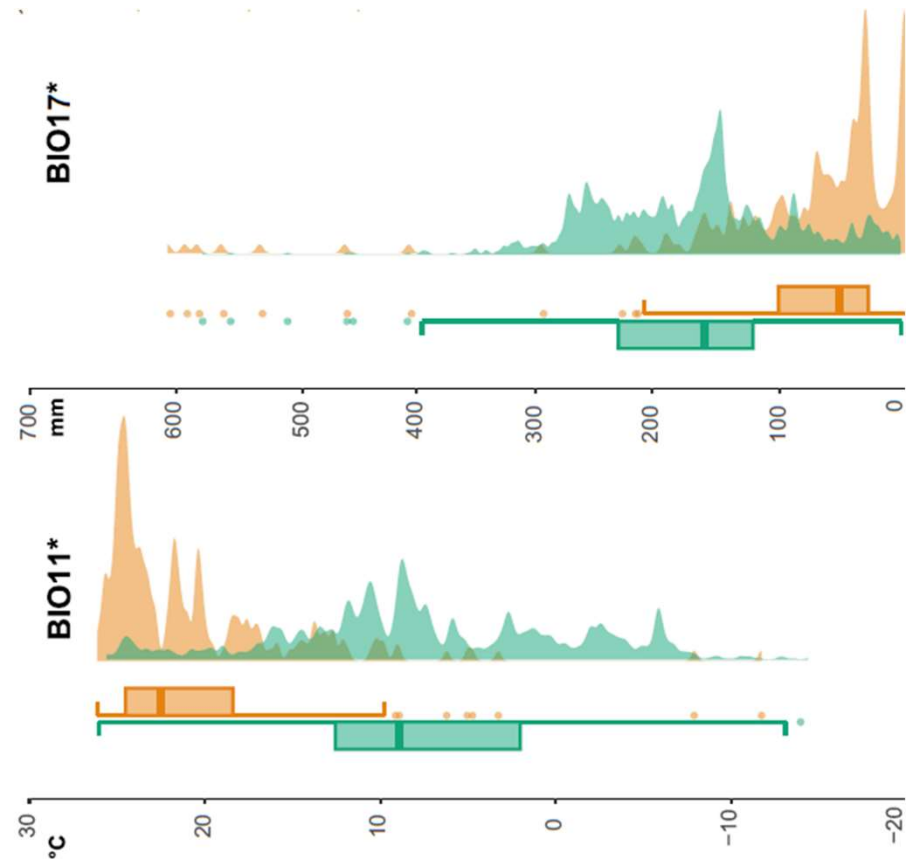


Niche overlap



Spodoptera frugiperda:

- native range
- invasive range



Primjena modela: širenje alohtonih / invazivnih vrsta



Research article | [Open Access](#) |

Plant invasion in Mediterranean Europe: current hotspots and future scenarios

[Luigi Cao Pinna](#), [Laure Gallien](#), [Laura J. Pollock](#), [Irena Axmanová](#), [Milan Chytrý](#), [Marco Malavasi](#), [Alicia T. R. Acosta](#), [Juan Antonio Campos](#), [Marta Carboni](#)

First published: 05 March 2024 | <https://doi.org/10.1111/ecog.07085> | [VIEW METRICS](#)

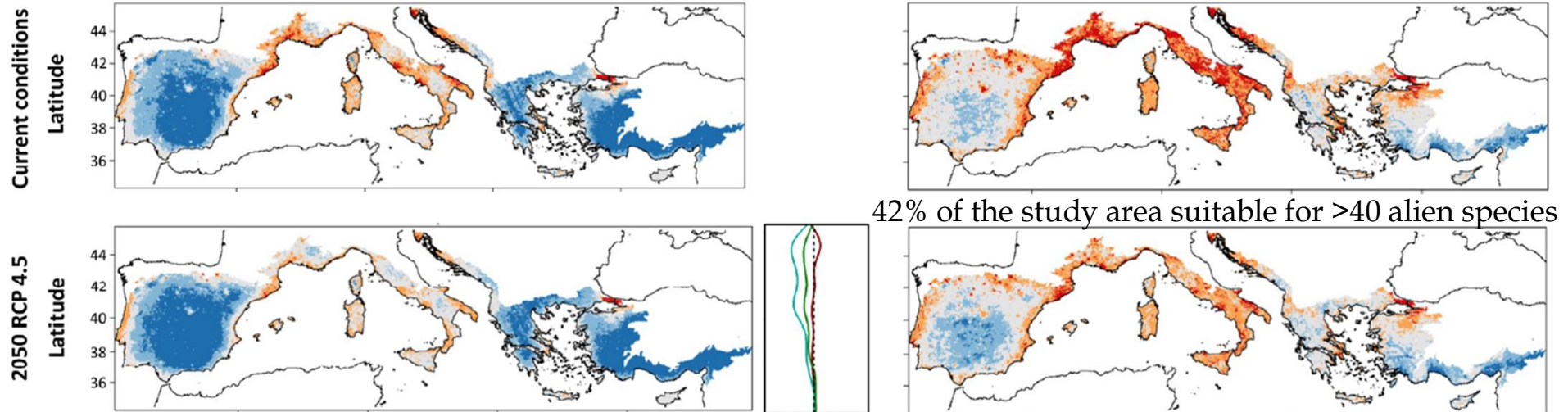
- 92 alien plant species widespread in Mediterranean Europe (EVA & GBIF)
- compiled data on their distribution in the Mediterranean and worldwide
- invasion is an ongoing process

Number of alien species

< 10 **< 20** **Non hotspots/coldspot** **> 40** **> 60**

Regional niche model

Global niche model



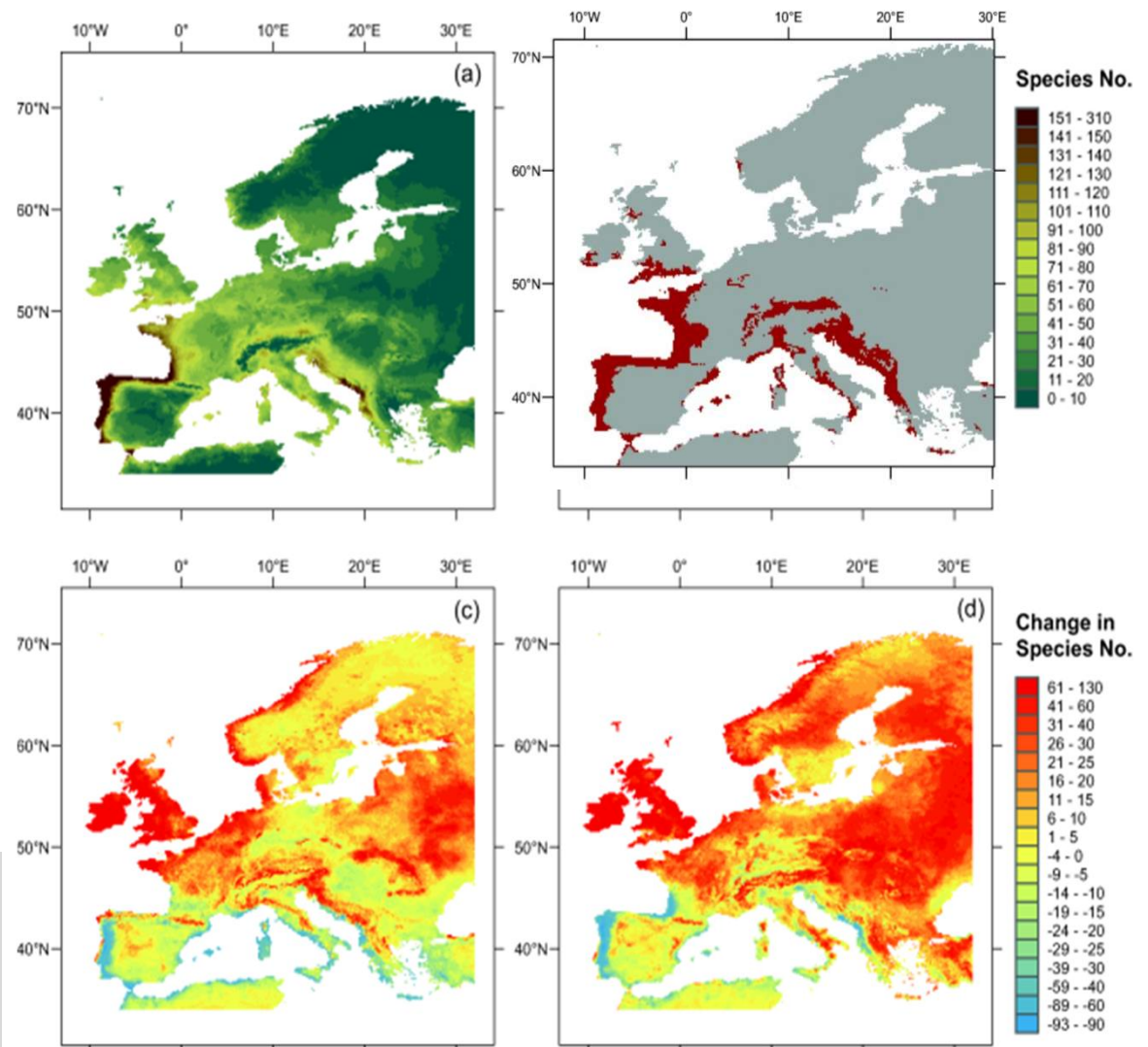
Climate change will increase the naturalization risk from garden plants in Europe

Iwona Dullinger [✉](#) Johannes Wessely, Oliver Bossdorf, Wayne Dawson, Franz Essl, Andreas Gatttringer, Günther Klöner, Holger Kreft, Michael Kuttner, Dietmar Moser, Jan Pergl, Petr Pyšek ... See all authors [v](#)

First published: 25 August 2016 | <https://doi.org/10.1111/geb.12512> | [VIEW METRICS](#)

- Procjena rizika naturalizacije ukrasnih alohtonih vrsta koje se uzgajaju u Europskim vrtovima u hortikulturi (783 vrste)
- Under current climate, **165 species** would already find suitable conditions in **> 5% of Europe**
- risk of naturalization will increase with warming climate

Naturalizacija je proces koji započinje kad unesena svojta savlada abiotičke i biotičke prepreke svojem preživljavanju, te započinje normalnu reprodukciju na novo nastanjenom području.



- projected climatic suitability for **783 ornamental species**
- species naturalized anywhere in the world **but not yet in Europe**

Primjena modela: translokacije, reintrodukcije, restoracije, kultivacije



RESEARCH ARTICLE | [Open Access](#) |

Using species distribution models and decision tools to direct surveys and identify potential translocation sites for a critically endangered species

Arabella C. Eyre , Natalie J. Briscoe, Dan K. P. Harley, Lindy F. Lumsden, Leo B. McComb, Pia E. Lentini

First published: 18 January 2022 | <https://doi.org/10.1111/ddi.13469> | [VIEW METRICS](#)



Global Ecology and Conservation

Volume 19, July 2019, e00653



Original Research Article

Species distribution models with field validation, a key approach for successful selection of receptor sites in conservation translocations

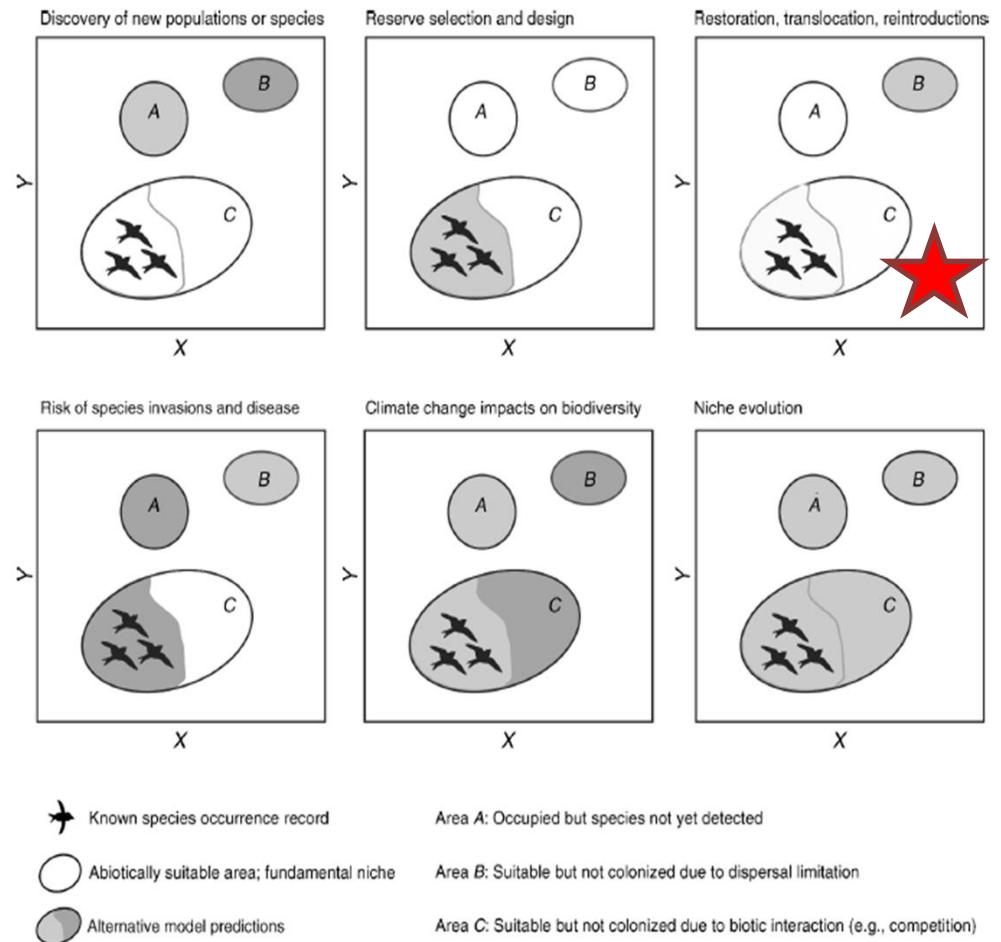
David Draper ^{a,b} , Isabel Marques ^{a,c}, José María Iriondo ^d

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Satureja cuneifolia (A), *S. subspicata* (B),
S. x karstiana (C) and *S. montana* (D).



Comparative assessment of habitat suitability and niche overlap of three medicinal and melliferous *Satureja* L. species (Lamiaceae) from the eastern Adriatic region: Exploring potential for cultivation

Ivica Ljubičić^a, Filip Varga^{b,c} ✉, Sandro Bogdanović^{a,c}, Lucija Sklepić^d, Mihaela Britvec^a,
Martina Temunović^e

