

Species distribution models: from theory to practice

Global change ecology
AA 2019-20

Introduction

my dreams vs my reality



The course for dummies

Language

Teacher

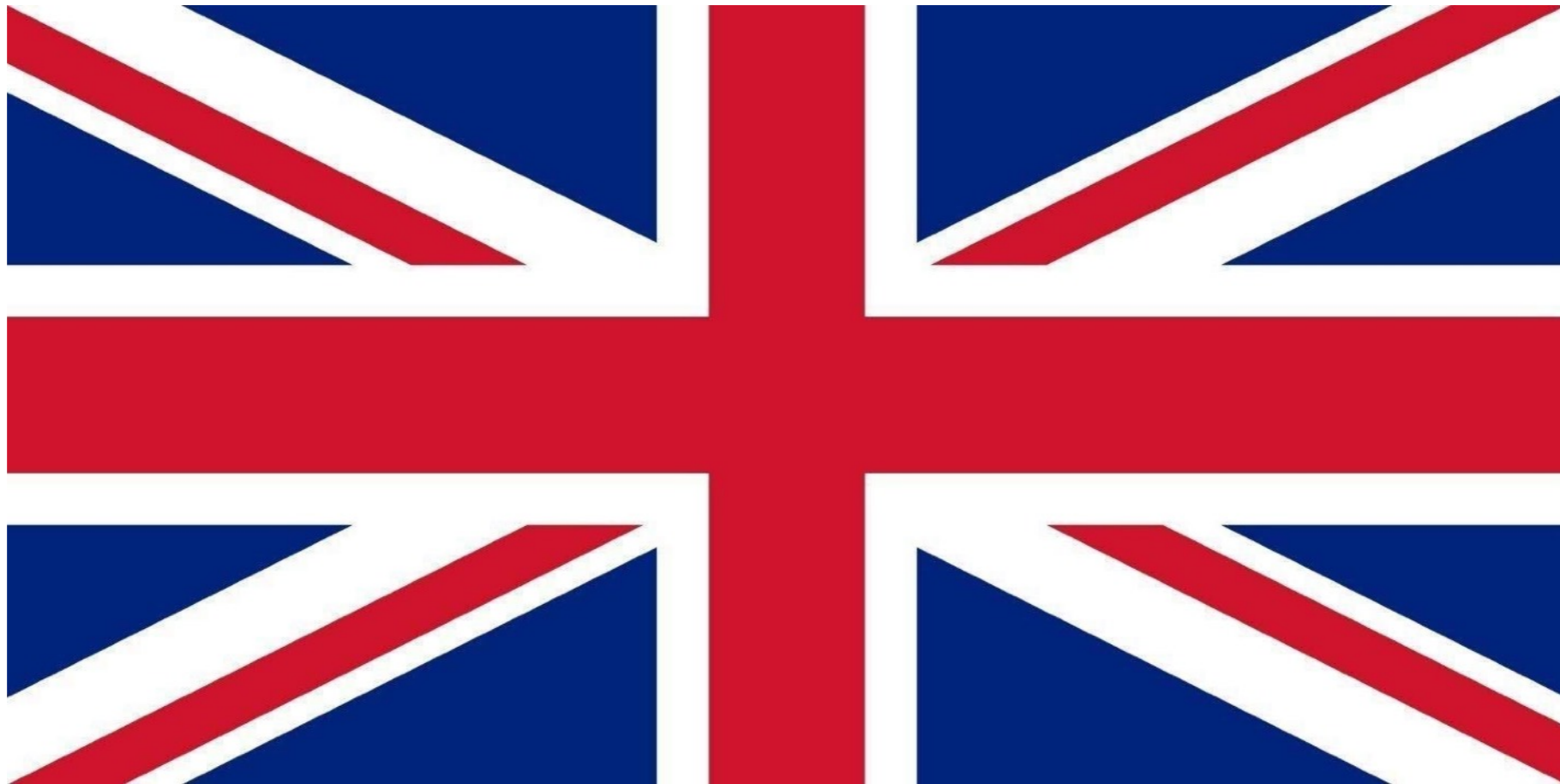
Topic

Schedule


Classes

Materials

Test



<http://dryades.units.it/SM/>



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Department of Life Sciences
University of Trieste, Italy

Contacts

Bibliography

Teaching

Conferences and meetings

Restricted area

f G ✉

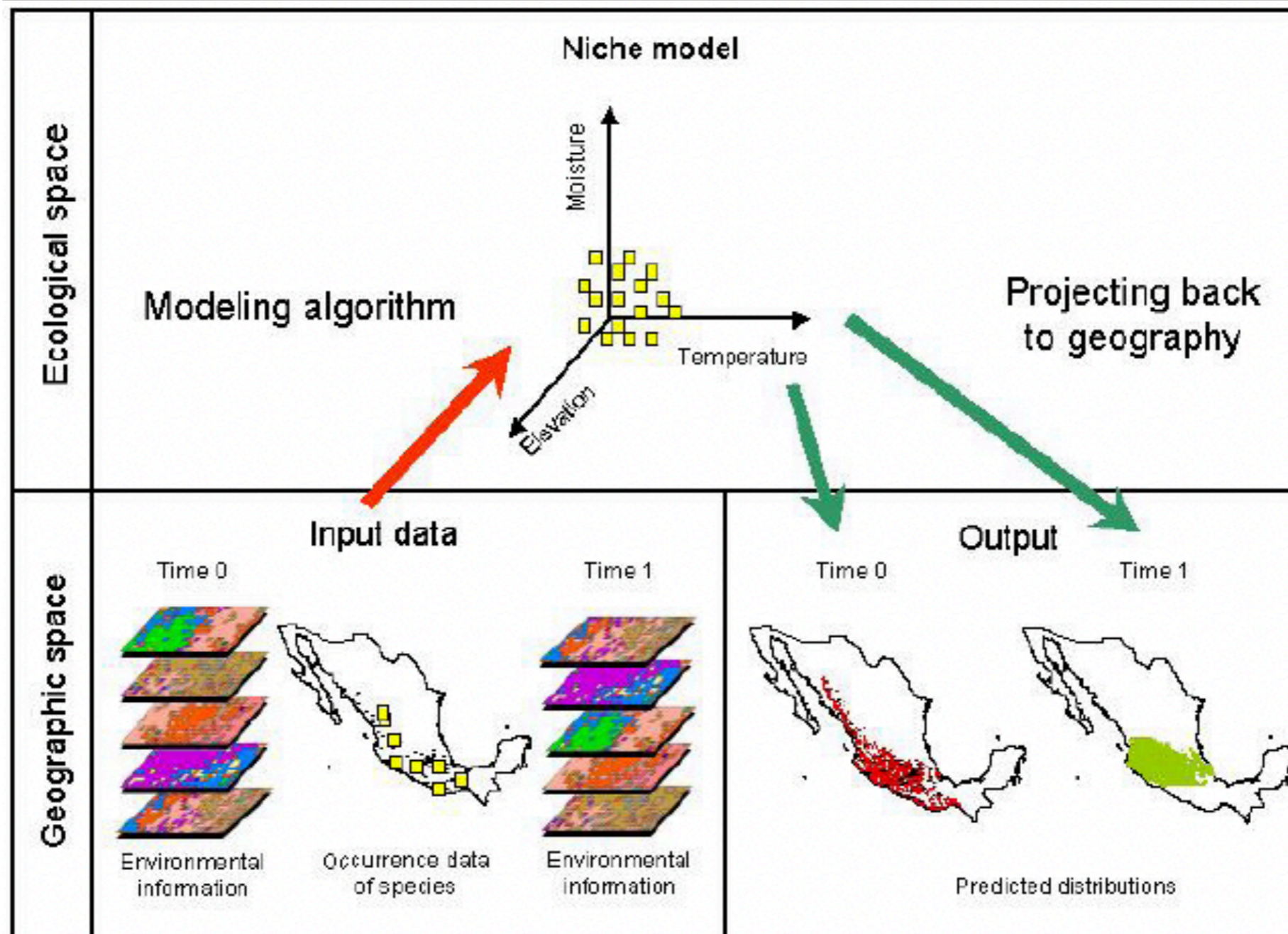
About me



I graduated in Biological Sciences in 1999, and defended my PhD thesis in 2005, at the University of Trieste (NE Italy). Since then I worked at the former Dept. of Biology (now Dept. of Life Sciences) of the University of Trieste, dealing mostly with lichens and biodiversity informatics.

I participated to several national and international projects, and coordinated the LIFE+ project CSMON-LIFE.

Curriculum vitae



Good question.....



Dream:
Frontal lessons
Groupwork
Q&A sessions

Reality:
Streaming
?

So what?

The screenshot shows the Moodle interface for the course 'SM57 - ECOLOGIA DEI CAMBIAMENTI GLOBALI' at the University of Trieste. The course is part of the 'Dipartimento di Scienze della Vita' and 'Laurea Magistrale' program. The course title is '985SV - MODELLI DI DISTRIBUZIONE DELLE SPECIE: DAL...'. The user is logged in as 'STEFANO MARTELLOS'. The course materials are listed as 'First class', 'Second class', and 'Third class'. A red box highlights the materials: 'Slides + Scientific papers + R scripts'.

Messaggi

UNIVERSITÀ DEGLI STUDI DI TRIESTE

Cerca corsi

Moodle@UniTs Corsi Supporto Dashboard Eventi I miei corsi Questo corso

Attiva modifica

Dipartimento di Scienze della Vita > Laurea Magistrale > SM57 - ECOLOGIA DEI CAMBIAMENTI GLOBALI > A.A. 2019 - 2020

985SV - MODELLI DI DISTRIBUZIONE DELLE SPECIE: DAL...

Ricerca nei forum

Vai

Ricerca avanzata ?

Annunci recenti

Aggiungi nuovo argomento...

Inizio e modalità delle lezioni
10 mar 2020, 17:37:05 STEFANO MARTELLOS

Argomenti precedenti ...

Prossimi eventi

Non ci sono eventi prossimi

Annunci

First class

Second class

Third class

Slides
+
Scientific papers
+
R scripts

**A discussion on the main theoretical topics
of the course.**

**Your practical work will be evaluated
during the practical classes
(if we will be able to have any....)**



Question Time

Let's start with an example....

Non sicuro — dryades.units.it


la Repubblica -... Botanica Sistem... Species distribu... A very brief intr... specie endemic... Biodiversità in It... Download Portale della Flo... Crocus biflorus...

Crocus biflorus Mill.


Endemica / Endemic
Abruzzo; Basilicata; Calabria; Campania; Emilia-Romagna; Friuli Venezia Giulia; Lazio; Liguria; Lombardia; Marche; Molise; Piemonte; Puglia; Sicilia; Trentino-Alto Adige; Toscana; Umbria; Veneto;









Iridaceae Juss.
 Asparagales Link
 Liliales Takht.
 Magnoliidae Novák ex Takht.

APG IV
 Angiosperm
 Phylogeny
 Group IV system



Andrea Moro
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presente present	segnalazioni storiche historical records	segnalazioni erranee wrong records	segnalazioni dubbie doubtful records
			
estinta extinct	alloctona invasiva invasive alien	alloctona naturalizzata naturalized alien	alloctona casuale casual alien

la Repub Botonica S Species distrib... A very brief intr... specie endemi... Biodiversità in I... Download Portale della Fl... Alnus cordata (... Crocus biflorus... +

Get data How-to Tools Community About flechte

DOWNLOAD | 28 MARCH 2020

Under processing

DOI 10.15468/dl.ybbr0p

Preparing CANCEL

FILTER APPLIED 28 MARCH 2020 RERUN QUERY

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Please expect up to 3 hours for the download to complete. Most downloads will complete within 15 minutes.
A notification email with a link to download the results will be sent to the following address once ready: martelst@units.it

Citation: GBIF.org (28 March 2020) GBIF Occurrence Download <https://doi.org/10.15468/dl.ybbr0p>
License: Unspecified
Make sure to read the [data user agreement](#) and [citation guidelines](#).

API

And

- Geometry POLYGON((6.50391 36.17336,18.54492 36.17336,18.50098 47.10004,6.54785 47.07012,6.50391 36.17336))
- Has coordinate true
- Scientific name Crocus biflorus Mill.
- Has geospatial issue false

gbif.org

la Repubblica - News i... Botonica Sistemtica -... Species distribution m... A very brief introductio... specie endemiche alpi... Biodiversità in Italia -... Occurrence search

Get data How-to Tools Community About

flechte

Occurrences 3

SEARCH OCCURRENCES | 35,996 RESULTS

TABLE GALLERY MAP TAXONOMY METRICS DOWNLOAD

Scientific name	Country or area	Coordinates	Month & year
<i>Larix decidua</i> Mill.	Italy	46.1N, 11.8E	2020 January
<i>Larix decidua</i> Mill.	Switzerland	46.8N, 9.8E	2020 February
<i>Larix decidua</i> Mill.	Italy	44.8N, 7.2E	2020 March
<i>Larix decidua</i> Mill.	Italy	44.8N, 7.2E	2020 March
<i>Larix decidua</i> Mill.	France	44.7N, 6.4E	2019 January
<i>Larix decidua</i> Mill.	Italy	45.9N, 10.8E	2019 February
<i>Larix decidua</i> Mill.	Italy	46.7N, 10.8E	2019 March
<i>Larix decidua</i> Mill.	Italy	45.0N, 7.2E	2019 March
<i>Larix decidua</i> Mill.	Slovenia	45.9N, 15.0E	2019 April
<i>Larix decidua</i> Mill.	Italy	44.5N, 6.9E	2019 April
<i>Larix decidua</i> Mill.	Italy	46.3N, 10.8E	2019 April
<i>Larix decidua</i> Mill.	Switzerland	46.2N, 7.1E	2019 April
<i>Larix decidua</i> Mill.	France	45.9N, 6.4E	2019 April

Machine observation 0

Human observation 35,805

Material sample 0

Literature 0

Preserved specimen 57

Fossil specimen 22

Living specimen 2

Unknown 5

Location

No preference

Including coordinates

Without coordinates

Include records where coordinates are flagged as suspicious

Non sicuro — dryades.units.it


la Repubblica -... Botonica Sistem... Species distribu... A very brief intr... specie endemic... Biodiversità in It... Download Portale della Flo... Fraxinus ornus...

Fraxinus ornus L. subsp. ornus


Abruzzo; Basilicata; Calabria; Campania; Emilia-Romagna; Friuli Venezia Giulia; Lazio; Liguria; Lombardia; Marche; Molise; Piemonte; Puglia; Sardegna; Sicilia; Trentino-Alto Adige; Toscana; Umbria; Valle d'Aosta; Veneto;









Oleaceae Hoffmanns. & Link
 Lamiales Bromhead
 Asteranae Takht.
 Magnoliidae Novák ex Takht.

APG IV
 Angiosperm
 Phylogeny
 Group IV system



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DOI 10.15468/dl.mrmar4

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Please expect up to 3 hours for the download to complete. Most downloads will complete within 15 minutes.
A notification email with a link to download the results will be sent to the following address once ready: martelst@units.it

Citation: GBIF.org (28 March 2020) GBIF Occurrence Download <https://doi.org/10.15468/dl.mrmar4>
License: Unspecified
Make sure to read the [data user agreement](#) and [citation guidelines](#).

And API

Geometry	POLYGON((5.29672 35.88961,20.14938 35.88961,20.14938 47.49916,5.29672 47.49916,5.29672 35.88961))
Has coordinate	true
Scientific name	Fraxinus ornus L.
Has geospatial issue	false

- BIO1 = Annual Mean Temperature
- BIO2 = Mean Diurnal Range (Mean of monthly (max temp - min temp))
- BIO3 = Isothermality (BIO2/BIO7) ($\times 100$)
- BIO4 = Temperature Seasonality (standard deviation $\times 100$)
- BIO5 = Max Temperature of Warmest Month
- BIO6 = Min Temperature of Coldest Month
- BIO7 = Temperature Annual Range (BIO5-BIO6)
- BIO8 = Mean Temperature of Wettest Quarter
- BIO9 = Mean Temperature of Driest Quarter
- BIO10 = Mean Temperature of Warmest Quarter
- BIO11 = Mean Temperature of Coldest Quarter
- BIO12 = Annual Precipitation
- BIO13 = Precipitation of Wettest Month
- BIO14 = Precipitation of Driest Month
- BIO15 = Precipitation Seasonality (Coefficient of Variation)
- BIO16 = Precipitation of Wettest Quarter
- BIO17 = Precipitation of Driest Quarter
- BIO18 = Precipitation of Warmest Quarter
- BIO19 = Precipitation of Coldest Quarter

The screenshot shows the WorldClim website interface. At the top, there is a navigation bar with the WorldClim logo and a 'Home' link. Below the navigation bar, a text block explains that users can download standard (19) WorldClim bioclimatic variables for WorldClim version 2, which are averages for the years 1970-2000. Each download is a 'zip' file containing 19 GeoTiff (.tif) files, one for each month. To the right of this text is a box containing three links: 'Historical climate data', 'Historical monthly weather data', and 'Future climate data'.

Below this text is a table showing download options for bioclimatic variables:

variable	10 minutes	5 minutes	2.5 minutes	30 seconds
Bioclimatic variables	bio 10m	bio 5m	bio 2.5m	bio 30s

Below the table, a text block provides reference information: 'For reference, here is the elevation data that was used to produce WorldClim 2.1. These were derived from the SRTM elevation data.' This is followed by another table showing download options for elevation data:

variable	10 minutes	5 minutes	2.5 minutes	30 seconds
Elevation	elev 10m	elev 5m	elev 2.5m	elev 30s

Below the elevation table, there is a 'Citation:' section with a text box containing the following citation: 'Fick, S.E. and R.J. Hijmans, 2017. WorldClim 2: new 1km spatial resolution climate surfaces for global land areas. *International Journal of Climatology* 37 (12): 4302-4315.'

At the bottom of the page, there is a text block stating: 'The development of WorldClim v2 was supported by a grant from Feed the Future to the Geospatial and Farming Systems Consortium of the Sustainable Intensification Innovation Lab.'

Let's switch to R Studio.

Does it seem simple?

However, this is indeed the simplest part of the job.

What is missing is the preparation of data.

And the interpretation part.

**Plus, several questions do arise
since the very beginning....**

Modelling what?

What are we modelling?

The actual distribution?

The realized, or fundamental niche?

Or habitat suitability?

First of all, however, we must answer to the following questions:

Why a given population is present in, or absent from, a given area?

Which are the drivers that shape the distribution of individuals of a species in the geographical space?

Species' distribution is mostly influenced by 4 groups of factors:

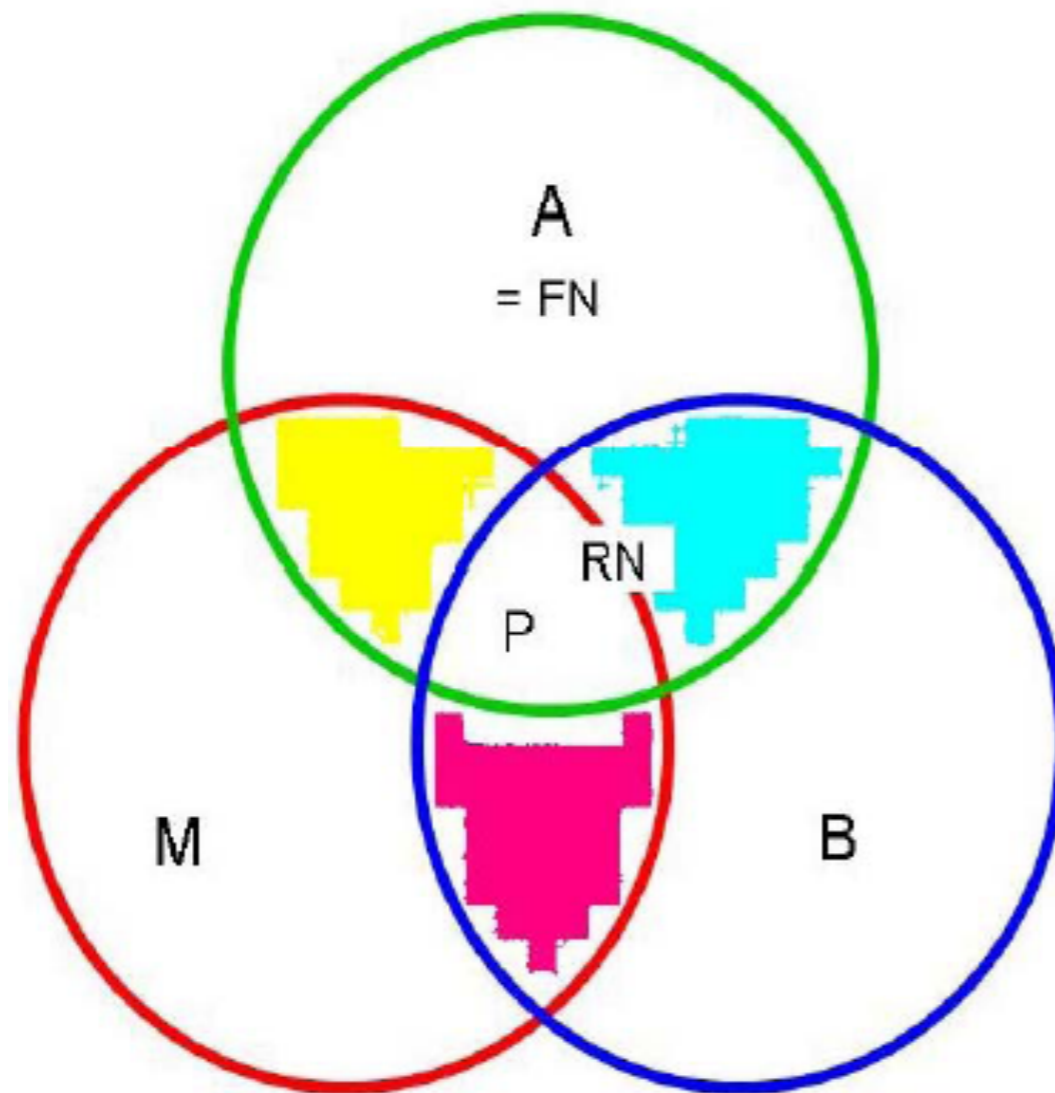
- abiotic conditions, which impose physiologic limits to the presence of a given taxon in a given area.
- biotic conditions, i.e. all the interactions of a taxon with the other organisms in the area.
- dispersal, i.e. the capability of a taxon to actually reach different areas in which abiotic conditions are suitable for its survival.
- evolution i.e. the capacity of a taxon to change in time. This factor, anyway, has little influence in short time lapses.

These factors interact to define the actual distribution of a taxon. Such interaction has different strength at different scale.

A taxon is present in a given area when:

1. physical and chemical factors permit a positive, density-independent fitness.
2. the overall interactions with all other livings produce a positive biotic, density-dependent fitness.
3. the area is accessible to the taxon. This factor can change along time, hence modifying the distribution of organisms.

Modelling what?



A = abiotic niche

B = biotic niche

M = accessible area

FN = fundamental niche

RN = realised niche

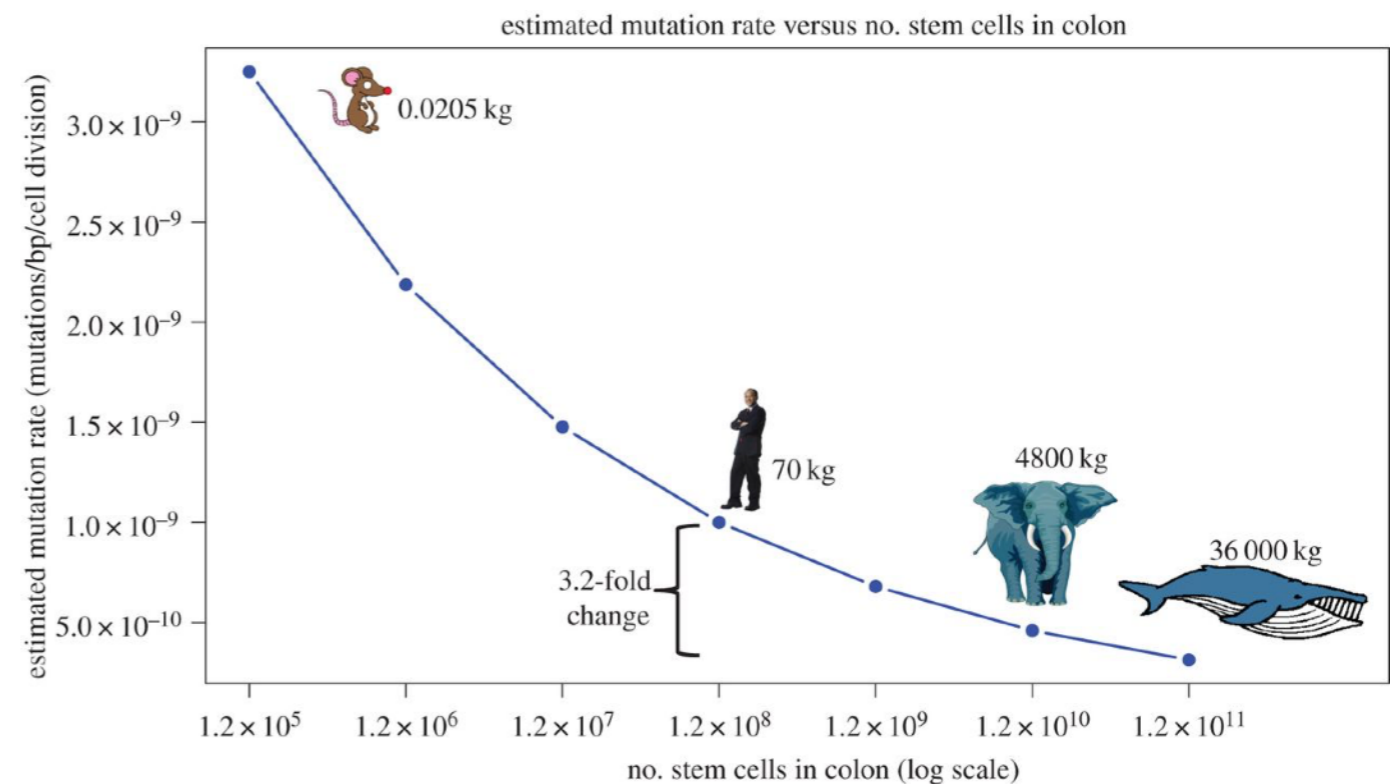
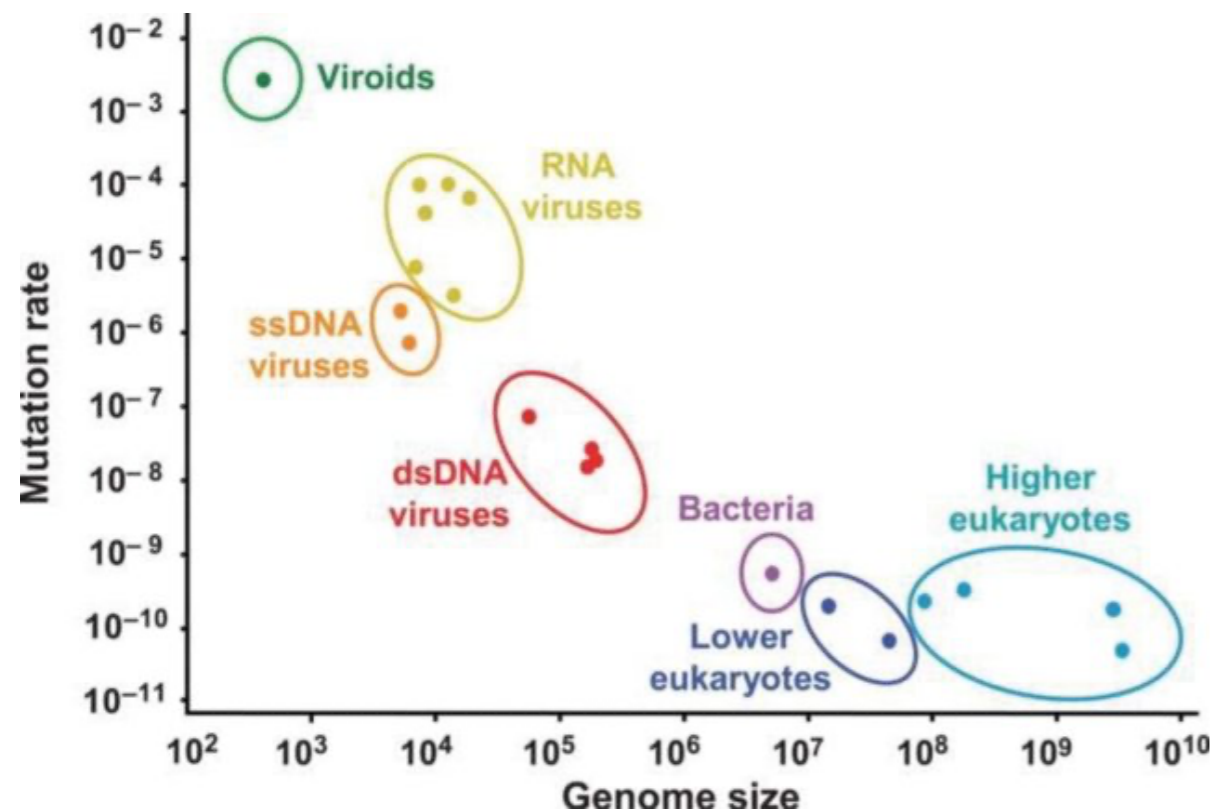
P = actual distribution

Evolution

We must bear in mind that this factor normally works on long times, thus is normally not affecting the present distribution of a species.

However...

While this is true, the time required for evolution does vary in different organisms. Certainly, in plants and animals it is normally not relevant. But when smaller organisms, with high mutation rates, and high number of generations per year, are taken into account, evolution could become relevant at a short temporal scale.



Dispersal

The capacity of dispersal of a species can account for its presence in a given area, and for its absence from other areas, in which climatic conditions could potentially allow its colonization.

The accessible area for a given species, at a given time, is the whole area within the colonizable reach of existing populations, i.e. where migration is not impeded by natural or human-made barriers to dispersal.

For the future conditions, it encompasses those areas that can be naturally colonized in the future, e.g. if species change their distribution in response to climate change or following invasions.

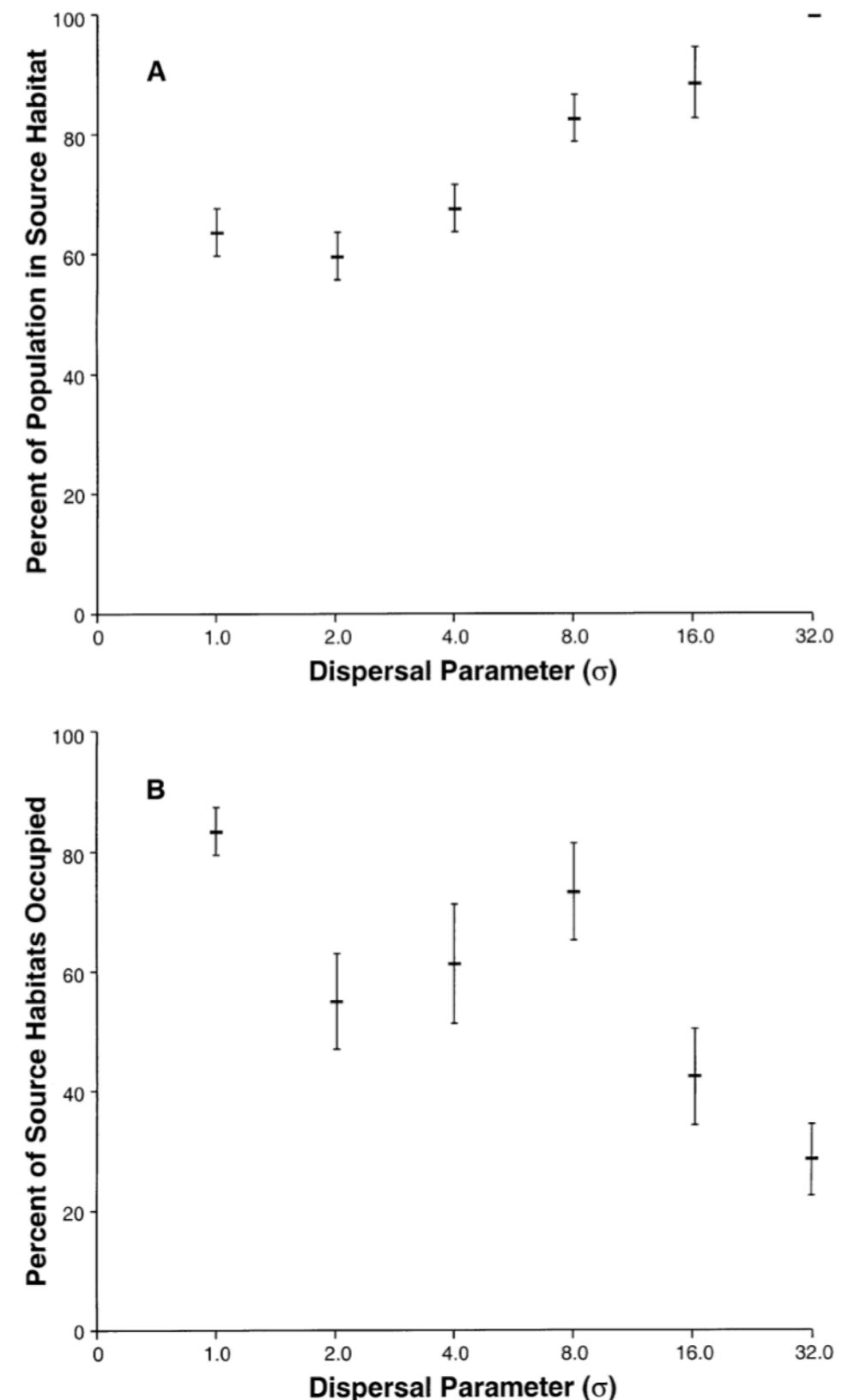
Evolution can affect dispersal, since mutations can improve or reduce dispersal ability of a taxon, or of one or more of its populations.

Dispersal

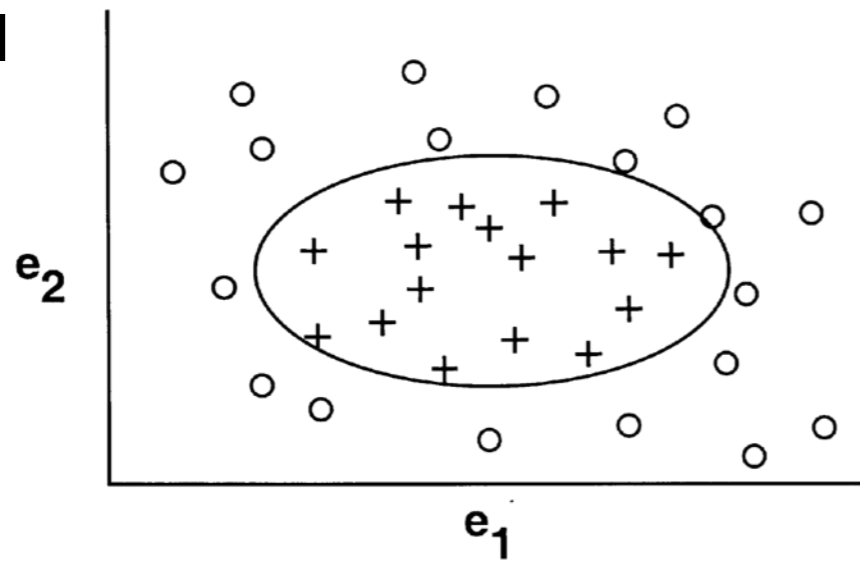
When dispersal rate is high (dispersal parameter < 2), often the portion of population which occurs in source habitat is lower than when dispersal is low (A). In the latter case, the amount of organisms occurring in sink populations is close to zero.

This increase in the percentage of the population in source habitat occurs despite a decrease in the fraction of source patches occupied (B).

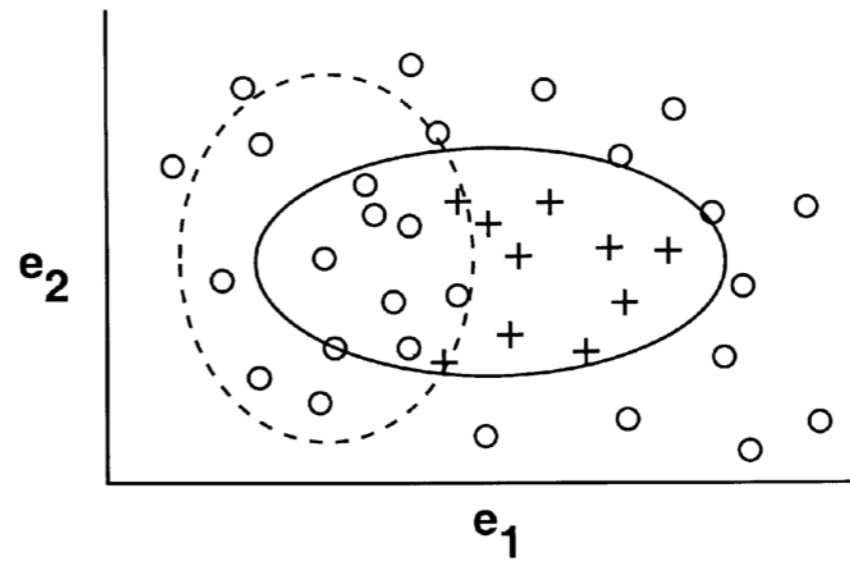
These two trends taken together depicted a situation described by the source-sink dynamics theory, with a high fraction of the population occurring outside the bounds of the niche when dispersal is high and a large fraction of empty suitable sites when dispersal is low.



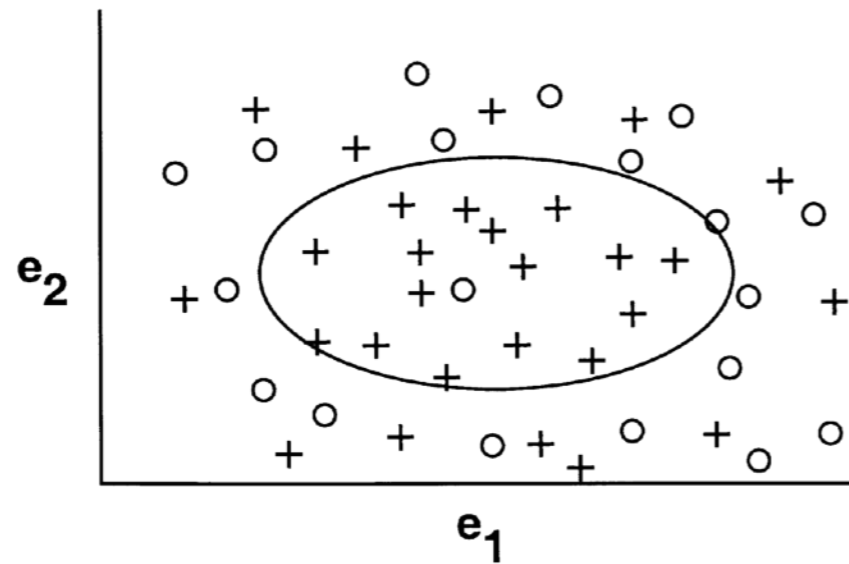
Dispersal



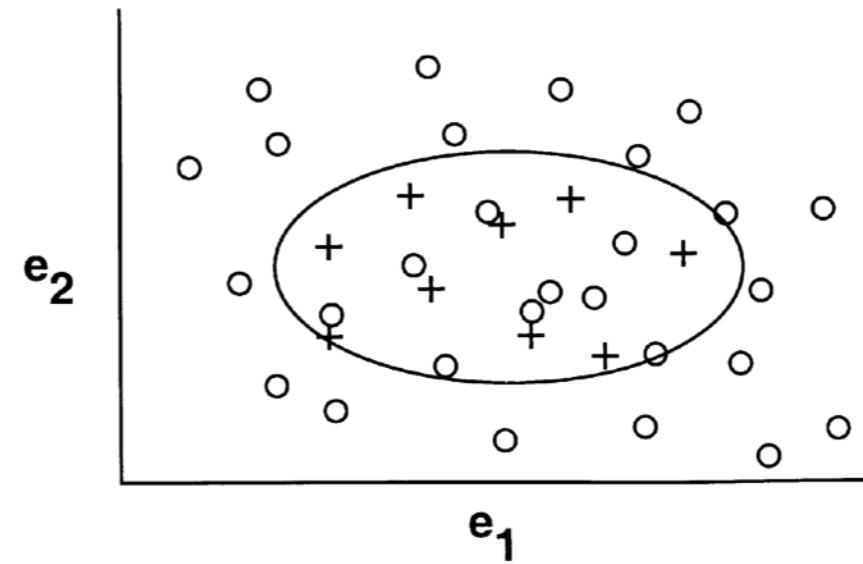
A. Grinnellian Niche



B. Hutchinsonian Realized Niche



C. Source-Sink Dynamics



D. Dispersal Limitation