GIUSEPPE CORRIERO
University of Bari – Department of Biology
*Coordinator of **Alien Species Show Case** - LifeWatch Ita*

Modellistica e carte di rischio in ambiente acquatico: specie aliene, tratte di navigazione e attività economiche

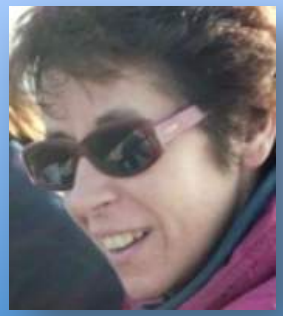
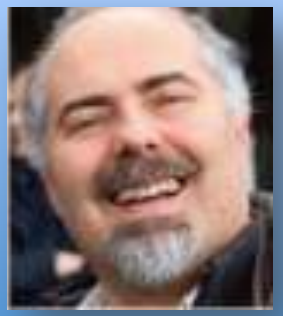
LifeWatch
e-Science European Infrastructure
for Biodiversity and Ecosystem Research

ATTIVITÀ IN CORSO & PRIORITA' STRATEGICHE

CENTRO TEMATICO MEDITERRANEO

Dino Pierri, Paolo Colangelo, Angela Boggero, Giorgio Matteucci



15 – 17 Febbraio 2016 ROMA

ALIEN SPECIES DEFINITION

FRESH WATER

Species deliberately or inadvertenly introduced to Italy by human activities after the discovery of the new word by C. Colombo

MARINE

IN THE MEDITERRANEAN TWO MAJOR BENCHMARKS ARE RECOGNIZED:

- 1869, the opening of the Suez Canal (Zenetos *et al*., 2010)
- 1945, the end of the second world war and the increasing traffic due to shipping, aquaculture and research (Occhipinti-Ambrogi *et al*., 2011; GSA-SIBM, 2012)

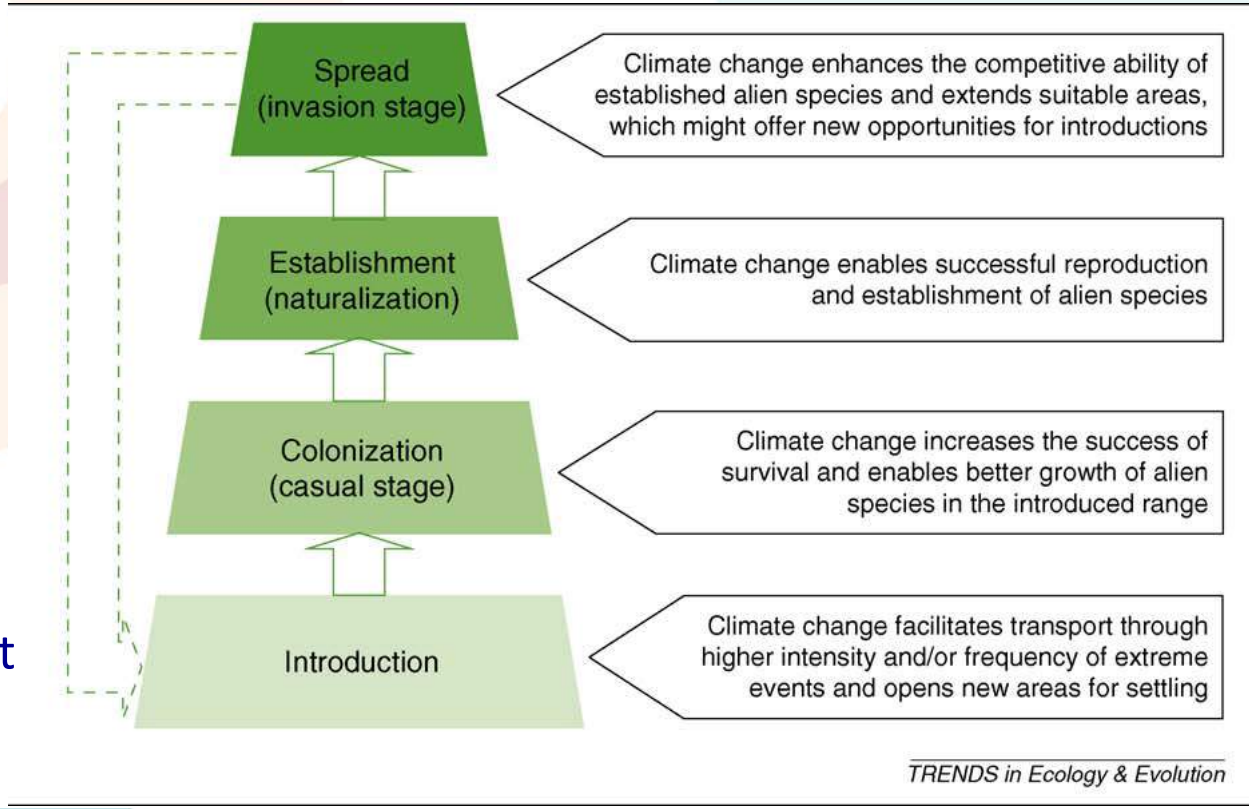
In the present study, all marine and lagoon species introduced into Italian waters since the opening of the Suez Canal are considered as aliens

No differences between invasive and naturalized AS have been considered….so the term alien was used in its broadest sense

INTRODUCTORY CONSIDERATIONS

- AS are considered one of the major threat to biodiversity, even though their role is going to be reconsidered

  - Influence of AS on both ecosystem structure and functioning (Vila et al, 2011)
  - Climate change is driving new colonisation and AS invasion (Walther et al., 2009)



INTRODUCTORY CONSIDERATIONS

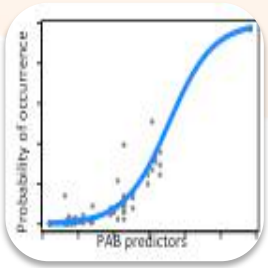
- On the other hand……
  - Most of AS are innocuous (Leung et al, 2012);
  - We are looking at AS invasion using a wrong temporal scale (i.e., too short) and focusing on processes at dis-equilibrium;
  - Evidence of massive invasions with negligible extinctions occurs, at least in plants

RESEARCH QUESTIONS

Identify emergent patterns regarding the potential drivers of occurrence and richness of AS in freshwater, marine and transitional ecosystems

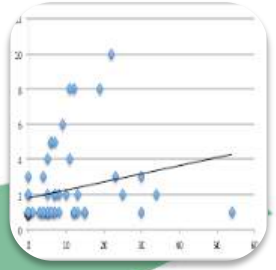
Habitat vulnerability

Are different EUNIS habitat more or less susceptible to invasion?



Invasion drivers

Which abiotic, biotic and pressure attributes of the recipient site affect invasion probabilities?



Determinants of AS richness

What are the determinants of high or low AS richness in the invaded sites?

THE ALIEN SPECIES CASE STUDY

- Invasion biology often focus on single alien taxon or group of related species (i.e. genera, family, orders)
- The availability of large database (i.e. LW database) allows to **test generalized invasion patters in a macroecological framework**:
  - Multiple taxa
  - Multiple habitat
  - Multiple sites

LTER ITALY

UNIVERSITY OF BARI
UNIVERSITY OF SALENTO
UNIVERSITY OF CAMERINO
UNIVERSITY OF FERRARA
UNIVERSITY OF FIRENZE
UNIVERSITY OF GENOVA
UNIVERSITY OF MOLISE
UNIVERSITY OF PARMA
UNIVERSITY OF PERUGIA
UNIVERSITY OF ROMA 3
UNIVERSITY OF ROMA «LA SAPIENZA»
UNIVERSITY OF ROMA "TOR VERGATA"
UNIVERSITY OF SASSARI
UNIVERSITY OF TORINO
UNIVERSITY OF VENEZIA "CA FOSCARI"
UNIVERSITY OF MARCHE
UNIVERSITY OF MILANO «BICOCCA»

CNR-ISE
CNR-ISMAR
CNR-IBBE
CNR-IREA
CNR-IBAF
CNR-IAMC

ENVIRONMENT AGENCY PUGLIA
ENVIRONMENT AGENCY OF BOLZANO
CORPO FORESTALE DELLO STATO
SZN ANTON DOHRN
OGS TRIESTE

Mediterranean Thematic Centre

Case study

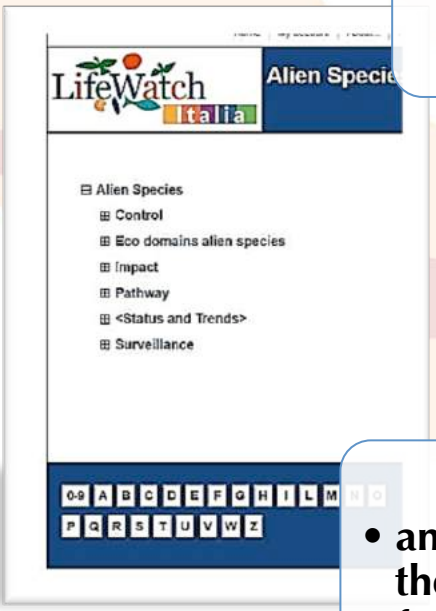
Habitat vulnerability to Alien Species Invasion

The **Biodiversity LifeWatch database** contains both native and alien species distributed within Eunis habitats along the Italian peninsula.

WHAT WAS DONE

- exploratory work on available data then increased over time

- Data Cleaning (taxonomic reliability and consistency) manually by the LW experts, then through the tools of data cleaning available on the LW portal

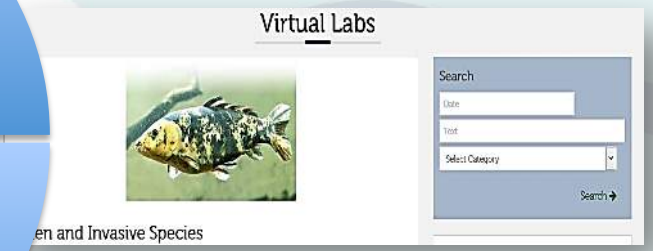


DATA GATHERING

VALIDATION

ALIEN SPECIES THESAURUS

DATA INTEGRATION



A VIRTUAL LAB

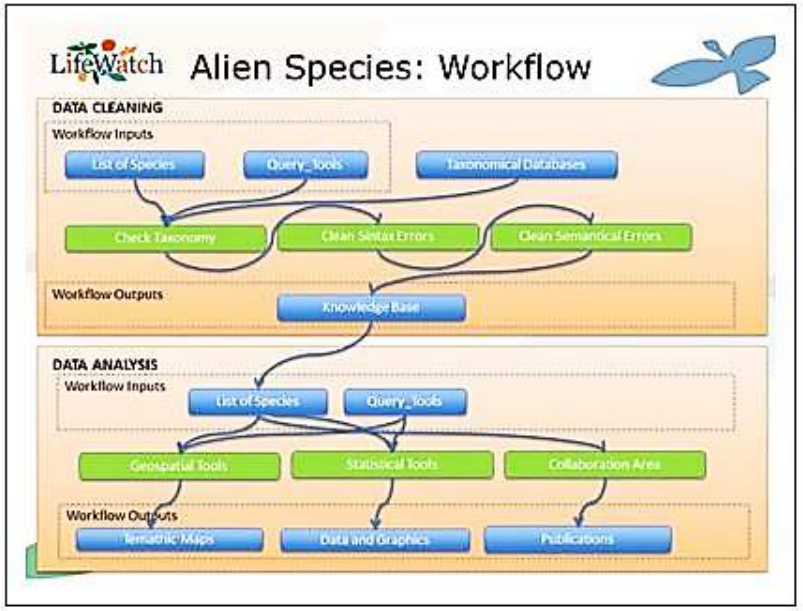
- an exhaustive thesaurus on AS for database management

- Metadata (surface, habitat, lat&long, year)
- AS Occurrence with ecological/ anthropic/ environmental drivers

DATA STANDARDISATION AND QUALITY CONTROL

Data standardisation:

- Sampling period
- Data source: biodiversity surveys (published or unpublished papers, reports, notes,…)
- Data homogeneity checked



Data cleaning by local/national experts:

- Taxonomic reliability
- Taxonomic consistency
- Assignment Alien /Native species

www.faunaitalia.it/checklist/ www.eunis.org omnidia.free.fr

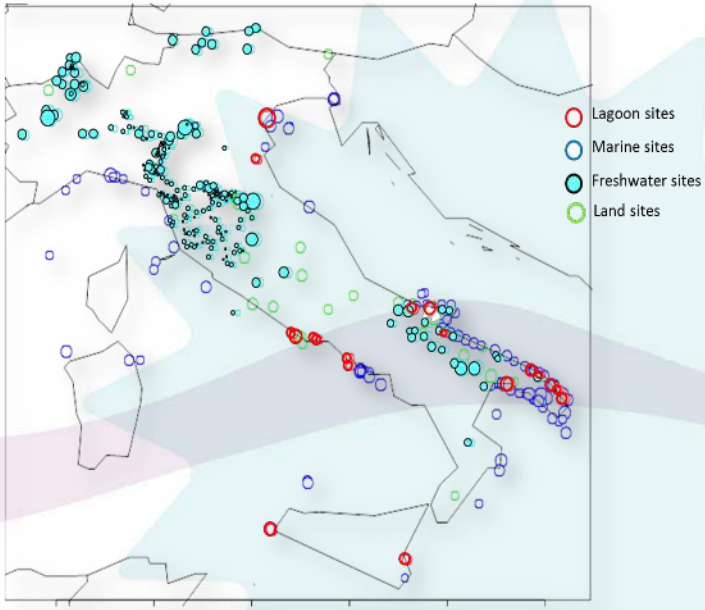
www.marinespecies.org www.ittiofauna.org www.fishbase.org

www.faunaeur.org www.algaebase.org scientific publications

The large database allows to test and describe generalized invasion patters

A large taxonomic, habitat and geographic coverage

34386 TOTAL OBSERVATIONS
12406 SPECIES
563 SITES
42 PHYLA
36 HABITATS (EUNIS LEVEL 2)
40 YEARS OF OBSERVATIONS



The **LifeWatch Biodiversity database** contains both native and alien species distributed within Eunis habitats along the Italian peninsula.

The accuracy of the results is linked to the spatial, ecological, taxonomic, and temporal data homogeneity.

Access to data is a priority strategy

Data papers

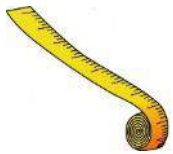
INTEGRATION OF DATA

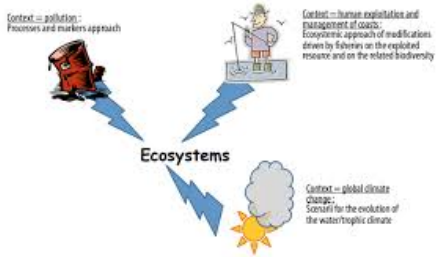
Data of occurrence were integrated with an array of variables abiotic on sites of observation.

Bioclimatic and environmental variables, interpolations of observed data, representative of 1950-2000

Annual Mean Temperature
Mean Diurnal Temp. Range
Isothermality
Temperature Seasonality
Max Temperature of Warmest Month
Min Temperature of Coldest Month
Temperature Annual Range
Mean Temperature of Wettest Quarter
Mean Temperature of Driest Quarter
Mean Temperature of Warmest Quarter
Mean Temperature of Coldest Quarter
Annual Precipitation
Precipitation of Wettest Month
Precipitation of Driest Month
Precipitation Seasonality
Precipitation of Wettest Quarter
Precipitation of Driest Quarter
Precipitation of Warmest Quarter
Precipitation of Coldest Quarter

Surface Chlorophyll-a Concentration (ChlA)
Annual Sea Surface Temperature 2009-2013
Distance (in min) from large cities
Distance (in km) from large harbors
Pathways and vectors
Anthropic pressure
Max length of a species (in mm)
Min salinity (PSU)
Mean salinity (PSU)
Max salinity (PSU)





WorldClim - Global Climate Data

Free climate data for ecological modeling and GIS

INTEGRATION OF DATA

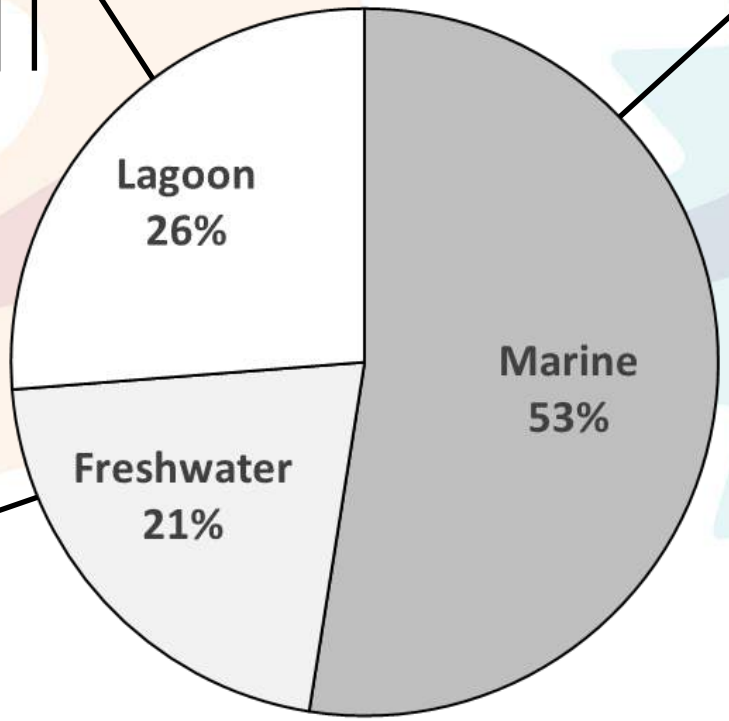
Maritime traffic

Aquaculture activities

DIFFERENT SPECIES IN DIFFERENT AQUATIC COMPARTMENTS

X02 saline lagoons
X03 brackish lagoons

1834 species



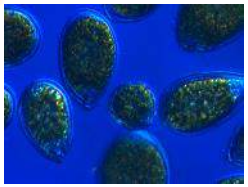
A1 littoral rocks
A2 littoral sediments
A3 infralittoral rocks
A4 circalittoral rocks
A5 sublittoral sediments
A6 deep sea beds
A7 pelagic waters

3962 species

C1 standing waters
C2 running waters
J5 artificial waters

1604 species

186 ALIEN SPECIES



Chordata

Myzozoa

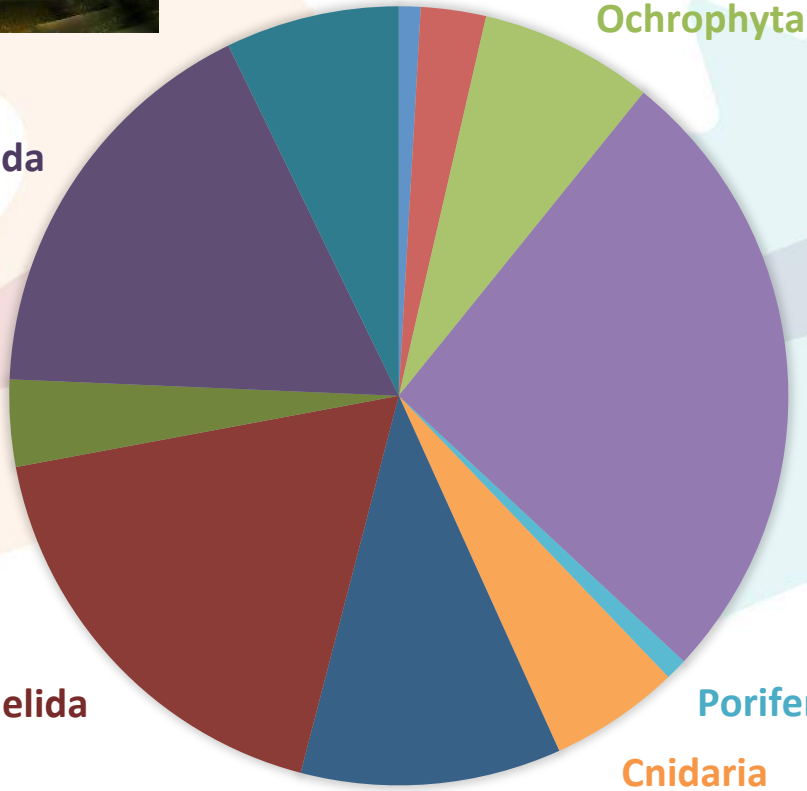
Chlorophyta

Ochrophyta

Arthropoda

Rhodophyta

Bryozoa



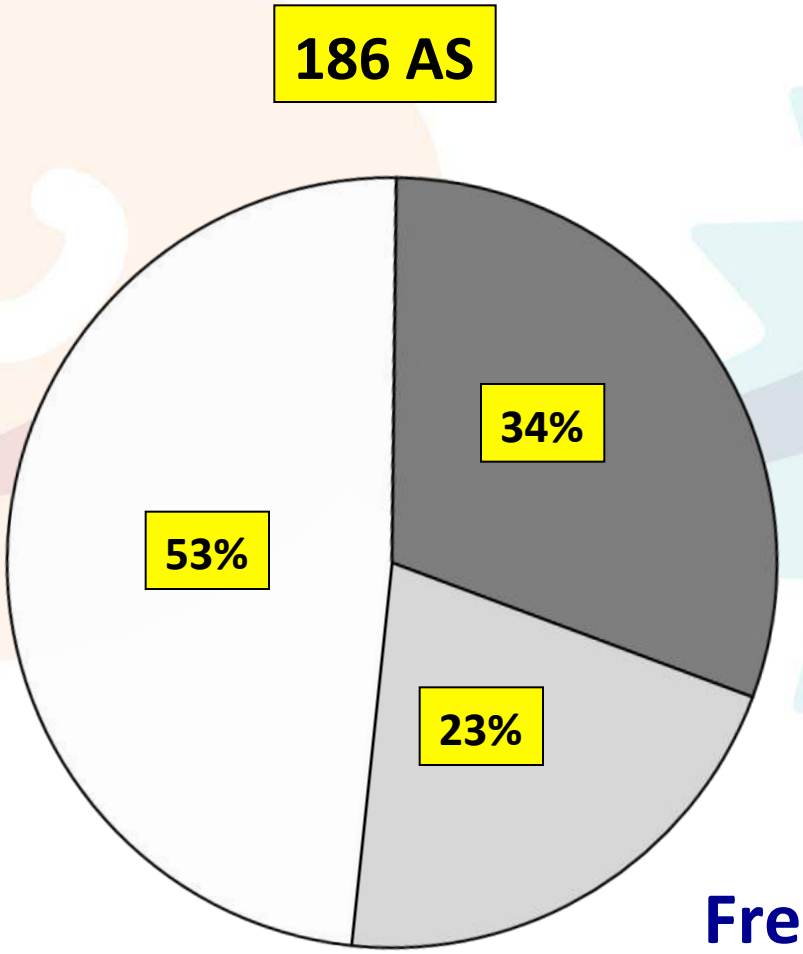
Porifera

Cnidaria

Annelida

Mollusca

ALIEN SPECIES IN DIFFERENT AQUATIC COMPARTMENTS

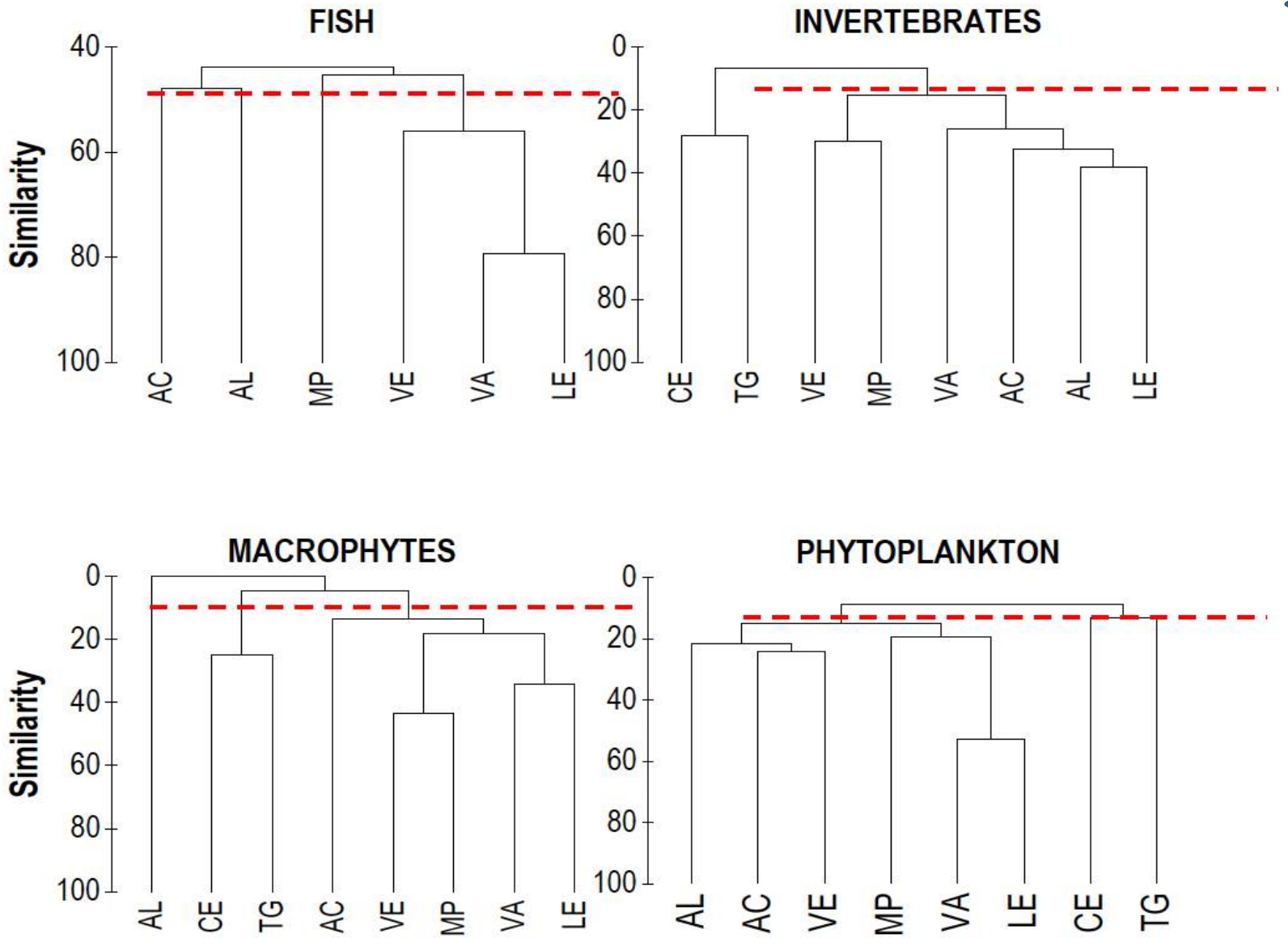


Marine
56 AS (1.5%)

Lagoon
78 AS (4.9%)

Fresh water
67 AS (2.6%)

LAGOON


FISH
Similarity
40
60
80
100
AC
AL
MP
VE
VA
LE
INVERTEBRATES
0
20
40
60
80
100
CE
TG
VE
MP
VA
AC
AL
LE
MACROPHYTES
Similarity
0
20
40
60
80
100
AL
CE
TG
AC
VE
MP
VA
LE
PHYTOPLANKTON
0
20
40
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AL
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VA
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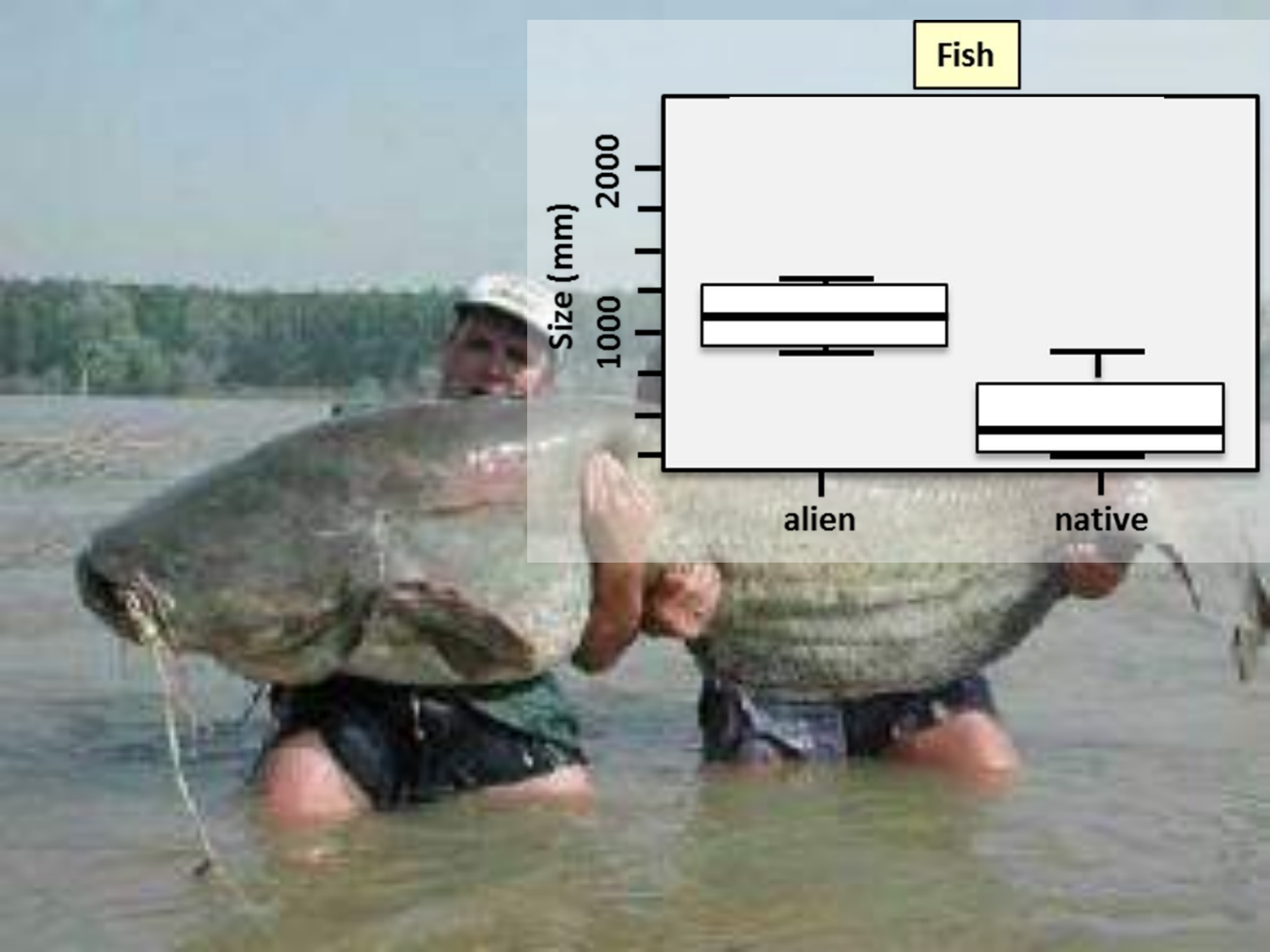
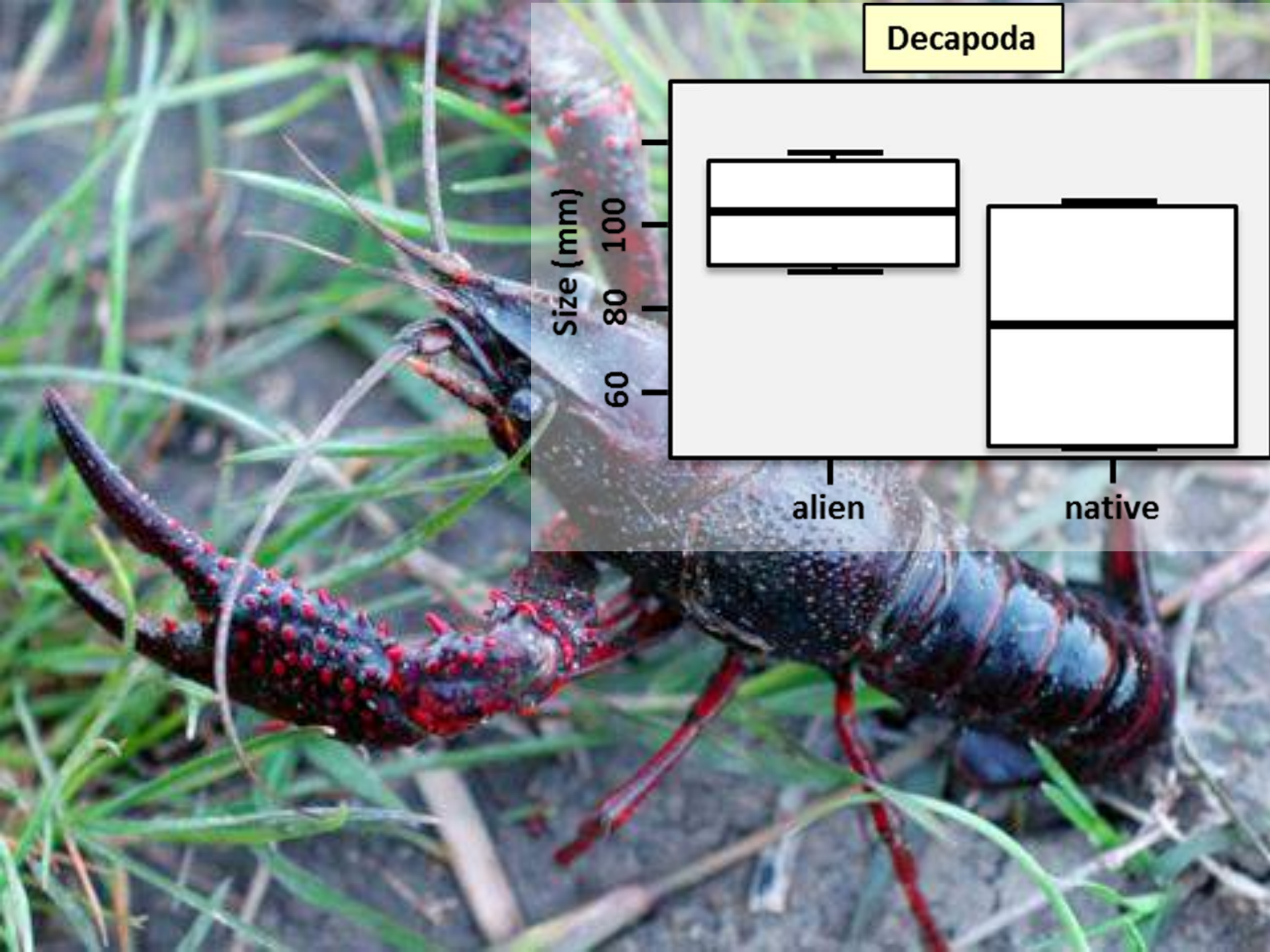
TG


Fish
Size (mm)
2000
1000
alien
native

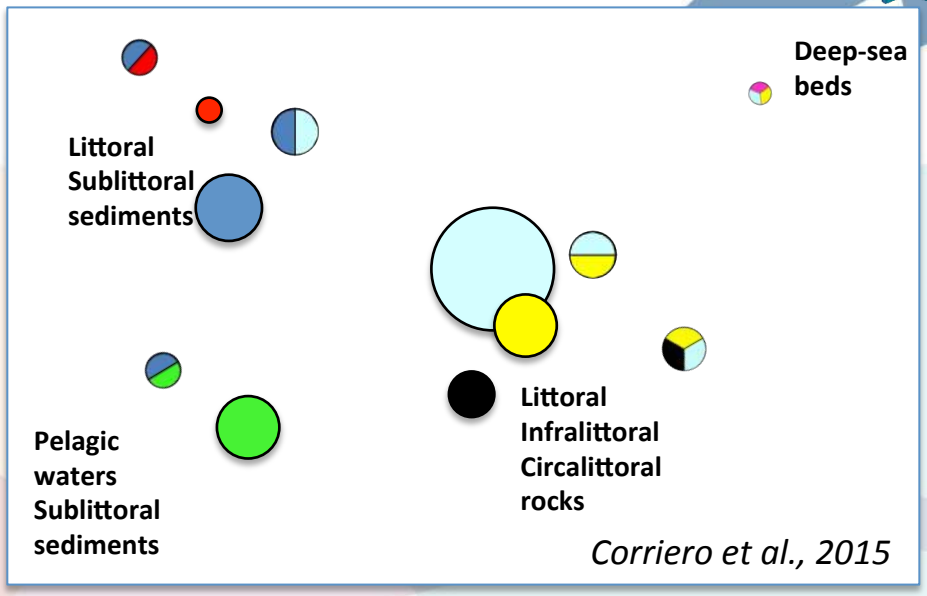

Decapoda
Size (mm)
100
80
60
alien
native

MARINE HABITATS

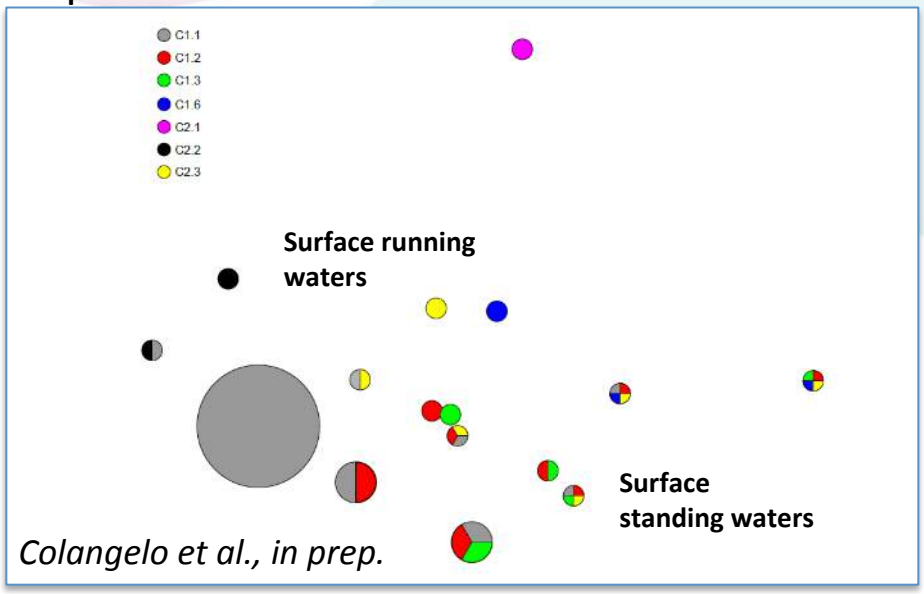
ACCORDING TO LITERATURE, 38 AS ARE POSSIBLE INVASIVE

THEY SHARE THE ABILITY TO COLONIZE DIFFERENT (SOMETIME VERY DIFFERENT) HABITATS (TRANS HABITAT AS)

THE TOTAL NUMBER OF TRANS HABITAT AS IN LIFEWATCH AQUATIC DATASET IS 65



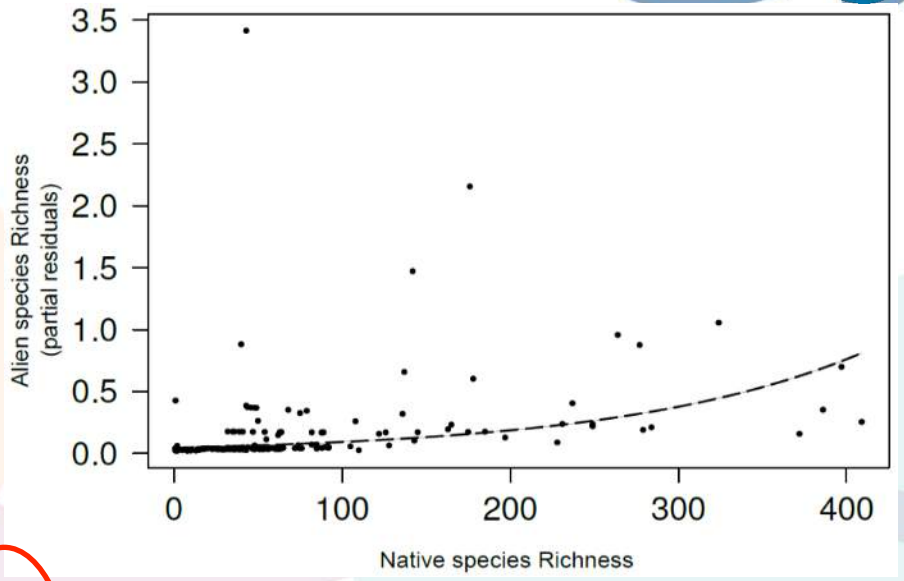
Acque interne

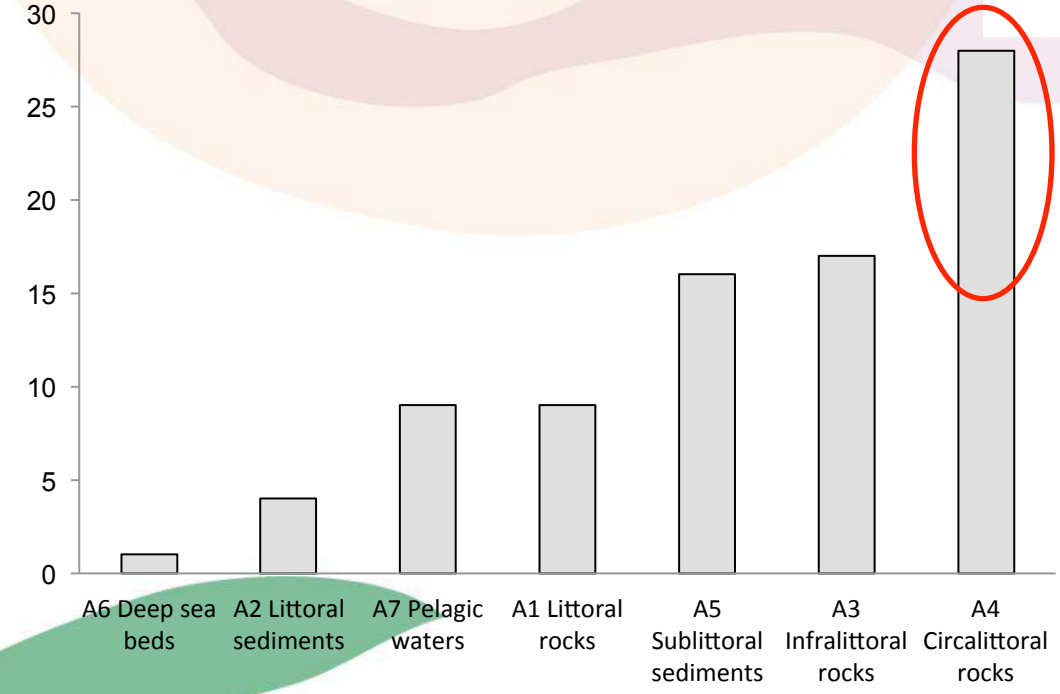


Streftaris and Zenetos, 2006. Alien Marine Species in the Mediterranean – the 100 «Worst Invasive» and their impact.

MARINE HABITATS

Positive correlation with species richness

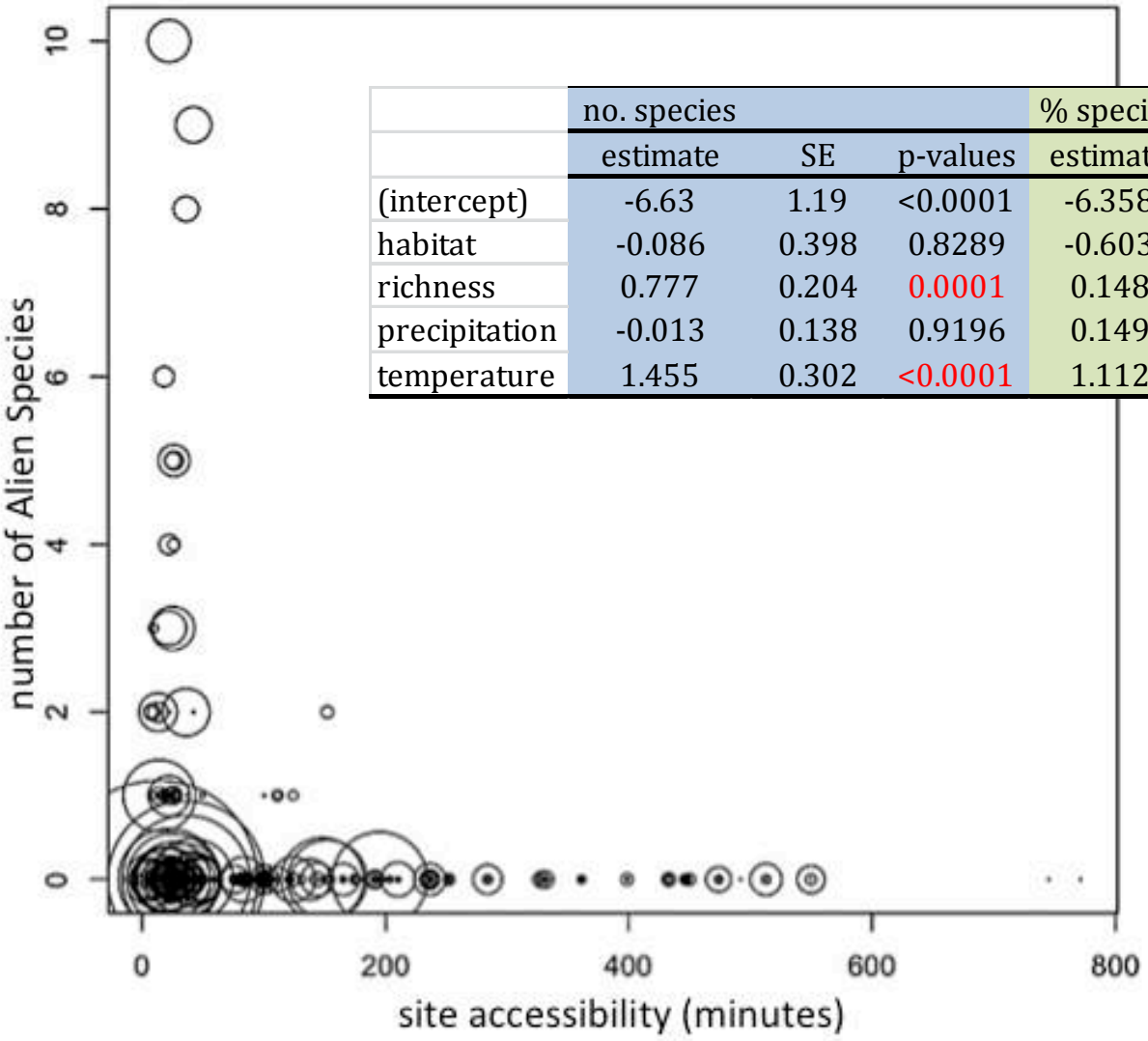




The highest number of AS occurs in Circalittoral rocks habitats, mainly represented by coralligenous communities

FRESH WATER

Positive correlation with species richness, accessibility and temperature



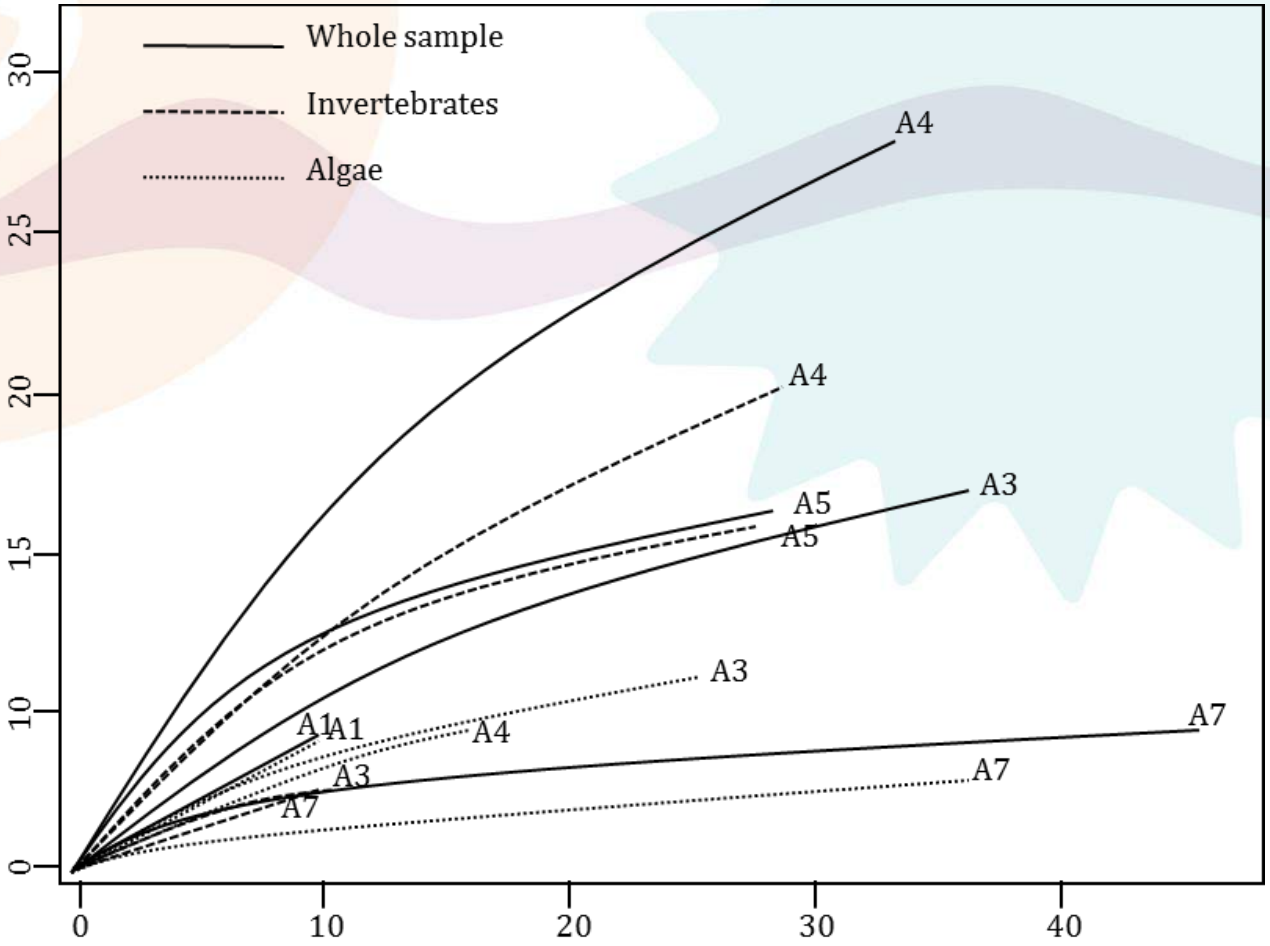
	no. species			% species		
	estimate	SE	p-values	estimate	SE	p-values
(intercept)	-6.63	1.19	<0.0001	-6.358	0.77	<0.0001
habitat	-0.086	0.398	0.8289	-0.603	0.376	0.1091
richness	0.777	0.204	0.0001	0.148	0.177	0.4012
precipitation	-0.013	0.138	0.9196	0.149	0.124	0.2277
temperature	1.455	0.302	<0.0001	1.112	0.266	<0.0001

RUOLO DELL'HABITAT COME FILTRO ABIOTICO ALLE INVASIONI

Species/Area (n° sites) curves

Rarefaction curves obtained as a count of AS against the sample size (number of sites) for the observed AS richness in the whole dataset, invertebrates and algae samples sub-datasets. On the “y” axis the number of observed species and on the “x” axis the sample size are reported.

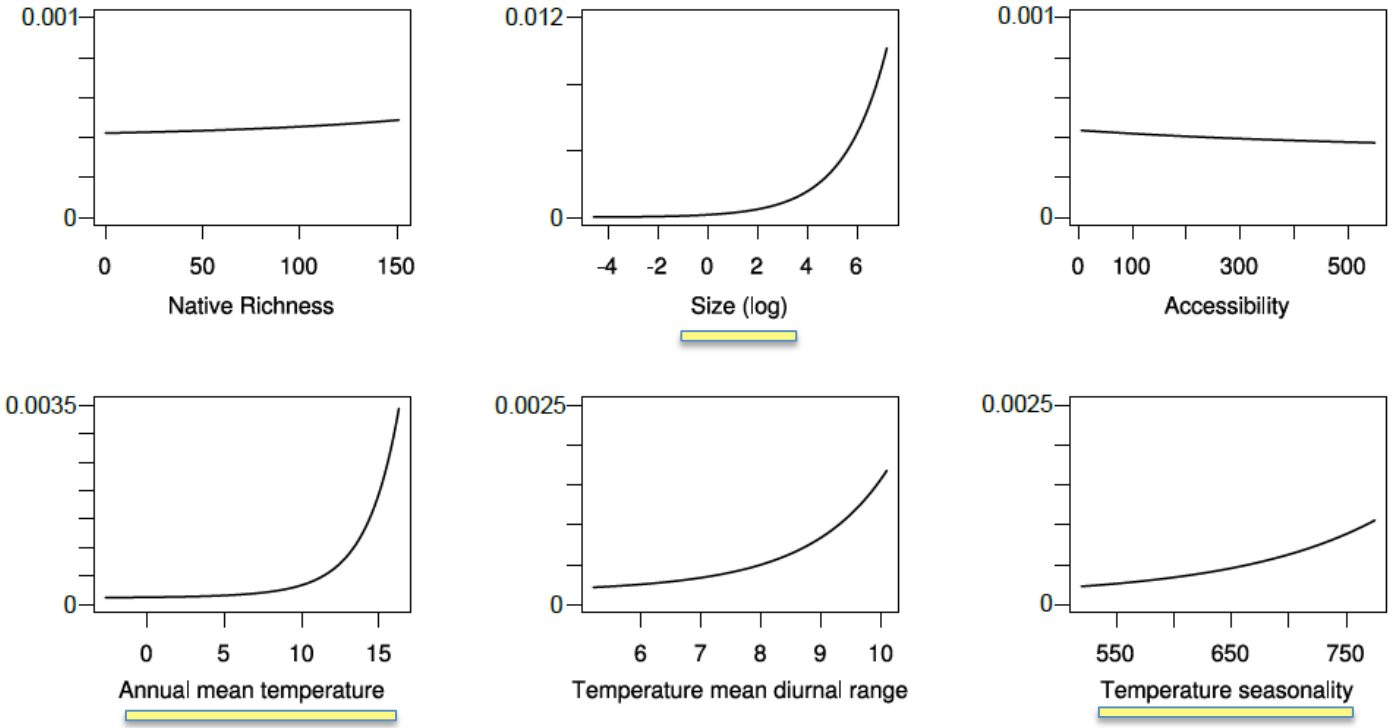
A1, littoral rock and other hard substrata; A2, littoral sediment; A3, infralittoral rock and other hard substrata; A4 circalittoral rock and other hard substrata; A5, sublittoral sediment; A6, deep-sea bed; A7, pelagic water column.



Predictive models and invasion risk map

Alien species occurence probability

FRESH WATER

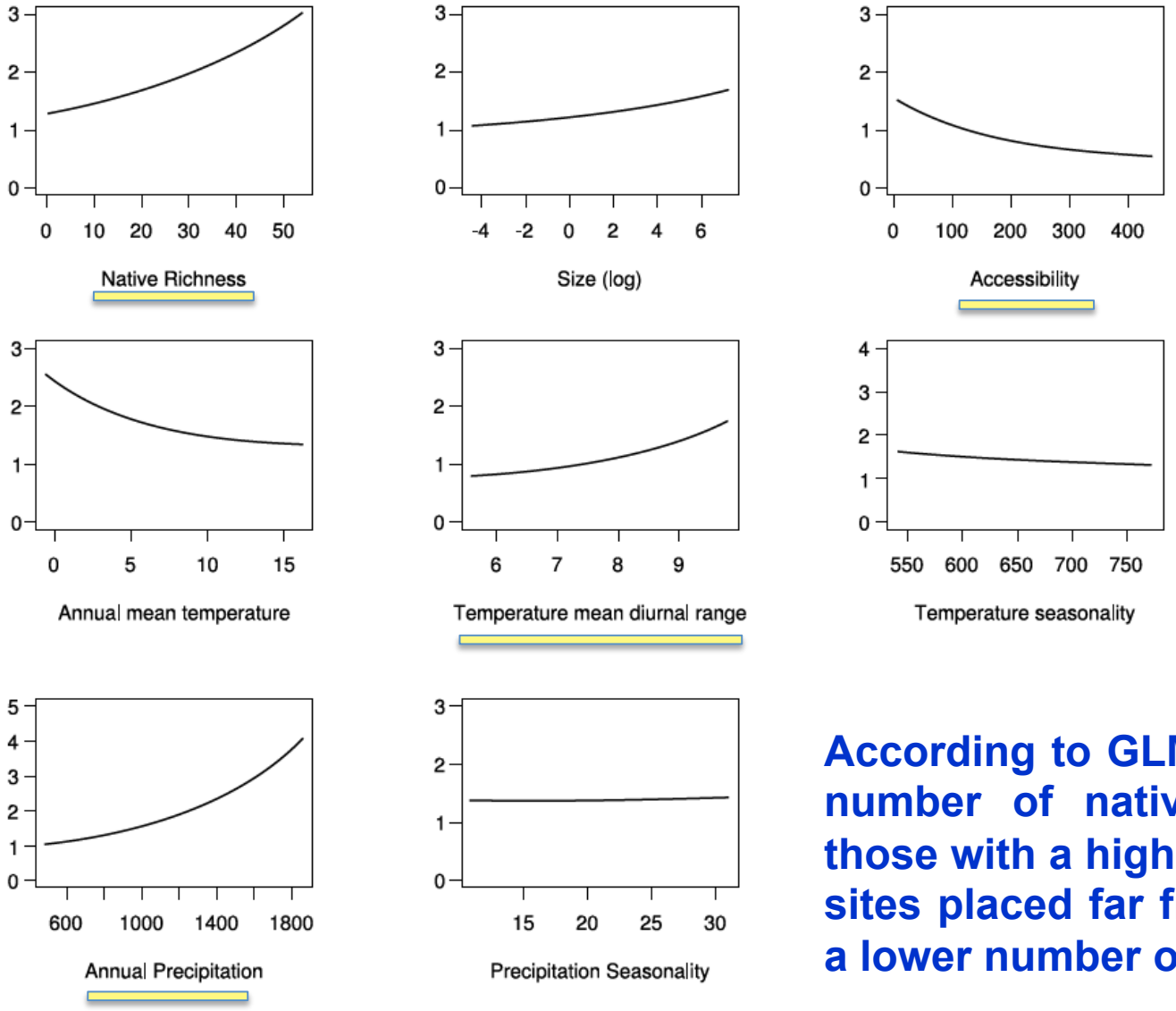


GLMM suggests that AS occurrence probability increases with increasing values in almost all the climatic variables. In particular, when the annual mean temperature reaches 10°C the probability to find AS increases exponentially. Also size may play a role in invasion risk

Colangelo et al., in prep.

FRESH WATER

Alien species predicted richness

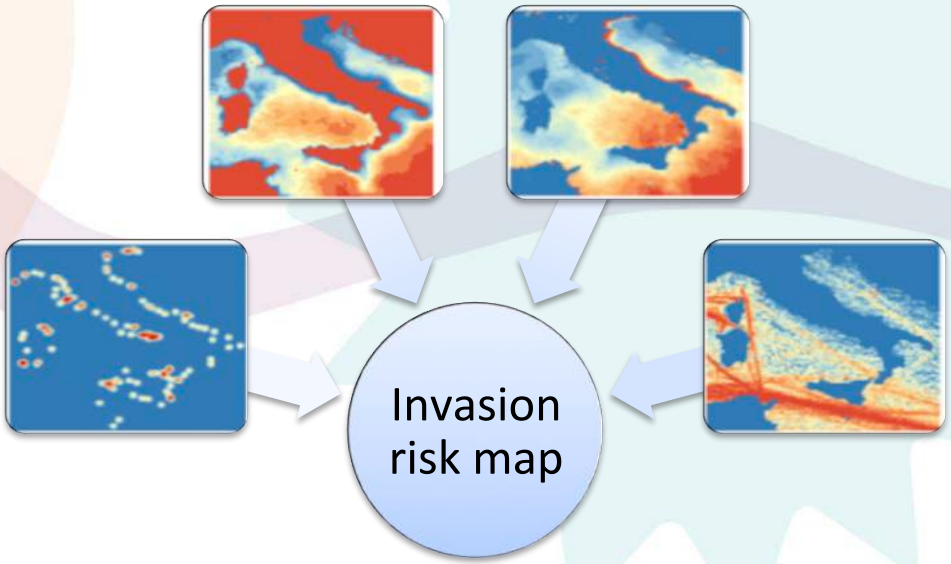


According to GLMM, sites with higher number of native species are also those with a higher number of AS, and sites placed far from main cities have a lower number of AS.

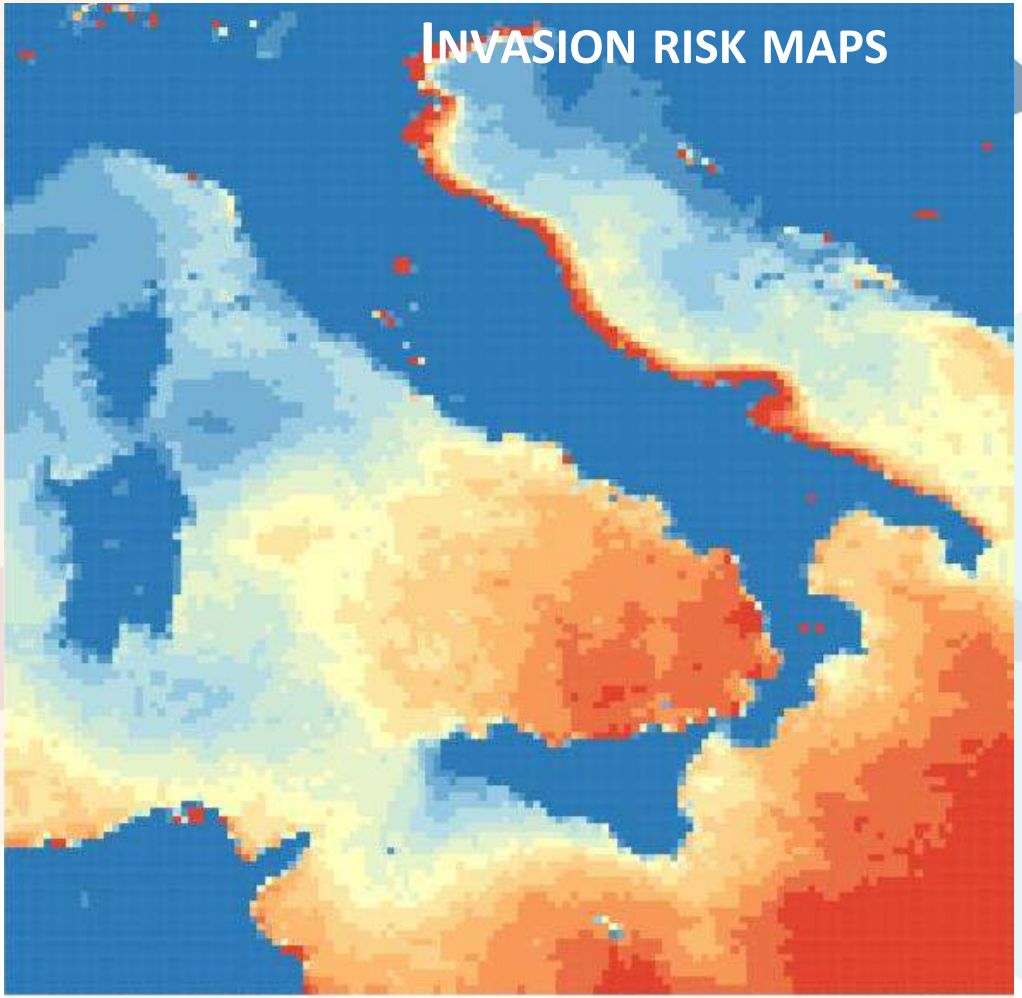
Colangelo et al., in prep.

Invasion risk map

- We are exploring the possibility to use the outcomes of GLMMs models to produce invasion risk maps
- We explored potential drivers on AS invasion (climate, human activities, ecc.) in sample sites and combined them to extraplotate results at a national level



INVASION RISK MAPS

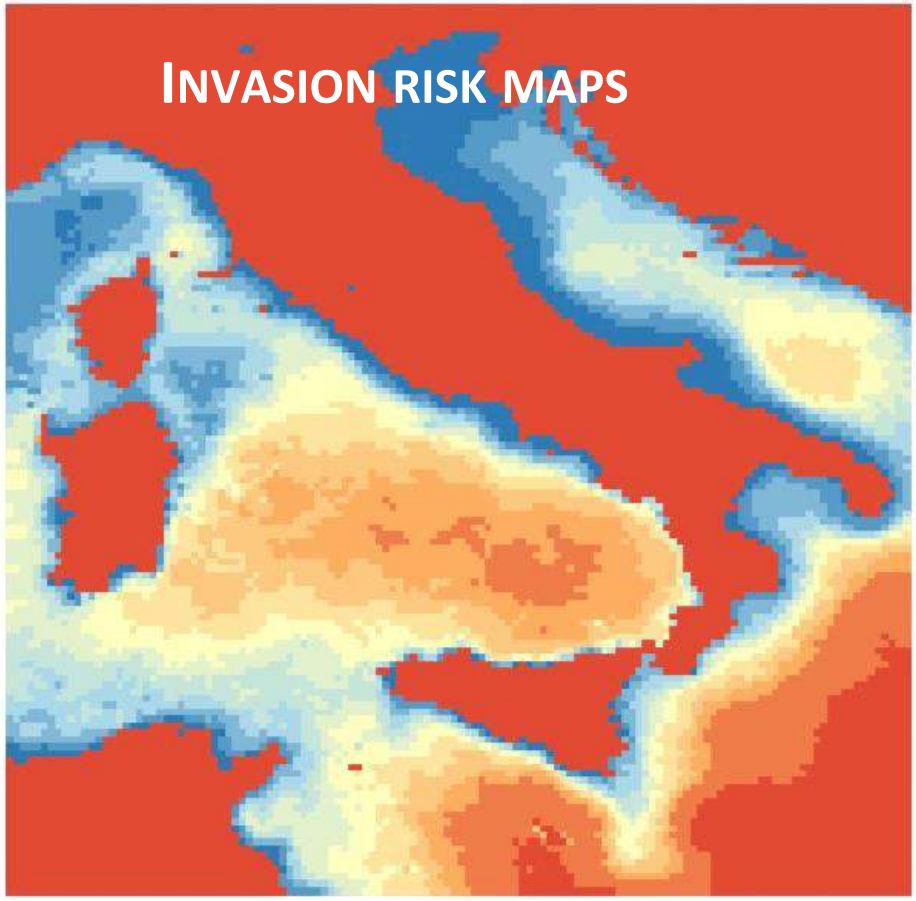


The closer relationship between distribution of AS and examined variables is with the SUPERFICIAL WATER TEMPERATURE.

Areas with warmer surface water are more suitable to the AS.

In the Adriatic sea, in particular, the data highlight a high suitability of AS for coastal areas. This is probably due to the low depth.
The model will be tested, as well as on the average, also the limit values of WATER TEMPERATURE, together with temporal variables.

INVASION RISK MAPS

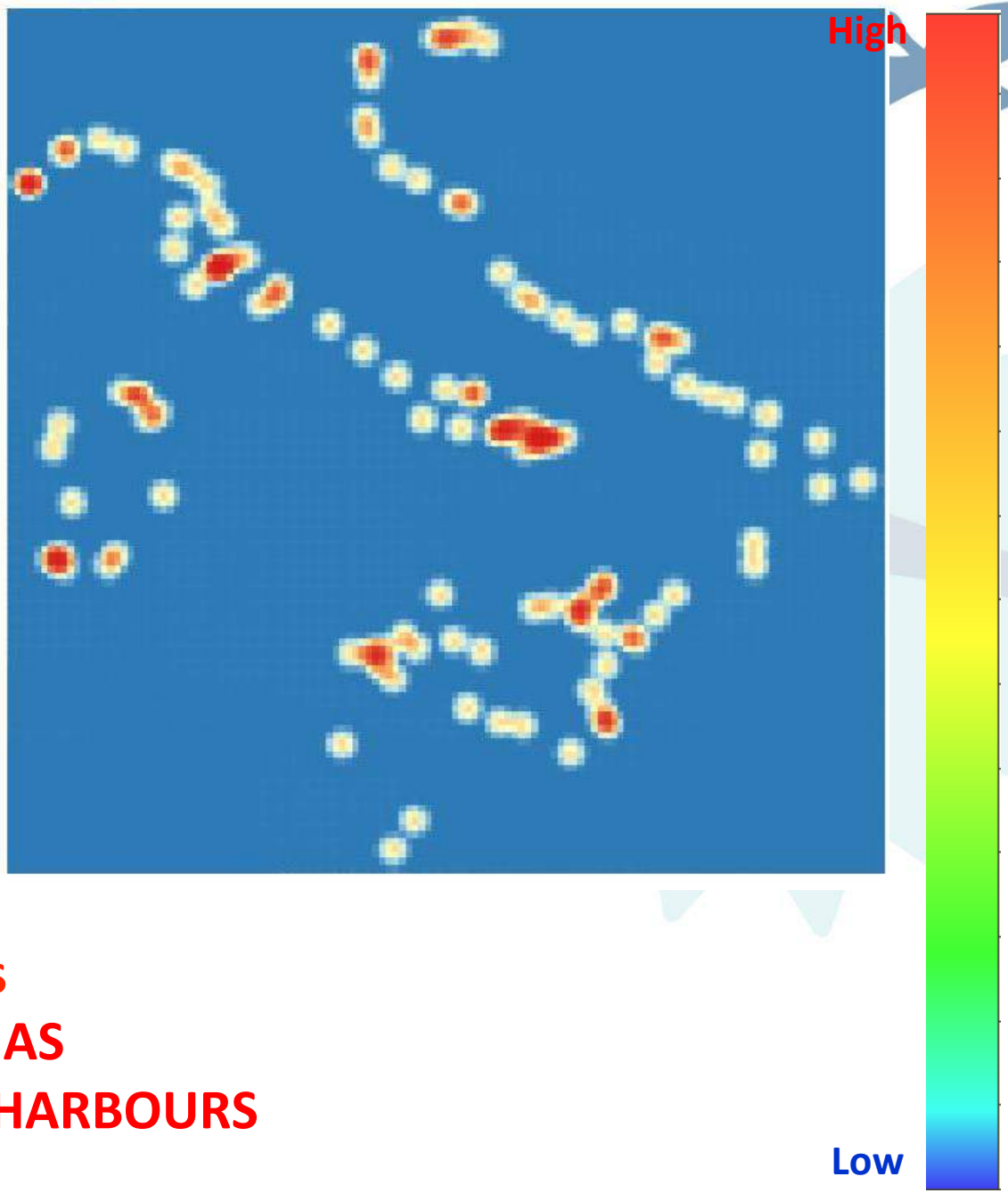


High

Low

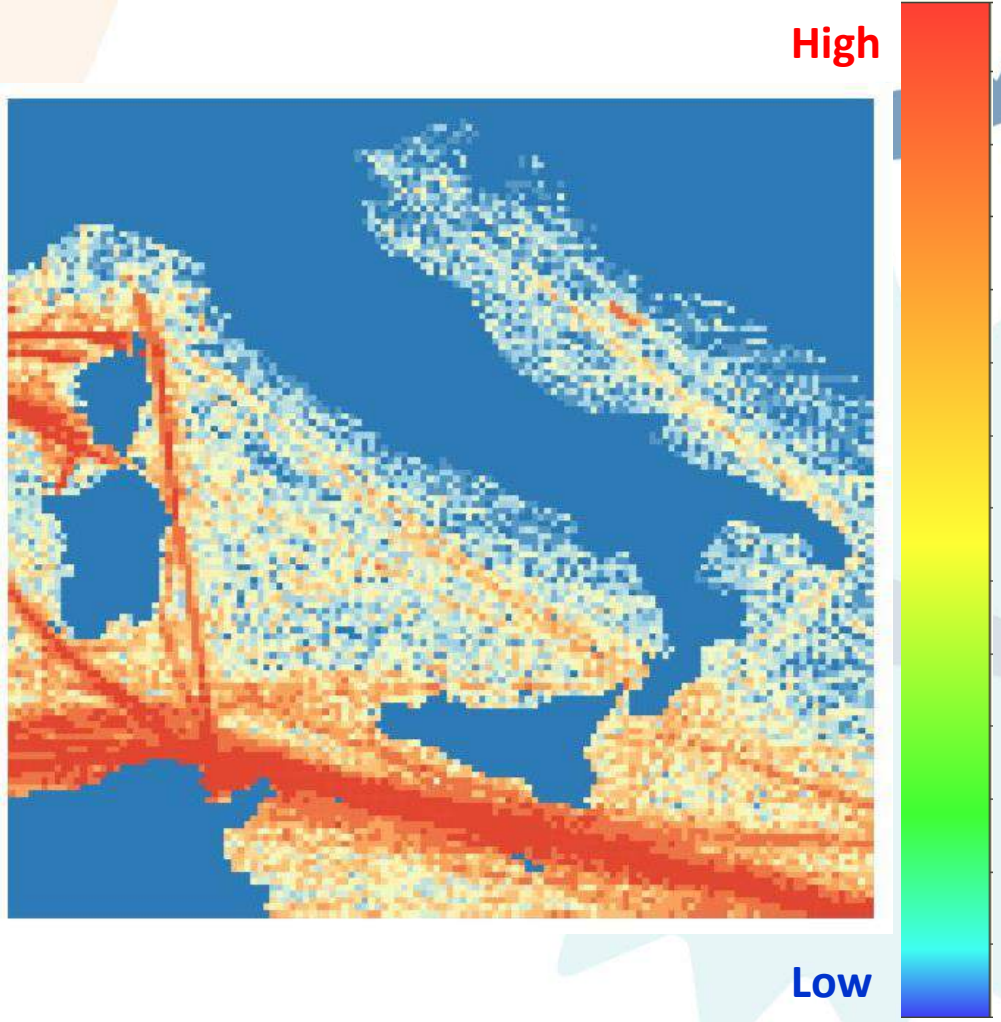
CHL *versus* AS: a negative relationship

The model suggests that it is more likely to find alien species where chlorophyll is lower. Although plausible from an ecological point of view, it does not explain the pattern of distribution of AS.



INVASION RISK MAPS
OCCURRENCE OF AS
VERSUS ITALIAN HARBOURS

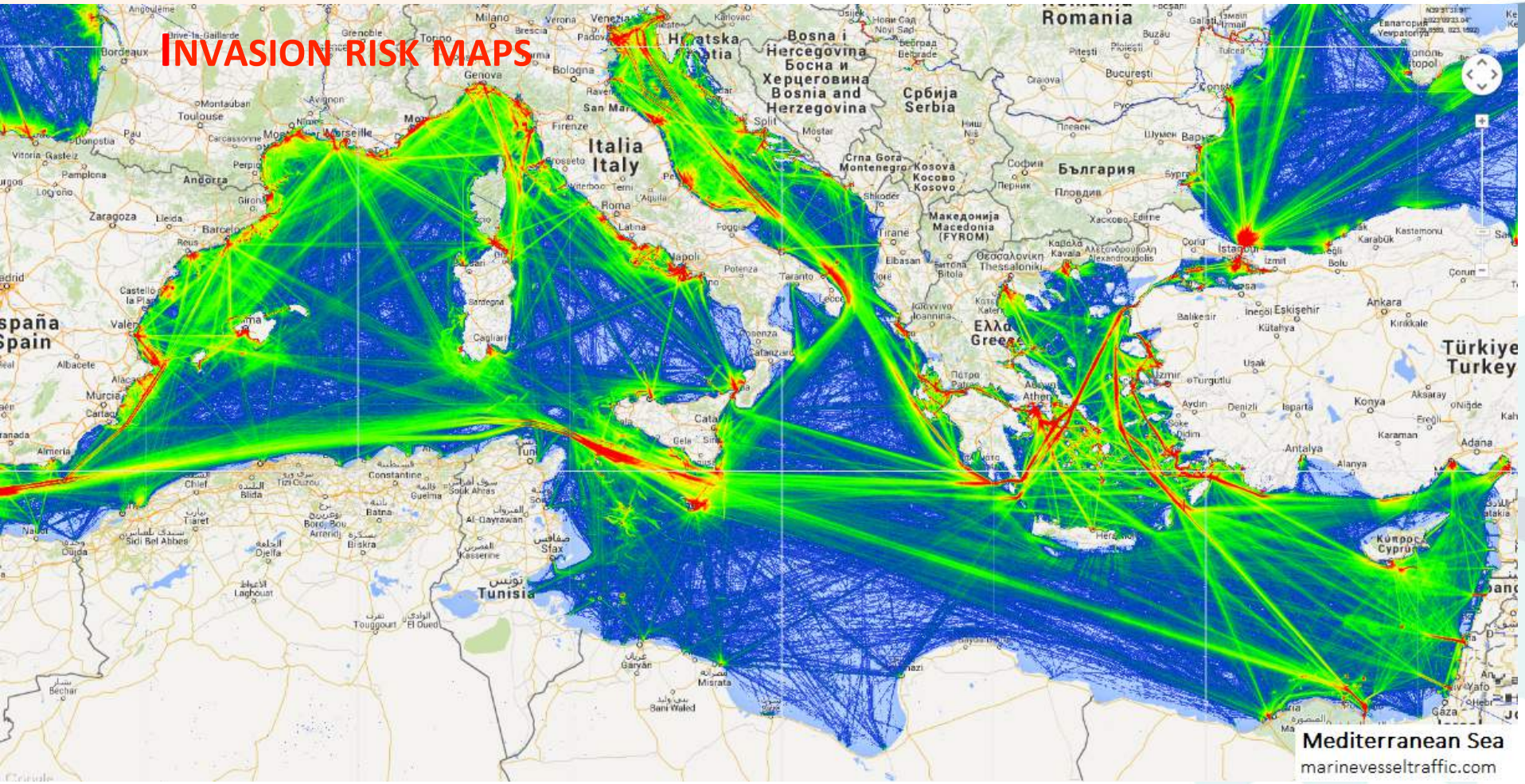
INVASION RISK MAPS



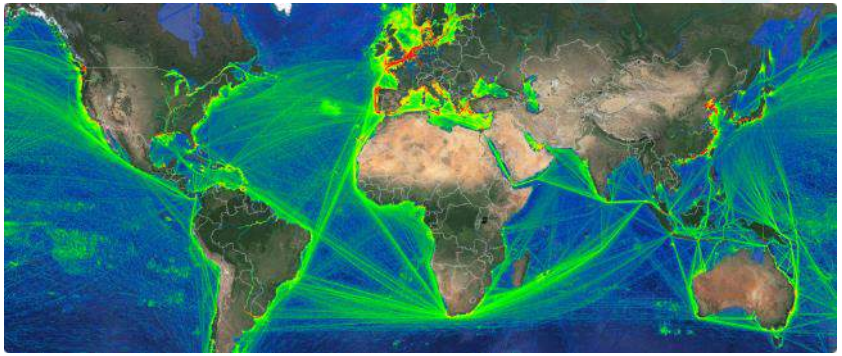
Maritime traffic little explains the AS distribution, with Taranto and Venice showing lower risks than the low Tyrrhenian and the low Ionian seas.

The model indicates the biggest risk values in the Sicily Channel, the Adiatic coast line, and the low Tyrrhenian.

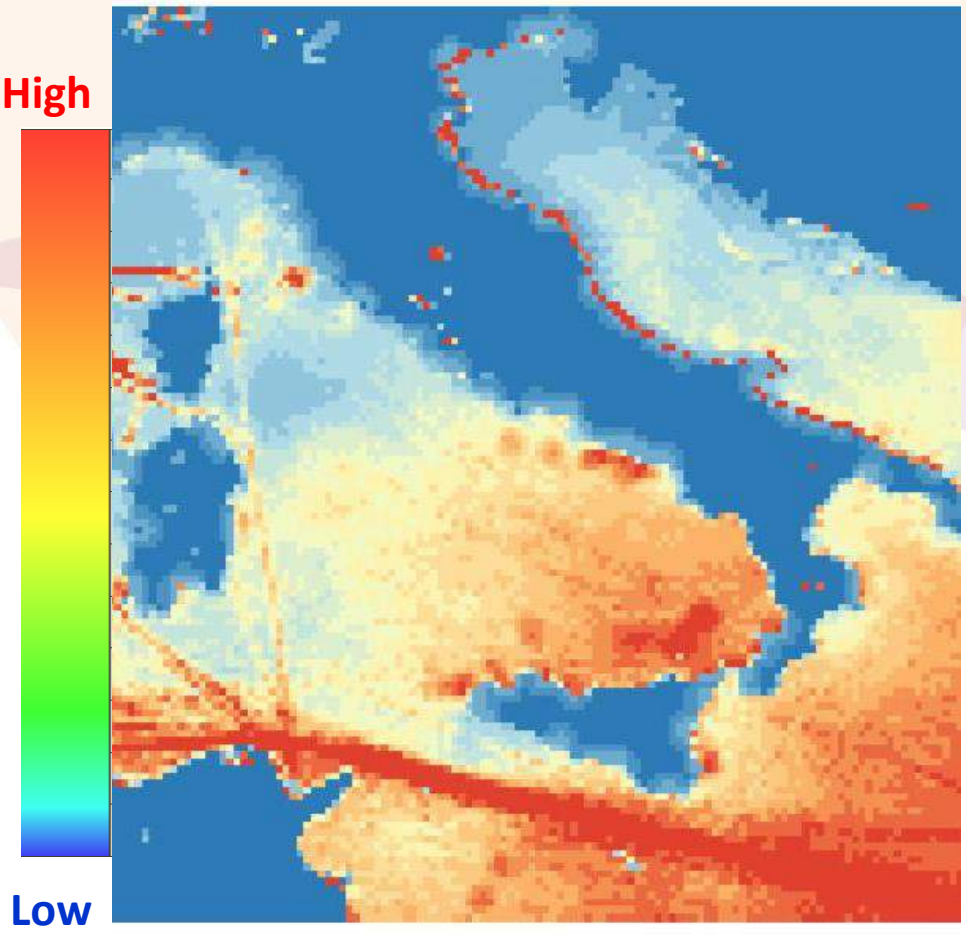
INVASION RISK MAPS



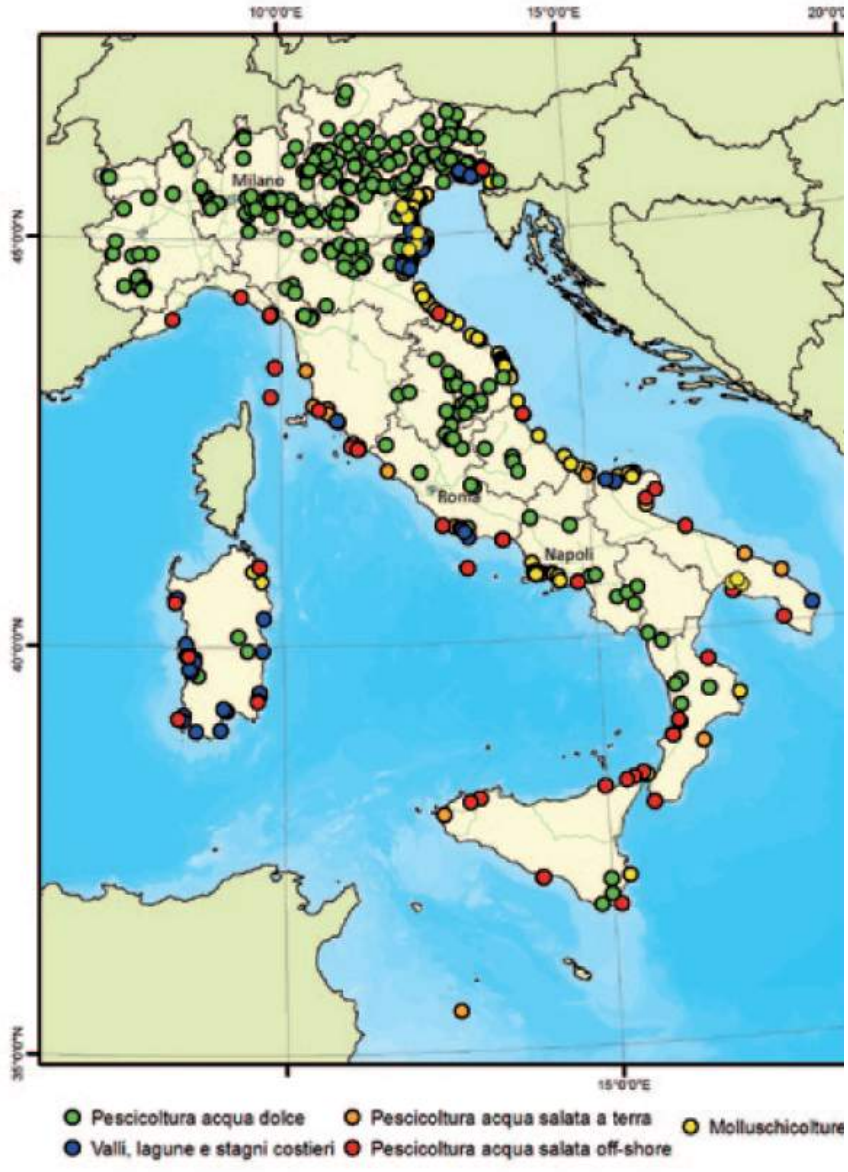
Many marine and lagoon AS spread outside of their native range through maritime traffic?



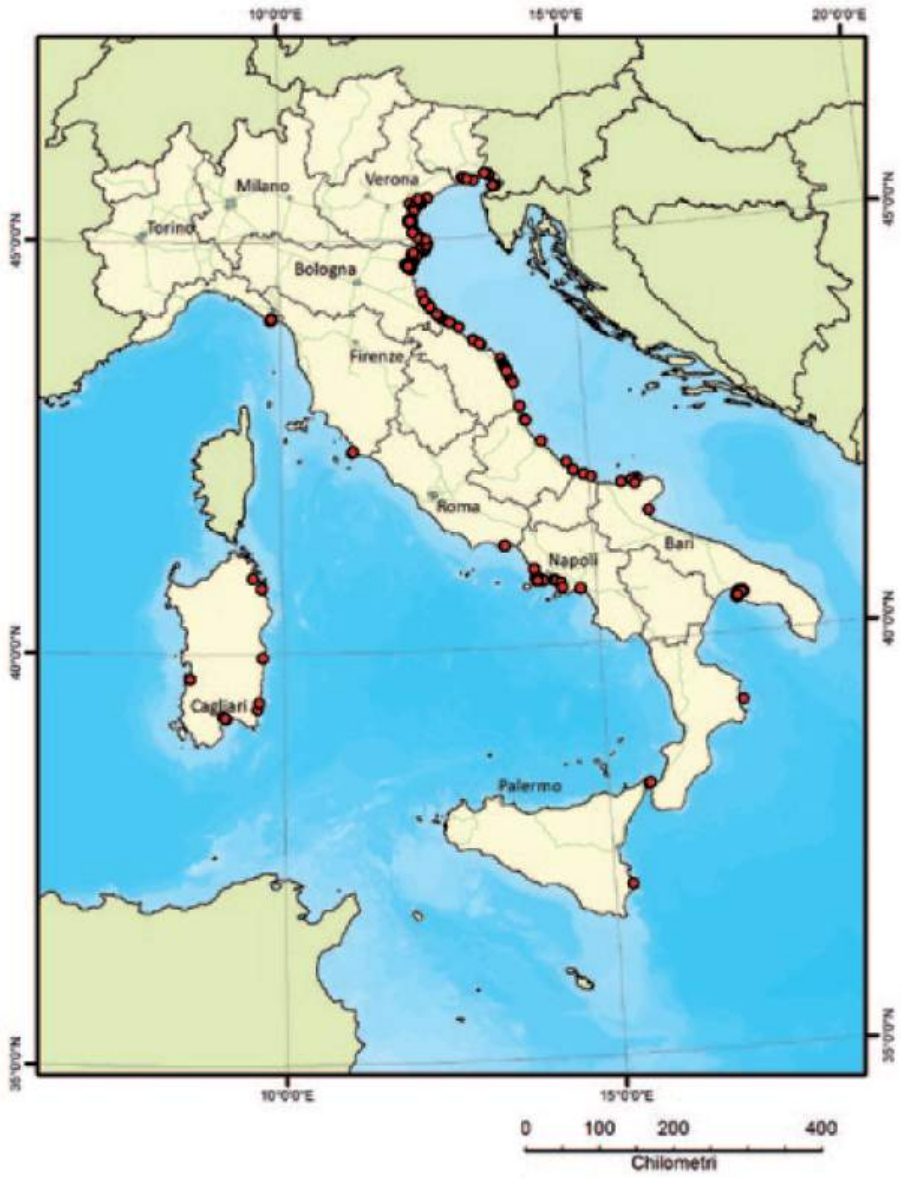
Invasion risk map



- The model that takes into account together **CHL, Water Temperature, Distance from ports** and **Maritme traffic** gives a more precise picture of the invasion risk.
  - The risk in mainly driven by temperature and ChlA. Maritime traffic and distance from harbours locally corrects the map.
- The Adriatic Sea, in particular, shows, unexpectedly, high risk only along the coast.
- Souther Tirrenial, Jonian sea and Sicily channel show the higher risk



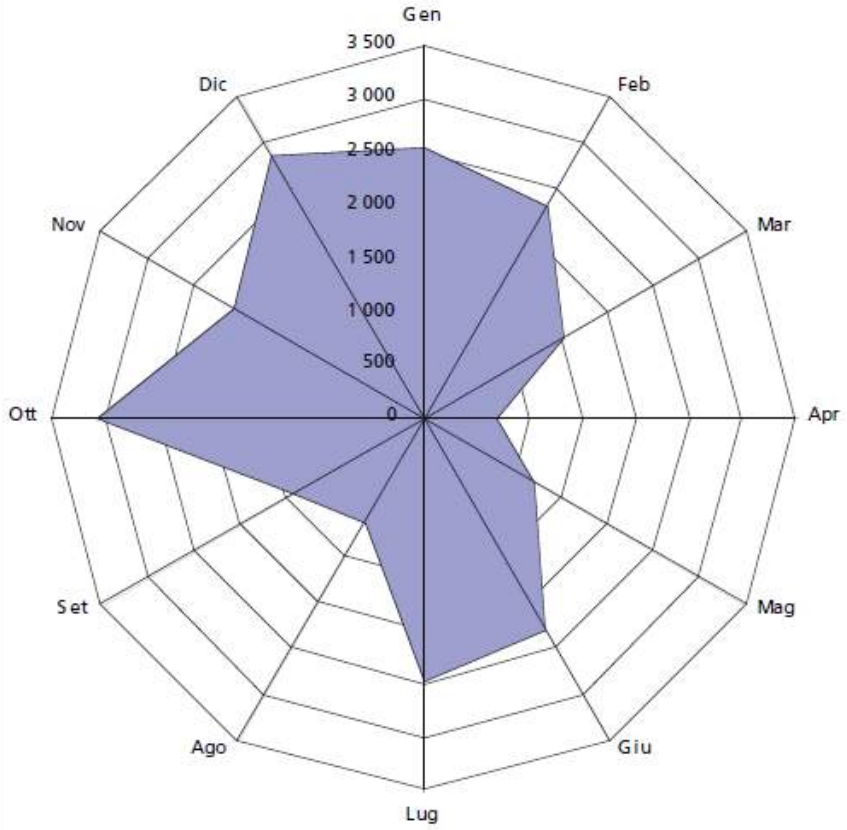
Distribution of aquaculture farms in Italy (both intensive and extensive systems)



Distribution of mollusc farms in Italy

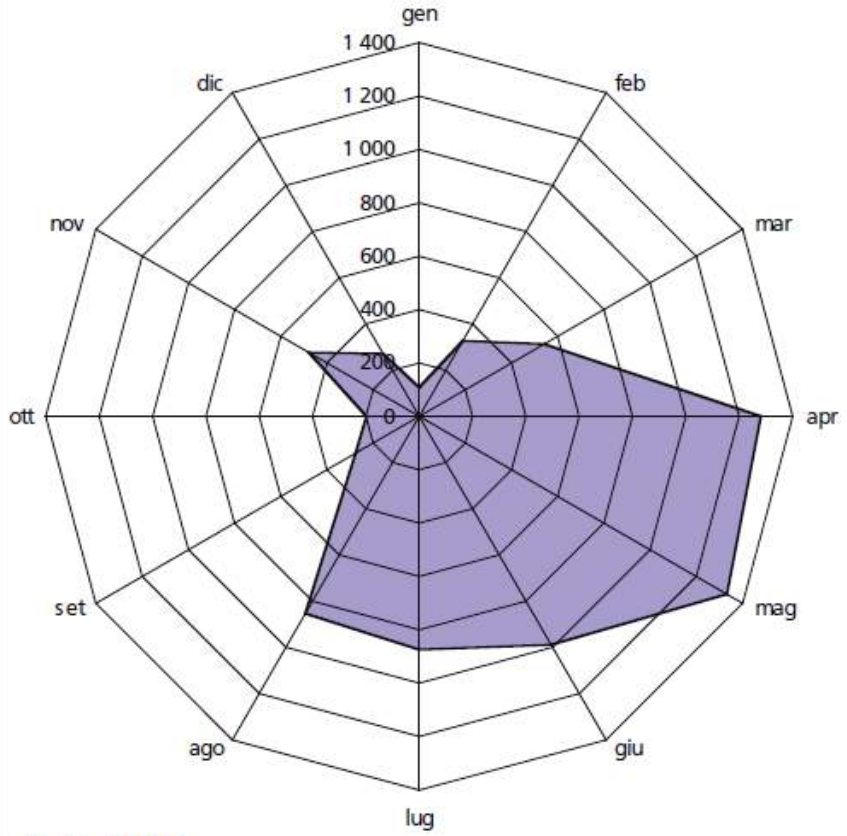
AS distribution *versus* Mollusc farming in Italy?

Importazione italiana mensile di mitili freschi – media 2005–2006



Fonte: ISTAT.

Esportazione italiana mensile di mitili freschi – media 2005–2006



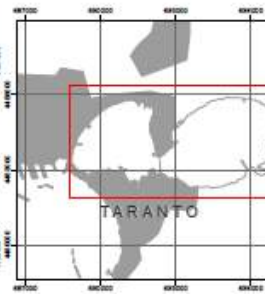
Fonte: ISTAT.

On warm seasons italian farmers marketing mostly their own product, while in the cold months, from October to February, they import product from several countries. Molluscs often are mantained in coastal waters before marketing.

Economic sector & pest taxa	Costs of damage (million EUR / year)	Costs of control (million EUR / year)
Fisheries / aquaculture		
Freshwater invertebrates	192.6	no info
Freshwater vertebrate	0.032	no info
Marine invertebrates	27.7	no info
Marine plants	19.0	no info
Terrestrial vertebrate	2.1	no info
Fungi / bacteria	0.2	no info
Total	**241.6**	

Overview of the documented economic costs (real costs & estimates) of different IAS taxa on different economic sectors in Europe. Kettunen et al., 2008.

Kettunen, M., Genovesi, P., Gollasch, S., Pagad, S., Starfinger, U. ten Brink, P. & Shine, C. 2008. Technical support to EU strategy on invasive species (IAS) - Assessment of the impacts of IAS in Europe and the EU (final module report for the European Commission). Institute for European Environmental Policy (IEEP), Brussels, Belgium. 44 pp. + Annexes.



Coordinate System: WGS 1984 UTM Zone
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500.000,0000
False Northing: 0,0000
Central Meridian: 15,0000
Scale Factor: 0,9996
Latitude Of Origin: 0,0000
Units: Meter

Authors: Francesco Mastrototaro, Giovanni Francesco Curci
- ULR CoNISMa Bari -
Dipartimento di Biologia
Università degli Studi di Bari Aldo Moro

0 0,5

Legenda

Impianti di mitilicoltura

Tav.:

Scala: 1:130

Titolo:

According to some Authors (Hewitt *et al.*, 2007; Cecere et al., 2010), the most likely vector for the introduction of AS could be the importation of aquaculture organisms for different purposes

An example of Lifewatch dataset: some AS reported from the Mar Piccolo di Taranto. Most of them strongly affect the autocthnous assemblages and show an invasive pattern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Thank You