BEeS

The LifeWatch ERIC Biodiversity & Ecosystem eScience Conference

Seville
22-24/05/23

Threats and challenges to biodiversity and ecosystem conservation from an eScience perspective

LifeWatch ERIC

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CESAM
CENTRE FOR ENVIRONMENTAL AND MARINE STUDIES

dbio universidade de aveiro departamento de biologia

PORBIOTA

UCLouvain

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Heliana Teixeira | CESAM UAveiro
Julien Radoux | UCLouvain

Lifewatch ERIC's Biotope vulnerability workflow – CIMPAL (Cumulative IMPacts of invasive ALien species) version

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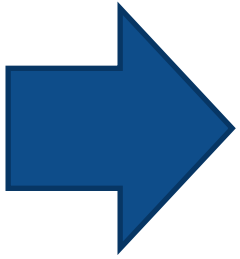
LifeWatch ERIC

e-science tools

- Deepening knowledge and obtaining rapid responses

- Mitigation of risks and impacts of NIS (Non-indigenous and Invasive species) in the terrestrial and aquatic domains



Researchers

Stakeholders

Citizens

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e-Science?

computationally intensive science

immense datasets

collaborative, computationally- or data-intensive research

e-Infrastructure

distributed network

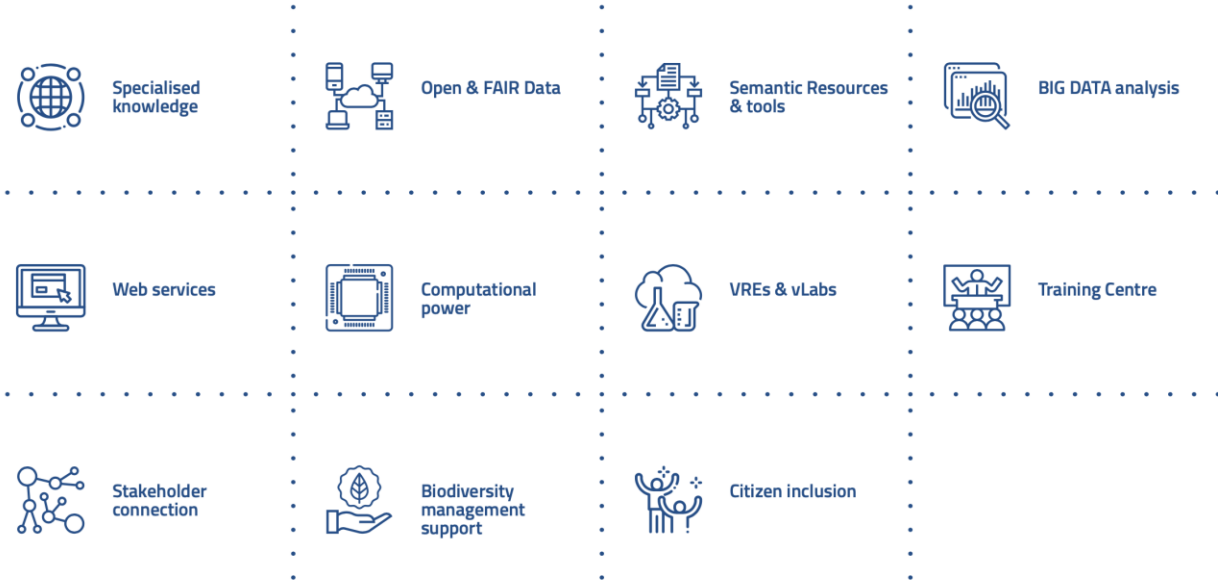
grid computing environments

multidisciplinary

Preparation, **experimentation**, **data collection**, results **dissemination**, and **long-term storage** and accessibility of all materials generated through the scientific process. E.g. *data modeling and analysis, electronic/digitized laboratory notebooks, raw and fitted data sets, manuscript production and draft versions, pre-prints, and print and/or electronic publications*

Virtual Research Environments (VREs)

The topic of **non-indigenous and invasive species (NIS)** was chosen as the first demonstration case of the functioning of the **LifeWatch ERIC e-Infrastructure**.



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BEeS Seville, 22-24 May 2023

Threats and challenges to biodiversity and ecosystem conservation from an eScience perspective

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https://www.lifewatch.eu/internal-joint-initiative/workflows/

1. Combining modelling and remote sensing techniques to monitor and control the spread of invasive species: the case of ***Ailanthus altissima***

2. The European Autonomous Reef Monitoring Structures (**ARMS)** programme: long-term monitoring of hard-bottom communities for invasive marine species

3. Risk assessment of NIS introduction and establishment, habitat vulnerability to NIS and estimation of the impact on large assemblages of plants and animals, known as **Biotopes**

4. Functional biogeography of invasive species: stable isotope analysis to establish the trophic position and feeding habits of two widely-distributed omnivorous **crustaceans**

5. An alert model reporting tool that combines e-DNA **metabarcoding** and molecular ecology to study freshwater fish communities and identify new invasive species

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https://www.lifewatch.eu/internal-joint-initiative/workflows/

Biotope vulnerability workflow – CIMPAL (Cumulative IMPacts of invasive ALien species) version

Biotope vulnerability workflow – CIMPAL (Cumulative IMPacts of invasive ALien species) version

Why a “biotope vulnerability” workflow?

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Non-indigenous and Invasive species (NIS)

NIS are among the **top 5** direct drivers of change in nature with the largest relative global impacts

Bondrizio *et al*. 2019 IPBES Global Assessment Report on Biodiversity and Ecosystem Services

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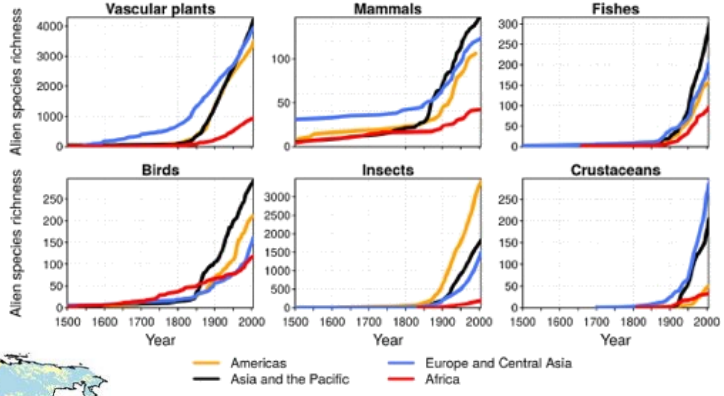
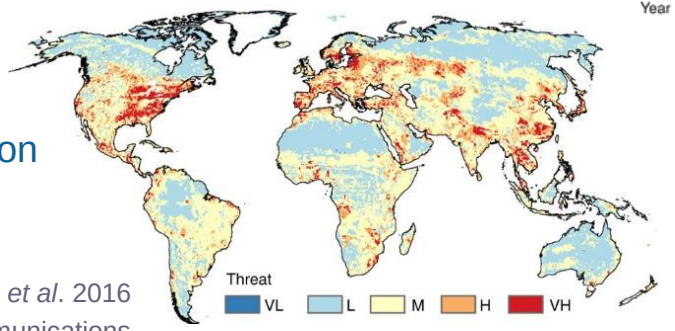
Non-indigenous and Invasive species (NIS)

- Indicator of pressures that shows increasing trends over recent decades
- Sources of compositional changes
- Global biological homogenization



Pyšek et al. 2020
Biological Reviews



Early *et al*. 2016
Nature Communications

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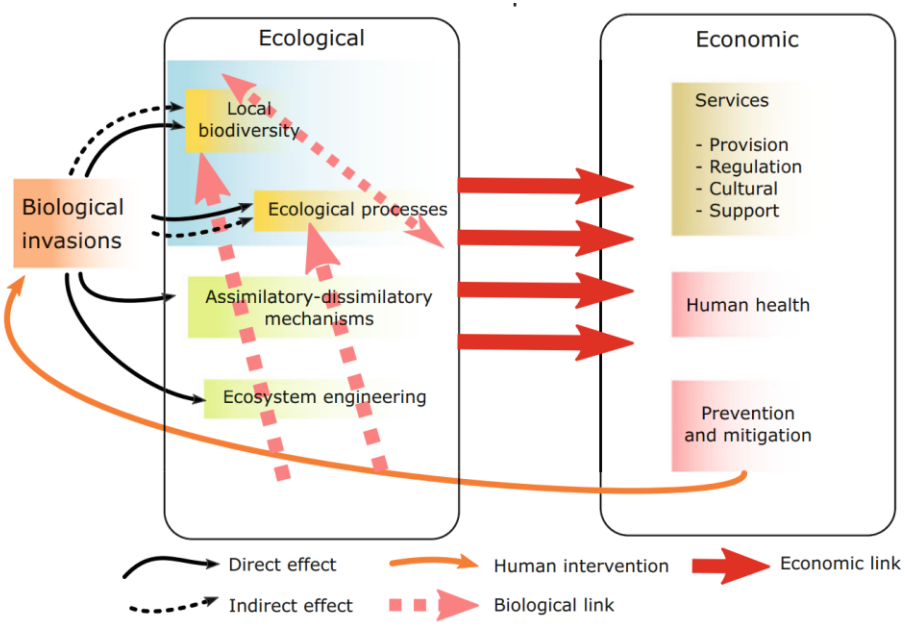
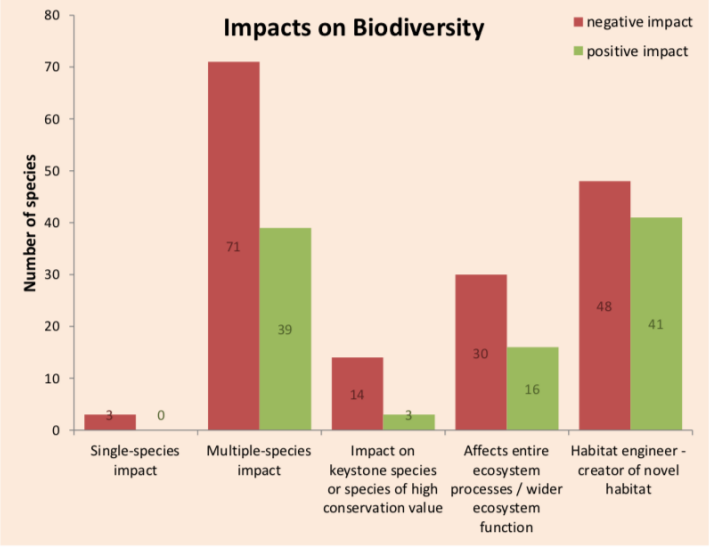
Non-indigenous and Invasive species (NIS)

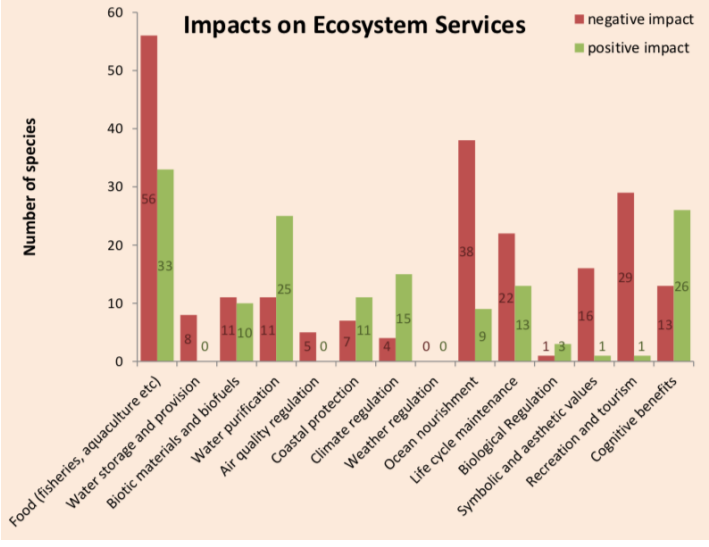


Crespo, D. (2021) doi.org/10.1007/978-3-319-71064-8_30-1

Non-indigenous and Invasive species (NIS)

Environmental Impacts





Katsanevakis *et al*. 2014
Aquatic Invasions

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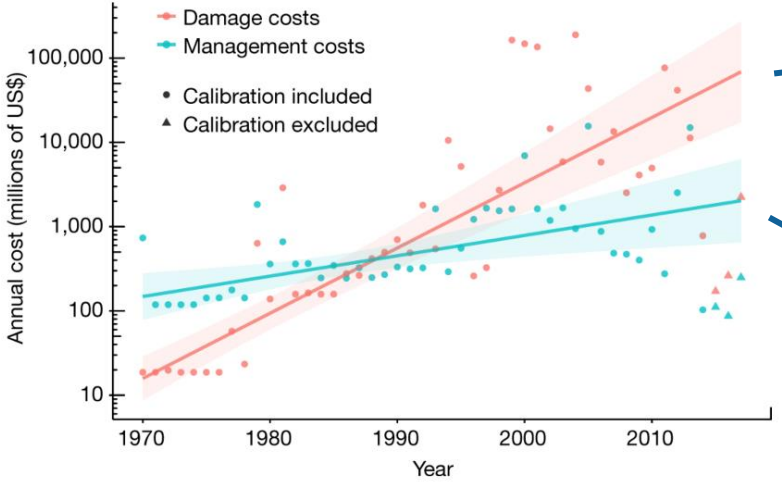
Non-indigenous and Invasive species (NIS)

Economic Impacts



Global damage and management costs

Diagne *et al*. 2021 Nature

economic losses due to direct and/or indirect impacts of invaders, such as yield loss, illness, land alteration, infrastructure damage or income reduction

economic resources allocated to actions to avoid the invasion or to deal with more or less established invaders such as prevention, control, research, long-term management or eradication

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Non-indigenous and Invasive species (NIS)

More than an ecological issue:

- ecology
- economics
- social sciences

- engineering
- resources
- management

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Non-indigenous and Invasive species (NIS)

Knowledge improvement

Pathways

Mechanisms

Impacts

Lagging behind

Prevention

Management and control

Mitigation

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Non-indigenous and Invasive species (NIS)

Policy & Regulatory context

Regional Seas <

European Seas <

All European Ecosystems <

Global

and other sectoral requirements…

Non-indigenous and Invasive species (NIS)

Why a biotope vulnerability workflow?

Lagging behind

Prevention

Management and control

Mitigation

Biotope vulnerability workflow

Risk assessment of **NIS introduction** and **establishment**, **habitat vulnerability** to NIS and **estimation of the impact** on large assemblages of plants and animals, known as **Biotopes.**

- NIS research needs spatio-temporal context
- Large amount of data
- Challenging spatial resolutions
- Integrate non-traditional data: impact magnitude; pathways introduction

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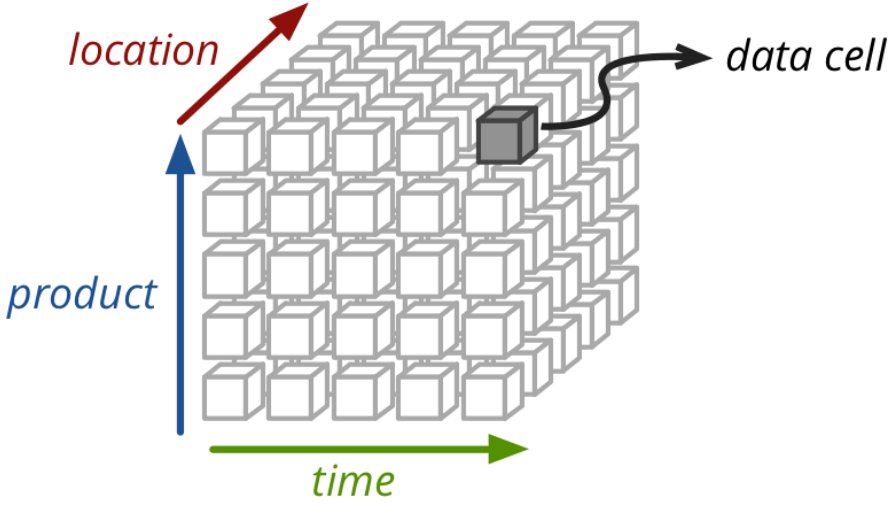
Biotope vulnerability workflow

Based on **occurrence datacubes**, i.e., data (taxonomic, temporal, and spatial) aggregated on a three-dimensional space, which allows the homogenization and aggregation of heterogeneous data collected using different methods and standards.



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CIMPAL (Cumulative IMPacts of invasive ALien species) Index

$$I_c = \sum_{i=1}^{n}\sum_{j=1}^{m} A_i H_j w_{i,j}$$

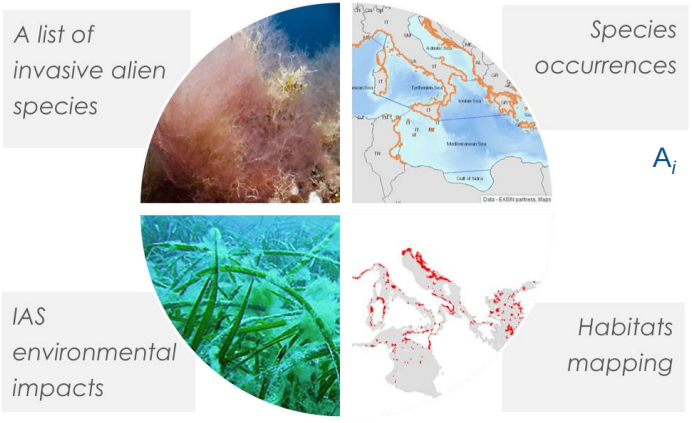
A_i status of invasive alien species (NIS) *i*

H_j index of the extent of habitat *j*

$w_{i,j}$ impact weight for NIS *i* and habitat *j*

n number of invasive alien species

m number of marine habitats



Diversity and Distributions, (Diversity Distrib.) (2016) **22**, 694–707

BIODIVERSITY RESEARCH

Mapping the impact of alien species on marine ecosystems: the Mediterranean Sea case study

Stelios Katsanevakis[1,2]*, Fernando Tempera[1] and Heliana Teixeira[1]

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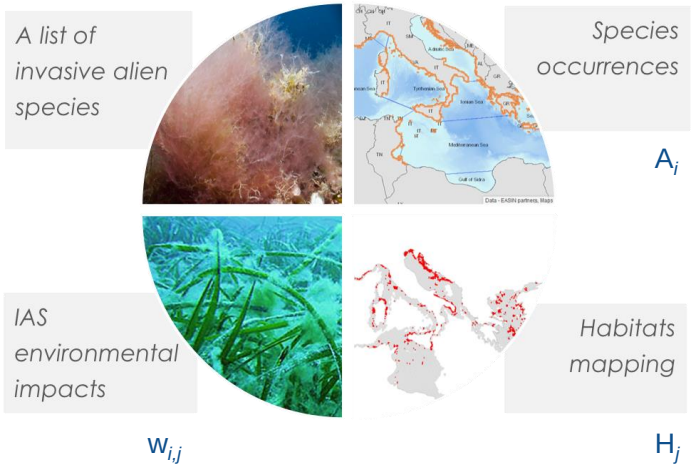
CIMPAL (Cumulative IMPacts of invasive ALien species) Index

Flexibility

Any environment or geographic scale, any taxonomic group and any type of impact!

Any other way of assessing impacts and deciding on impacts weights can be used!



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CIMPAL (Cumulative IMPacts of invasive ALien species) Index

Two decision-making strategies:

a precautionary approach

↓

an uncertainty-averse approach

W_{ij}: impact weights for species *i* and habitat *j*

Strength of Evidence	Magnitude of Impact: Minimal	Minor	Moderate	Major	Massive
Robust	0	1	2	4	8
Medium	0	0	1	2	4
Limited	0	0	0	1	2

experiments

modelling
observations
correlations

exp. judgement

no or negligible

individual fitness

population level

community level reversible

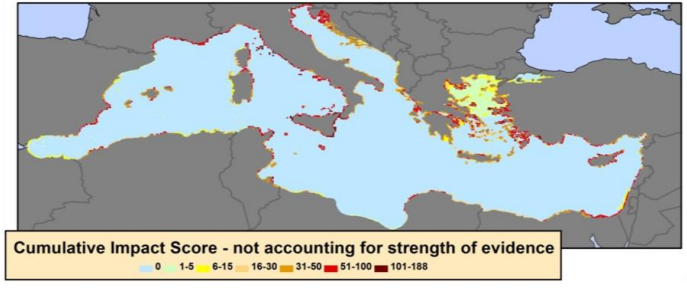
community level irreversible

Flexibility in CIMPAL

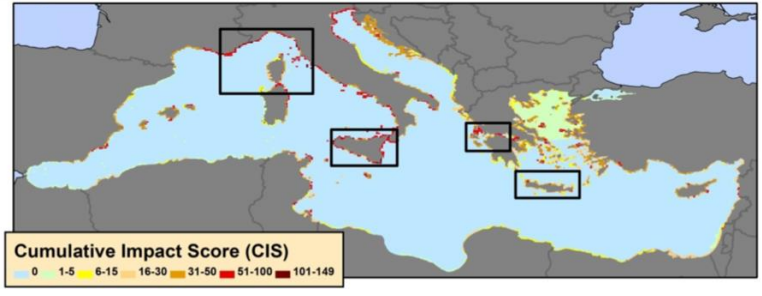
Any other way of assessing impacts and deciding on impacts weights can be used!

CIMPAL (Cumulative IMPacts of invasive ALien species) Index

Precautionary approach



Uncertainty-averse strategy



46% under IAS impact
100% impacts with high confidence

Assesses the cumulative negative impacts of invasive alien species

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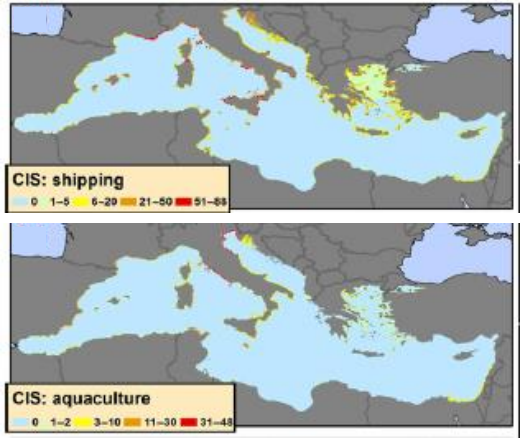

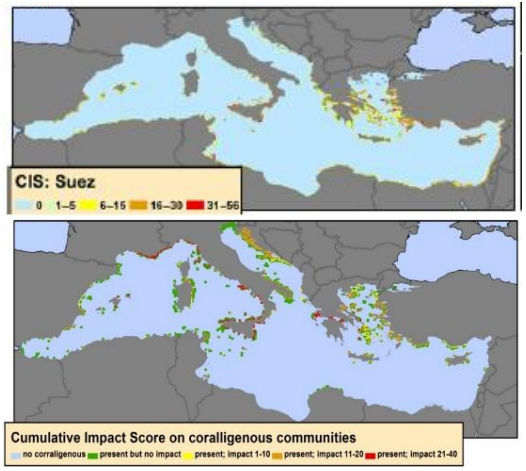

Assesses the cumulative negative impacts of invasive alien species

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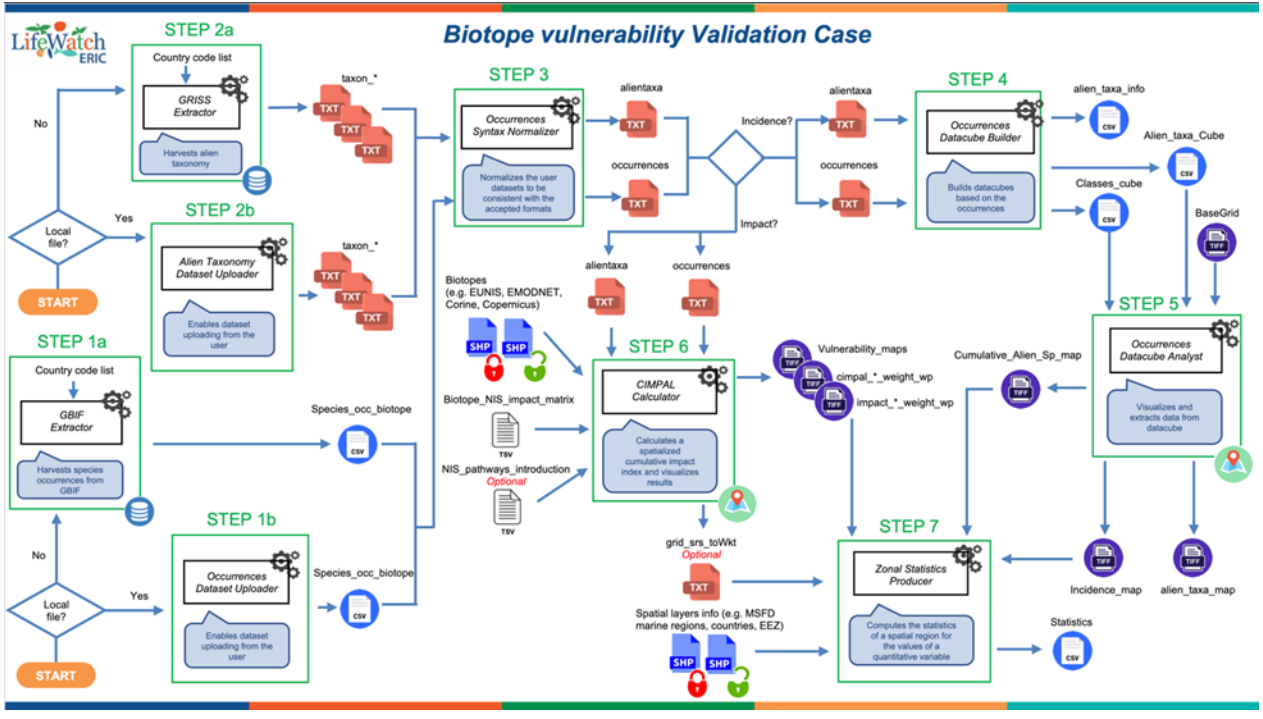
Biotope vulnerability workflow

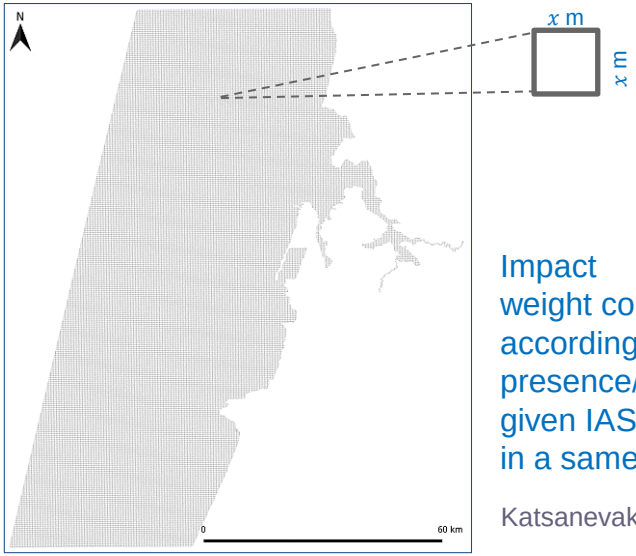


Inputs

Occurrences Dataset	Dataset of species occurrences. It should be a .txt file contained within a .zip file
Alien Taxonomy Dataset	List of alien species scientific names. It should be a .txt file contained within a .zip file
CIMPAL paths of introduction	Paths of introduction for each NIS taxa. It should be a .csv file
Weight file	List of values of impact for each taxon inside each of biotope. It should be a .csv file
Biotope shapefiles	Spatial layers for each habitat. It should be a set of shapefiles contained within a .zip file
Zones shapefiles	Spatial layer(s) for aggregating results. It should be one or more shapefiles contained within a .zip file

CIMPAL index LW IJI NIS improvements

$$I_c = \sum_{i=1}^{n} \sum_{j=1}^{m} A_i H_j w_{i,j}$$

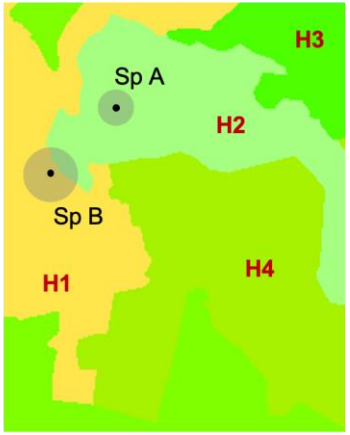


Impact weight considered according to the presence/absence of a given IAS and habitat in a same cell

Katsanevakis *et al*. 2016

per grid cell

Sp A	Sp B
H1	H1
H2	H2
H3	H3
H4	H4



high resolution approach

Sp A	Sp B
~~H1~~	H1
H2	H2
~~H3~~	~~H3~~
~~H4~~	~~H4~~

a posteriori aggregation

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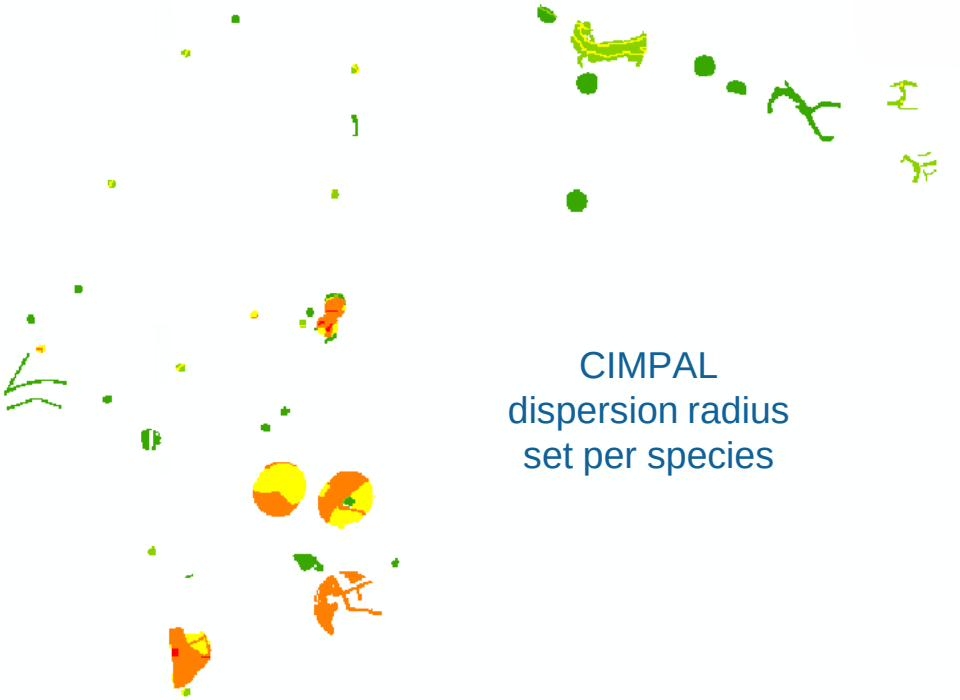
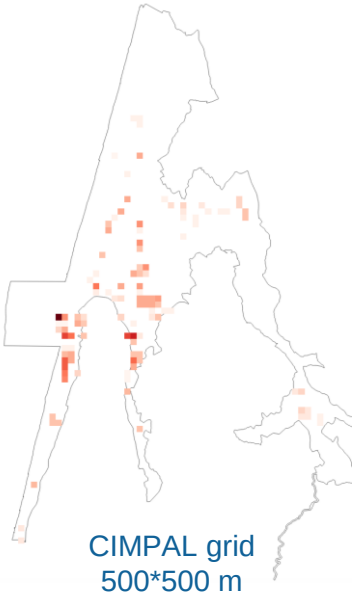
CIMPAL index LW IJI NIS improvements



CIMPAL
dispersion radius
set per species



CIMPAL grid
500*500 m

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What can you explore from CIMPAL outputs?

Spatially

- Identify areas at risk, hotspots of invasions with highest potential negative impacts
- Rank habitats according to vulnerability
- Focus on priority habitats / Conservation status
- Aggregate per e.g. Country, Protected areas
- Provide a grid e.g. EEA, user defined
- Cadastral references
- Spatial Maritime Planing

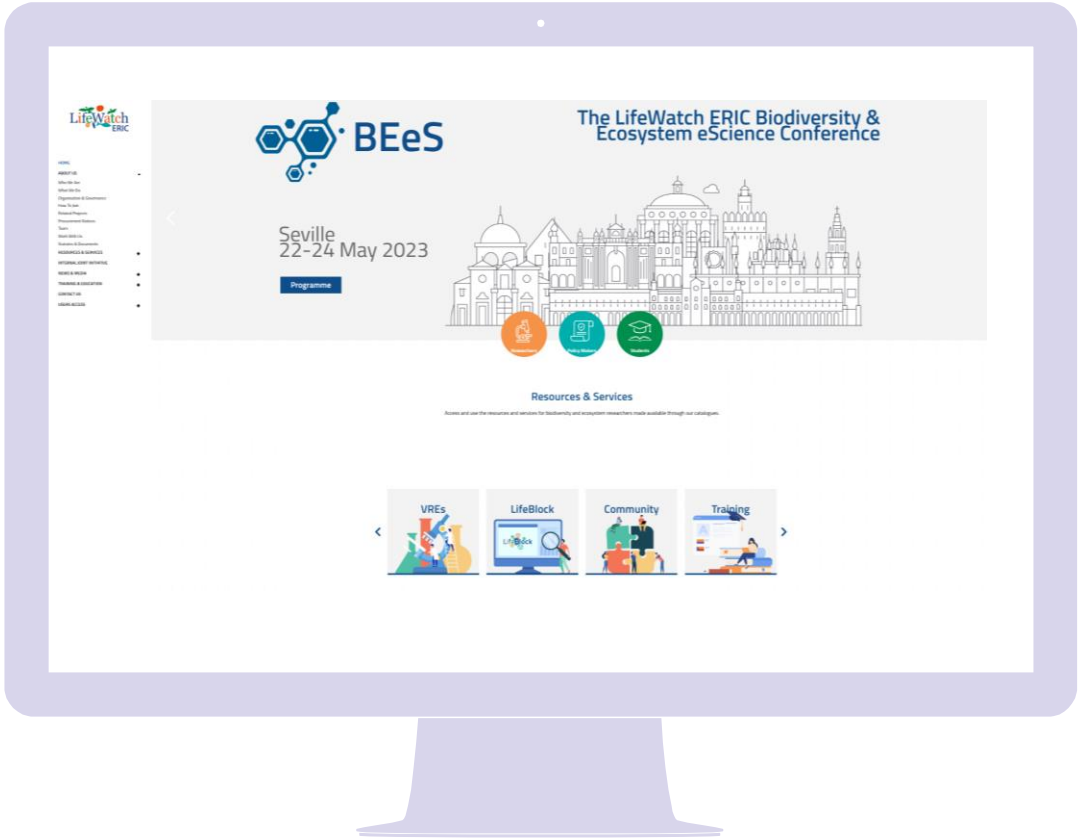
Species level

- Cumulative impact map per species
- Rank species according to highest threat

Per Pathway of introduction *(optional)*

- Management

For further information, visit
https://www.lifewatch.eu/



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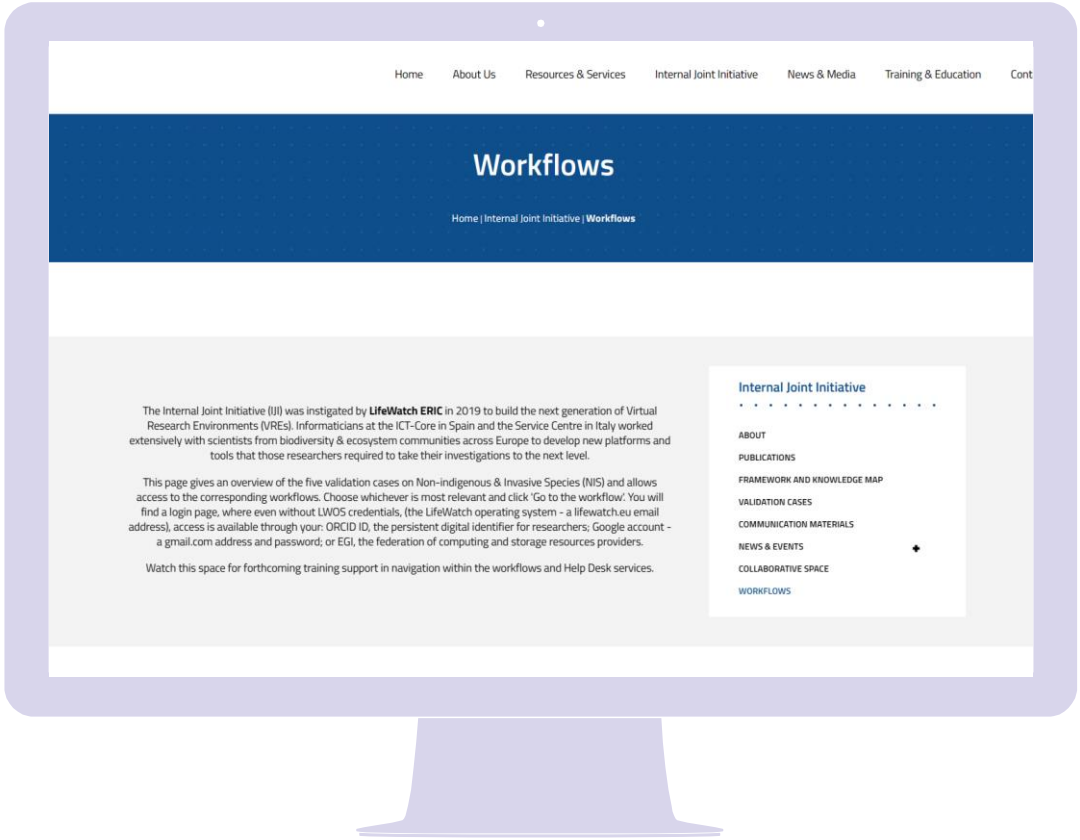

Workflow implementation:

Yannis Probonas | LW-ERIC-ICT

Nikos Minadakis | LW-ERIC-ICT/ Advance SVS

Antonio José Sáenz-Albanés | LW-ERIC ICT-Core Operations Coordinator

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