

Propagule pressure corresponds with occurrence of non-indigenous species across broad taxonomic groups in freshwater habitats

Boggero A., A. Basset, M. Austoni, E. Barbone, L. Bartolozzi, I. Bertani, A. Campanaro, A. Cattaneo, F. Cianferoni, G. Corriero, A.M. Dörr, A.C. Elia, G.F. Ficetola, L. Kamburska, G. La Porta, S. Lauceri, A. Ludovisi, E. Gaino, E. Goretti, M. Lorenzoni, M. Manca, A. Marchetto, G. Morabito, A. Oggioni, C. Pierri, N. Riccardi, G. Rossetti, N. Ungaro, P. Volta, S. Zaupa, D. Fontaneto

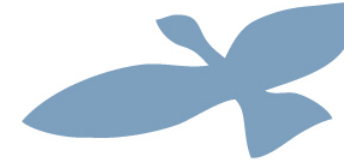
World Lake Conference

Special Session - MS 01-05 Alien species: an increasing threat to freshwater ecosystems?

Perugia, September 1-5, 2014



<http://www.lifewatch.eu>



E-Science European Infrastructure for Biodiversity and Ecosystem Research

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Show Cases

The LifeWatch show cases will facilitate the development of integrative researches on key scientific issues by using already existing evidences, which will be organized and reinforced with additional LifeWatch information and made accessible to the scientific community and the general public.

The case studies thus far identified (and now in the starting phase) are:

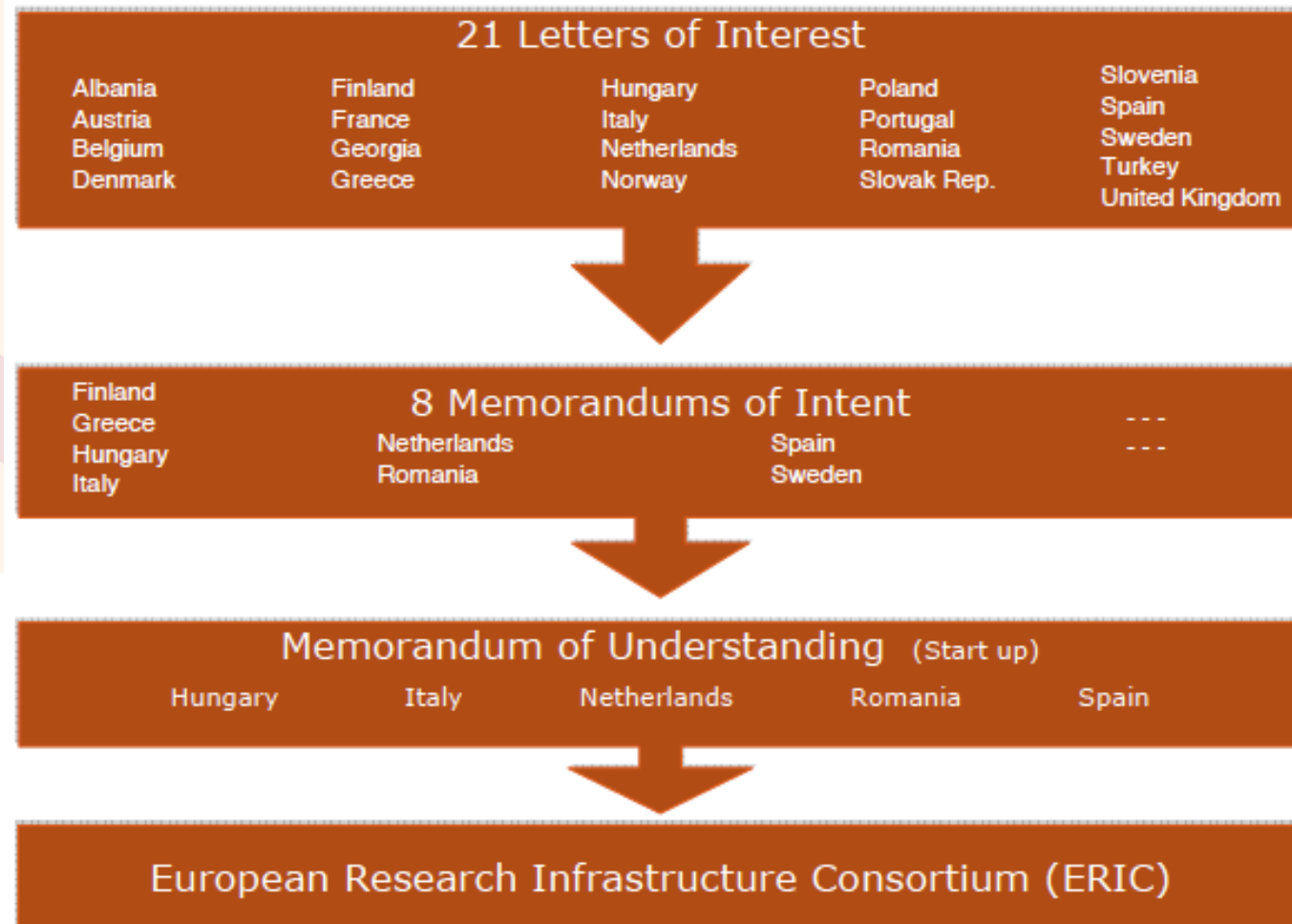
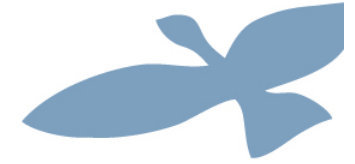
- Monitoring Alien Species (coordinated by Italy),
- Migrating Birds (coordinated by Netherlands) and
- Wetlands (coordinated by Spain).

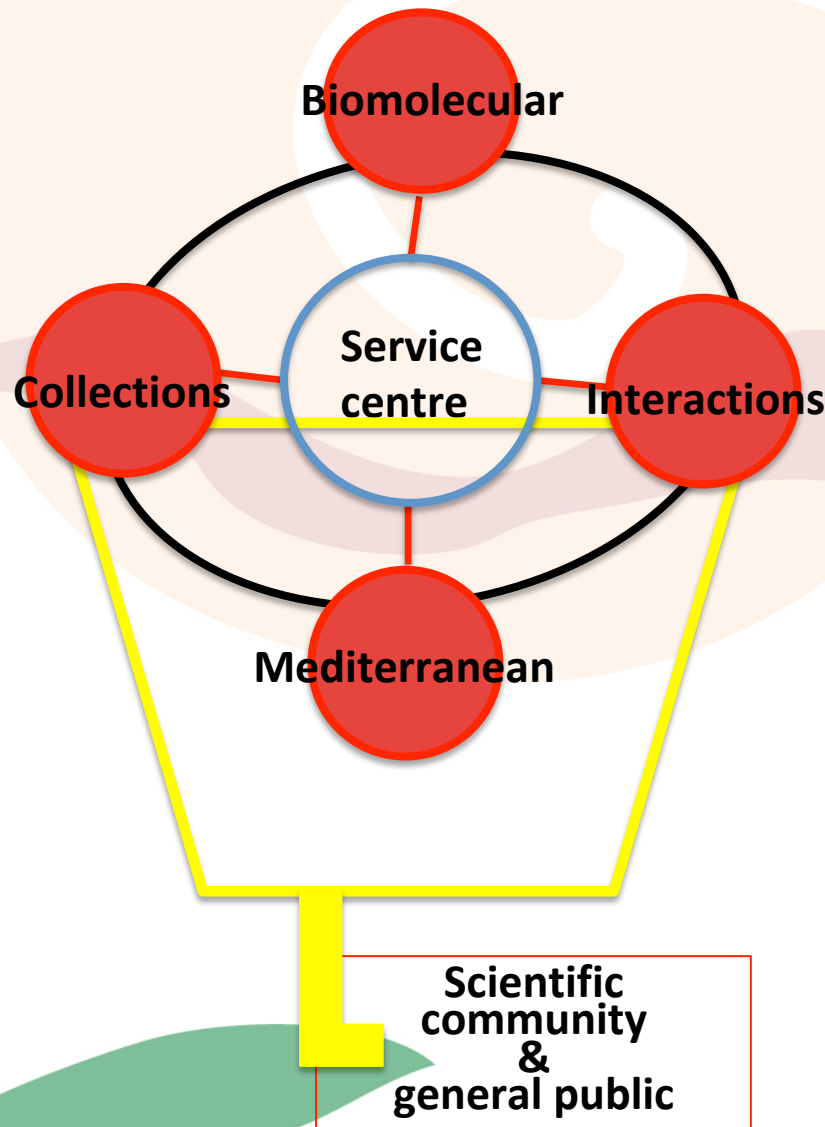


Print



Organisation





LIFEWATCH through the distributed biodiversity institute and its thematic Centres is:

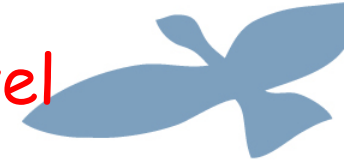
- capitalising on existing knowledge (i.e., knowledge-based resources);
- integrating inter-disciplinary fields, data sources and data processing tools (to strengthen collaboration through sharing software facilities)

to create the environment to:

- address innovative scientific questions (i.e., virtual research projects, virtual experiments etc);
- deepen current understanding of Biodiversity in its broadest sense;
- decrease the uncertainty of environmental management, governance and policy



LifeWatch Show cases at European level

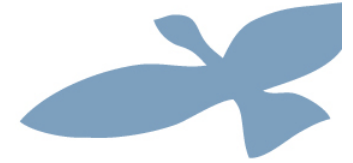


- *Wetlands* - SP (to study biodiversity in marine wetlands with examples from Waddenzee, Adriatic lagoons, Doñana marsh, Danube delta)
- *Migratory birds* - NL (to study migration, navigation, foraging strategies on land and at sea)
- *Alien species* - IT (to study the vulnerability of fresh-, marine and brackish waters and forests to AS invasion. The results will allow the mapping of the vulnerability of different ecosystem types)





LifeWatch Construction in Italy



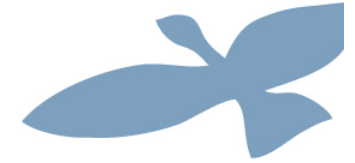
LW-ITA has been established as a formal entity - Joint Research Unit, involving:

- National Research Council (Depts / Institutes)
- Research Centres (Zoological Station Naples)
- Universities (Bari, Florence, Rome, Salento, Milano..)
- Agencies (UNESCO-IAMB, EPAs...)
- Institutions (Academy XL, Presidency of the Republic...)
- Private companies (Comunità Ambiente....)
- LTER (Long Term Ecological Research Network) community, Scientific societies, Consortia





Alien Species definition



Freshwater Biology (2010), 55 (Suppl. 1), 152–174

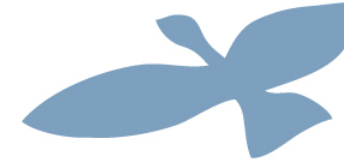
doi:10.1111/j.1365-2427.2009.02380.x

Alien species in fresh waters: ecological effects, interactions with other stressors, and prospects for the future

DAVID L. STRAYER

Cary Institute of Ecosystem Studies, Millbrook, NY, U.S.A.





Freshwater Biology (2010), 55 (Suppl. 1), 152–174

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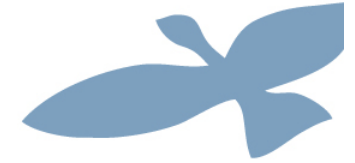
Alien Species (AS) = any species introduced into Italy after the XVth century, deliberately or inadvertently by human activities, that successfully survives and reproduces itself.

In the present work no difference between invasive and naturalized AS was considered....so the term **alien was used in its broadest sense**

Only presence/absence data were considered



The freshwaters Showcase



Based on:
data platform of species lists derived by LTER & LifeWatch Inst.

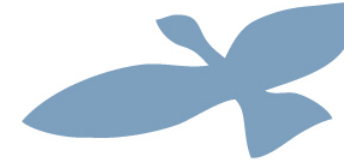
1	CNR - Istituto per lo Studio degli Ecosistemi (ISE)
2	Dipartimento di Scienze e di Tecnologie Biologiche ed Ambientali - Università del Salento
3	Agenzia Regionale per la Prevenzione e Protezione dell' Ambiente (APPA) - Puglia
4	Dipartimento Entomologico, Museo di Storia Naturale - Università di Firenze
5	Dipartimento di Scienze della Vita - Università di Parma
6	Dipartimento di Scienze Biologiche - Università di Montréal
7	Dipartimento di Biologia - Università di Bari "Aldo Moro"
8	Dipartimento di Biologia Cellulare e Ambientale - Università di Perugia
9	Dipartimento di Scienze dell' Ambiente e del Territorio e di Scienze della Terra - Università di Milano Bicocca
10	CNR - Istituto per il Rilevamento Elettromagnetico dell' Ambiente (IREA)

10 Institutions

5 nodes (EPA Puglia, Univ. Florence, Parma, Perugia & CNR-ISE)

182 sites





Site types coded following EUNIS:

C1.1 permanent oligotrophic
 C1.2 permanent mesotrophic
 C1.3 permanent eutrophic
 C1.6 temporary

C2.1 springs
 C2.2 fast turbulent
 C2.3 smooth-flowing

J5.3 highly artificial standing
 J5.4-J5.5 highly artificial fast-flowing



data including.....

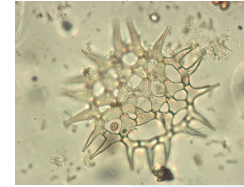


cyanobacteria



✘ Impossibile visualizzare l'immagine. La memoria del computer potrebbe essere insufficiente per aprire l'immagine oppure l'immagine potrebbe essere danneggiata. Riavviare il computer e aprire di nuovo il file. Se viene visualizzata di nuovo la x rossa, potrebbe essere necessario eliminare l'immagine e inserirla di nuovo.

diatoms

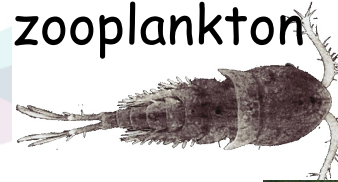


phytoplankton

rotifers



zooplankton



macrophytes



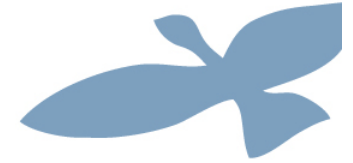
macroinvertebrates

fishes





Data standardisation & quality control



Data standardisation:

- same sampling period considered (1980-2012: 30 years of published or unpublished papers, reports, notes,...)
- data homogeneity checked

Data cleaning by local/national experts:

- taxonomic reliability checked
- taxonomic consistency checked



www.faunaeur.org

www.faunaitalia.it/checklist/

www.eunis.org

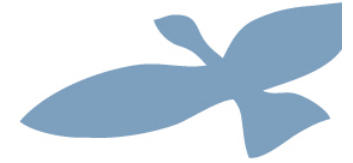
www.algaebase.org

www.ittiofauna.org

www.fishbase.org

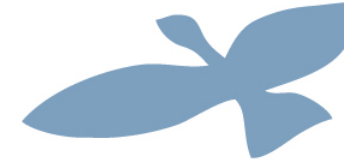
omnidia.free.fr



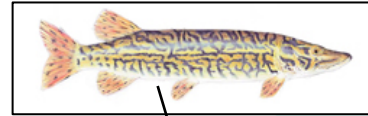


- Species dimensions (max length of a species in mm)
- Data on amount of precipitation from WorldClim database
<http://www.worldclim.org/current> (average 1950-2000)
- Data on temperature from United Nations Environmental Programme
<http://www.grid.unep.ch/data/data.php> (average 1950-2000)
- Site accessibility (distance in min. from the nearest inhabited centre with population > 50000) as a correlate of propagule pressure
<http://bioval.jrc.ec.europa.eu/products/gam/>
- Dimension of the study area (lake area in m²)

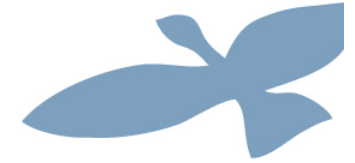




Absolute number of AS per each taxonomic group
 Over 1604 species & 54 taxa
42 alien (<3%)

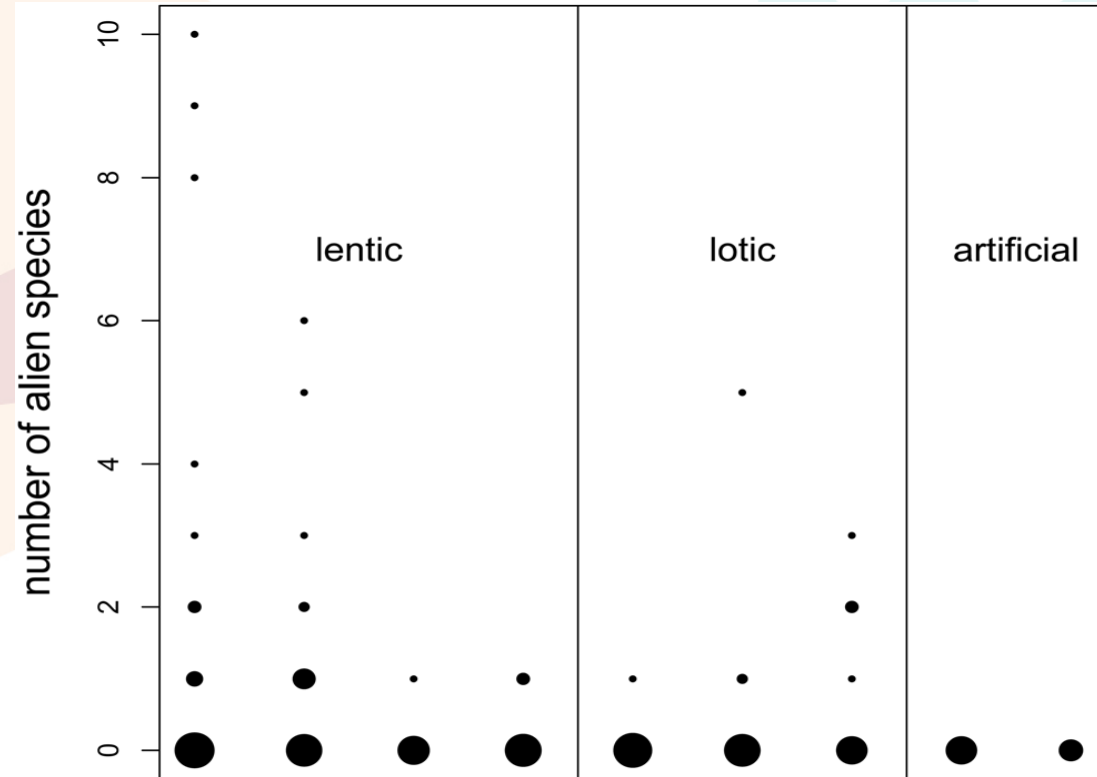


Impossibile visualizzare l'immagine. La memoria del computer potrebbe essere insufficiente per aprire l'immagine oppure l'immagine potrebbe essere danneggiata. Riavviare il computer e aprire di nuovo il file. Se viene visualizzata di nuovo la x rossa, potrebbe essere necessario eliminare l'immagine e inserirla di nuovo.



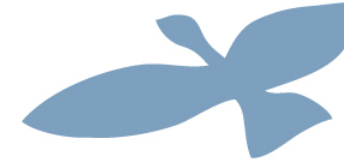
Absolute number of AS per each site

No AS
in artificial waterbodies



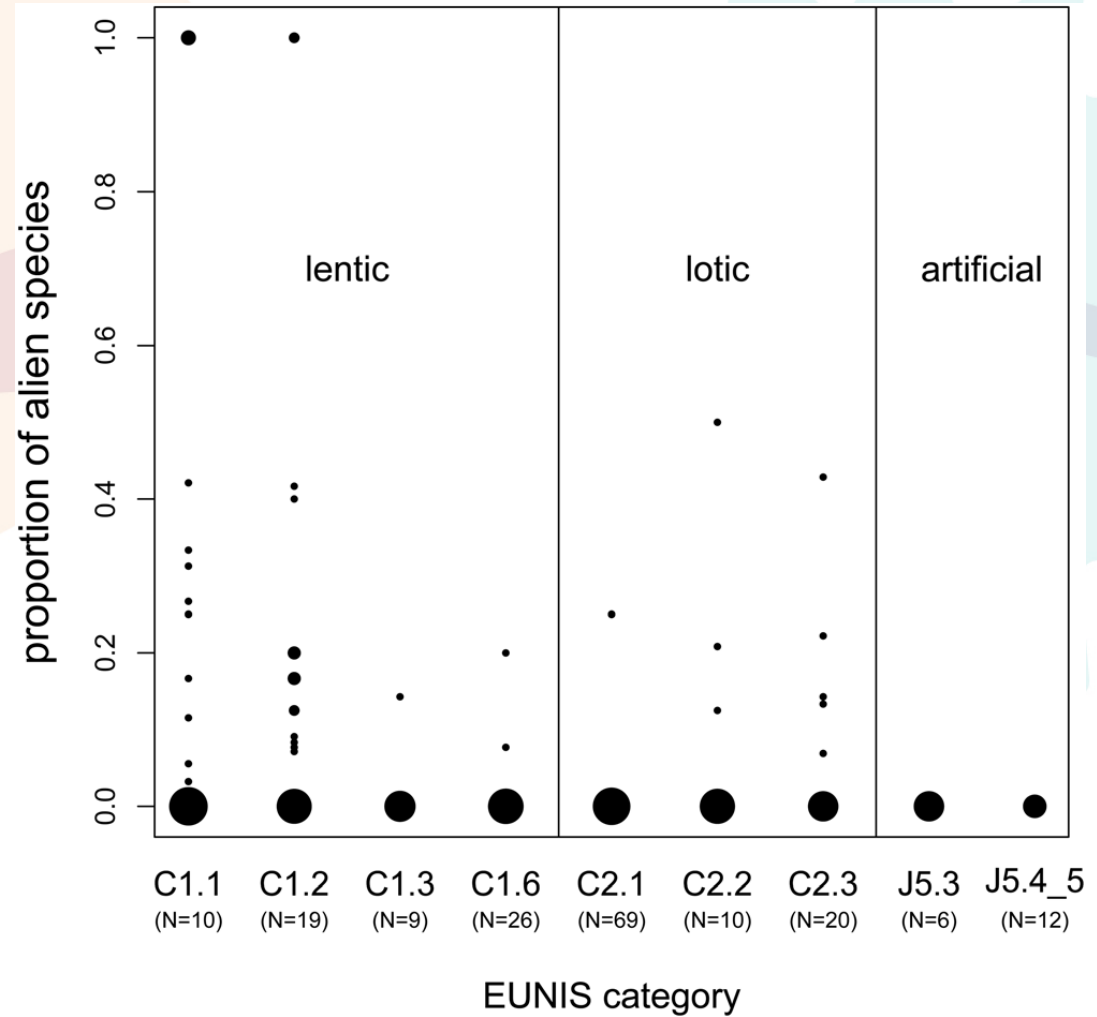
Impossibile visualizzare l'immagine. La memoria del computer potrebbe essere insufficiente per aprire l'immagine oppure l'immagine potrebbe essere danneggiata. Riavviare il computer e aprire di nuovo il file. Se viene visualizzata di nuovo la x rossa, potrebbe essere necessario eliminare l'immagine e inserirla di nuovo.

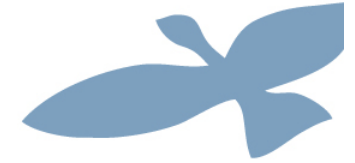




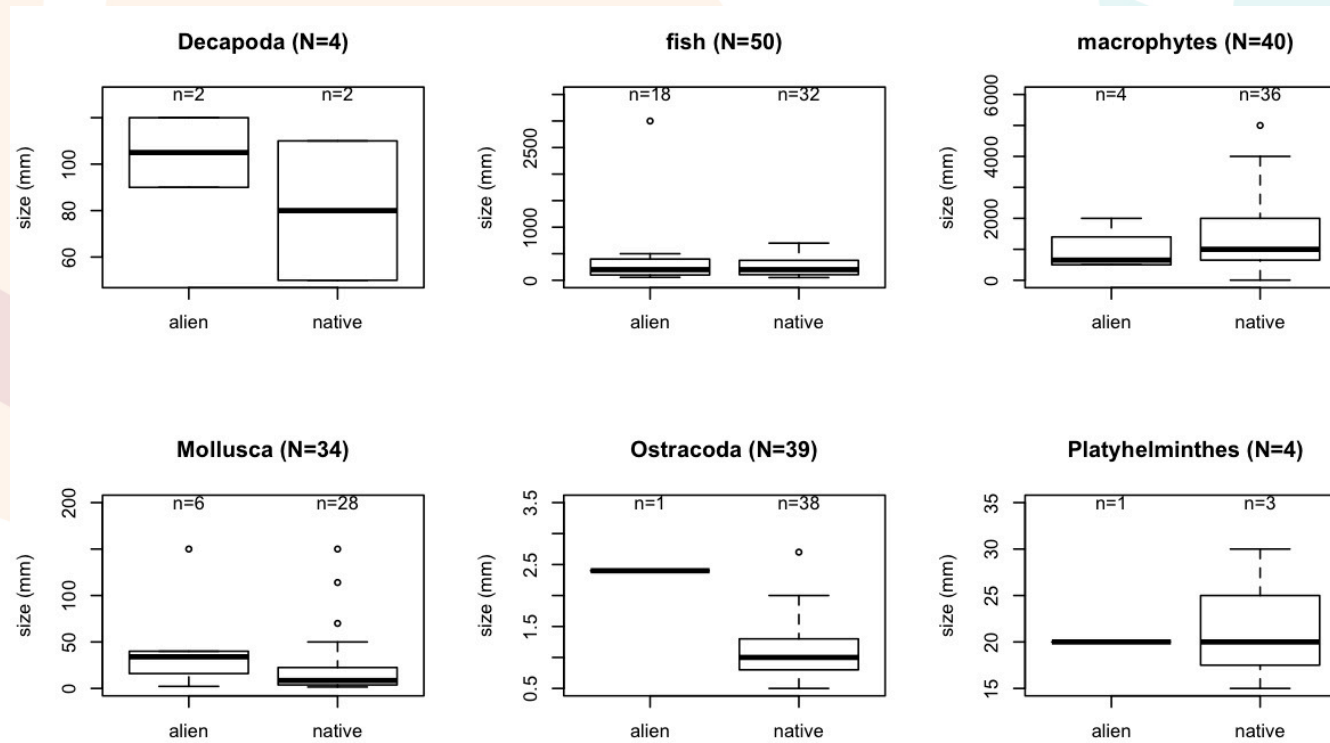
Relative number of alien species per each site

No AS
in artificial waterbodies





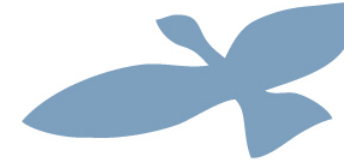
In general, are AS larger or smaller than autochthonous species?



AS not significantly diverse from native species

One way ANOVA





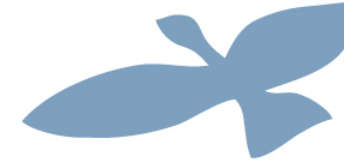
Are the absolute and the relative number of AS in each taxonomic group related to habitat, richness, precipitation and temperature?

	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

Positive correlation with richness of the taxonomic group in the receiving community and with local air temperature

The proportion of AS for each group confirmed the effect of temperature, not of richness

Linear Mixed Effect Models



Are the absolute and the relative number of AS in each taxonomic group related to habitat, richness, precipitation and temperature analyzing **lentic waters separately**?

	no. species			% species		
	estimate	SE	p-values	estimate	SE	p-values
(intercept)	-6.121	1.145	<0.0001	-6.924	1.019	<0.0001
EUNIS code	---	---	>0.3	---	---	>0.4
richness	0.877	0.26	0.0008	0.039	0.269	0.8851
precipitation	-0.074	0.137	0.589	-0.088	0.151	0.5594
temperature	2.108	0.586	0.0003	2.057	0.626	0.001

The overall number of AS was again positively related to richness and temperature

The positive effect of temperature was also revealed analyzing the proportion of AS



Questions

Are the absolute and the relative number of AS in each taxonomic group related to habitat, richness, precipitation and temperature analyzing lotic waters separately?

	no. species			% species		
	estimate	SE	p-values	estimate	SE	p-values
(intercept)	-10.672	4.004	0.0077	-7.502	1.701	<0.0001
C2.1-C2.2	-0.209	1.877	0.9111	0.001	1.967	0.9998
C2.1-C2.3	2.467	1.298	0.0573	2.972	1.357	0.0285
C2.2-C2.3	2.257	1.674	0.1775	2.972	1.89	0.1159
richness	2.22	0.673	0.0009	-0.085	0.374	0.8205
precipitation	0.459	0.715	0.5209	1.165	0.77	0.1305
temperature	0.141	0.813	0.8626	0.369	0.893	0.6793

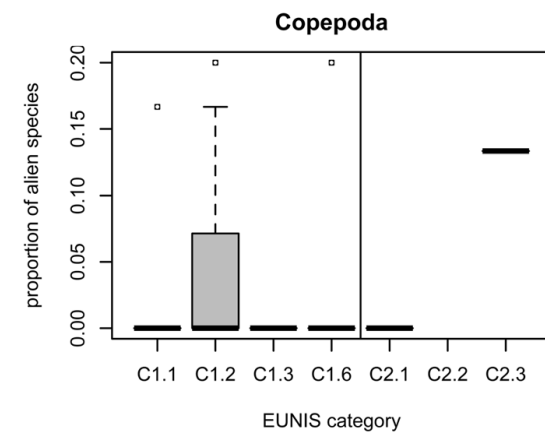
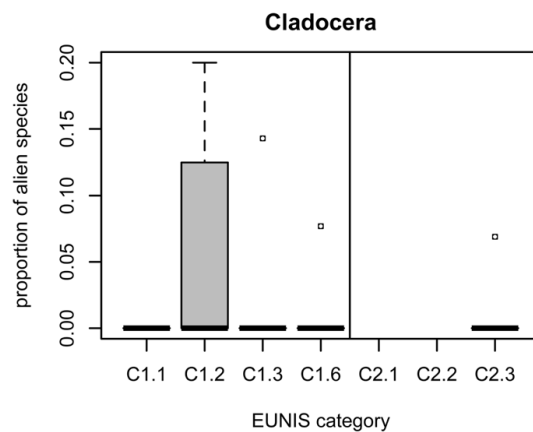
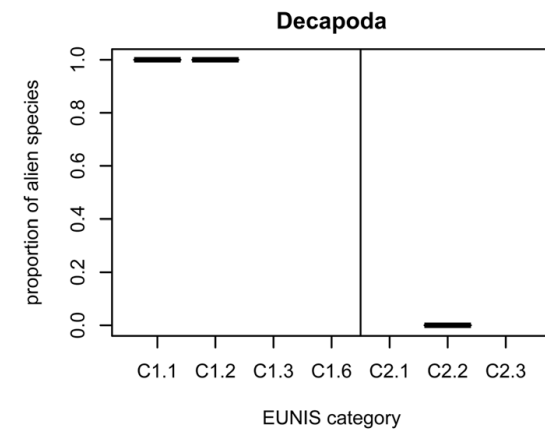
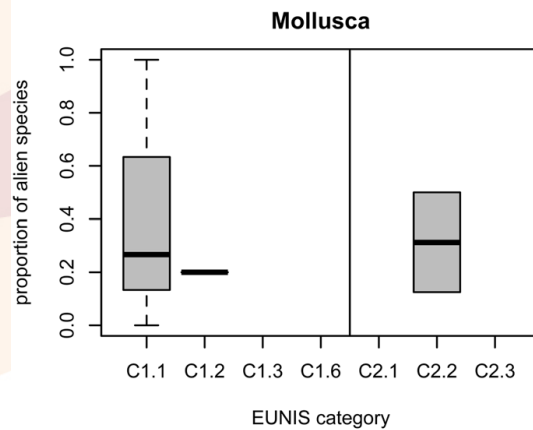
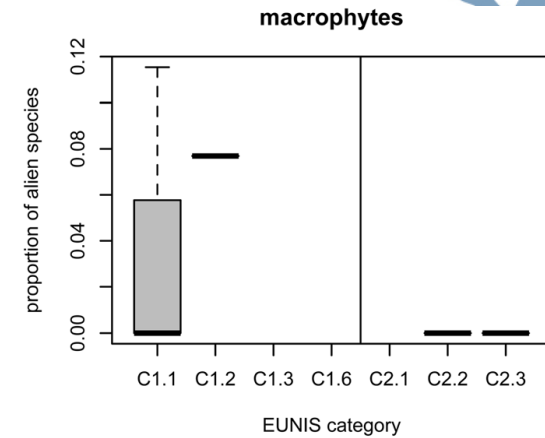
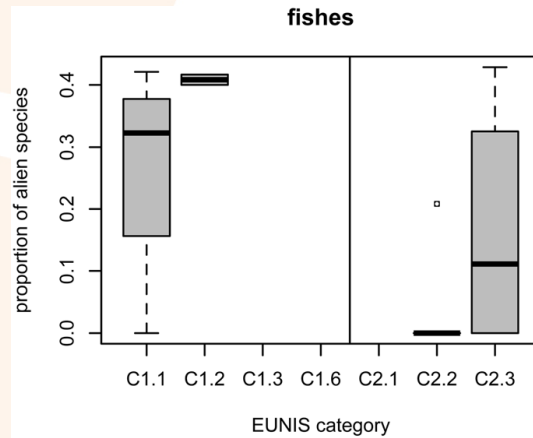
Only species richness was correlated to the number of AS

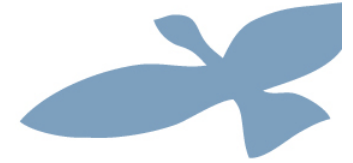
The proportion of AS highlighted significant differences between habitats, with smooth-flowing watercourses (C2.3) hosting a higher proportion of AS than springs (C2.1)

Linear Mixed Effect Models

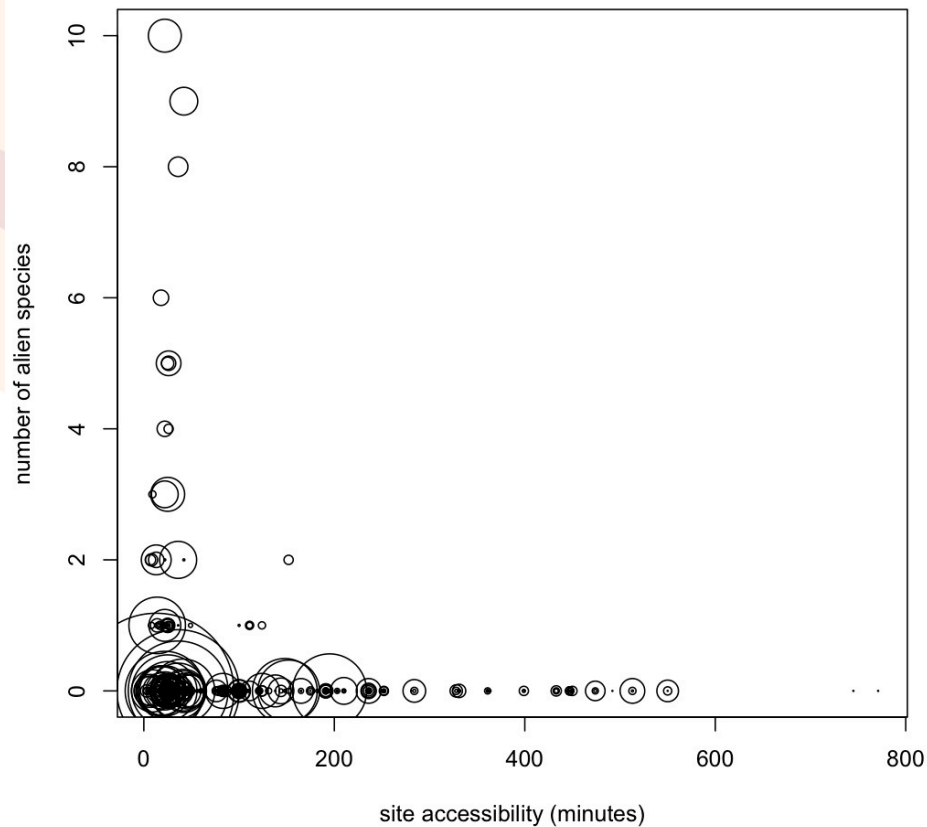
Distribution of the proportion of AS in each site in each of the six taxonomic groups with the highest number of AS

The results of all the previous models were qualitatively confirmed by the results of the analyses from the reduced dataset demonstrating no biases in the analyses





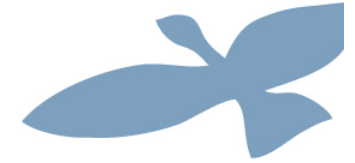
Do more accessible and frequented sites show more AS than remote and unfrequented sites?



Circle diameter is proportional to the local species richness of each taxonomic group in each site.

Number of AS correlated to species richness and to site accessibility

linear mixed effects models



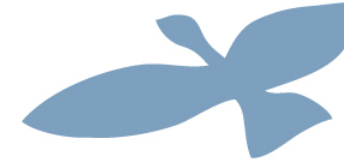
Do more accessible and frequented **lentic habitats** show more AS than remote and unfrequented ones?

	no. AS			% AS		
	estimate	SE	p-values	estimate	SE	p-values
(Intercept)	-6.79	1.32	<0.0001	-8.02	1.4	<0.0001
Richness	0.79	0.22	0.0003	-0.09	0.25	0.7077
Body size	0.51	0.35	0.1422	0.41	0.32	0.1952
Accessibility	-4.34	1.5	0.0039	-4.29	1.6	0.0075
Surface area	-0.06	0.11	0.5855	-0.06	0.11	0.575
EUNIS habitats	-	-	>0.5857	-	-	>0.3727

Accessibility is confirmed to be one of the emerging drivers of AS presence

model averaging



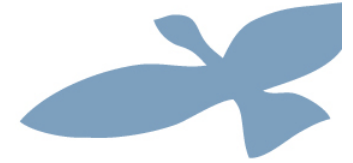


Do larger and eutrophic lentic habitats show more AS than smaller and oligotrophic ones?

	no. AS			% AS		
	estimate	SE	p-values	estimate	SE	p-values
(Intercept)	-6.79	1.32	<0.0001	-8.02	1.4	<0.0001
Richness	0.79	0.22	0.0003	-0.09	0.25	0.7077
Body size	0.51	0.35	0.1422	0.41	0.32	0.1952
Accessibility	-4.34	1.5	0.0039	-4.29	1.6	0.0075
Surface area	-0.06	0.11	0.5855	-0.06	0.11	0.575
EUNIS habitats	-	-	>0.5857	-	-	>0.3727

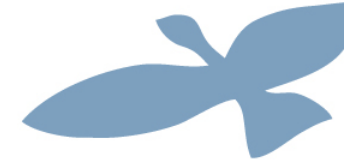
No correlation between presence of AS vs lake area or trophic level

model averaging



- a) Occurrence of AS is similar in lentic and lotic habitats, thus their spread should be controlled with equal efforts in both and conservation priorities should focus on all freshwater habitats not only on biologically rich waterbodies
- b) The present analysis suggests that conservation strategies for freshwater habitats in temperate areas (Italy) should focus on the warmest and most accessible sites, regardless of habitat type, to maximize their efficiency and efficacy
- c) The strong influence of temperature correlated with the occurrence of AS confirms previous indications that biological invasions may be potentially controlled and limited by mitigating human activities in the environment
- d) Being part of a community facilitates the availability and accessibility to data and the request for information





AQUATIC CONSERVATION: MARINE AND FRESHWATER ECOSYSTEMS

Aquatic Conserv: Mar. Freshw. Ecosyst. (2014)

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Weak effects of habitat type on susceptibility to invasive freshwater species: an Italian case study

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^eDepartment of Life Sciences, University of Parma, Parma, Italy

^fNational Forestry Service, National Center for Biodiversity Study and Conservation, Marmirolo MN, Italy

^gDépartement de Sciences Biologiques, Université de Montréal, Montréal, Québec, Canada

^hDepartment of Biology, University of Bari "Aldo Moro", Bari, Italy

ⁱDepartment of Cellular and Environmental Biology, University of Perugia, Perugia, Italy

^jDipartimento di Scienze dell'Ambiente e del Territorio e di Scienze della Terra, University of Milano Bicocca, Milano, Italy

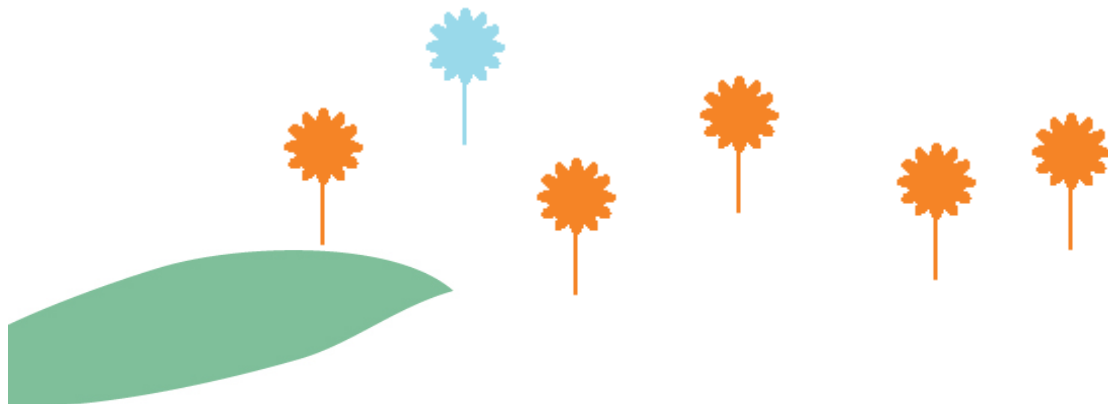
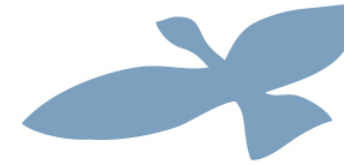
^kNational Research Council, Institute for Electromagnetic Sensing of the Environment, Milano, Italy



For major information on **LifeWatch**:
Alberto Basset
University of Salento, Lecce
LIFEWATCH - Board of Directors

For major information on the **statistical approaches**:

Diego Fontaneto, Paolo Colangelo, Aldo Marchetto
CNR Institute of Ecosystem Study, Verbania Pallanza
&
Alessandro Ludovisi
University of Perugia





Biodiversity is life
Biodiversity is our life

