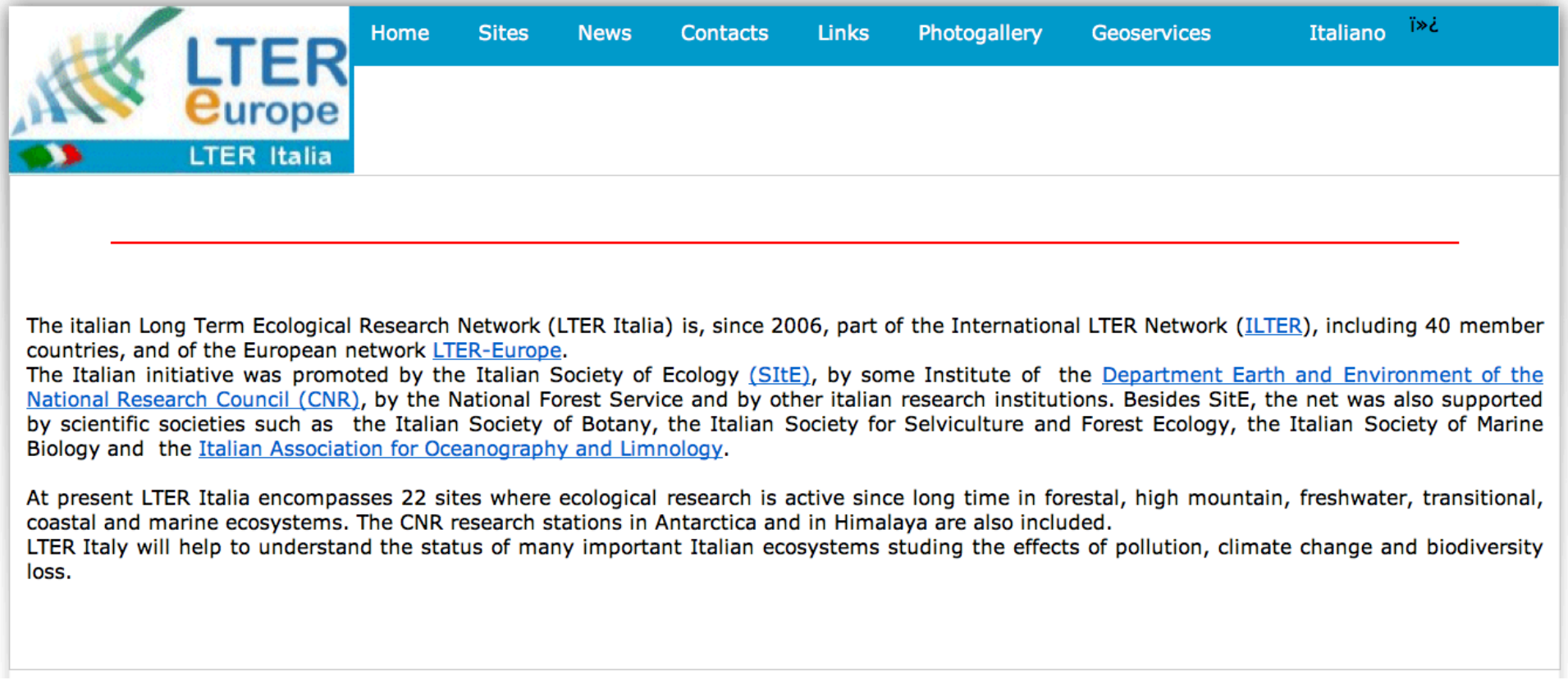
Fragility of LTER freshwater habitats to alien species: testing the ecological correlates of alien occurrence across several taxonomic groups

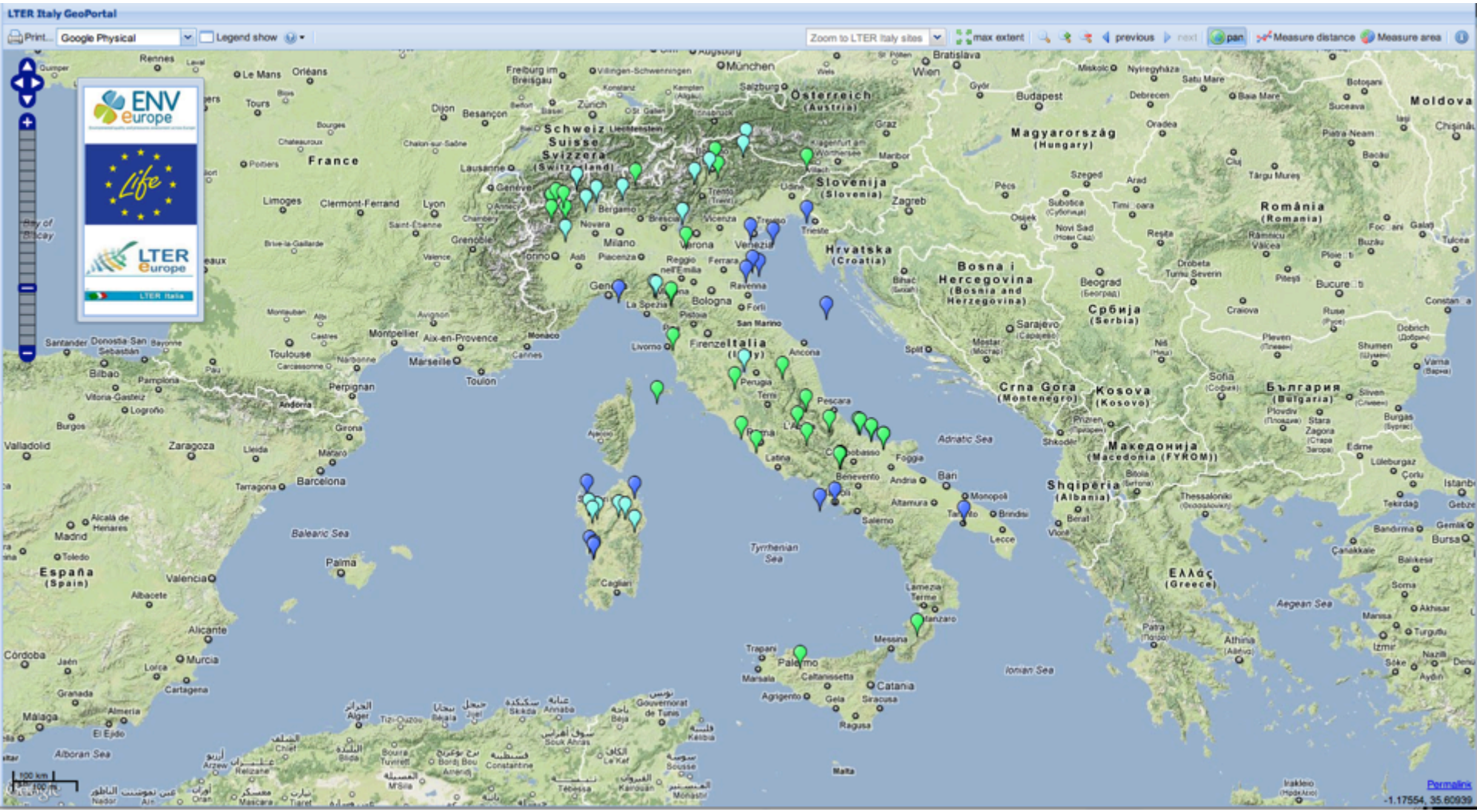
Diego Fontaneto[1], Angela Boggero[1], Alberto Basset[2], Martina Austoni[1], Enrico Barbone[3], Luca Bartolozzi[4], Isabella Bertani[5], Antonella Cattaneo[6], Fabio Cianferoni[4], Giuseppe Corriero[7], Ambrosius Martin Dörr[8], A. Concetta Elia[8], G. Francesco Ficetola[9], Lyudmila Kamburska[1], Gianandrea La Porta[8], Sara Lauceri[1], Alessandro Ludovisi[8], Elda Gaino[8], Enzo Goretti[8], Massimo Lorenzoni[8], Marina Manca[1], Aldo Marchetto[1], Giuseppe Morabito[1], Alessandro Oggioni[1,10], Cataldo Pierri[7], Nicoletta Riccardi[1], Giampaolo Rossetti[5], Nicola Ungaro[3], Pietro Volta[1], Silvia Zaupa[1]

Consiglio Nazionale delle Ricerche - Istituto per lo Studio degli Ecosistemi
Largo Tonolli 50 - Verbania Pallanza - d.fontaneto@ise.cnr.it

http://www.lteritalia.it



LTER-Italy sites



www.lteritalia.it

LTER-ITALY SITES

IT-01 HIGH ALTITUDE APENNINES
IT-02 FORESTS OF THE ALPS
IT-03 FORESTS OF THE APENNINES
IT-04 MEDITERRANEAN FORESTS
IT-05 LOWLAND FORESTS
IT-06 PIANOSA ISLANDS
IT 07 PO RIVER DELTA LAGOONS
IT-08 SUBALPINE LAKES
IT-09 MOUNTAIN LAKES
IT-10 LACUSTRINE ECOSYSTEMS OF SARDINIA
IT-11 HIMALAYAN LAKES*
IT-12 NORTHERN ADRIATIC SEA
IT-13 GULF OF NAPLES
IT-14 MARINE ECOSYSTEMS OF SARDINIA
IT-15 MARINE PROTECTED AREA OF PORTOFINO
IT-16 LAGOON OF VENICE
IT-17 RESEARCH STATIONS IN ANTARCTICA*
IT-18 ESTATE OF CASTELPORZIANO
IT-19 NORTH-WESTERN ALPS
IT-20 COASTAL DUNES OF CENTRAL ITALY
IT-21 LAKE TRASIMENO
IT-22 MAR PICCOLO OF TARANTO

FRESHWATER ECOSYSTEMS

Availability and accessibility

Reliable data and metadata

http://www.lifewatch.eu

LifeWatch

E-Science European Infrastructure for Biodiversity and Ecosystem Research

Show Cases

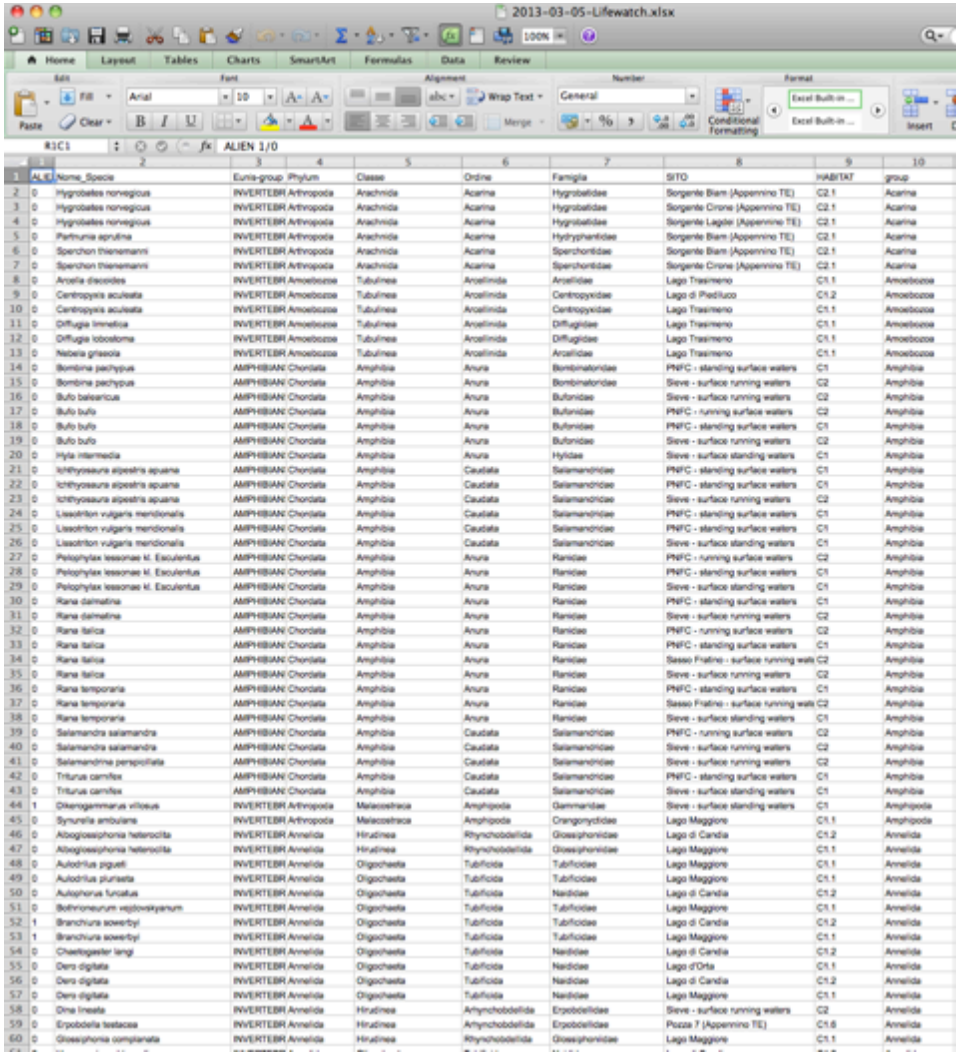
The LifeWatch show cases will facilitate the development of integrative researches on key scientific issues by using already existing evidences, which will be organized and reinforced with additional LifeWatch information and made accessible to the scientific community and the general public.
The case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

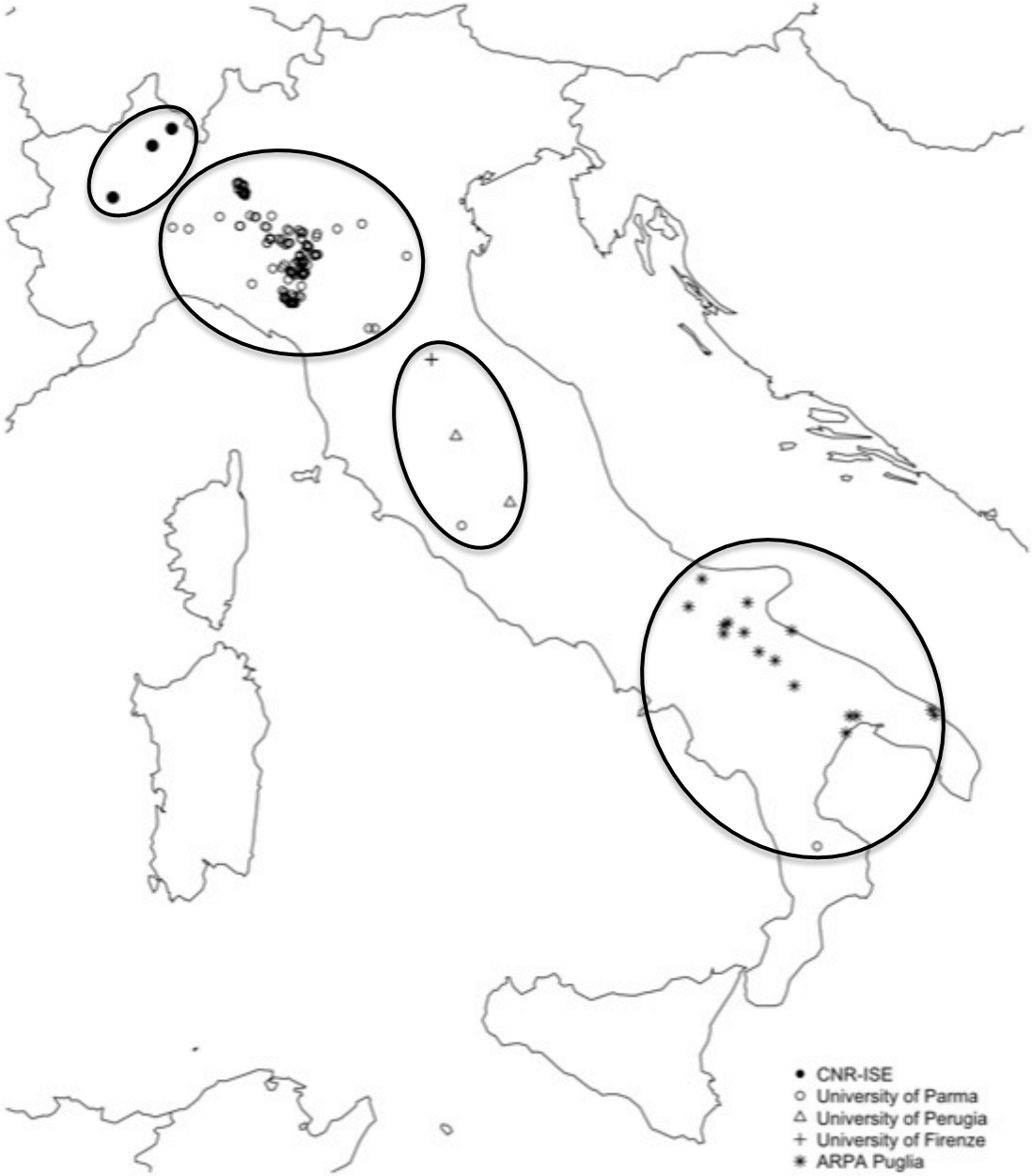
LifeWatch

Large datasets

on species presence in freshwater habitats from LTER through LifeWatch to Alien ShowCase



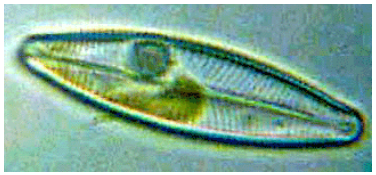
ALIEN	Nome_Specie	Euria-group	Phylum	Classe	Ordine	Famiglia	SITO	HABITAT	group
0	Hygrobates norvegicus	INVERTEBR	Arthropoda	Arachnida	Acarina	Hygrobatidae	Sorgente Biarn (Appennino TE)	C2.1	Acarina
0	Hygrobates norvegicus	INVERTEBR	Arthropoda	Arachnida	Acarina	Hygrobatidae	Sorgente Cirone (Appennino TE)	C2.1	Acarina
0	Hygrobates norvegicus	INVERTEBR	Arthropoda	Arachnida	Acarina	Hygrobatidae	Sorgente Lagole (Appennino TE)	C2.1	Acarina
0	Partnunia aprutina	INVERTEBR	Arthropoda	Arachnida	Acarina	Hydryphantidae	Sorgente Biarn (Appennino TE)	C2.1	Acarina
0	Sperchon thienemanni	INVERTEBR	Arthropoda	Arachnida	Acarina	Sperchontidae	Sorgente Biarn (Appennino TE)	C2.1	Acarina
0	Sperchon thienemanni	INVERTEBR	Arthropoda	Arachnida	Acarina	Sperchontidae	Sorgente Cirone (Appennino TE)	C2.1	Acarina
0	Arcella discoides	INVERTEBR	Amoebozoa	Tubulinea	Arcellinida	Arcellidae	Lago Trasimeno	C1.1	Amoebozoa
0	Centropyxis aculeata	INVERTEBR	Amoebozoa	Tubulinea	Arcellinida	Centropyxidae	Lago di Piediluco	C1.2	Amoebozoa
0	Centropyxis aculeata	INVERTEBR	Amoebozoa	Tubulinea	Arcellinida	Centropyxidae	Lago Trasimeno	C1.1	Amoebozoa
0	Difflugia limnetica	INVERTEBR	Amoebozoa	Tubulinea	Arcellinida	Difflugiidae	Lago Trasimeno	C1.1	Amoebozoa
0	Difflugia lobostoma	INVERTEBR	Amoebozoa	Tubulinea	Arcellinida	Difflugiidae	Lago Trasimeno	C1.1	Amoebozoa
0	Nebela griseola	INVERTEBR	Amoebozoa	Tubulinea	Arcellinida	Arcellidae	Lago Trasimeno	C1.1	Amoebozoa
0	Bombina pachypus	AMPHIBIAN	Chordata	Amphibia	Anura	Bombinatoridae	PNFC - standing surface waters	C1	Amphibia
0	Bombina pachypus	AMPHIBIAN	Chordata	Amphibia	Anura	Bombinatoridae	Sieve - surface running waters	C2	Amphibia
0	Bufo balearicus	AMPHIBIAN	Chordata	Amphibia	Anura	Bufonidae	Sieve - surface running waters	C2	Amphibia
0	Bufo bufo	AMPHIBIAN	Chordata	Amphibia	Anura	Bufonidae	PNFC - running surface waters	C2	Amphibia
0	Bufo bufo	AMPHIBIAN	Chordata	Amphibia	Anura	Bufonidae	PNFC - standing surface waters	C1	Amphibia
0	Bufo bufo	AMPHIBIAN	Chordata	Amphibia	Anura	Bufonidae	Sieve - surface running waters	C2	Amphibia
0	Hyla intermedia	AMPHIBIAN	Chordata	Amphibia	Anura	Hylidae	Sieve - surface standing waters	C1	Amphibia
0	Ichthyosaura alpestris apuana	AMPHIBIAN	Chordata	Amphibia	Caudata	Salamandridae	PNFC - standing surface waters	C1	Amphibia
0	Ichthyosaura alpestris apuana	AMPHIBIAN	Chordata	Amphibia	Caudata	Salamandridae	PNFC - standing surface waters	C1	Amphibia
0	Ichthyosaura alpestris apuana	AMPHIBIAN	Chordata	Amphibia	Caudata	Salamandridae	Sieve - surface running waters	C2	Amphibia
0	Lissotriton vulgaris meridionalis	AMPHIBIAN	Chordata	Amphibia	Caudata	Salamandridae	PNFC - standing surface waters	C1	Amphibia
0	Lissotriton vulgaris meridionalis	AMPHIBIAN	Chordata	Amphibia	Caudata	Salamandridae	PNFC - standing surface waters	C1	Amphibia
0	Lissotriton vulgaris meridionalis	AMPHIBIAN	Chordata	Amphibia	Caudata	Salamandridae	Sieve - surface standing waters	C1	Amphibia
0	Pelophylax lessonae kl. Esculentus	AMPHIBIAN	Chordata	Amphibia	Anura	Ranidae	PNFC - running surface waters	C2	Amphibia
0	Pelophylax lessonae kl. Esculentus	AMPHIBIAN	Chordata	Amphibia	Anura	Ranidae	PNFC - standing surface waters	C1	Amphibia
0	Pelophylax lessonae kl. Esculentus	AMPHIBIAN	Chordata	Amphibia	Anura	Ranidae	Sieve - surface standing waters	C1	Amphibia
0	Rana dalmatina	AMPHIBIAN	Chordata	Amphibia	Anura	Ranidae	PNFC - standing surface waters	C1	Amphibia
0	Rana dalmatina	AMPHIBIAN	Chordata	Amphibia	Anura	Ranidae	Sieve - surface running waters	C2	Amphibia
0	Rana italica	AMPHIBIAN	Chordata	Amphibia	Anura	Ranidae	PNFC - running surface waters	C2	Amphibia
0	Rana italica	AMPHIBIAN	Chordata	Amphibia	Anura	Ranidae	PNFC - standing surface waters	C1	Amphibia
0	Rana italica	AMPHIBIAN	Chordata	Amphibia	Anura	Ranidae	Sasso Fratino - surface running wate	C2	Amphibia
0	Rana italica	AMPHIBIAN	Chordata	Amphibia	Anura	Ranidae	Sieve - surface running waters	C2	Amphibia
0	Rana temporaria	AMPHIBIAN	Chordata	Amphibia	Anura	Ranidae	PNFC - standing surface waters	C1	Amphibia
0	Rana temporaria	AMPHIBIAN	Chordata	Amphibia	Anura	Ranidae	Sasso Fratino - surface running wate	C2	Amphibia
0	Rana temporaria	AMPHIBIAN	Chordata	Amphibia	Anura	Ranidae	Sieve - surface standing waters	C1	Amphibia
0	Salamandra salamandra	AMPHIBIAN	Chordata	Amphibia	Caudata	Salamandridae	PNFC - running surface waters	C2	Amphibia
0	Salamandra salamandra	AMPHIBIAN	Chordata	Amphibia	Caudata	Salamandridae	Sieve - surface running waters	C2	Amphibia
0	Salamandrina perspicillata	AMPHIBIAN	Chordata	Amphibia	Caudata	Salamandridae	Sieve - surface running waters	C2	Amphibia
0	Triturus carnifex	AMPHIBIAN	Chordata	Amphibia	Caudata	Salamandridae	PNFC - standing surface waters	C1	Amphibia
0	Triturus carnifex	AMPHIBIAN	Chordata	Amphibia	Caudata	Salamandridae	Sieve - surface standing waters	C1	Amphibia
1	Dikerogammarus villosus	INVERTEBR	Arthropoda	Malacostraca	Amphipoda	Gammaridae	Sieve - surface standing waters	C1	Amphipoda
0	Synurella ambulans	INVERTEBR	Arthropoda	Malacostraca	Amphipoda	Crangonyctidae	Lago Maggiore	C1.1	Amphipoda
0	Alboglossiphonia heterocita	INVERTEBR	Annelida	Hirudinea	Rhynchobdellida	Glossiphoniidae	Lago di Candia	C1.2	Annelida
0	Alboglossiphonia heterocita	INVERTEBR	Annelida	Hirudinea	Rhynchobdellida	Glossiphoniidae	Lago Maggiore	C1.1	Annelida
0	Aulodrilus pigueti	INVERTEBR	Annelida	Oligochaeta	Tubificida	Tubificidae	Lago Maggiore	C1.1	Annelida
0	Aulodrilus pluriseta	INVERTEBR	Annelida	Oligochaeta	Tubificida	Tubificidae	Lago Maggiore	C1.1	Annelida
0	Aulophorus furcatus	INVERTEBR	Annelida	Oligochaeta	Tubificida	Naididae	Lago di Candia	C1.2	Annelida
0	Bothrioneurum vejdovskyanum	INVERTEBR	Annelida	Oligochaeta	Tubificida	Tubificidae	Lago Maggiore	C1.1	Annelida
1	Branchiura sowerbyi	INVERTEBR	Annelida	Oligochaeta	Tubificida	Tubificidae	Lago di Candia	C1.2	Annelida
1	Branchiura sowerbyi	INVERTEBR	Annelida	Oligochaeta	Tubificida	Tubificidae	Lago Maggiore	C1.1	Annelida
0	Chaetogaster langi	INVERTEBR	Annelida	Oligochaeta	Tubificida	Naididae	Lago di Candia	C1.2	Annelida
0	Dero digitata	INVERTEBR	Annelida	Oligochaeta	Tubificida	Naididae	Lago d'Orta	C1.1	Annelida
0	Dero digitata	INVERTEBR	Annelida	Oligochaeta	Tubificida	Naididae	Lago di Candia	C1.2	Annelida
0	Dero digitata	INVERTEBR	Annelida	Oligochaeta	Tubificida	Naididae	Lago Maggiore	C1.1	Annelida
0	Dina lineata	INVERTEBR	Annelida	Hirudinea	Arhynchobdellida	Erpobdellidae	Sieve - surface running waters	C2	Annelida
0	Erpobdella testacea	INVERTEBR	Annelida	Hirudinea	Arhynchobdellida	Erpobdellidae	Pozza 7 (Appennino TE)	C1.6	Annelida
0	Glossiphonia complanata	INVERTEBR	Annelida	Hirudinea	Rhynchobdellida	Glossiphoniidae	Lago Maggiore	C1.1	Annelida



182 sampling sites
in 4 nodes

1632 species
in 55 taxa

cyanobacteria



diatoms

rotifers

copepods

macrophytes

fish

Correlates of occurrence of alien species in freshwater

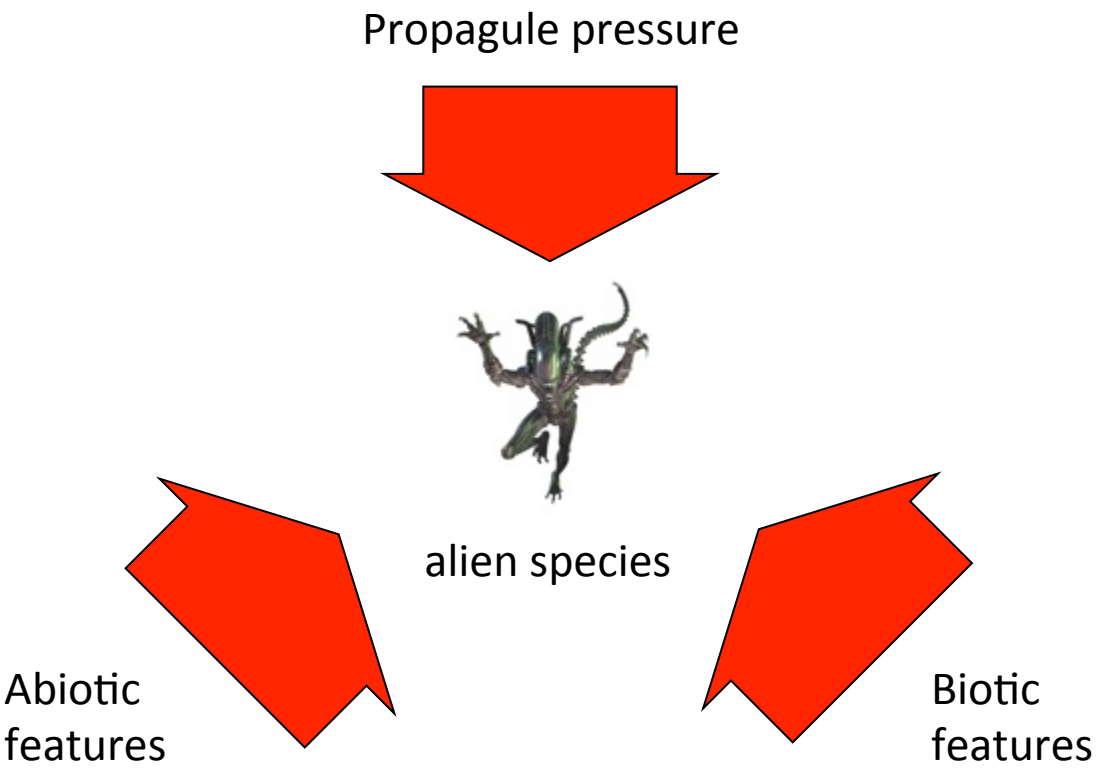
Definition of aliens

alien species = non-indigenous species

unambiguous evidence in the literature that they were **introduced** in Italy, deliberately or inadvertently by **human activities**, after the 15th century, outside their natural past or present distribution area, and successfully survive and reproduce

Correlates of occurrence of alien species in freshwater

Emerging driver?



Correlates of occurrence of alien species in freshwater

Emerging driver?

accessibility of the site

Propagule pressure

habitat type

Abiotic features

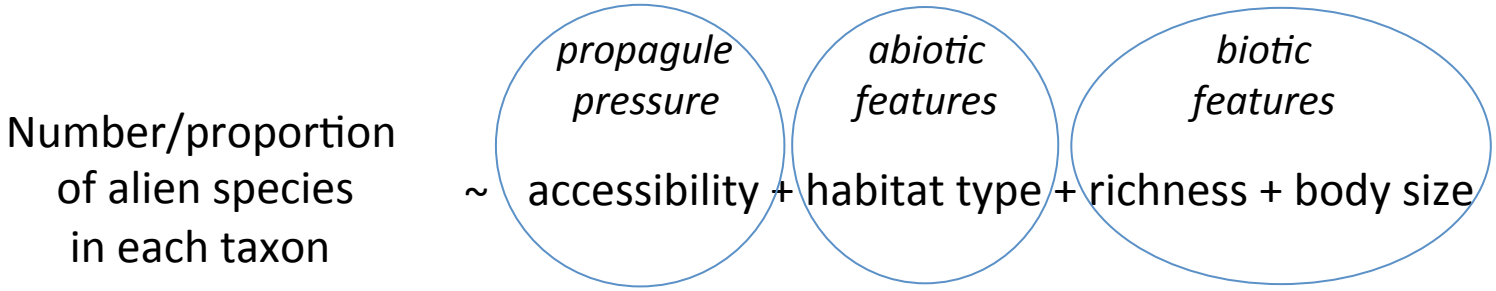
alien species

Biotic features

species richness
body size

Correlates of occurrence of alien species in freshwater

The model



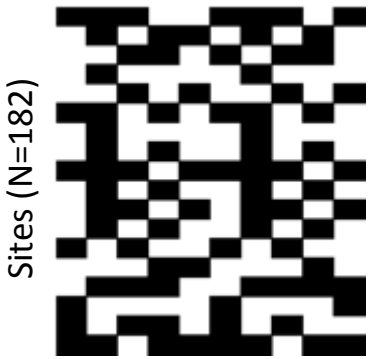
Correlates of occurrence of alien species in freshwater

The model

Number/proportion of alien species in each taxon ~ *propagule pressure* accessibility + *abiotic features* habitat type + *biotic features* richness + body size

Taxa (N=55)

Sites (N=182)



pseudoreplication + spatial autocorrelation

Correlates of occurrence of alien species in freshwater

The model

Number/proportion of alien species in each taxon ~ *propagule pressure* accessibility + *abiotic features* habitat type + *biotic features* richness + body size

+ (1|node/site) + (1|taxon)

Linear Mixed Effect Models

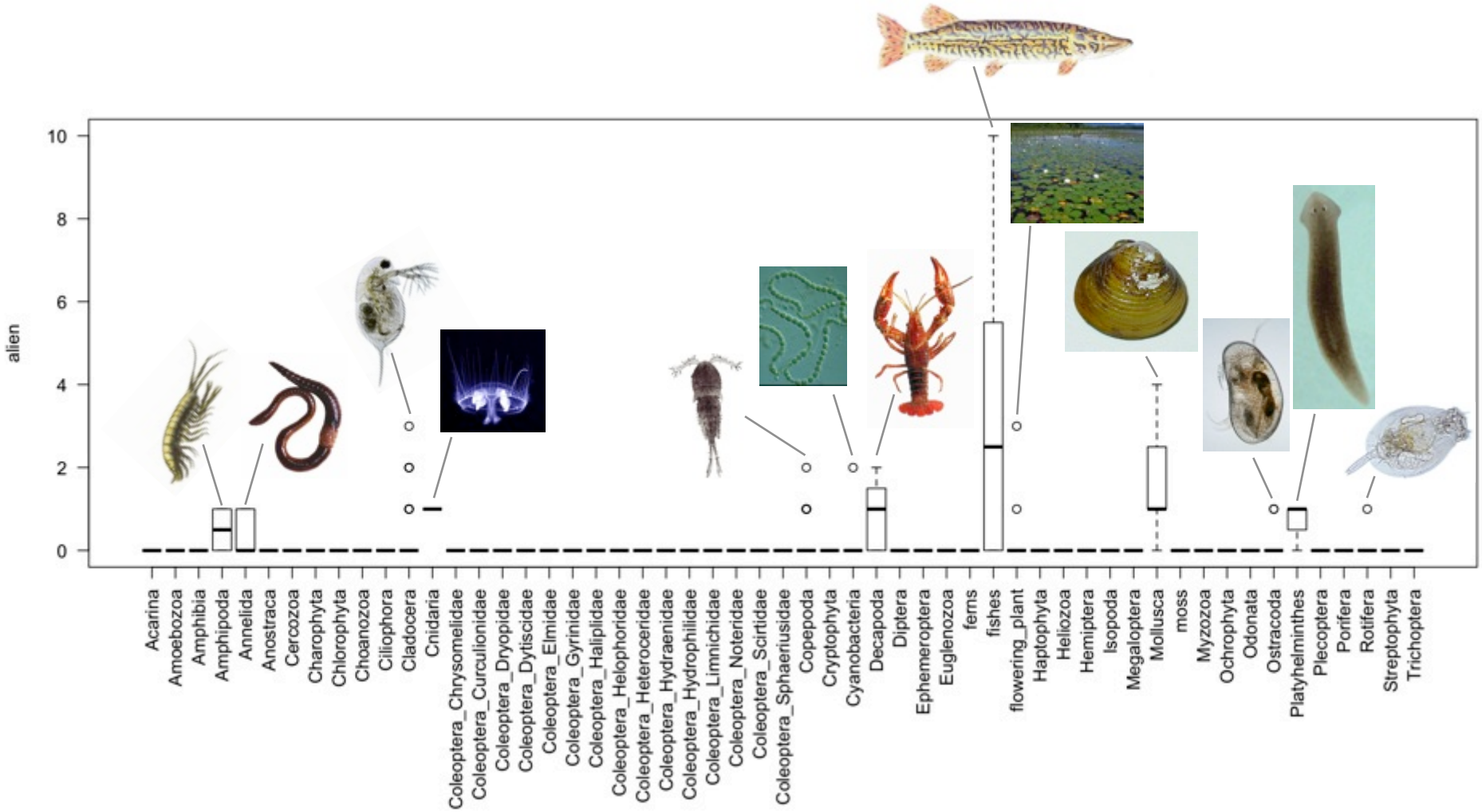
pseudoreplication + spatial autocorrelation

Taxa (N=55)

Sites (N=182)

Correlates of occurrence of alien species in freshwater

The results



Correlates of occurrence of alien species in freshwater

The results

Proportion of alien species

Variable	Estimate ± SE	P-value	Relative Importance
(Intercept)	-6.72 ± 0.73	<0.0001	
Richness	-0.03 ± 0.16	0.826	0.23
Body size	0.67 ± 0.50	0.175	0.46
Habitat	-0.50 ± 0.29	0.087	0.67
Accessibility	-1.83 ± 0.51	0.0004	1.00

Correlates of occurrence of alien species in freshwater

Emerging driver?

accessibility of the site

Propagule pressure

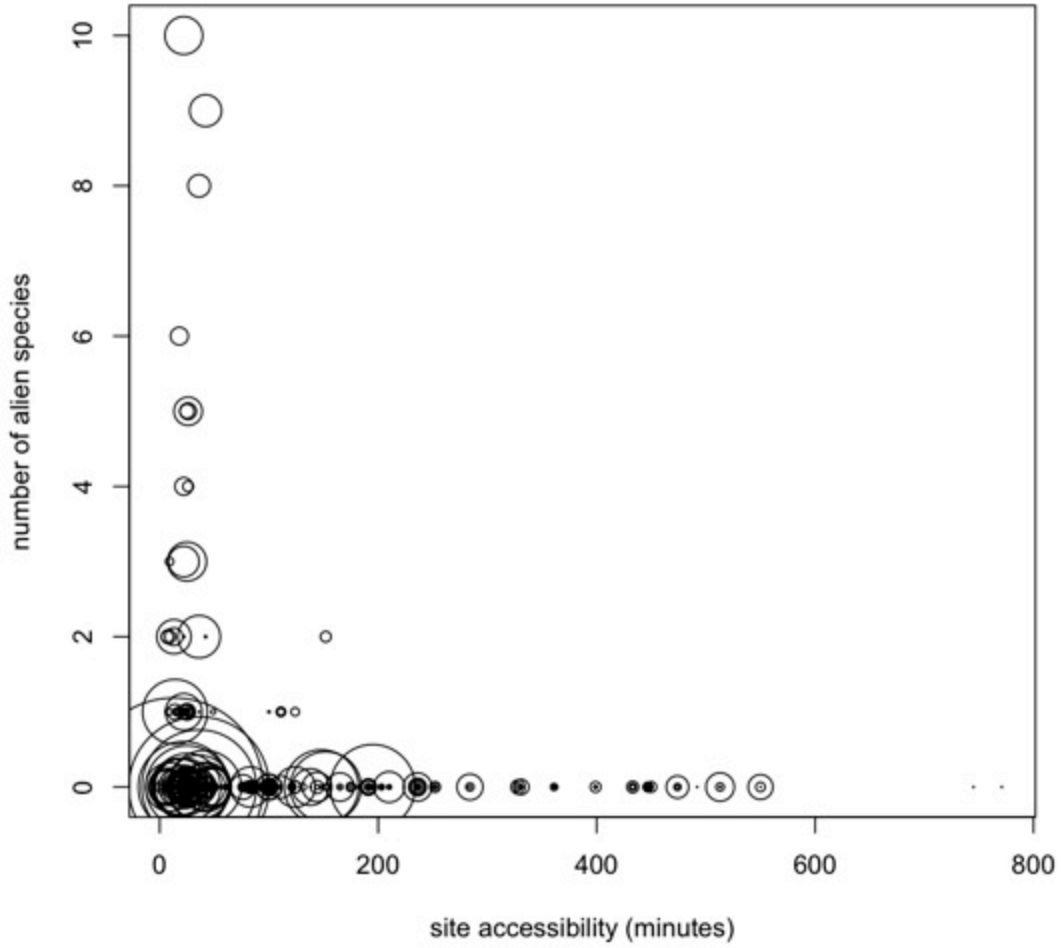
alien species

Abiotic features

Biotic features

Correlates of occurrence of alien species in freshwater

Emerging driver?



Fragility of LTER freshwater habitats to alien species: testing the ecological correlates of alien occurrence across several taxonomic groups

Diego Fontaneto[1], Angela Boggero[1], Alberto Basset[2], Martina Austoni[1], Enrico Barbone[3], Luca Bartolozzi[4], Isabella Bertani[5], Antonella Cattaneo[6], Fabio Cianferoni[4], Giuseppe Corriero[7], Ambrosius Martin Dörr[8], A. Concetta Elia[8], G. Francesco Ficetola[9], Lyudmila Kamburska[1], Gianandrea La Porta[8], Sara Lauceri[1], Alessandro Ludovisi[8], Elda Gaino[8], Enzo Goretti[8], Massimo Lorenzoni[8], Marina Manca[1], Aldo Marchetto[1], Giuseppe Morabito[1], Alessandro Oggioni[1,10], Cataldo Pierri[7], Nicoletta Riccardi[1], Giampaolo Rossetti[5], Nicola Ungaro[3], Pietro Volta[1], Silvia Zaupa[1]

Consiglio Nazionale delle Ricerche - Istituto per lo Studio degli Ecosistemi
Largo Tonolli 50 - Verbania Pallanza - d.fontaneto@ise.cnr.it