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## DATAPAPER: A geographic distribution data set of biodiversity in Italian freshwaters

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Keywords: artificial habitats, freshwater biota, lentic waters, LifeWatch, lotic waters, natural habitats, reference collection.

## SUMMARY

We present a data set on the biodiversity of Italian freshwaters, including lakeshores and riverbanks of natural (N=379: springs, streams and lakes) and artificial (N=11: fountains) sites. The data set belongs partly to the Italian Long Term Ecological Research network (LTER-Italy) and partly to LifeWatch, the European e-Science infrastructure for biodiversity and ecosystem research. The data included cover a time period corresponding to the last fifty years (1962-2014). They span a large number of taxa from prokaryotes and unicellular eukaryotes to vertebrates and plants, including taxa linked to the aquatic habitat in at least part of their life cycles (like immature stages of insects, amphibians, birds and vascular plants). The data set consists of 6463 occurrence data and distribution records for 1738 species. The complete data set is available in csv file format via the LifeWatch Service Centre.

## BACKGROUND & SCOPE

Many freshwater and taxonomic data sets exist at both European and National levels, such as the Freshwater Biodiversity Data Portal - BioFresh (<http://data.freshwaterbiodiversity.eu/metadb/metaDBfts/index.php>), the National Network of Biodiversity ([http://193.206.192.106/portalino/home\\_it/dati.php](http://193.206.192.106/portalino/home_it/dati.php)), and Nature 2000 (<http://www.minambiente.it/pagina/rete-natura-2000>). Further web-links exist that are data portals to locations along the Italian peninsula where information pertaining to the distribution of freshwater biodiversity is available (e.g., Checklist of the Italian Fauna, AQEM-STAR invertebrate database, Alpine GIG lakes phytoplankton, macrophytes and macroinvertebrates data, European Trichoptera, etc.). Of all of these websites and portals, no one site combines the simultaneous presence of different taxonomic groups. There is a clear need to collate different data sets based on broad-scale and long-term monitoring projects. Hence, we have compiled a data set that represents one of the most comprehensive and thorough collection nationwide, which is part of a larger LifeWatch data set including also coastal lagoons, littoral marine waters and terrestrial habitats.

This vast data set was created under the umbrella of a case study on Alien Species (AS) that was proposed and coordinated by LifeWatch Italy at the European level. The case study is designed using species occurrence data to assess the vulnerability of different Italian ecosystems to AS arrival (Boggero et al. 2014, Corriero et al. 2016). The taxonomic resolution adopted in the data set is at the species level for all the included taxonomic groups across different phyla. The utility of such a data set is widely recognized and reflected in INVASIVESNET (Lucy et al. 2016) joining together with the LifeWatch and several other existing initiatives at the European level to trace, monitor and counteract

the arrival of AS. By collaborating and combining efforts, the objective is to capitalise on existing knowledge and data exchange, scopes, and ideas, to create a better understanding of the AS problem, to find a common solution and to spread the news about this issue – including spreading the news to the general public.

The purpose of the present data set, which in line with the previously cited data sets, is to collect and share curated and verified species presence and geographic distribution data. This has been done for all the species recorded at 390 Italian freshwater sites belonging to the Italian Long Term Ecological Research network (LTER-Italy, <http://www.lteritalia.it>) (Bertoni 2012) and to the LifeWatch network (<http://www.lifewatch.eu>, <http://www.servicecentrelifewatch.eu>) (Basset and Los 2012, Basset 2016). The data set spans over a temporal period of about fifty years (1962-2014) across the Alpine, Continental and Mediterranean biogeographic zones of Italy (EEA 2002).

This data set is of particular interest as it aims to make biodiversity information available to future research that focuses on the occurrence and distribution of freshwater species at the national level. Data may also be relevant to policy makers, public authorities and enterprises involved in protection, management and sustainable use of freshwater ecosystems and their biodiversity. The analysis of this extensive survey of freshwater biodiversity in continental Italy will provide a basis for setting conservation priorities, developing monitoring programs and enforcing regulation (Boggero et al. 2014).

## RESULTS

### *SUMMARY STATISTICS*

The data set contains 17 different columns of information (Table 1), including: “Catalognumber”, to avoid replicates of species names; “eunisorganismgroups”, not strictly hierarchically identified, but assigned according to the EUNIS species group subdivision (<http://eunis.eea.europa.eu/species-groups.jsp>); then, from “phylum” to “providedscientificname” or to “scientificname”, Linnean categories were considered. Information on subspecies was kept to avoid losing information that could be useful for some users. Another series of columns specify: the verified “Alien” status of a species; the “eventdate” during which the sampling campaign occurred; the “locality” where the species were found following Darwin Core standards (<http://rs.tdwg.org/dwc>) with “decimallatitude” and “decimallongitude” description; “eunishabitatstypecode” to define the EUNIS type of habitat (used at level 1 only); the “scientificnameauthorship” and “namepublishedinyear” with information about author and year of description of each species.

Reported data include species occurrence from 390 sites (Fig. 1) and taxa from 11 different EUNIS groups (“algae”, “amphibians”, “birds”, “cyanobacteria”, “ferns”, “fishes”, “flowering plants”, “invertebrates”, “mosses and liverworts”, “protists”, “reptiles”) spanning 24 phyla (Table 2).

All of the records were verified by experts belonging to the different LifeWatch nodes. The LifeWatch nodes are represented by different Institutions (Universities, Research Centres, Museums, Environmental Agencies, National Forest Service, etc.) that gathered and managed species occurrence data from the different sites. The sites represent only freshwater habitats.

TABLE 1: Description of the dataset with specific information relative to definitions, units and storage.

LifeWatch DataPortal Fields	Variable definition	Units	Storage type
catalognumber	An identifier (preferably unique) for the record within the data set or collection		Integer
eunisorganismgroups	Assignment of the organism group based on the EEA, EUNIS species groups ( <a href="http://eunis.eea.europa.eu/species-groups.jsp">http://eunis.eea.europa.eu/species-groups.jsp</a> )		String
phylum	Full scientific name of the phylum in which the taxon is classified		String
class	Full scientific name of the class in which the taxon is classified		String
order	Full scientific name of the order in which the taxon is classified		String
family	Full scientific name of the family in which the taxon is classified		String
genus	Full scientific name of the genus in which the taxon is classified		String
providedscientificname	Full scientific name of the species as assigned by providers		String
scientificname	Full scientific name of the species assigned following the rules of currently (in 2015) accepted nomenclature for the taxonomic group, without authorship and date information		String
alien	Any species deliberately or inadvertently introduced to Italy by human activities after the discovery of the New World by Columbus in 1492 (Boggero et al. 2014)		Integer
eventdate	Date-time or interval during which an event occurred. For occurrences, this is the date-time when the event was recorded		DateTime
locality	Specific description of the place where the species was captured		String
decimallatitude	Geographic latitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a location	Decimal degrees (projection EPSG:4326 WGS84)	Double
decimallongitude	Geographic longitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a location	Decimal degrees (projection EPSG:4326 WGS84)	Double
eunishabitatstypecode	Assignment of the habitat type code based on the EEA, EUNIS habitat types. Only the levels 1-3 are used		String
scientificnameauthorship	Authorship information for the scientific name formatted according to the conventions of the applicable nomenclatural code		String
namepublishedinyear	Four-digit year in which the scientific name was published		Integer



FIGURE 1. Sampling sites distributed along the Italian peninsula.

*DATA SET*

*Object name:* Dataset\_Biodiversity\_Freshwaters\_LifeWatch\_2015.

*Data set citation:* Dataset\_Biodiversity\_Freshwaters\_LifeWatch\_2015.

*Character encoding:* UTF-8.

*Format name:* csv, json.

*Format version:* 1.0.

*Distribution (permanent link):* <http://www.servicecentrelifewatch.eu>

*Date of creation:* 7 March 2014.

*Date of last revision:* 29 November 2015.

*Date of publication:* 8 April 2016.

*Update policy:* following update policy rules of LifeWatch.

*Language:* English.

*License of use:* if used by researchers, administrators, managers, teachers, amateurs, general public, and others, the access is free and the use is based upon request. Details are defined in the intellectual property information. The data set authors would appreciate users providing a link to the original data set (<http://www.servicecentrelifewatch.eu>), when possible, or when researchers use the data to cite the present paper and/or to consider the data set authors for co-authorship. Stakeholders can contact authors via the contact information provided in the metadata.

*Metadata language:* English.

*Metadata managers:* Angela Boggero ([a.boggero@ise.cnr.it](mailto:a.boggero@ise.cnr.it)), Ilaria Rosati ([ilaria.rosati@unisalento.it](mailto:ilaria.rosati@unisalento.it)).

TABLE 2: Contribution of the different phyla to the composition of the data set.

Phylum	No. of records	No. of species
Amoebozoa	6	5
Annelida	97	43
Arthropoda	1893	426
Bryophyta	1	1
Cercozoa	1	1
Charophyta	123	63
Chlorophyta	486	224
Choanozoa	2	2
Chordata	883	98
Ciliophora	2	2
Cnidaria	1	1
Cryptophyta	89	24
Cyanobacteria	164	83
Euglenozoa	31	22
Haptophyta	40	3
Heliozoa	1	1
Mollusca	54	28
Myozoa	57	23
Nematoda	9	2
Ochrophyta	1387	362
Platyhelminthes	15	5
Porifera	1	1
Rotifera	915	205
Tracheophyta	205	113

#### MANAGEMENT DETAILS

*Project title:* Vulnerability of ecosystems to Alien Species invasion.

*Database managers:* Angela Boggero, Cataldo Pierri.

*Temporal coverage:* the present data set refers to the last 52 years (1962-2014).

*Record basis:* Mainly preserved specimens. Sometimes sample collection was based on field observation without specimen collection and preservation.

*Sampling methods:* The data set was created by collating different data sets managed by several research institutions. The data is shared within the context of the Alien Species Showcase of the

LifeWatch infrastructure. The definition of alien species that is adopted for the data set is very general, and is defined and available in the Alien Species Thesaurus produced by LifeWatch Italy (<http://thesauri.lifewatchitaly.eu/alienspecies/index.php>): where species are considered alien if deliberately or inadvertently introduced to Italy by human activities after the discovery of the New World by Columbus in 1492 (Boggero et al. 2014). This definition is similar to what plant invasion biologists call “neophytes” (Pyšek, 1998).

*IT specialist:* Nicola Fiore.

*Funding grants:* Data were obtained within the framework of several European and Italian projects, and thanks to the LifeWatch support. LifeWatch Italy is funded by Ministero dell’Istruzione, dell’Università e della Ricerca (MIUR) and managed by the National Research Council of Italy.

### *GEOGRAPHIC COVERAGE*

*Study area:* Sites are distributed along the Italian peninsula. The five main geographical areas are North-West, North-East, North, Centre, and South (Fig. 1). The data were georeferenced by each LifeWatch node according to WGS 84 datum.

*Bounding box:* min Longitude: 7.39 – min Latitude 39.38 – max Longitude: 17.95 – max Latitude: 46.98.

*Sampling design:* The general strategy developed within LifeWatch was to try to cover most of the territory and many different freshwater habitats. However, the data set covers only a minor part of Italy. It is anticipated that in the near future the data set will increase exponentially. The sampling design was intended to compile the information necessary for assessing Italian freshwater biodiversity and, in particular, the impacts of alien species on ecosystems. The idea is to design adequate management strategies to minimize the impacts of alien species and enable stakeholders to adapt the developed services to their particular needs (local, regional, or national scales).

*Habitat type:* Four habitat types (Fig. 2) were covered by the different sites belonging to the LifeWatch network according to the European Nature Information System (EUNIS; <http://eunis.eea.europa.eu/>) hierarchical protocol of habitat identification considering only the first-level option. The EUNIS habitat type classification is a pan-European system that aims to facilitate the harmonized description and collection of data across Europe. Thus, the EUNIS classification is a reference framework for the development of indicators and environmental reporting at the administrative and political level, and is particularly suitable for a study focusing on alien species impact.

Following The EUNIS system, the sites were classified as:

C1 - Surface standing waters;

C2 - Surface running waters;

C3 - Littoral zone of inland surface waterbodies;

J5 - Highly artificial man-made waters and associated structures.

*Biogeographic region:* Alpine, Continental and Mediterranean (EEA 2002).

*Country:* Italy.

*Quality control for geographic data:* Quality control was performed using Google maps identification of sites, and latitude and longitude coordinates provided by data providers. Geographic coordinate



format, coordinates within country/provincial boundaries, absence of ASCII anomalous characters in the dataset were additionally controlled.

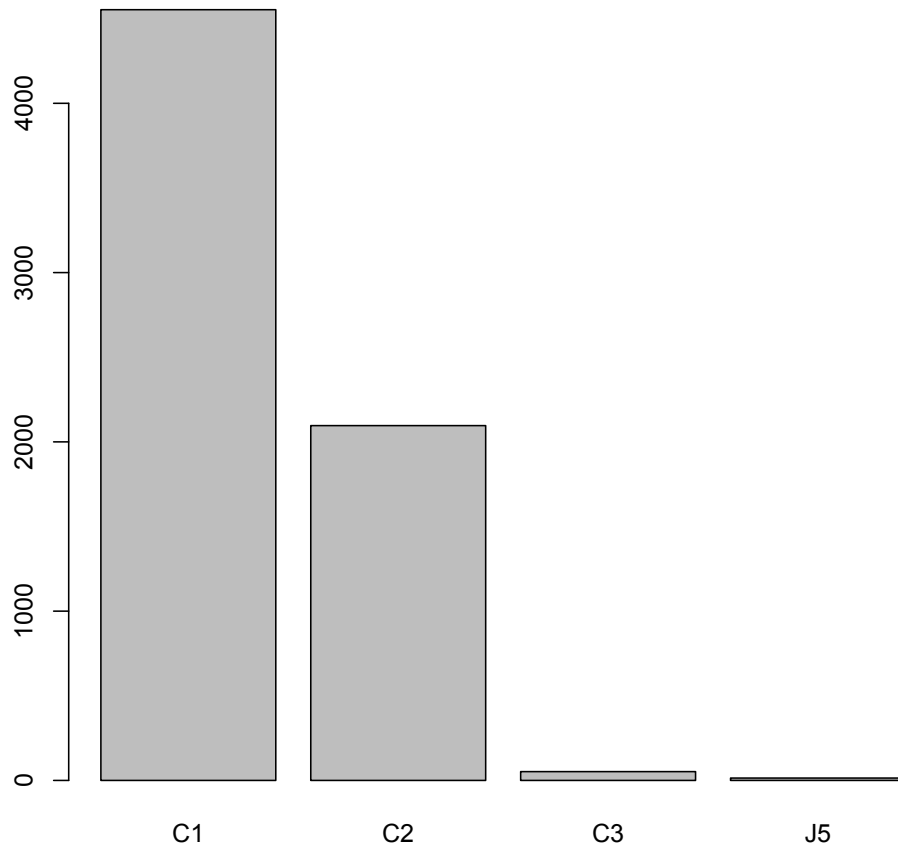


FIGURE 2: Representativeness of the different EUNIS habitats in the data set. C1 Surface standing waters; C2 Surface running waters; C3 Littoral zone of inland surface waterbodies; J5 Highly artificial man-made waters and associated structures.

### *LITERATURE SEARCH*

*General description:* The information on species presence at each site comes from published papers on surveys directly conducted by the authors and their collaborators from 1962 to 2014. Moreover, it includes additional papers and reports from universities and research institutions, as well as notes in technical reports from local authorities.

*Literature search methods:* All relevant literature (Supplementary file S1) was obtained using data from published papers on national and international journals directly supplied by data providers. Moreover, for each site, all the published grey literature (papers internal to public organizations, master thesis, reports, research deliverables, books, monographs) was screened.

*Quality control for literature data:* The data collated was property of most of the authors and co-authors of this paper, and since the same researchers are experts in their disciplines at National and International levels, they were involved as experts of the LifeWatch nodes. Therefore, the published data are considered reliable and simply checked for nomenclatorial consistency.

## TAXONOMIC COVERAGE

*General description:* The data set covers a wide spectrum of taxonomic groups inhabiting freshwater habitats and their surroundings. The inclusion of a species as aquatic or its exclusion as not aquatic was carried out considering its life cycle, linked or not to the aquatic habitat in at least part of its life. Thus, we included truly aquatic organisms, together with those that have immature stages in water, nest in or on water, and have roots in water.

*Taxonomic ranks:* All living freshwater biota or organisms related to waters in at least part of their life were considered. In particular, we gathered data from 24 phyla.

*Taxonomic methods:* These include revision of names, synonymizing, delimitation of genera and higher taxa, both conducted manually and through online tools supplied by the LifeWatch infrastructure (<http://www.servicecentrelifewatch.eu>).

*Taxon specialists:* Each LifeWatch node was responsible for data management from specific geographical areas and for the taxonomic control. Taxonomists from each node screened the data set for taxonomic reliability, potential problems in taxonomic identification, consistency and homogeneity of taxonomic coverage, and temporal coverage of repeated sampling for each site.

*Quality control for taxonomic data:* Record validation and cleaning were based on several steps and divided into: a) data standardization (considering the same time-span length, check of nomenclatural changes or synonyms); b) data cleaning and validation for taxonomic reliability and taxonomic consistency using different large zoological and botanical taxonomic indexes and databases known at European level following Pan-European Species directories Infrastructure (PESI), World Register of Marine Species - WoRMS, and Catalogue of Life; and c) final semi-automatic data cleaning, through the tools available on the LifeWatch portal. The online tools facilitate the taxonomic cleaning work of the researchers presenting at once the information on the species coming from different main international Global Species Databases (WoRMS, PESI, and Catalogue of Life).

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## AUTHOR CONTRIBUTIONS

Angela Boggero: freshwater responsible and coordinator in LifeWatch Italy, contacts with data providers.

Cataldo Pierri: assembler of the data set, contacts with data providers.

Angela Boggero, Cataldo Pierri: these authors contributed equally to the present paper.

Renate Alber, Martina Austoni, Enrico Barbone, Luca Bartolozzi, Isabella Bertani, Angela Boggero, Alessandro Campanaro, Antonella Cattaneo, Fabio Cianferoni, Ambrosius Martin Dörr, A. Concetta Elia, G. Francesco Ficetola, Diego Fontaneto, Elda Gaino, Enzo Goretti, Lyudmila Kamburska, Gianandrea La Porta, Rosaria Lauceri, Massimo Lorenzoni, Alessandro Ludovisi, Marina Manca, Aldo Marchetto, Giuseppe Morabito, Francesco Nonnis Marzano, Nicoletta Riccardi, Giampaolo Rossetti, Bertha Thaler, Nicola Ungaro, Pietro Volta, Silvia Zaupa: data providers.

Giuseppe Corriero: coordinator of the Alien Species showcase in LifeWatch Italy.

Cataldo Pierri, Ilaria Rosati, Nicola Fiore: full database managers in LifeWatch Italy.

Nicola Fiore, Alessandro Oggioni, Paolo Tagliolato: ICT in LifeWatch Italy.

Paolo Colangelo, Diego Fontaneto, Aldo Marchetto: responsible for statistical elaboration and statistical tools development.

Alberto Basset: JRU Manager in LifeWatch Italy.

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