

# EXPRESSION OF INTEREST: Integrated Project

## EVBL: European Virtual Biodiversity Laboratory: *assessing and forecasting changes in biodiversity*

Prepared for the  
*ENBI Consortium*

### Lead site

The University of Reading, UK (*contact: Frank Bisby*) - (Species 2000 europa\*, Euro+Med, ILDIS LegumeWeb)

### Core Consortium

University of Amsterdam (Zool. Mus. & Inf. Inst.), NL - (ENBI\*, Fauna Europaea, VL-Amsterdam)

Cardiff University, UK - (BiodiversityWorld)

New University of Lisbon, PT - (THINKcreative, Vomap, PRODNET)

National University of Ireland, Galway, IR - (ERMS/SMEBD, AlgaeBase)

Russian Academy of Sciences, Bot. & Zool. Inst., RU - (Virtual Herbarium/Museum)

Max Planck Institut für Biogeochemie, Jena, DE - (LPJ, BIOME4, ATEAM)

Botanischer Garten & Botanisches Museum, Berlin, DE - (BioCASE)

The Natural History Museum, London, UK - (WorldMap, ENHSIN, Lepidoptera Taxome)

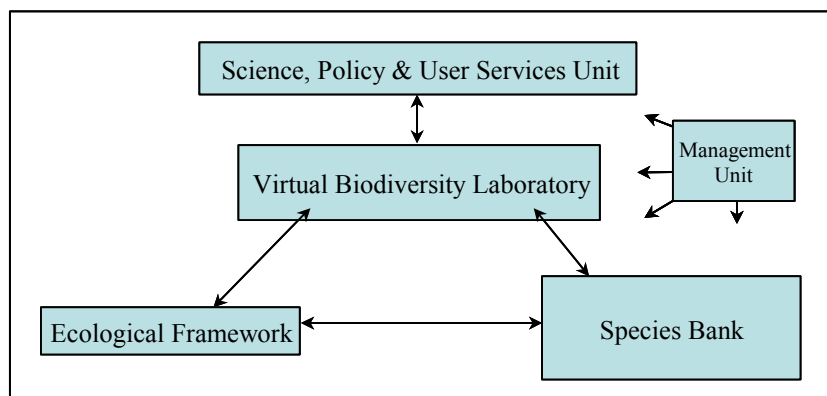
Institut für Meereskunde, Kiel, DE - (FishBase)

\* EC projects presently under negotiation

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## 1. Need & Relevance

The aim of this EoI is *to assess and forecast changes in biodiversity* by using a Virtual Biodiversity Laboratory, built to utilise the rich Species Bank and Ecological Framework already under development in Europe. A Science, Policy and User Services Unit will provide the interface to society, interpreting biodiversity problems into precise scenarios for investigation and modelling, and subsequently disseminating solutions or postulated outcomes back to society and policy-makers.



### 1.1 Contribution to Priority Thematic Area of Framework 6

This EoI addresses directly thematic area 1.1.6.3: *Research will focus on: assessing and forecasting changes in biodiversity, structure, function and dynamics of ecosystems and their services; with emphasis on ... biodiversity and habitats, ...* It also impacts on 1.1.2.i *Applied IST: research in the area of environment will focus on knowledge-based systems for natural resource management, and Complex problem-solving: computing and information GRIDS*, 1.1.6.3 *Desertification: mapping and management strategies*, 1.1.6.3 *Strategies for sustainable land management: tools for the sustainable use of land*, 1.1.6.3 *Operational forecasting and modelling, including global climate change...: development of the necessary tools for integrated management of coastal zones*, and 1.1.6.3 *Complementary research: advanced methods for risk assessment ...*

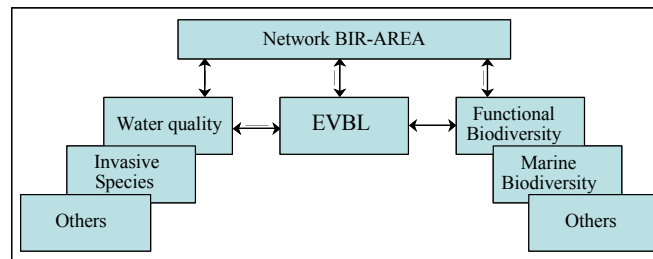
### 1.2 Contribution to the European Research Area

This EoI addresses three of the problems identified in 'Towards a European Research Area'. Most importantly, it integrates vertically its three scientific disciplines: (i) the Virtual Laboratory, (ii) the Species Bank, and (iii) the Ecological Framework.

Within each of these it will also integrate laterally: those working on modelling environments, those working on the taxonomy, species data and specimen data, and teams working on the ecological framework. Other problems to note include underfunding (e.g. in the taxonomy), the dominant role played by the United States (in certain areas of modelling), and weakness in bringing research results into full service (e.g. in integrating the habitats, taxonomic data and modelling capabilities).

### 1.3 Co-ordinated European Action

This is one of two co-ordinated EoIs arising directly from the European Network for Biodiversity Information (ENBI\*), a large, active, and internationally prominent community of biodiversity information systems. This one (EVBL) is an Integrated Project driven by scientific goals and the steps needed to reach them. The second is a Network of Excellence (BIR-AREA: Structuring the Biodiversity Information Research Area) focussed on restructuring the fragmented and dispersed landscape of species diversity, domesticated organisms and ecological databases.



## 2. Scale of Ambition & Critical Mass

A central problem for European biodiversity science (and indeed in all continents), is to analyse biodiversity patterns on a continental scale, as well as at national and regional levels, including the species interactions and dynamics; to model continent-wide biodiversity processes under conditions of change due to dependencies on human and abiotic factors; and to provide scientific decision support to policy bodies at many different scales. The rapid development and increases in sophistication of species, vegetation, and ecosystem services modelling make it entirely possible that, if given sufficient priority and sufficient data, we shall be able to model processes and change across Europe with some confidence in 2 - 3 years from now. We shall then be able to compare models based on different scenarios, and to provide the first steps in decision-support both for society at large and for the many agencies responsible for planning and policy.

The EVBL Consortium proposes to accelerate, co-ordinate, and develop these facilities in a distributed high capacity GRID-based virtual environment, to equip this environment with access to a wide range of species and ecosystem framework data, and to run simulations for understanding, projecting and comparing outcomes of different policy scenarios. It will then focus these analytical abilities on studying the three major biodiversity challenges besetting European society at the present time:

1. *How to predict and respond to the biodiversity changes in Europe that may be caused by climate change.*
2. *How to predict and respond to the effects on biodiversity caused by demographic change and large-scale population movements.*
3. *How to predict and respond to the biodiversity changes that will be caused by rapid change in the Common Agricultural Policy and all aspects of agriculture (including responses to 1 and 2).*

A fourth challenge is certainly in the minds of many people, although there are many who believe it cannot be met:

4. *How to bring biodiversity loss in Europe to a virtual halt within 10 years.* A more tractable but still huge problem would be to answer the question: for X protected areas of size Y hectares in Europe, where would these areas have to be placed to maximise the number of species conserved, and what is the total number of species conserved by this solution? Algorithms for such analyses do exist, but at this scale it is the supporting data that is limiting. Of course species richness is just one of the indicators of interest. It is urgent to develop systematic conservation planning for Europe in order to optimise the location and design of nature reserves and to ensure that they represent adequately the biodiversity at regional scales and that they do protect it from threat.

Now is the time to act. Bioclimatic modelling techniques are 'coming of age', and the advances in distributed computation and planning for the GRID mean that such techniques could be made widely available to the relevant scientists. Secondly, Europe has within its reach a co-ordinated framework for species data that could become the envy of scientists in other continents (Fauna Europaea, Euro+Med and ERMS connected through EuroCat will together enumerate 140,000 species). There is also an emerging new framework for ecosystems (the European Vegetation Survey/SYNBIOSYS project) as well as the EUNIS Habitat Classification supporting the Habitats Directive and Natura 2000 sites. These will *enable* the proposed research: but further and sustained development of such resources is essential if the potential of the virtual biodiversity laboratory is to be realised. It is for this reason that we propose to integrate the virtual laboratory, the species bank and the ecological framework within a single Integrated Project, an integration that has been missing up to now.

Major users are likely to be the European Environment Agency (especially its Topic Centre for Nature Protection and Biodiversity), the Commission, ECNC, international bodies (such as IUCN, the CBD, GBIF, & UNEP), and the very many policy and biodiversity management agencies throughout the European States.

The consortium comprises over 130 institutions and organisations, includes nearly all of the key players in the three areas, and represents a community of about 2,500 scientific and technical staff.

### 3. Integration

#### 3.1 Science, Policy & User Services Unit

Contributors include: ECNC (European Centre for Nature Conservation), English Nature (UK), NERC CEH (UK), EFB (European Federation of Biotechnology) Biodiversity Section, Biodiversity Conservation Laboratory (University of the Aegean). This unit will:

- liaise with biodiversity agencies and research councils at European and national level to articulate and prioritise scientific and policy questions in relation to changes in biodiversity, to include (i) public Stakeholder Dialogue, (ii) Advisory Board with representatives of the Commission, EEA, ESF, national agencies, and CBD.
- articulate, structure and prioritise individual research problems, describe suitable workflows, and call for proposals for funded sub-projects.
- deliver data, models, scientific conclusions, and decision-support to science, to society and to policy agencies (including 'Think Tank' workshops, dissemination 'programmes' in the media and scientific community).

(Associated training: biodiversity science and policy)

#### 3.2 The Virtual Laboratory for Biodiversity Analyses

Contributing projects are: EC ENBI, EC VOSTER, EC ThinkCreative, EC VO-map, EC ATEAM/AVEC, BiodiversityWorld (UK), VL-Amsterdam (Netherlands), CORMAS (France), ZADI-model (Germany), BioGIS (Israel), MONARCH (UK), WorldMap (UK) and SPICE (UK).

##### (i) To establish a virtual collaborative environment by developing a virtual laboratory

- to develop a 'virtual laboratory' (workbench, and generic tools, ontology, workflows, interface, access to a wide range of relevant data),
- to build a 'virtual biodiversity community' (who will use the laboratory, and/or contribute its components), and
- to install a high-capacity distributed computing environment GRID among the key biodiversity institutes, providing seamless, flexible access to the laboratory components.

##### (ii) To create a problem-solving and data analysis environment within the virtual laboratory

- with a canonical model for the universe of biodiversity objects and their dynamics in interaction with human and abiotic factors.
- with a toolbox for information access, for data analysis and management, for modelling and simulation, and for knowledge extraction (data mining), to include: (i) further development of existing GIS-based spatial biodiversity presentation tools; (ii) provision of a range of bioclimatic species distribution modelling tools; (iii) provision of a range of ecosystem and community modelling tools including both statistical and multi-agent simulation tools; (iv) development of a wide range of novel biodiversity analytical tools, including conservation evaluation of floras and faunas, historical analyses using climate and phylogeny, etc.
- with access to the 'digital library' provided by the Species Bank and the Ecological Framework, and value-added services, interfaces and visualisation

##### (iii) To carry out a core programme of biodiversity analysis subprojects.

The central objective of the EVBL is to carry out an extensive series of modelling and simulation projects to make progress with priority questions of biodiversity change on the European scale. The questions will be prioritised and formulated by the Science & Policy Unit with the participation of both stakeholders and the European Policy institutions. The modelling will progress both with state-of-the-art high capacity distributed modelling facilities on the GRID-based Virtual Laboratory, but also against the background provision of focussed and co-ordinated Taxonomic and Ecological Frameworks, and with in-depth species information support prioritised for the needs of the modellers. Provision will also be made to access the support data and models from related areas of science (particularly climate forecasting and substrate analysis) and from socio-economic domains such as land use, population pressure, and planning constraints. A link is envisaged with the Virtual Institute for Sustainability Assessment (VISA) being developed from the Tyndall Centre.

Depending on the prioritisation, possible action areas include: (i) modelling of species distributions; (ii) contrasting species models with vegetation models; (iii) further development of biophysical models including atmosphere and transboundary pollution; (iv) taxic and species richness evaluation of protected areas; (v) modelling equiprobable phylogenies against past climate; (vi) using meta-population models in relation to habitat fragmentation; (vii) using individual-based (multi-agent) systems; and (viii) monitoring marker genes to quantify gene flow from crops to wild relatives.

(Associated training: problem-solving environments, bioclimatic modelling and conservation evaluation)

#### 3.3 The European Species Bank (a digital library of European species information)

Contributing projects are EC ENBI, EC EuroCat, EC Fauna Europaea, EC Euro+Med PlantBase, EC ERMS, EC FishBase, EC BioCASE, EC MEDUSA, VIADOCS (UK), ILDIS LegumeWeb (global), ETI World Biodiversity Database (global), Lepidoptera Taxome (global), AlgaeBase (global), MarLIN (UK), Komarov Virtual Herbarium (Russia), The European Invertebrate Survey, Mansfeld's World Database of Cultivated Plants (global), RHS PlantFinder Database (UK), ZADI

Animal Database (Germany), ICES North Sea Benthos Project, EFB (European Federation of Biotechnology) Biodiversity Section, Database of Italian Lichens (Italy), National Biodiversity Network (UK).

What is effectively a European 'Catalogue of Life' has been initiated by the joint efforts of ERMS, Euro+Med PlantBase and Fauna Europaea and will be unified through Species 2000 europa (EuroCat), working closely with 'species bank' organisations such as FishBase, ETI, AlgaeBase and ILDIS LegumeWeb. The proposal is to use the developing European Catalogue of Life as a framework for delivering in-depth taxon-based biodiversity knowledge to the Virtual Biodiversity Laboratory, as well as a public service to major programmes in biodiversity action areas such as conservation, genetic resources, medicinal and aromatic plants, environment monitoring, ecological and biodiversity indicators and trade regulation. To do this will require direct co-operation with those programmes, prioritisation of groups and knowledge domains for in-depth treatment, and a range of subprojects to deliver these priorities.

**(i) Core framework of species-based subprojects**, including cross-cutting focus on marine species (Med., NE Atlantic, & Baltic), freshwater quality indicators, quarantine organisms, and Mediterranean plants.

1. To build up the 'Pan-European Species List Framework', a framework being initiated by EuroCat/Species 2000 europa, and to be further enhanced jointly by EuroCat, Fauna Europaea, Euro+Med and ERMS.
2. To integrate the Pan-European Species List Framework with the BioCASE access system.
3. To enhance Fauna Europaea in in-depth coverage of terrestrial and freshwater Macro-fauna.
4. To enhance Euro+Med PlantBase in in-depth coverage of flowering plants and ferns from Europe and the Mediterranean.
5. To enhance ERMS in in-depth coverage of all Marine Species.
6. To initiate European coverage of the orphan groups (e.g. Freshwater Algae, Protists, Fungi, Bryophytes)
7. To initiate co-operative programmes for the above projects to work jointly with the major taxon-based and species bank organisations in Europe, such as FishBase, AlgaeBase and ILDIS LegumeWeb.

**(ii) Supplementary subprojects** that will be linked to the framework above.

These to be prioritised from the Science, Policy & Services Unit. The following are just examples:

(i) Taxonomic monographic revisions of a number of selected priority groups; (ii) Sample field surveys to discover all species for a particular group; (iii) Rich descriptive, image or autecological data sets for priority taxa; (iv) Filling gaps in the taxonomic framework databases; (v) Creation of identification tools for priority taxa; (vi) Experimental subprojects to revolutionise the taxonomic process: e.g. web-based registration of names, virtual community taxonomic programmes, automated card index reading; (vii) Harmonisation of the taxonomies of domesticated organisms and species in Europe.

**(Associated training:** biodiversity informatics, species information systems, experimental taxonomic techniques)

### 3.4 The Ecological Framework

Contributing projects include: EC ATEAM/AVEC, EEA EUNIS Biotope Classification, European Vegetation Classification/SYNBIOSYS, Centre for Ecology & Hydrology (UK), English Nature (UK), as well as projected co-operation with the sister NoE BIR-AREA.

- teams establishing the environmental needs of individual species so that responses to change can be modelled
- teams classifying and mapping European vegetation, and monitoring components through time.
- teams involved in exploring ecosystem functioning and ecosystem services, and relationships between ecosystem processes and biodiversity richness

**(Associated training:** European Vegetation & Biotope Classifications, monitoring, ecosystem services)

### 3.5 EVBL Management Unit

Contributing institutions: The University of Reading and the University of Amsterdam are putting in place professional units to manage large programmes such as Integrated Projects (EVBL) and Networks of Excellence (BIR-AREA).

- the whole EVBL Integrated Project is managed by a Consortium Council
- scientific co-ordination of the components, and their subprojects
- Consortium Council evaluates subproject proposals, negotiates the rolling programme, and evaluates finished subprojects.
- legal, media, administrative and dissemination functions.

## 4. The Role of SMEs

A number of SMEs belong to this consortium and are likely to play significant roles in data generation, basic research, user-friendly dissemination of results, and professional project and database management.

## 5. Resources Needed

The programme outlined here is an ambitious vision of large scale that brings together disciplines that are presently separate. We estimate that a *minimum* cost for the three main components would be 14M euro (Virtual Laboratory & Science Policy Unit), 17M euro (Species Bank), and 9M euro (Ecological Framework), a total of 40M euro to be spread over five years.

## 6. List of Envisaged Participants

Institutions and Organisations	Country		
Biologiezentrum des OÖ Landesmuseums, Linz	Austria	Latvian Museum of Natural History, Riga	Latvia
Natural History Museum, Vienna	Austria	Institute of Botany, Vilnius	Lithuania
Vorarlberger Naturschau, Dornbirn	Austria	Musée National d'Histoire Naturelle	Luxembourg
National Botanic Garden of Belgium, Meise	Belgium	Environment Protection Department, Floriana	Malta
Royal Belgian Institute of Natural Sciences	Belgium	Inst Agron. & Vét. Hassan II Rabat	Morocco
Bulgarian Academy of Sciences, Sofia	Bulgaria	ETI, Amsterdam	Netherlands
Cyprus Wildlife Society, Nicosia	Cyprus	European Centre for Nature Conservation	Netherlands
Czech Acad. Sciences	Czech Rep.	Nat. Inst. of Public Health & Environment, Bilthoven	Netherlands
Czech Technical Univ.	Czech Rep.	National Museum of Natural History, Leiden	Netherlands
Moravian Museum	Czech Rep.	Netherlands Institute of Ecology	Netherlands
Univ. Copenhagen	Denmark	Royal Netherlands Acad. of Arts and Sciences	Netherlands
Estonian Agricultural University, Tartu	Estonia	Univ. Amsterdam (Informatic Inst.)	Netherlands
Finnish Museum of Natural History, Helsinki	Finland	Univ. Amsterdam (Zool. Museum)	Netherlands
Univ. Helsinki	Finland	Univ. Utrecht	Netherlands
VTT (SME)	Finland	Univ. Wageningen	Netherlands
CEFE, Montpellier	France	Akvaplan-niva, Tromsø (SME)	Norway
CIRAD Paris / Montpellier	France	Computas (SME)	Norway
Inst. de Recherche pour le Développement, Paris	France	Natural History Museum, Oslo	Norway
Intergovernmental Oceanographic Commission, Paris	France	Univ. Bergen	Norway
Muséum National d'Histoire Naturelle, Paris	France	Museum and Institute of Zoology of the Polish Acad. Sci., Warsaw	Poland
UNESCO, Paris	France	Silesian Univ. of Technology	Poland
Univ. Louis Pasteur	France	Univ. Szczecin	Poland
Univ. Pierre et Marie Curie, Paris VI	France	Inst. Gulbenkian de Ciencia, Oeiras	Portugal
Aachen Univ. of Technology	Germany	Inst. de Engenharia de Sistemas e Computadores do Porto	Portugal
AlgaTerra	Germany	New Univ. of Lisbon	Portugal
Botanische Staatssammlung München	Germany	Univ. Algarve	Portugal
Botanischer Garten und Botanisches Museum, Berlin	Germany	Grigore Antipa National Museum of Natural History	Romania
CAS Software AG (SME)	Germany	Romanian Academy	Romania
Center for Technology and Innovation Management	Germany	Komarov Botanical Institute, St Petersburg	Russia
Deutsche Sammlung von Mikroorganismen und Zellkulturen GmbH	Germany	Zoological Institute, St Petersburg	Russia
Dresden Univ. of Technology	Germany	Slovak Acad. of Sciences, Bratislava	Slovak Rep.
ePortas GmbH, Düsseldorf (SME)	Germany	Slovenian Museum of Natural History, Ljubljana	Slovenia
Institut für Arbeitswirtschaft und Organisation	Germany	Consejo Sup. de Inv. Cientificas (RJB & MNCN), Madrid	Spain
Institut für Genetik, Forschungszentrum Karlsruhe	Germany	Univ. Sevilla	Spain
Institut für Meereskunde, Kiel	Germany	Swedish Museum of Natural History	Sweden
Institut für Pflanzengenetik und Kulturpflanzenforschung, Gatersleben	Germany	Swedish Species Information Centre, Uppsala	Sweden
Institute for Open Communication Systems (FOKUS)	Germany	Univ. Lund	Sweden
Max Planck Institut für Biogeochemie, Jena	Germany	Univ. Stockholm	Sweden
Potsdam Institute for Climate Impact Research	Germany	EFB (European Federation of Biotechnology), Biodiversity Section	Switzerland
SKANDIA Insurance	Germany	IUCN - The World Conservation Union	Switzerland
Staatliches Museum für Naturkunde, Stuttgart	Germany	Univ. Bern	Switzerland
Univ. Gießen	Germany	Univ. Groningen	Switzerland
Univ. Hamburg	Germany	Univ. Zürich	Switzerland
Verlag für interaktive Medien GbR, Gaggenau (SME)	Germany	BIOSIS UK, York (SME)	UK
Virtuelle Fabrik	Germany	CABI Bioscience, Egham	UK
Zentralstelle für Agrardokumentation und information,	Germany	Cardiff University	UK
Institute of Marine Biology, Crete	Greece	Climate Research Group - Univ. East Anglia	UK
Mediterranean Agronomic Institute of Chania, Crete	Greece	Cranfield Univ.	UK
National Univ. Athens	Greece	English Nature, Peterborough	UK
Univ. Aegean, Mytilini	Greece	FreshwaterLife	UK
Univ. Patras	Greece	Joint Nature Conservation Committee	UK
Hungarian Natural History Museum, Budapest	Hungary	Loughborough Univ.	UK
Icelandic Institute of Natural History	Iceland	Marine Biological Association	UK
EcoServe Dublin (SME)	Ireland	National Biodiversity Network Trust	UK
National Univ. Ireland, Galway	Ireland	National Museums & Galleries of Wales	UK
Trinity College Dublin	Ireland	Natural History Museum, London	UK
Hebrew Univ. Jerusalem	Israel	NERC Centre for Ecology & Hydrology, Monkswood	UK
Israel Nature and National Parks Protection Authority	Israel	Royal Botanic Garden, Edinburgh	UK
CE Consulting (SME)	Italy	Royal Botanic Gardens, Kew	UK
International Plant Genetic Resources Inst., Rome	Italy	Royal Horticultural Society, Wisley	UK
Tor Vergata Univ., Rome	Italy	Univ. College London	UK
Univ. Bari	Italy	Univ. Essex	UK
Univ. Padova	Italy	Univ. Newcastle	UK
Univ. Paiva	Italy	Univ. of Reading	UK
Univ. Palermo	Italy	Univ. of Southampton	UK
Univ. Trieste	Italy	Univ. Salford	UK
Univ. Tuscia in Viterbo	Italy		