

Where is what, and what is where?

Online mapping of marine species



By Mark J Costello, J Frederick Grasse, Yunqing Zhang, Karen Stocks & Edward Vanden Berghe

BECAUSE OF THEIR AREA, VOLUME AND DIVERSITY OF LIFE, THE world's oceans are the dominant component of the biosphere. Thus, an assessment of life on Earth must, in major part, be an assessment of life in the world's oceans – a Census of Marine Life. The complexity of the marine ecosystem, and its interactions with social and political systems, demand an interdisciplinary and integrated approach. Traditional, discipline-centred research methodologies yield a wealth of snapshots of the complex and ever-changing marine world. The challenges are to fill the gaps in these insights, to synthesise coherent patterns of marine life in space and time, and to develop testable hypotheses and predictive models of the origin and maintenance of these patterns.

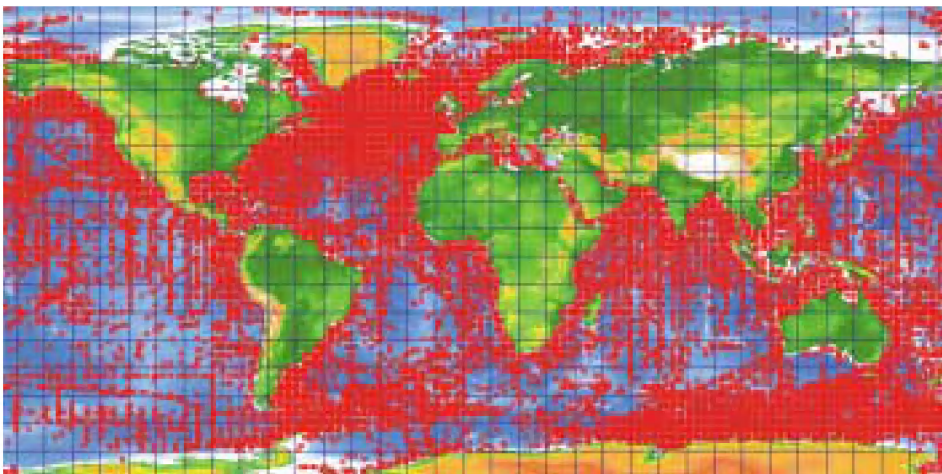


Fig 1. Distribution of data on marine species available from the OBIS portal in November 2004.

OBIS – why now?

Today, as never before, the tools are at hand to meet this challenge; to conduct quantitative, geographically and temporally explicit observations and analyses of the living ocean. Taxonomists have new tools to define and identify species through combinations of genomic and morphological analyses, greatly aided by access to worldwide knowledge resources through the internet. Computer and communications capabilities permit rapid assembly and meaningful analysis of immense volumes of diverse data. Moreover, earth and life scientists have developed systems for planning, coordinating and executing coherent and effective programmes on a global scale. However, the marine biological community was not so organised until OBIS arrived.

What is OBIS?

The Ocean Biogeographic Information System (OBIS), the information component of the Census of Marine Life (CoML), is a rapidly

developing international science infrastructure. It provides access to data, information infrastructure and informatics tools through an online, dynamic, global atlas of biogeographic information. The basic ingredients of OBIS are authoritative specimen and observational data, with emphasis on species-level geo-referenced data. Through the use of internet-enabled GIS and other web-based analytical tools, biological data can readily be integrated with environmental data, maps, visualisations and model outputs for a broadly-based community of users. The OBIS atlas will be used to reveal spatial and temporal patterns, generate hypotheses about global marine ecosystems, and guide future field expeditions. These hypotheses are unlikely to be tested by experiments, but will be supported or rejected by the biogeographic patterns that are the reality of our planet. The scope of OBIS offers new challenges in data management, scientific cooperation and organisation, and innovative approaches to data analysis. The online digital atlas

Box 1. Members of the OBIS International Committee (IC) 2001-2004. (*Present members)

- Dr Mark J Costello, Leigh Marine Laboratory, University of Auckland, New Zealand (formerly Executive Director, Huntsman Marine Science Centre, St Andrews, Canada). (Chair OBIS IC).*
- Dr Karen Stocks, San Diego Supercomputer Centre, University of Southern California, San Diego (Vice-Chair OBIS IC).*
- Dr J Frederick Grasse, Director, Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, USA (Director OBIS Secretariat).*
- Dr Daphne G Fautin, Curator, The University of Kansas Natural History Museum, Lawrence, USA.*
- Dr Rainer Froese, FishBase-Coordinator, Institut für Meereskunde, Kiel, Germany.*
- Dr Edward Vanden Berghe, Manager, Flanders Marine Data and Information Centre, Flanders Marine Institute, Ostend, Belgium.*
- Mr Tony Rees, CSIRO, Australia.*
- Dr Phoebe Zhang, Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, USA (OBIS Portal Manager).*
- Dr Richard Chinman, Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, USA (OBIS Program Manager).
- Dr Yoshihisa Shirayama, Director and Professor, Seto Marine Laboratory, Shirahama, Japan.
- Dr Neil Ashcroft, HMAP Research Fellow, University of Hull, UK.
- Ms Kim Finney, Chief Information Officer, National Ocean Office, Hobart, Australia, was replaced in 2003 by:
- Dr Geoff Boxshall, Merit Researcher, Dept of Zoology, The Natural History Museum, London, UK.
- Dr Dennis P Gordon, Principal Scientist, National Institute of Water & Atmospheric Research (NIWA), Wellington, New Zealand.
- Dr John Wilkin, Professor, Institute of Marine and Coastal Sciences, Rutgers University.
- Dr Pat Halpin, Duke University, USA.
- Dr James Wood, The Bermuda Biological Station for Research, St George's, Bermuda (OBIS post-doctoral fellow).

developed by OBIS is expected to provide a fundamental basis for societal and governmental decisions on how to use and conserve marine life.

What does OBIS provide, and for whom?

OBIS provides the following on an 'open access' basis through the World Wide Web:-

- taxonomically and geographically resolved data on marine life and the ocean environment;
- data from museums, fisheries, and ecological studies;
- data from all ocean environments – seabed to plankton, coastal to deep sea;
- interactivity with many other databases, including other online databases;
- access to physical oceanographic data at regional and global scales;
- software tools for checking species names, mapping, modelling, and biogeographic analysis.

OBIS has two sources of species names. It uses the "Catalogue of Life" (CoL) annual checklist of species names, which contains expert-prepared lists of about 20% of all described marine species. In addition, OBIS captures species names from its data sources. CoL is a cooperative programme led by Species 2000 and the Integrated Taxonomic Information system (ITIS).

OBIS is for the use of students, researchers, fishery scientists and managers, educators, amateur naturalists, industry, consultants, and environmental and nature conservation organisations. OBIS complies with the data policies of the Global Biodiversity Information Facility (GBIF) and Intergovernmental Oceanographic Commission (IOC), and is one of the largest data providers to GBIF.



Fig 3. Members of the OBIS International and Management Committees with guests at the Bedford Institute of Oceanography, Canada, 2004. **Front row:** J Black, D Ricard, M Lewis, K Stocks, U Von St Ange, V Chavan, F da Silveira. **Back Row:** P Zhang, P Halpin, A Marino, R Branton, M Costello, T Rees, F Grassle, R Froese, R Escribano, M Kennedy, D Robertson, L Van Guelpen. **Missing:** P Boivin, S Song, G Pohle, K Zwanenburg, J Bartley.

What is OBIS doing?

Since becoming established in 2002, the OBIS International Committee (IC) (Box 1) has worked with international and national organisations (Box 2), scientific projects and programmes, and individual scientists, to create a portal serving over four million geo-referenced records of about 40,000 marine species (Figure 1). This data is the critical component to conducting a census of marine life (Figure 2). Data can be overlaid on global maps of ocean depth, surface temperature, salinity and chlorophyll. The geographic ranges of species can be predicted online, based on the data selected by the user, and a model can be used to predict species distributions.

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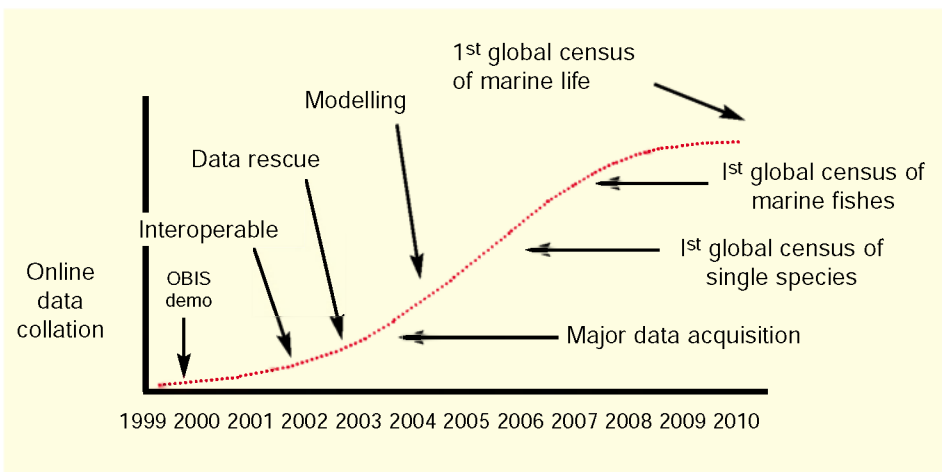


Fig 2. A diagrammatic presentation of activities required to produce a census of marine life in relation to the rate of data acquisition by OBIS.

Box 2. OBIS IC is working with these, among other organisations:

(a) Global organisations such as the Food and Agricultural Organisation (FAO), Intergovernmental Oceanographic Commission (IOC), Intergovernmental Ocean Data and Information Exchange (IODE), International Association for Biological Oceanography (IABO), Global Biodiversity Information Facility (GBIF), Scientific Committee on Oceanic Research (SCOR), World Conservation Monitoring Centre (WCMC), Species 2000, Diversitas, Joint Commission on Oceanography and Meteorology (ICOMM);

(b) Multi-national organisations such as International Council for the Exploration of the Sea (ICES), NatureServe (USA and Canada), Conservation International, Integrated Taxonomic Inventory System (ITIS);

(c) National organisations such as Fisheries and Oceans Canada, Centre of Marine Biodiversity (Canada), World Wildlife Fund (Canada), Flanders Marine Institute (VLIZ), Commonwealth Scientific and Industrial Research Organization (CSIRO), National Institute for Water and Atmospheric Research (NIWA), National Oceanic and Atmospheric Administration (NOAA), National Center for Atmospheric Research (NCAR), Integrated Ocean Observing System (IOOS; Ocean.US);

(d) Programmes and projects in Europe (MARBEF/EurOBIS, EuroCAT/Species 2000 Europa, BioCASE, BIOMARE, MarLIN, SAHFOS), the US (e.g. CORONA, PEET, SEAMAP) and elsewhere (e.g. HMAP, FMAP, NaGISA, GoM Census, ChESS) (see www.iobis.org for a full list of acronyms).

Box 3. The host organisations and managers of the Regional OBIS Nodes network, including candidate RONS (*).

Location	Host organisation	RON Manager
Australia	National Oceans Office & CSIRO	Kim Finney
Canada	Centre of Marine Biodiversity & Bedford Institute of Oceanography	Bob Branton
China	Institute of Oceanology, Qingdao	Song Sun
Europe	Vlaams Instituut voor de Zee (VLIZ)	Edward Vanden Berghe
Indian Ocean area	National Chemical Laboratory (with the National Institute of Oceanography), India	Vishwas Chavan
Japan	National Institute for Environmental Studies	Iunko Shimura
New Zealand	National Institute of Water & Atmospheric Research	Don Robertson
South America	University of Sao Paulo	Fabio Lang da Silveira
Sub-Saharan Africa	Southern African Data Centre for Oceanography (SADCO)	Marten Grundlingh
Alaska*	North Pacific research Board	Clarence Pautkze
USA*	Kansas University	Daphne Fautin

OBIS IC members have attended over 140 conferences and workshops during 2002-2004 to improve awareness of OBIS and develop an understanding of user needs, potential data sources and related activities. To advance the globalisation of OBIS, a network of Regional Nodes to expand the data provider and user community has been established (Box 3). Membership in the OBIS federation is open to any interested individual, country or organisation committed to the long-term maintenance of an accessible, relevant, biological database, and provision of its data through the OBIS portal.

OBIS today

The Ocean Biogeographic Information System (OBIS) is the leading online source for marine species distributions in the world. The bringing together of this information through a federation of databases, with instant access to analytical tools and maps, delivers new insights into the distribution of life throughout the world's oceans. Synthesis of this information aids understanding of collective patterns in biodiversity, such as species relationships, food-web structure, and effects of climate change on ecosystems.

Future developments

As OBIS grows in both data content and participation of organisations and individuals, its structure will evolve. The International Committee (IC) oversees OBIS and develops policies and priorities, with an Executive Office, Secretariat and Portal. The Regional OBIS Nodes network is coordinated by a Management Committee (Figure 3), and a Technical Committee provides advice as requested. Cooperative relationships with other organisations will be formalised through Memoranda of Agreement. For example, OBIS is working closely with Species 2000 and ITIS to have a complete catalogue of all marine species available online within the next three years. This catalogue will form a key part of

quality control in biological databases by providing the correct names for species and their relationships to other names. In addition, it is a fundamental requirement for a "census of marine life."

The technical functionality of the data portal is constantly being improved. Enhanced mapping and visualisation features, and new search and display options, are being developed. These will include developments of standards for data fields to facilitate interoperability between databases, in conjunction with other organisations such as the GBIF and the Taxonomic Data Working Group (TDWG). A globally-applicable standard marine habitat classification will build on existing systems to enable users to select data by habitat. OBIS members constantly monitor parallel developments in informatics and marine science to ensure a synergy of effort.

In 2005, an Editorial Board will be established to further develop quality assurance for data served by OBIS. Quality control processes and feedbacks will become formalised and involve more external peer-review as they develop. OBIS will be the legacy of the Census of Marine Life programme (to be completed in 2010) and a permanent infrastructure for marine and biodiversity sciences. It has been launched by funding from the Alfred P Sloan Foundation, and individual members and organisations additionally obtain their own funding from national and other sources to enable them to contribute data. Over US\$18 million in funding has been obtained by the OBIS community for the period 2002-2006. In the next few years OBIS will develop a long-term funding and management strategy for future decades.

EurOBIS: MarBEF's contribution to OBIS

Like several other regions, Europe has a regional OBIS node, run by the data

management team of MarBEF. On the EurOBIS site, European biodiversity data will have its own face, and will give visibility to the large biodiversity datasets that will be collected and collated in the framework of the research themes of MarBEF. There will be two-way data traffic between the international OBIS and EurOBIS. European data will be extracted from global databases, such as FishBase and CephBase, and made available through the EurOBIS site. With the MarBEF data management team, we will solicit data from European researchers. All data available to EurOBIS will obviously be made available to OBIS, and hence also to GBIF. This way, MarBEF scientists will make a contribution to several major international initiatives with just one move. Their data will be visible through several portals, serving as an invitation for collaboration with like-minded scientists worldwide. •

Relevant links

www.vliz.be/obis

www.iobis.org

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Edward Vanden Berghe, Manager, European OBIS Node, Flanders Marine Data and Information Centre, Flanders Marine Institute, Vismijn, Pakhuizen 45-52, B-8400 Ostend, Belgium.



Fig 4. Members of the OBIS International and Management Committees with guests at the San Diego Supercomputer Centre, California, 2004.