# European Network for Biodiversity Information (ENBI)


# Definition of methodologies linking taxonomic, collection and specimen databases with observational databases • End-user's point of view

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# Definition of methodologies linking taxonomic, collection and specimen databases with observational databases • End-user's point of view

## Abstract

Observational biodiversity information is one category of biodiversity information and can be defined as *museum or legacy data without voucher specimens*. This report discusses aspects that need to be considered when efforts are made to link observational databases with databases that manage taxonomic, collection and specimen databases in order to make this vast observational information base available for biodiversity management. These different types of data are all very important in conservation and sustainable use of biological diversity and each has its role to play in the management of it. The study was conducted by assessing a number of Internet sites managed by organizations that collect information on animal and plant observations. From this it can be concluded that there is a long way to go before observations and collections are linked together in searchable databases structured by taxonomic information. Nevertheless this should be the long-term goal as these datatypes provide essential information for managing of biodiversity and for decision-making regarding its conservation and sustainable use.

# 1 Introduction

## Description of context

This report is developed in the context of a thematic network, the European Network for Biodiversity Information (ENBI), which is supported by the European Commission under the fifth Framework Programme and contributing to the "Energy, environment and sustainable development" programme. ENBI is the European Union's (EU) contribution to the Global Biodiversity Information Facility (GBIF). The mission of the Global Biodiversity Information Facility is to make the primary data on biodiversity freely and universally available via the Internet. GBIF visions that it will contribute to economic growth, ecological sustainability, social outcomes and scientific research by increasing the utility, availability and completeness of primary scientific biodiversity information available on the Internet. (GBIF, 2004).

The major objective of ENBI is to establish a European network that makes accessible primary biodiversity data through digitization and integrated and shared information infrastructure (ENBI, 2004). Biological diversity (biodiversity) is the term given to the variety of life on Earth and the natural patterns it forms. The biodiversity is a result of evolution, shaped by natural processes and, especially presently, by the influence of humans. It forms a web of life which is essential to maintain life on earth. (CBD, 2004). Biodiversity has important social, scientific, economic, cultural and aesthetic values. In order to use, monitor and understand biodiversity, it is necessary to utilize the existing biodiversity information to its full potential. This is to what ENBI aims. ENBI will also establish communication platforms to inquire the needs of the users of biodiversity information and to disseminate biodiversity expertise to professionals and policy makers. (ENBI, 2004). Exchange, maintenance and organization of biodiversity information in all its facets was acknowledged[1] in the Convention of Biological Diversity (CBD, 1992) to be an important tool in biodiversity management and that scientific knowledge and technological know-how have a vital role to play. (CBD, 2004).

## Observational Data – ENBI Work Package 7

As the first priority, GBIF concentrates on making primary biodiversity data globally available focusing on taxonomic data and on biological collection and specimen data, as well as on promoting the common access and interoperability between these databases. ENBI follows these priorities by concentrating on databases at the European scale and on activities that need cooperation at a European level. The interest of ENBI lies also in making use of a vast amount of observational databases. The activities and objectives of ENBI are grouped into four main clusters. Each cluster accommodates several work packages all with a specific theme. In the cluster working on maintenance, enhancement and presentation of biodiversity

[1] Convention on Biological Diversity (CBD, 1992):
"Article 17. Exchange of Information
1. The Contracting Parties shall facilitate the exchange of information, from all publicly available sources, relevant to the conservation and sustainable use of biological diversity, taking into account the special needs of developing countries.
2. Such exchange of information shall include exchange of results of technical, scientific and socio-economic research, as well as information on training and surveying programmes, specialized knowledge, indigenous and traditional knowledge as such and in combination with the technologies referred to in Article 16, paragraph 1. It shall also, where feasible, include repatriation of information."

databases, there is included a work package that deals with observational survey data (Work Package 7) (ENBI, 2004). This work package is coordinated by the University of Turku, Section for Biodiversity and Environmental Science in Finland.

There can be identified four different categories of biodiversity information: 1) the collections of natural history museums (specimens in museums), 2) descriptive biodiversity data (e.g. observational biodiversity data collected by amateur naturalists and professional scientists), 3) synthetic information (e.g. scientific publications) and 4) metadata (biodiversity data describing the other three categories) (Laihonen, 2003).

One way to define descriptive biodiversity data or *observational biodiversity data* is as *museum or legacy data without voucher specimens*. This kind of definition is very simple but reflects well the nature of observational biodiversity data. It also reflects many similarities that the observational data and museum collection data share. However, there are also many differences between these two data types. One of the most obvious differences is that of the validation. The correct identification of museum specimens can always be checked in the collections, but observations are much more complicated to validate as they lack any permanent connection to the observed animal or plant in nature. The only aspect of observation that can be validated is the observer • his or her experience as observer. (Vieno & Sääksjärvi, 2003).

It is, however, very important to notice that the size of the observational biodiversity data may be many times larger than the size of the biodiversity data represented as specimens in natural history museums of the world (Vieno & Sääksjärvi, 2003). Larger collections of observations can roughly be divided into two classes: 1) results of systematic and directed surveys that base on national or international agreements, executed by research institutions, such as universities, or museums, and 2) observations by volunteer enthusiasts of nature, managed and compiled by taxon-specific societies, either at national or sub-national level. The difference between these two is not absolute, as many systematic, nationally coordinated surveys are originally based on the work of volunteer non-governmental organizations (NGOs). (Toivonen *et al.*, 2005)

Almost all standardization and sharing efforts of biodiversity data have had their primary emphasis in sharing of biological collections data that is stored in the natural history museums. Observational datasets have generally either been excluded from the scope of interest, or, been treated similarly to collections data. Up-to-date and geographically comprehensive data of many important and interesting taxa like birds or mammals are, however, mostly based on observations. Therefore, these data cannot be excluded if the aim is to comprehensively make available world's biodiversity data. (Toivonen *et al.*, 2005).

All in all, observational databases provide very extensive datasets, many very recent and with an ongoing updating scheme, and many with exact timeframes suitable for monitoring and modeling activities. Observational data needs to be properly integrated into biodiversity information management schemes in order to get a more complete picture of biodiversity information. Also, it is important that the network of keen observers of nature are recruited into the work for integration of biodiversity information in order to, on one hand, promote overall environmental awareness and, on the other hand, to make more complete the knowledge managed on biodiversity for decision-making processes on pan-European and global scales.

## Aims of this study

This report has an intention of discussing aspects that need to be considered when efforts are made to link observational databases with databases that manage taxonomic and collection and specimen databases in order to make this vast observational information base available for biodiversity management. Very often problems of data management are not related so much to the information technology *per se*, although this has proven to be very problematic as well, but more to different groups and types of end-users and producers of information and their needs and intentions. One important aspect that needs to be kept in mind when developing biodiversity databases and their interlinkages is that they need to be easy-to-use and understandable to the end-user who can be a member of the public interested in finding information on the plant growing in his or her backyard or a scientist comparing his or her findings to information produced by other scientists on the same subject.

The aim of this study is to be a conceptual reflection on some of those concerns that relate to methods for linking the different datatypes in different types of databases. These different types of data are all very important in conservation and sustainable use of biological diversity and each has its role to play in the management of biodiversity. The aim is not ponder the issue from the technical side, rather than from the sociological side of the issue and especially from the end-user's point of view.

# 2 Conceptualization of study

In this study, the term "taxonomic database" is used to refer to taxonomic checklists that give names of species and of lower and higher taxa and that might also provide phylogenetic tree to indicate taxonomic relations of the species or other taxa in question. These checklists in many cases also include the vernacular or common names of the species in question. Collection and specimen databases refer to databases that harbor collections of natural history museums or other institutions and that include a voucher specimen for each individual collected.

Observational data comes basically from two sources: 1) systematic and directed surveys done by government agencies, research institutions, special interest groups, and individual researchers, and 2) more random observations usually done by amateur naturalists, such as enthusiastic amateur ornithologists, botanists, entomologists and similar. Observational data typically comprises information about the number and individuals of certain species in a given area and at a given time, or information, for example, about all birds and all vascular plants in a given place and point of time. At the best of cases, long observational series or monitoring programs have been going on for many decades, such as National Forest Inventory in Finland (www.metla.fi/ohjelma/vmi/nfi.htm) that has provided information on Finnish forests since 1921. (Toivonen & Vieno, 2004).

There are several characteristics of observational data that differentiate it from normal museum collection. The differences depend on taxa examined, but apply to most groups. In all cases the characteristics are not directly related to standardizing issues, but indirectly they are reflected in the standardization and usability of the data. A good overview of the special characteristics of observational data and the typical contents of observational databases can be found in Toivonen *et al.* (2005). As these are well documented in the report mentioned they are not discussed here.

It is only recently that more attention has been given to observational databases and only recently some efforts have been undertaken to incorporate them into international initiatives dealing with biodiversity information (such as GBIF) (Vieno & Sääksjärvi, 2003). It is understandable that observational data has only a while back marched onto stage in international initiatives of biodiversity information management. The sheer volume of observational data sets is overwhelming and has been estimated to be even larger than all the museum material put together. This is such a vast amount of information to be considered summing to other data types that linking observational data to other database types seems like a mountainous task to perform. Also, there has been a need to start somewhere and the logical place has been to start with collection and specimen data as these have been more readily available on a structured basis and often within governmental institutions making their use less problematic. The observational databases vary considerably in their focus, the possibilities to validate the data presented and in the motivation for collecting the data thus rendering them difficult to use in serious biodiversity management efforts not withstanding their obvious importance.

As pointed out earlier, it is of utmost important to bear always in mind that all biodiversity information databases are intended to be used for multiple purposes. This results in that they need to be user-friendly and provide information to very different types of end-users for their multiple needs. One of the problems in observational databases is the problem

of validation of the observation and thus its value and usefulness for biodiversity management. On one hand a member of the general public might not be interested in validating the information as he or she lacks the expertise to do it; on the other hand it might be essential, for instance, for environmental authorities to be able to validate the value and usefulness of a specific observation or a set of observations. This brings forth further complications in the presentation of information from observational databases and their linkages to other database types.

## Method of study

The study was conducted by accessing a number of Internet sites managed by organizations that collect information on animal and plant observations. These sites were obtained from the list of sites researched by Toivonen *et al.* (2005) in such a way that all the sites that were identified as observational sites pertaining to species in that report were selected and consequentially ploughed through in order to see whether observational sites used or not used the available other sites containing other information types, e.g. specimen and taxonomic lists, or if this use or the lack of it was evident to a casual end-user. This was done in order to get an idea whether observational databases demonstrated any linkages to other database types. The researcher entered the site as a casual end-user.

# 3 Observational Internet sites

The Internet sites that were researched are the ones pertaining to species that were studied in the report of Toivonen *et al.* (2005). This resulted in 67 Internet sites that were researched including a follow-up of links that were presented inside the site in question. All these follow-ups are counted as one site (the one that the researcher entered) in this research. The list of these sites is presented in the Appendix 1.

13% of the sites provided a database that was searchable by a casual end-user. 46/ of the sites included species lists, especially the ones that did not have a searchable database provided a species list of the species referred to in their Internet site. It was not always apparent though if this was a valid taxonomic list; valid taxonomic lists were provided only on three of the sites. Collection data was present in three sites but it was not apparent when the information that the casual end-user looked for originated from observational databases or from collection databases. In none of the researched sites information was provided in such a way that it would have been readily implicit whether the particular information originated from observational or collection sources rendering it impossible to study methods of database linkages between different database types.

In 37% (25/67) of the sites there was a possibility to search the information on a particular species by either typing the species name on the space provided or by selecting from a given list. 12 sites allowed the use of both scientific and vernacular names, 11 sites allowed only vernacular names and one site only scientific names. 16 of the 25 sites that allowed a search of a particular species providing a list of species that were available at the site, eight allowed for a freely typed search and one site provided both a list and a possibility to type the wanted species. None of the sites at which the casual end-user could type the species looked for provided suggestions on e.g. misspelled words or words resembling the intended ones (providing suggestions on possibilities that the end-user tried to search).

# 4 Conclusions

Observations on plants and animals either by professional scientists collecting information on biodiversity within structured study regimes promoted by national research institutions, or by enthusiastic amateur botanists, ornithologists, entomologists, etc. promoted by their own interests or by species-oriented non-governmental organizations, can provide and do provide an important source of biodiversity information that has only recently been taken onto the platform of biodiversity information management. Unfortunately, the information that these observations provide is difficult to validate and remains patchy and biased to certain conspicuous and interesting groups, such as birds, mammals, flowering plants, and butterflies. Furthermore it has not been readily available.

It is important, though, that information receives due attention and is incorporated to the biodiversity management schemes, such as GBIF. Observational data need to be properly integrated into biodiversity information management schemes in order to get a more complete picture of biodiversity information. Observational data differ in some key aspects from data found in museum collections. Museum collections that have specimens collected attached to taxonomic information are a powerful tool to glimpse especially into the past and thus make assessments of the present and even predictions of the future.

Unfortunately collections provide information on certain groups of species collected over a certain time period in certain areas and are usually in the hands of European or North American museums despite collections having been made in tropical America or Africa. There are certain groups of animals, such as insects that are continuously collected and deposited in museums due to the fact that their study is practically impossible without a real collection of them. On the other hand some groups of especially mammals are not collected anymore at all, such as rhinoceros or other large and endangered mammals. Such animals are not collected any more but they are extensively observed in number of international programs. Basically all the information available on these animals comes from present-day observations; at least all information that has any relevance to conservation and management efforts in the wild.

*Linking observational and taxonomic databases could and should be mutually beneficial.* In the study that was made by Toivonen *et al.* (2005) a large number of European and international observational internet sites were studied. In this study especially information sheets were taken under scrutiny in order to see exactly what kind of information is fed to various databases. These were all information sheets that are online or that can be printed from the web sites of the organizations administering the sites. Organizations gather observations on various topics, such as rare birds, or species that are considered indicators, whether it is for water quality or urban landscape, and the public can send in their observations on sheets provided by the organizations on their web sites. One of the things that were studied was how names are treated in information sheets. Whether the information is given as scientific or as vernacular name, or if it is freely written on the space provided or if it can be taken from a list.

One of the findings is that names can be written freely on many information datasheets thus making it impossible to control correct spelling of the observed taxon. Here links to taxonomic databases that provide correct way of writing especially the scientific names would be very important and useful. There is a danger that such observations that refer to an

incorrect name render themselves useless. They cannot be used. This is of course a waste of effort and time as this problem would be easy to solve by linkage to taxonomic database. This has also been suggested by Roskov *et al.* (2004) who encourage the use of taxonomic information as the guiding light in all biodiversity database development.

Very often data sheets are used by nature enthusiasts that have no education in biology and thus taxa and correct scientific names are more unknown to them. In that case vernacular names are fed to the data sheets. Here also taxonomic databases could be very useful as they could provide a choice of scientific names to a vernacular name; the choice would then be limited by e.g. language and geographic area of the observation. Of the choices the correct scientific name could then be chosen to a particular vernacular name of a particular observation.

This is also true from the end-user's point of view. For a casual end-user it is very important that he can use common names and that there is a list to help him out if he cannot remember it correctly and also this is important when dealing with scientific names, the database should give suggestions of possible names that the end-user is trying to give.

Users should be able to differentiate between information that comes from collections and information that comes from observations due to the special characteristics of each data type. This might not be so important to a casual end-user but could be of utmost importance to e.g. environmental authorities that need to be able to validate the information. It should be clear in the databases that use collection and observational databases as their information source from which source the information originates.

It is clear that there is a long way to go before observations and collections are linked together in searchable databases structured by taxonomic information. Nevertheless this should be the long-term goal as these datatypes provide essential information for managing of biodiversity and for decision-making regarding its conservation and sustainable use. It is encouraging that observational databases have entered the arena of biodiversity information management as one key aspect in biodiversity management.

# 5 References

CBD. 1992. Convention on Biological Diversity, The text is available at www.biodiv.org. doc/legal/cbd-en.pdf.

CBD. 2004. Web pages of the Convention on Biological Diversity. Secretariat of the Convention on Biological Diversity (SBD) and United Nations Environment Programme (UNEP). www.biodiv.org. Accessed 28 December, 2004.

ENBI. 2004. European Network for Biodiversity Information. www.enbi.info. Accessed 28 December, 2004.

GBIF. 2004. Global Biodiversity Information Facility. www.gbif.org. Accessed 28 December, 2004.

Laihonen, P. 2003. Global biodiversity information exchange: processes and methodological challenges, PhD thesis, Annales Universitatis Turkuensis, Ser All, Biologica, geographica, geologica, tom 163. ISBN: 951-29-2389-0, 38 pp + 78 pp.

Roskov, Yu., Harling, P. & Bisby, F. 2004. Report on assessment of existing electronic rich data sources ('Species Bank'). ENBI Report No. WP5_ D5.4_05/2004. Version 1.0. Available at www.enbi.info/forums/ig/repository.php.

Toivonen, T. & Vieno, M. 2004. Review on databasing standards of biological databases – how are observational databases treated? ENBI Report No. WP7_D7.2a_03/2004 Version conceptual v.1.0. Available at www.enbi.info/forums/ig/repository.php.

Toivonen, T., Vieno, M. & Kumpulainen, R. 2005. Sharing and exchange of observational data sets - Exchange standards and good databasing practices. ENBI Report No. WP7_D7.2b, 3 March 2005. Available at enbi.utu.fi.

Vieno, M. & Sääksjärvi, I.E. 2003. Observations on observational data – Network of organizations, institutions and specialized interest groups that hold, analyse and present spatial, observation-based biodiversity data. ENBI Report No. WP7_D.7.1_11/2003. Version Draft 1.0. Available at enbi.utu.fi.

## Version History

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| 0.2 | 21/08/2005 | S-K. Juvonen and Ilari E. Sääksjärvi | |
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| 1.0 | 19/112005 | S-K. Juvonen and Ilari.E. Sääksjärvi | Final version for distribution |

# Annex 1. Studied observational Internet sites

| Observation announcement service/contents | Species | Coverage | WWW-address |
|---|---|---|---|
| ***Aves*** | | | |
| 1. Birdlife Finland | Birds | Finland | http://www.birdlife.fi |
| 2. California Bird Records Committee | Birds | California, U.S. | http://www.wfo.cbrc.org/cbrc |
| 3. Manaaki Whenua, Landcare Research | Birds | Canterbury, New Zealand | http://www.landcareresearch.co.nz/databases |
| 4. Avian Society of Turku | Birds | SW Finland | http://webkanta.info |
| 5. BirdLife, Finnish rarity committee | Birds | Finland | http://www.birdlife.fi/lintuharrastus/rariteettikomitea |
| 6. Comite de rarezas, Spain | Birds | Spain | http://www.rarebirdspain.net |
| 7.British Trust for Ornithology | Birds | UK & Ireland | http://www.bto.org |
| 8. Estonian Ornithological Society | Birds | Estonia | http://www.eoy.ee/atlas |
| 9. Northern Prairie Wildlife Research Center | Birds | New Mexico, US | http://www.npwrc.usgs.gov/resource/resource.htm |
| 10. Oklahoma University | Birds | Oklahoma, US | http://www.biosurvey.ou.edu/srchable.html |
| 11. Stanford Alumni Association | Birds | Stanfod University campus, US | http://www.stanfordalumni.org/birdsite/ |
| 12. Icelandic Rarities Committee | Birds | Iceland | http://www.ni.is/bliki/RCform.pdf |
| 13. Finnish Museum of Natural History | Birds | Finland | http://www.fmnh.helsinki.fi |
| 14. Dutch Birding Association | Birds | Netherlans | http://www.dutchbirding.nl/recent/waarntemp/waarntempform.php?lang=2 |
| 15. Artportalen | Birds | Sweden | http://WWW.artportalen.se |
| 16. Scottish Bird Records Committee | Birds | UK, Scotland | http://www.the-soc.zenwebhosting.com/ |
| 17. Wildlife Trusts | Birds | UK, Wales | http://www.wildlifetrust.org.uk/ |
| 18. Birdnews | Birds | UK | http://www.birdnews.co.uk/ |
| 19. The Barn Owl Centre of Cloucestershire | Birds: owls & kestrel | UK | http://www.barnowl.co.uk/news/sightings.asp |
| 20. Herts Bird Club | Birds | UK | http://www.hertsbirdclub.org.uk |
| 21. Comission de'l avifauna Suisse | Birds | Switzerland | http://www.vogelwarte.ch/pdf/popmonitoring_neuprot_e.pdf |
| 22. Kent Ornithological Society Rarity Panel | Birds | UK, Kent | http://www.kentos.org.uk/ |
| ***Mammalia*** | | | |
| 1. Government of Michigan | Moose | United States | http://www.dnr.state.mi.us/wildlife/pubs/moose_obsreport.asp |
| 2. Michigan Dept. of Natural Resources | Gray wolf | Michigan, US | http://www.northland.edu/soei/ |
| 3. Massachusetts Div. of Fisheries & Wildlife | Rare animals | Massachusetts, US | http://www.mass.gov/dfwele/dfw/ |

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|---|---|---|---|
| 4. Ministry of the Environment | Porpoise | Finland | http://www.ymparisto.fi/download.asp?contentid=5269 |
| 5. SYKE/Environment Institute | Flying squirrel | Finland | http://www.ymparisto.fi/download.asp?contentid=3060 |
| 6. Irish Whale and Dolphin Group | Whale, Dolphin | Ireland | http://www.iwdg.ie |
| 7. British Big Cat Society | Big cat animals | UK | http://www.britishbigcats.org |
| 8. Whale and Dolphin Conservation Society | Whale, Dolphin | Global | http://www.wdcs.org |
| 9. Durlston Marine Project | Dolphin, whale, seal | UK | http://www.durlston.co.uk/marine/reportform.htm |
| 10. The Marine Conservation Society | Whale, Dolphin | Seychelles | http://www.mcss.sc |
| 11. Seawatch Foundation | Whale, Dolphin | UK | http://www.seawatchfoundation.org.uk/pdf/swfrecord.pdf |
| 12. Swiss Center of Cartography of The fauna | Several species | Switzerland | http://www.cscf.ch |
| 13. Durham Wildlife Trust | Otter | UK | http://www.wildlifetrust.org.uk/durham |
| 14. Durham Wildlife Trust | Squirrels | UK | http://www.wildlifetrust.org.uk/durham |
| 15. Marine Conservation Society Seychelles | Whale, Dolphin | Seychelles | http://www.mcss.sc |
| 16. Cheshire biodiversity | Otter, mink | UK | http://www.cheshire-biodiversity.org.u |
| 17. Tracking Mammals Partnership | All mammals | UK | http://www.mtuk.org |
| 18. The Whale and Dolphin Group | Whale, Dolphin | UK, Bailiwick water area | http://www.bbc.co.uk/guernsey |
| 19. Scottish Big Cat Society | Big cat animals | UK, Scotland | http://www.scottishbigcats.co.uk |
| 20. Zoological Society of London | Dolphine, Porpoise, seal | Global | http://www.zsl.org |
| 21. Joint nature Conservation Committee | Marine mammals | UK | http://www.jncc.gov.uk |
| ***Insecta*** | | | |
| 1. Lepidopterological Society of Finland | Butterflies | Finland | http://www.bioshare.net/sps |
| 2. Svenska artportalen | Butterflies | Sweden | http://www.artportalen.se/butterfly |
| 3. Museum of Victoria | Butterflies | Australia | http://flyingcolours.museum.vic.gov.au/resources |
| 4. Butterfly conservation | Butterflies | UK | http://www.butterfly-conservation.org/species/bdata/index.html |
| 5. Dragonflies of Finland | Dragonflies | Finland | http://korento.net |
| 6. Pacific Northwest Dragonfly Migration Project | Dragonflies | US, Pacific northwest | http://www.ent.orst.edu/ore_dfly/Migrform.htm#top |
| 7. B.C. Conservation Data Center | Dragonflies | Canada, British Columbia | http://srmwww.gov.bc.ca/atrisk/toolintro.html |
| 8. B.C. Conservation Data Center | Dragonflies | Canada, British Columbia | http://srmwww.gov.bc.ca/cdc/documents/odonaobs.pdf |

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|---|---|---|---|
| 9. Dragonfly & Damselfly Recording sheet | Dragonflies | UK, Durham | http://www.ijwaller.demon.co.uk/dragonfly.htm |
| 10. British Dragonfly Society | Dragonflies | UK | http://www.dragonflysoc.org.uk/frameset.htm?home&home |
| ***Amphibia & Reptilia*** | | | |
| 1. Finnish Museum of Natural History | Amphibia, Reptilia | Finland | http://www.herpetomania.fi/levinneisyyskartoitus |
| 2. Gov. of Michigan | Reptilia | United States | http://www.dnr.state.mi.us/wildlife |
| 3. Irish Wildlife Trust | Lacerta vivipara | Ireland | http://www.iwt.ie |
| 4. National Park Service, Alaska Region Inventory & Monitoring Program | Amphibia | US, Alaska | http://www.nature.nps.gov/im/units/AKRO/Amphibians/ak_amphibs.htm |
| 5. Dept. of conservation | Amphibia, Reptilia | New Zealand | http://www.doc.govt.nz/Conservation/001~Plants-and-Animals/001~Native-Animals/Herpetofauna/index.asp |
| ***Pisces*** | | | |
| 1. Mike Johnson marine Natural History Photography | Ocean Sunfish | California, US | http://www.earthwindow.com/report.html |
| 2. Fish Base | Fishes | Global | http://64.95.130.5/FishWatcher/menu.cfm |
| 3. National Marine Aquarium | Rare fish species | UK | http://www.national-aquarium.co.uk/marinelife/rare-form.asp |
| 4. Basking Shark Sighting Form | Basking Shark | UK, Isle of Man | http://www.isle-of-man.com/interests/shark/form2.htm |
| 5. Wildlife Trust | Basking Shark | UK | http://baskingsharks.wildlifetrusts.org/helpus.php |
| ***Plantae, Bacteria, Fungi*** | | | |
| 1. Nevada Natural Heritage Program | Plants | Nevada; US | http://heritage.nv.gov/comintro.htm |
| 2. Finnish Marine Research Institute | Cyanobacteria | Finland | http://jolly.fimr.fi/algaline/bloomreport.nsf?OpenDatabase |
| 3. Artportalen | Plants | Sweden | http://www.artportalen.se |
| 4. Artportalen | Fungi | Sweden | http://www.artportalen.se |