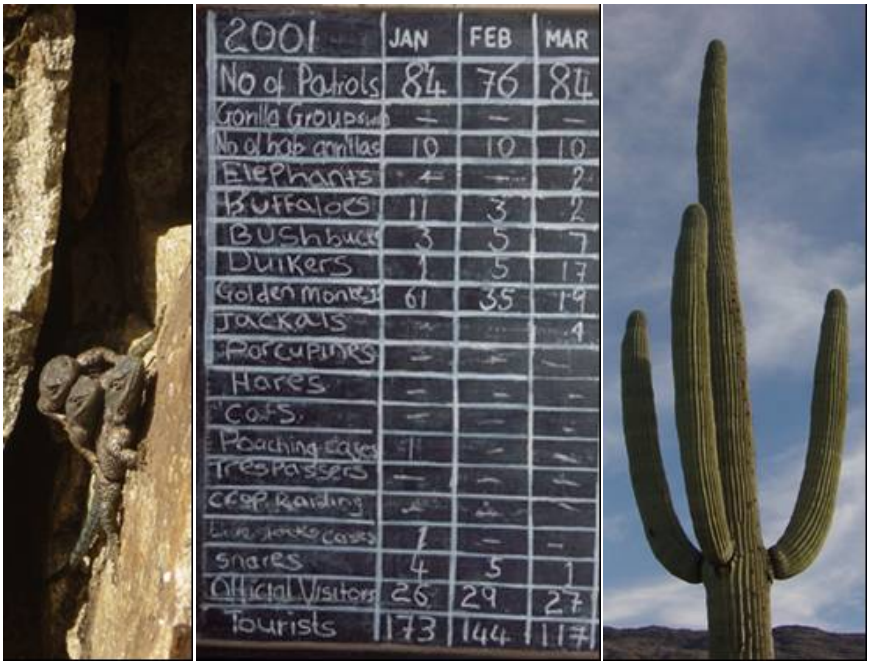
IUCN
The World Conservation Union

Sharing Information with Confidence

"The Biodiversity Commons": past experience, current trends and potential future directions



"*The field of knowledge is the common property of all mankind"*
Thomas Jefferson, 1807

An issues paper
May 2004

Executive Summary

The "information explosion" has become a cliché but is none the less real. There are already an estimated 43 million web sites yet most information remains outside electronic form and there are a far greater number of paper publications, even more unpublished material…and a huge amount of information stored in people's minds. Information can contribute to capacity building, education and science, but benefits can be seriously weakened if information is fragmented, incomplete or hard to access.

Good information is critically important to good conservation of biodiversity and there is a recognition that we all need to share information far more regularly and openly than in the past. The cultural shift towards making information more readily available is already underway. The aim of the current report is to chart and analyse this change in relation to information on biodiversity, and to suggest how biodiversity information can be managed cooperatively, allowing greater access to data that will improve global responses to the challenges of biodiversity loss, climate change and ecosystem degradation.

Three things have become clear in researching this report:

- A lot of information is already publicly available but is often hard to find either because it only exists in paper form or because potential users cannot isolate it from the mass of electronic data on the web
- Even more information is private by default – as personal notes, unpublished papers or in the fragile form of personal knowledge; although lack of access is unintentionally in most cases it is unavailable to other users
- Another set of information is private or restricted – because researchers don't want to share data until they have published the results, or for commercial or tactical reasons.

This report is contributing to a process which is trying to unlock good information about biodiversity and make it available for general use in advancing the aims of conservation and sustainable development.

The report is divided into nine sections, looking at:

- **Biodiversity and the information explosion**: an introduction to the report
- **Experience with on-line, open access information systems**: a review of the trend towards developing open access publishing via the internet, and assessment of the possible benefits and drawbacks associated with open access information
- **Experiences and lessons learnt from biodiversity conservation information systems**: a short review of biodiversity information sharing initiatives, looking particularly at the Biodiversity Conservation Information System and steps taken to develop Biodiversity Knowledge Commons
- **The needs, wants and aspirations of potential partners and users of biodiversity information**: a summary of opinions from partners and users of a Biodiversity Commons on how the biodiversity community can share data more openly and more effectively
- **Types of information**: a summary of information types
- **Gaps in availability of biodiversity information and datasets**: a brief typology of information sources and some recommendations on how to fill gaps in current data availability
- **Future scenarios for biodiversity information sharing**: includes five models of information sharing
- **Challenges to building the commons**: it has been argued that access to biodiversity data, information and knowledge is limited by a combination of technology, economics, culture and law. This section looks at the series of issues related to each of these elements
- **Recommendations**

The main aim of the paper is to provide a background to issues of biodiversity information management and to set some suggestions for a framework for information sharing within the biodiversity sector. It aims to spark discussions at the meeting planned at IUCN in late May 2004. As such the conclusions remain general.

The level of sensitivity to the issue of creating, developing and sharing a Biodiversity Commons suggests a need for an agreed framework for information sharing. This should probably be in the form of a series of simple ***principles***, rigorously applied and policed so that the global community can, with luck, build growing trust in the way that information can be shared and used to common good purpose.

Discussion of the principles will take place at the workshop; we include some early pointers here[1]:

Principle 1: Timely, high quality biodiversity information has value: the extent to which users would pay for this depends on circumstances (e.g. in general commercial users might be expected to pay)

Principle 2: Providers of information have the rights to control and license this information and users have a responsibility to use it responsibly

Principle 3: Licensing of information sharing must contain enough options to satisfy all potential information providers and thus to remove barriers to information sharing.

Principle 4: A global commitment to capacity building and support is needed to ensure that the full range of knowledge is available within the biodiversity commons

Such principles transcend simple issues of use and ownership, and imply a large effort to redress current inequities in information availability both in terms of access and in the ability to generate and collect such information. The ***responsibility*** of sharing also implies capacity building and helping to create conditions in which such sharing can best take place.

Key elements in success relate to how information is ***exchanged***, where and if information is accorded monetary or other value, who pays and who benefits.

Throughout this report we have emphasised the ***culture*** of sharing rather than the technical mechanisms that might be involved. Whether or not there is one controlling "portal" for the so-called biodiversity commons is debatable. We suspect that it is already too late to contemplate the development of such a super-system and that some measure of sharing amongst existing databases will be more realistic and cost effective.

Finally, a successful system also implies a measure of élan and excitement. The "biodiversity knowledge commons" may be an accurate statement of purpose but will likely not set the world's pulses roaring. If this initiative is to go forward, we suggest agreeing on a more captivating name (e.g. "aardvark" , "bioknowledge", "biodata") rather than creating another acronym.

Sue Stolton and Nigel Dudley[1]
Machynlleth, Wales, May 2004

[1] We came to this process rather late and without the benefit of past discussions about biodiversity information sharing. However, we are long-time producers and users of the type of information discussed, as consultants working with NGOs, UN agencies, governments and companies, and by running our own website containing information on our past and present work (www.equilibiumconsultants.com). We therefore have a keen and personal interest in improving access to information on biodiversity in the most practical ways possible. What follows, whilst commissioned by IUCN and TNC, should be seen as a personal analysis by the two of us.

Contents

Acknowledgements

We would like to thank Tom Hammond of IUCN – The World Conservation Union and Jonathan Adams of The Nature Conservancy (TNC) for suggesting we take on this report. Although we are users and producers of biodiversity information, as mentioned above, we came to the subject of information provision and to writing this report rather late in the day. We would therefore first and foremost like to thank Colin Bibby – who was to have been the author of this report and who has built up enormous experience on this issue over the last few years – for taking the time to discuss with us the content of this report in particular and the subject of biodiversity information provision in general. We would also like to thank Colin for the wealth of material he lent us, which greatly aided putting the report together. Jean-Louis Ecochard and Jonathan Adams at TNC, and Stuart Slater at IUCN, all found the time to meet us at short notice and provided useful input into the planning of the report. We're also grateful for various comments on the draft, including very detailed input from Jean-Louis and Tom Moritz.

We have also discussed (in various medium) this project, formally and informally, with many people – all of whom have added immeasurably to the ideas contained in the report. Any errors however remain our own.

Finally, of course, reports tend not to be written unless someone funds them. So we would like to thank TNC's Technology and Information Systems department, whose grant made this report possible, and IUCN for administering the grant.

Section 1: **Biodiversity and the information explosion**

"*Historically, researchers have relied on editors, publishers and librarians to systematically evaluate, collect, manage, and distribute or make available scholarly information. Because of changes in the nature of information, technology, the global importance, and the scope of the dialogue it is time to re-examine our dependency on this expensive, time-consuming, elitist/exclusive method of managing this information resource.*[2]"

Given the millions of genes of millions of species interacting in millions of ways in hundreds of millions of hectares of protected and conserved areas managed with billions of dollars by tens of thousand of people, making it perhaps the largest information set in the world…how can biodiversity information be managed cooperatively and fulfil users needs?

From the moment that information could be stored digitally the ways in which we use it changed forever. The development of the internet accelerated this process. Whatever the future holds for information availability, we can no longer rely on a small number of editors, publishers and librarians to provide the information we wish to disseminate or to use. This paper suggests how biodiversity information can be managed cooperatively, allowing greater access to data that will improve global responses to the challenges of biodiversity loss, climate change and ecosystem degradation.

A world full of unused information

The 'information explosion' has become a cliché but is none the less real – it is estimated that new stored information grew by about 30 per cent a year between 1999 and 2002[3]. There are already an estimated 43 million web sites[4] yet most information remains outside electronic form and there are a far greater number of paper publications. Outweighing both in terms of sheer volume is an immeasurable mass of unpublished material: theses, papers, working notes, half finished monologues…not to mention information stored in the minds of individuals.

The twentieth century revolution in ecology went in parallel with this information revolution: when *The Last Whole Earth Catalogue* appeared in 1972[5] we were still living with the notion that information on one aspect of the environment (self sufficiency) could be summarised in one hefty book but these beliefs soon evaporated under the weight of information.

In the biodiversity field the very number of species (1.1 new species are described every day) means that information management has always been a huge challenge while advances in ecosystem study, ecological monitoring and gene mapping has added to the volume of data.

Unfortunately, much of the information generated by humanity is dissipated and lost. Estimates put the average lifetime for a URL address on the world wide web, for instance, at 44 days[6]. In the field of medical research held up by many biodiversity specialists as a leader in information access, nearly a fifth of websites mentioned over the past decade in Medline, the main clearing-house for biomedical papers, have since disappeared[7]. Many research documents, theses and even published papers are released once and never referred to again. In *The Abortion: an Historical Romance* author Richard Brautigan[8] imagined a huge building storing unpublished and unread books: he could have been describing most university collections of dissertations.

Five years ago email access in Tanzania was limited to Dar es Salaam. In 2001 it reached Arusha and by 2003 there was high quality broadband reception in the heart of the Serengeti National Park.

These problems are widely recognised and one response is that information is increasingly being digitised and made available on the web. Once digitized, information can be easily copied and transported at almost zero cost. During the writing of this report, for example, Kew Gardens announced the aim to photograph and load onto the web its collection of 7 million plant specimens[9]. Access to the internet is increasing all the time. What was five years ago still the preserve of the rich is rapidly democratising under force of demand, and cheap internet cafes are springing up all over the world.

The amount of biodiversity information available online has changed dramatically… a profound cultural shift is already underway.

Improving access to the biodiversity knowledge commons

Effective conservation of the world's biodiversity is already an immense challenge. In a world where there is common cause in addressing the challenge of biodiversity loss, access to information is a key tool in developing, implementing and measuring effective conservation strategies. A major step in this process, and the focus of the current report, is improving access to biodiversity data and information.

The amount of biodiversity information available online has changed dramatically over the last five years. A profound cultural shift towards making such information more readily available is already underway. The aim of the current report is to chart and analyse this change, to see what is still missing and to suggest some practical ways in which information flow could be both increased and made more useful. Three things have become clear in researching this report:

- A lot of information is already publicly available but is often hard to find (one study reported finding 187 *significant* information sources on conservation available on the internet in English[10]) either because it only exists on paper or because potential users cannot isolate it from the mass of electronic data on the web (see Appendix 3)

- Even more information is private by default – as personal notes, unpublished papers or in the fragile form of personal knowledge; although no-one is intentionally keeping this secret it is unavailable to most users

- Another set of information is private or restricted – because researchers don't want to share data until they have published result, or for commercial reasons or for tactical reasons.

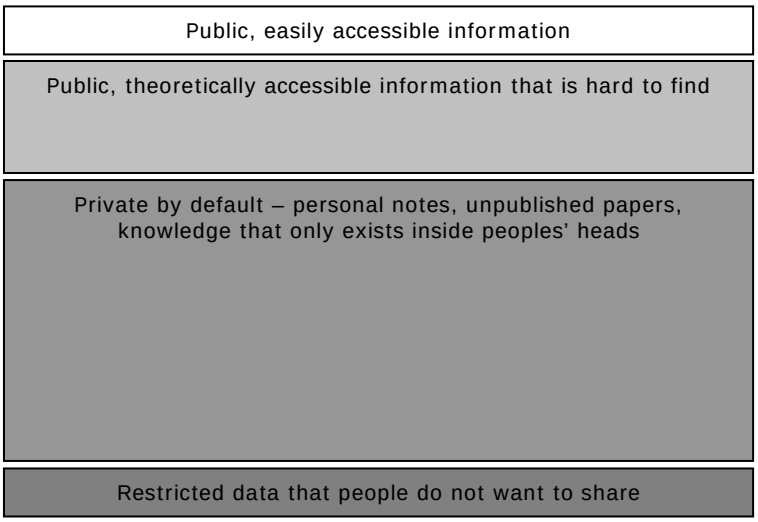


Figure 1: Different categories of biodiversity data

We don't know exactly what proportions of information fall into the different boxes but it is certain that easily accessible information is only a small proportion of the total.

Are there some types of biodiversity information that will never be freely available?

This paper gives a background to issues of biodiversity information management and sets out some suggestions for a framework for information sharing within the biodiversity sector. We look at the challenges and opportunities; take a quick tour of the views of producers and users of information and suggestion options for streamlining information management. As this is aimed to spark discussions, we also pose a number of questions which might provide starting points for the meeting planned at IUCN Headquarters on the 25th and 26th of May, 2004.

Section 2: **Experience with on-line, open access information sharing systems**

"*The whole power of science is the power of shared ideas, not the power of hidden ideas*".[11]

People interested in biodiversity conservation are not the first to struggle with the idea of an information commons. In fact we can learn much from experience in other fields.

The internet quickly spawned a mass of information but to begin with much of this was informal and hard to verify; there was far less easy access to academic papers, refereed journals and detailed reports. Or more accurately, material was available but at a cost; currently usually about US$20 to download a scientific paper. Increasing frustration with this system, and resentment at the handful of giant companies who control most of the world's academic journals, has led to proposals for open access information sharing through the web.

What is open access information?
The Budapest Open Access Initiative of February 2002 defined the term "open access" as literature which is freely available on the internet thus:

> "…permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, trawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited[12]."

In the last few years there have been a number of initiatives to develop open access publishing via the internet[13]. These can be divided into two areas: **open access journals** and **open access archives**.

Open access journals perform peer reviews and then make the approved contents freely available to the world. The costs incurred by all journal publishers can be broken down into *fixed* costs and *variable* costs. Fixed costs do not change, whilst variable costs are directly related to output. In the traditional publishing model in which subscriptions are paid for access to a paper or electronic journal, fixed costs relate principally to the preparation of the articles which go into the journal. Variable costs vary according to the number of copies of the journal in circulation[14]. Although free to the user, open access publishers must still cover the fixed cost element of publishing: i.e. getting agreement for material to be open access; digitisation, if material is not already in digital format; peer review and editing; and loading the material online.

Open access publishing assumes researchers can pay to publish papers. But what about the amateur, retired or voluntary scientists who provide a vital backbone to much conservation study? Or researchers in countries where $1500 is a huge sum to find? Also, would open access result in journals filled with poor quality papers from people with funds and further <u>reduce</u> access to useful information? Should published material be driven by economic buying power or by user needs – regardless of their ability to

Open access publishing costs are generally covered by charging the author for outgoing papers, not the reader for incoming papers or journals and are often published in-house, for instance by university or library employees, where editors' and reviewers' time is already paid for. For example, the US Public Library of Science's journal *Biology* charges authors US$1,500 per accepted article to cover peer review, technical editing and electronic distribution[15]. Another model is to cover costs through alternative income. The British Medical Journal has been an open access journal via its web site since 1998, with the costs being covered by advertising[16].

Charging authors US$1,000–2,000 may seem a high price for making information freely available. However, the Wellcome Trust, the UK's

leading biomedical research charity, has estimated payment of US$1,950 per published research paper would be sufficient to support a high quality and sustainable open-access publishing model, compared to an average of US$2,660 to publish a paper in subscription journals[17]. Furthermore, publishers rather than researchers, or their funding bodies, have control over the distribution of material in subscription-based journals, whilst control returns to the researchers or donors with open access publishing. Large funding bodies have estimated that if they funded the costs of open access their research grants would increase by only a few per cent[18], and there are already examples of funding agencies deciding to pick up the costs of open access (i.e. the Wellcome Trust and the US National Institutes of Health)[19]. It should be noted however that this positive view of the economics of open access contrast sharply with statements made by the publishers of *Nature*, who have stated that switching to open access would require the company to charge authors between US$10,000 and US$30,000 for each article published[20].

40,000 scientists in the US have already committed to only publishing in journals that are freely available within six months

Despite this, the trend towards open access appears to be gathering momentum. An open letter from the Public Library of Science (a US-based initiative which commits to only publish in journals that make content freely available after six months) has now been signed by 40,000 scientists[21] (there were an estimated 3.5 million scientists and engineers in the workforce in 1999[22]).

The trend towards formalising the move towards open access can also be seen in the draft Public Access to Science Act (HR 2613) introduced to the US House of Representatives in June 2003. Its strategy is to deny copyright to all the results of government-funded research. The bill is controversial, mainly because it chooses to base open access on the public domain rather than on copyright-holder consent[23].

Open access archives are repositories of information which is freely available to users around the world. The physical prerequisites for these archives are that a work be digital and reside on an internet server. The legal prerequisite is that the work is free of copyright and licensing restrictions (statutory and contractual restrictions). There are two ways to meet these latter criteria: put new work directly into the public domain or obtain the copyright holder's consent for all legitimate scholarly uses. The difference between these two legal foundations are summarised below[24].

Table 1: **Different approaches to copyright**

Public domain information	**Copyright-holder consent**
No owner	Owner
No rights retained	Some rights retained
All rights either expired or waived	Some rights waived (permitting the uses needed for free and legitimate scholarship)
Not always voluntary (copyright expiration may be resisted; lack of copyright may be resisted)	Always voluntary, though sometimes required in exchange for a job or research grant
No permission needed for scholarly uses	Permission granted for scholarly uses

Does open access mean that we have to rethink the whole peer review process? How could open access help researchers in developing countries where funds for journals are lacking? Could scientists and organisations in rich countries help the process of information dissemination?

The discussion of open access archives in colleges and universities is of particular interest. These institutions are considering developing "institutional repositories" online for research papers, data sets and other work, and according to one author "*some imagine a day when every research university gives its research away through the Web, allowing scholars and non-academics to mine it for ideas and information*."[25] . An early example of this is the eScholarship archive created to serve the University of California system[26].

The benefits of open access

For ***researchers*** on-line open access can enlarge their audience and increase their works' impact. Their information is also freed from any bias caused by costs or availability of their information

For ***users*** open access has a wealth of benefits related to the freedom of access to information. An indication of this spread of information is the comparison between citations of online and offline articles. In 2001, researchers in *Nature* reported that the mean number of citations to offline articles is 2.74, whilst the mean number of citations to online articles is 7.03[27].

For ***donors***, better information can focus funding onto the most urgent tasks and on innovative approaches – rather than repeating what has been tried and failed before – and can also help to measure the success of funded activities

Librarians see benefits in that it will solve the crisis of funding the ever increasing price of subscription journals (see page 23) and solve issues related "permission" found with complicated copyright laws, non-negotiable licensing agreements and software locks.

As with librarians, the simplification of access is also a benefit for those ***organisations*** promoting more open information sharing. The related development of open access protocols also provides a sound technological basis for information sharing.

The potential problems with open access is that the costs involved will risk keeping some useful information out of the public domain because people will not be able to afford to publish, further cementing the domination by Western-based research institutes and organisations. Indeed, the whole idea of open access and / or public domain does not exist in traditional knowledge systems. In many cultures knowledge is a gift from the Creator and there are collective systems in place for using these gifts, which generally have complex arrangements of regulating use. Where knowledge is shared openly, rights of use can also exist[28].

If funding organisations are paying for research, should they insist on publication before releasing the final grant funding? Could donors insist on data being made available after a certain period of time?

Increasingly, however, open access is being seen as a right and the momentum for its application is growing all the time. For example, the right to public information, participation and legal action on environmental matters was emphasised in the Aarhus Convention of June 1998[29]. Some of this thinking has already been applied within the field of biodiversity conservation.

Section 3: **Experiences and lessons learnt from biodiversity conservation information systems**

"We can in effect choose to create an inter-operable global diversity information 'Commons' that will bring together people, information, and analytical capabilities that can accelerate the process of knowledge discovery, deliver answers to natural resource management and research questions, and affect the quality of life on earth for the good"[30]

In January 1996, the Subgroup for Biodiversity Informatics of the Working Group on Biological Informatics of the OECD Mega-science Forum, made up of an international group of scientists and civil servants, concluded that existing biodiversity information is neither readily accessible nor fully useful[31]. Their conclusions were echoed by the US President's Committee of Advisors on Science and Technology[32], and by many people interviewed for this report.

The idea of sharing biodiversity information between groups of organisations is not new. Many initiatives exist from single organisations such as the New York Botanical Garden's Virtual Herbarium, which provides on-line data to improve access to its collections by the worldwide scientific community, to loose-knit groups such as the World Database on Protected Areas Consortium, which aims to increase the effectiveness of the protected area database held by the UNEP-World Conservation Monitoring Centre. One research project carried out in 2002 found 66 programmes, projects and institutions attempting to harmonise, integrate or rationalise nature conservation information[33]. More generally, many organisations now automatically publish their reports simultaneously on paper and / or in electronic form on the web. The culture of sharing is thus well established but as yet un-formalised in any global sense.

To date, biodiversity information sharing has perhaps been strongest amongst the world's herbaria and natural history museums, and there are several attempts to link this information into one initiative. The Subgroup on Biodiversity Informatics referred to above, for example, recommend that OECD country governments establish and support a system of interlinked and interoperable modules (databases, search engines, software and networking tools, analytical algorithms, etc.) that together formed the Global Biodiversity Information Facility (GBIF)[34]. The GBIF is concerned primarily with biodiversity data, which it defines as scientific information, primarily about biological species and specimens (see appendix 3)[35].

A survey of 18 biological collections and institutions, commissioned by the GBIF, found that international collaboration is enhanced by on-line data dissemination. Furthermore, data sharing disseminates information to a wider public and promotes a wider range of uses of scientific data. None of the institutions have "formal contracts" for collaboration. Important issues in relation to intellectual property rights were identified as proper attribution or credit to partners, custodianship and ownership of data and acknowledgement. The main constraint has been financial, followed closely by technological problems and human resources constraints[36].

In 2003 WWF and the World Bank published "*Running Pure*" a report on the role of protected areas in maintaining urban drinking water supplies. Around a thousand paper copies were produced but over 50,000 have since been down-loaded off WWF's website

The sharing of information also takes place amongst communities. The Inuit of Nunavik, Canada have over the last twenty–five years developed a 'closed' database on Inuit ecological and environmental knowledge, along with a long–term programme to apply it to resource management, planning, environmental impact assessment and economic development[37].

In general biodiversity information and data sharing has been less successful between large non-governmental organisations (NGOs). Large NGOs have often been in competition for donor funding and this has created some tension. Recently these barriers have been breaking down and there has been increased information sharing (and perhaps recognition that large funding is not the only key to good conservation). Smaller NGOs and voluntary groups have long sought to increase information flow and special organisations have developed to help facilitate this such as the Taiga Rescue Network, working on conservation across boreal communities and the Biodiversity Action Network.

The Biodiversity Conservation Information System[2]
In 1995, a consortium of 12 international conservation NGOs (see appendix 3) developed a framework known as the Biodiversity Conservation Information System (BCIS), which aimed to:

- Establish a global alliance and framework for managing data and information on the status, management and utilisation of biodiversity
- Make available data and information of documented quality to aid decision-making at all levels
- Facilitate data access and provide easy-to-use products and services
- Support data management by custodians at various levels
- Enhance consortium members' capacity to maintain an integrated information framework, with supporting systems and services

Members developed a common meta-database (i.e. data about data, with details of its location, source, content and quality) to facilitate access to member information and a series of handbooks – *BCIS Framework for Information* Sharing – distributed in three languages in print, on CD and on the website. Subgroups worked on three pilot collaborative projects, which all revealed serious deficiencies in the ability of members to manage their own data let alone share and combine resources. Most effort subsequently has gone into rectifying internal data management and specific collaborations; for instance in developing a large integrated database to support the IUCN-Species Survival Commission Red List programme through the Species Information Service, which aims to be fully integrated with the 120 Specialist Groups of the SSC[38]. Members of BCIS also participated in a review of the global database on protected areas recommending modifications of system and process to bring this critical resource to a good standard of quality and accessibility[39].

BCIS remains incomplete, and the fact that it did not reach its full potential has caused some consternation. In part BCIS was developed when technology was changing so quickly that its original assumptions became obsolete, in addition it has been suggested too much time was spent on process and not enough on practical application. The business model which expected 'members' to pay US$10,000 per year also proved inadequate[40]. Nonetheless, its goal '*to support environmentally sound decision making and action affecting the status of biodiversity and landscapes at the local, national, regional and global levels through the co-operative provision of data, information, advice and related services*' remains entirely valid and central to the current initiative.

Did BCIS fail to take off because it was too early? Or did it stumble as a result of disagreements or lack of trust between members and associates? How can we ensure that effective collaboration works in the future?

Acknowledging that the task of creating a commons for biodiversity information is larger than any small consortium of organisations can develop alone, the original BCIS members invited a wider participation to develop the notion of the 'Biodiversity Commons' and in June 2001, BCIS formally adopted the 'Biodiversity Knowledge Conservancy' as an initiative.

[2] The sub-section entitled BCIS has been edited from Colin Bibby's draft document for BCIS: *Creating the Biodiversity Knowledge Commons. Business plan and implementation strategy* (undated).

Towards the Biodiversity Knowledge Commons

In March and May 2002, fourteen organisation and three IUCN Commissions[3] under the leadership of BCIS took part in two participatory workshops to develop a proposal to secure a critical mass of institutions to make their knowledge, information and data freely available to meet the needs of stakeholders in biodiversity. The model developed for a 'Biodiversity Commons' was presented at a session organised by IUCN at the World Summit on Sustainable Development[41]. Around the same time, Thomas Moritz of the American Museum of Natural History and deputy chair of BCIS published an article on the Biodiversity Information Commons[42], which looked at the factors – technology, economics, culture and law – that limit access to biodiversity data (see section 8).

…the Biodiversity Knowledge Commons aims to facilitate a network of inter-operable databases distributed globally…

Some of the participants in the workshops, frustrated at the lack of progress, decided to start taking steps towards building the Commons. One initiative focused on information-sharing. In 2002, The Nature Conservancy (TNC) (through ConserveOnline) and Conservation International (CI) (through Centre for Applied Biodiversity Science Knowledge Management System) launched a search engine that takes a single query and sends it to different databases simultaneously, then compiles and ranks the results[43].Unlike BCIS, this step towards the Biodiversity Knowledge Commons aims not to develop a single centralised organising framework but a network of linked databases distributed globally[44]. There are now eight partners in this initiative (see appendix 3) and the agreements between them are informal. A second initiative is being developed by the American Museum of Natural History Library (through funding from the North American Commission for Environmental Cooperation and the North American Biodiversity Information Network). The library is developing a draft model for a North American Biodiversity Commons[45]. The World Database on Protected Areas (see above) is also seen as a central component of the Biodiversity Knowledge Commons[46]. Individual organisations have also continued to explore the ideas of building comprehensive information sources, which could be linked to the Commons, such as the Protected Areas Learning Network (PALNet) under development by IUCN.

Conservation NGOs have thus recognised the need for the type of information sharing pioneered by BCIS. A joint statement by eight NGOs[4] at the 7th Conference of Parties of the Convention on Biological Diversity in February 2004 included:

> **"Information dissemination:** Dissemination of best practices, case studies, methodologies, technical studies, and other information to support protected area managers and others. Elements of such a biodiversity knowledge commons would include, for example, interactive web sites such as the Protected Areas Learning Network (PALNet) and Conserve On-Line, and distance learning programs such as Lideres Sociales, etc".

The current initiative is a reflection of that philosophy.

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[3] Biodiversity Conservation Information System; BirdLife International; Conservation International; Global Biodiversity Information Facility; Inter American Biodiversity Information Network; IUCN Environmental Law Commission; IUCN Species Survival Commission; IUCN The World Conservation Union; IUCN World Commission on Protected Areas; NatureServe; North American Biodiversity Information Network; Rio Tinto; Society for Conservation Biology; The Nature Conservancy; TRAFFIC International; UNEP- World Conservation Monitoring Centre; Wildlife Conservation Society

[4] BirdLife International, Conservation International, Flora and Fauna International, Greenpeace, The Nature Conservancy, The Wildlife Conservation Society, WWF International and the World Resources Institute

Section 4: **The needs, wants and aspirations of potential partners and users of biodiversity information**

"*Scientists, land managers, practitioners, research institutions, conservation organisations, and indigenous peoples have accumulated a wealth of data and information concerning the world's biological diversity. The key to lasting conservation success lies in leveraging this knowledge and building a community of conservation practitioners. We need to transform conservation practice so that learning from experience and especially from failure becomes an expectation and a duty.*" [47]

What is the fundamental concern with information security and how can we ensure this? Are we concerned that open information sharing may allow someone else to innovate faster with it?

There is widespread agreement that the biodiversity community needs to share data more openly and more effectively. But what does this mean in practice? Below we summarise some opinions from both potential partners and users of a biodiversity information commons.

Partners are those groups, institutions or individuals who are "contributing members" of the commons by virtue of providing information. They could include for instance governments, non-governmental organisations, companies, research bodies, indigenous peoples, religious groups, communities or individuals. Most partners will also be users of the commons, but as data/information providers two main areas of need have been repeatedly expressed:

- **Security** – i.e. confidence that information given will not be misused in ways that disadvantage or offend the providers, or used in unlicensed commercial use; that they are not obliged to provide *all* information but only that which they feel comfortable about; that information is properly attributed/credited; that the original integrity of the data/information will be preserved; and that information is used to advance biodiversity conservation and not undermine it.

- **Good return on investment** – i.e. access to good information from the database; the possibility of payment for information if it is used for commercial purposes; and help with capacity building in terms of the ability to collect and store information better in the future.

A review of North American Biodiversity Information Network (NABIN), the Inter-American Biodiversity Information Network (IABIN), the Clearing House Mechanism (CHM) and Global Biodiversity Information Facility (GBIF) draws four shared principles that these users require:

- Open access to scientifically credible biodiversity information
- Interoperable data systems linking geographically dispersed resources
- Data ownership remaining with data providers
- Respect for full intellectual property rights in the data[48].

These concerns are summarised in the Figure 2 below (*n.b.* scientific uses might fit into non-profit or commercial depending on circumstances)

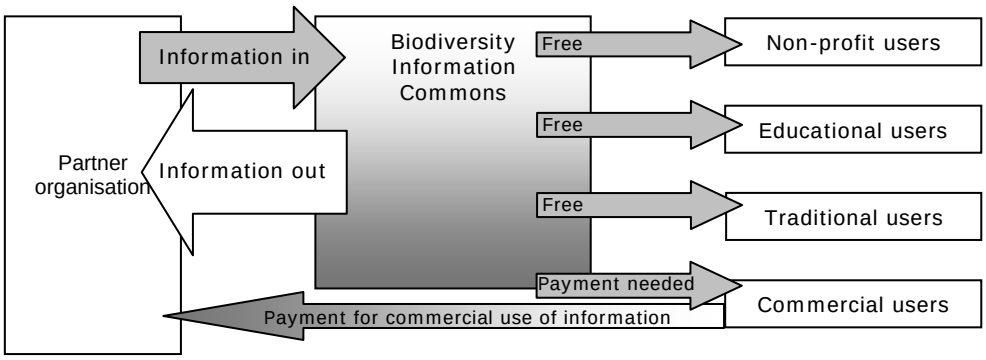


Figure 2: Needs of partner organisations

Should users have to "join" the commons through some form of agreement? Is there a need for a gate-keeping mechanism or will peer pressure be enough?

Users are also diverse – in theory every citizen of the planet. There is still different opinions about whether access to the biodiversity knowledge commons should be open to anyone who can get access to an online terminal or whether people should sign on to a statement of principles and agreement (like signing up to Microsoft software – although hopefully simpler). In either case, we can expect millions of users, who want information for many different purposes. Table 2 below summarises major information needs, looking at concepts, main aims, some specific uses and some of the "tools" – i.e. the particular types of information that could help address the needs. Tools often fit more than one need and the line between the last two columns is dashed to reflect this.

Table 2: **Information needs from a biodiversity commons**

Concepts	Aims	Details	Tools
Understanding	Better knowledge about the global ecosystem	Biodiversity surveys	Species lists
		Ecosystem functioning	Specimens
		Long-term change	Ecosystem monitoring
Planning	Interventions that impact on ecosystems	Resource management	Toolkits
		Infrastructure development	Software
		Conservation management	Principles
Implementing	Highest standards of ecosystem management	State policy and management	Treaties Conventions
		Industry operations	Best practice
		NGO advocacy / management	Exposés
		Community management	Project reports
Measuring	Tracking conservation success or failure	Conservation targets	Monitoring
		Impacts on ecosystems	Surveys
		Adherence to standards	Certification
Communicating	Building support for good ecosystem management	Capacity building/training	Manuals
		Advocacy and watchdog	Case studies
		Building a constituency	Teaching kits
Living	Ensuring sustainable lifestyles	Living sustainably	Oral records
		First nation places	Maps
		Indigenous knowledge	Databases
Giving	Identification of financial needs for conservation	Income / expense / outcome	Financial system
		Needs analysis	Gap analysis
		Failed projects	Lessons learned

Within this portfolio of needs and aspirations, divisions can be seen between different user groups. Below we discuss a few in more detail

International targets and goals

Targets have been set for a range of conservation and development goals by international conventions, NGOs and governments. Just one sub-set of these targets: the outcome-orientated targets of the Convention on Biological Diversity, the Commission on Sustainable Development and the Millennium Development Goals provide an indication of the increasing need for biodiversity information to support effective decision making.

- **Commission on Sustainable Development (CSD):** The 1992 United Nations Conference on Environment and Development delivered the Framework Convention on Climate Change and the Convention on Biological Diversity and adopted the Rio Principles and *Agenda 21*. The CSD was created to ensure effective follow-up and to monitor implementation. The *Plan of Implementation of the World Summit on Sustainable Development* was adopted at the World Summit on Sustainable Development in Johannesburg in 2002[49]. In particular, participants agreed to halt and reverse the loss of biodiversity by 2010.

- **Convention on Biological Diversity (CBD):** The CBD establishes three goals: the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits from the use of genetic resources. The 6th Conference of the Parties (COP) of the CBD adopted the *Global Strategy for Plant Conservation*, which includes 16 outcome-oriented global targets for 2010. At COP-7 a *Programme of Work for Protected Areas*, containing a range of target drive goals was also agreed[50].

The Convention on Biological Diversity continues to call for good information and this is stressed continually in the Programme of Work on Protected Areas, agreed after the Seventh Conference of Parties meeting at Kuala Lumpur in February 2004

- **Millennium Development Goals:** In September 2000, 189 heads of state and governments came together at the United Nations Millennium Summit. The main outcome was the adoption of the *Millennium Development Goals*, which commit governments to fight poverty and hunger, gender inequality and environmental degradation and to improve access to education, health care and clean water, by 2015. The Goals include 8 goals, 18 targets and over 40 indicators[51].

These and other targets mean that governments must collect and disseminate information for reporting. The Millennium Development Goals alone will require a huge amount of data. Some agreements specifically mention the collection and exchange of information i.e. Rio Principle 10[52]. For example the CBD includes the following Article: *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 …It shall also, where feasible, include the repatriation of information"[53].* In its broadest sense this could refer to all published literature whether in print or on the web from all organisations in CBD signatory countries.

Commercial users of biodiversity information

Commercial users need accurate information to help make informed and responsible decisions about their work, particularly in areas or activities where they are likely to be exposed to sensitive issues relating to biodiversity. Currently some of the largest resource companies have "licence agreements" with a variety of large NGOs and biodiversity information providers to supply information relating to their operations. In an ideal world, most commercial users would like to have a single point of entry for information, although not necessarily a single source. They are interested in obtaining high quality, consensus information (i.e. a single agreed opinion rather than trying to make sense of many different opinions about a particular topic). Initially they want very simple and clear information – for example an early warning system of potential problems – and only in cases where this is necessary are they interested in obtaining more complete or complex data. Commercial users also need a clear understanding of the conditions of use of data.

Many commercial users are currently unsatisfied with the data that they receive from the conservation community, finding it contains too many

Many commercial users express dissatisfaction in the quality of data they can obtain on biodiversity. How can conservation groups work with companies to increase useful knowledge? Do joint ventures, like the research project carried out by Shell and the Smithsonian in Gabon, offer a viable way forward? Will research sponsored by companies with a commercial interest convince sceptics?

errors and omissions. One way to address this is for commercial users of information to become more active themselves as data providers.
For example, the pilot ECOiSHARE projects aims to facilitate wider access to the biodiversity-related data and information collected by multinational companies in the course of their activities. The project is a collaborative exercise between UNEP-WCMC and BP, Rio Tinto and Shell. It has three objectives: 1) to ensure potential users can identify what data exists and who holds them, 2) to make the relevant data and reports available; and 3) to extract key data for incorporation into other datasets and information services, or for forwarding to other organisations[54].

Non-governmental organisations
NGOs increasingly have the same needs as governments including data for planning (conservation importance, status, threats, spatial data and socio-economic data), information for implementation (methodologies) and monitoring. Many NGOs are starting to amalgamate information sources so that they are working from the same information as their partner (for instance, recent attempts to agree on approaches to prioritisation in conservation). The Conservation Measures Partnership, a loose-knit coalition of several large NGOs, is also agreeing a joint set of broad indicators with which to measure progress in conservation. Such moves are increasingly being backed by demands from donors to see concrete results for their investments, all of which add to data requirements[55]. NGOs have a range of particular requirements for monitoring data, all of which may require particular types of data[56]:

- Reporting / communicating: clear information that can be conveyed to governments, the public etc to provide an easily digestible message
- Auditing: to help management processes and strategic decisions
- Lessons learned: detailed analysis to help adaptive management

Academics
Academics and research institutions have serious issues of access to journals, particularly in the poorer countries where subscriptions are often prohibitive. In addition, most academics rely on data, including those that they collect personally but also material built up by others. Currently access to other researchers' data often prove problematic, either because it in difficult to find or because professional secrecy means that people keep information to themselves until they publish (which in some cases means the data are never released if papers get abandoned or rejected).

Indigenous People
Indigenous peoples are increasingly using information technology to help maintain their traditional lifestyles, for example by accessing data to the prices of resources they produce or collect and trading directly, rather than relying on middlemen who siphon off the majority of the profits. Indigenous peoples are also aware that their own knowledge often has commercial value and that this is one of the few assets they have available; ownership and protection of this knowledge is therefore of critical importance and must be rigorously addressed in discussions relating to the commons

Donors
Donors, along with their trustees or governments, increasingly wish to see verifiable results from the resources that they provide: either conservation success or, if a project completely or partially fails, useful lessons that can help avoid similar problems in the future. Funding agencies also want better access to information so that when they are considering funding a project they will not simply be repeating work that has been tried before. They also demand that lessons learned are disseminated as widely as possible. As demands on available funds continue to increase, applicants that can demonstrate the best research and best information will be at an increasing advantage.

Some user perspectives

How can we know what users want? Are decisions about information systems being made by those who have carried out most of their professional work before the web was even available?

The following section represents a synthesis of what we have read or discussed. More directly, we asked a few users around the world what they currently found was missing in terms of information on the web. Here are some of the responses:

"…not more information (especially on the web); there is already much, much more information than anyone could ever hope to digest on almost any topic if you look hard enough. What are needed are "resource centres" and other information networks that transcend institutional politics and provide information about topics for many different audiences (legislators, academics, practitioners, advocates, politicians, the press)…" Charles Besancon, transboundary protected areas initiative South Africa

"Information needs here: raw data on biodiversity, as well as academic papers on conservation practices and successful models around the world on Community Based Natural Resource Management. Data on protected areas in Vietnam, though this is getting better. Access through internet is more difficult for people in the field and government partners due to no internet access or low capacity in connection. Many other papers you have to pay to get…": Nguyen Thi Dao, WWF Indochina

"From Serengeti National Park it is difficult to get up-to-date academic papers … when I was in school at Washington State University I was able to access tons of publications using University Web library. Even research papers from Serengeti are easily found, but here it is difficult to get them. Also GIS satellite images to monitor trends of Serengeti in various seasons. We know this information is somewhere and it is so useful in our fire management, vegetation monitoring etc": Ephraim Mwangomo, Tanzania National Parks Authority

"Unequal information and communication technology infrastructure is an impediment to maintaining distributed scientific communities of excellence, especially when that expertise includes researchers in the north and south, as well as in urban centres and rural outposts… Necessary investments include the purchase of and effective training in essential information technology, including hardware, software and communication equipment upgrades… Additional challenges stem from sharing information among people with different backgrounds (farmers, scientists, policy makers), different languages…": Dagmar Timmer, ICRAF Alternatives to Slash and Burn programme, Nairobi

"I find Google a huge help when I'm stuck, even when I know that the relevant information can be found in the other datasets because searches in Google using the right "key words" leads to the same datasets, and in the process one gains the advantage of coming across other relevant and useful sites, sometimes unintentionally…Very often, I've used this technique to triangulate information from different sources, to weigh off and reconcile one against the other and achieve a certain degree of consistency… I don't think it is possible, or even realistic/desirable, for any single database or organisation to have a monopoly over all data …But, of course, something like the FAO Forest Resources Assessment is immensely important as a "credible" data source, but even sources like these cannot produce customised information, or be everything to everyone all the time. I guess linkages or "talking" between big existing databases would be a big help": Sandeep Segupta, IUCN Forest Programme, Switzerland

"…for someone looking for quick facts, I really like to see things in one place that people can all agree…As for raw data, this could be difficult for me to digest if it is too scientific and technical. I have to work at the very simplistic level… so unless there is interpretation and analysis at the same time as the raw data, I will not find these helpful. I think the main problem is that there is a lot of data - too much maybe, with everyone collecting data and having their own system…": Soh Koon Chung, WWF International (Communications), Switzerland

"Information that I would find useful and find it hard to find on the Internet is information about species, habitat requirements, and management options to assist in the protection of these species… It would be good to have a one stop shop for this type of information, however this may be better done at a national level rather than internationally…we really struggle getting access to scientific journals and papers to keep up to date on what is going on with regards to biodiversity studies and methodologies…": Benita Dillon, Department of Environment and Heritage, Canberra Australia

From this quick survey, some clear patterns emerge and these are at least partly geographical. In some cases there are still real gaps in knowledge (in Indochina, for instance, information about biodiversity is poor and even basic biodiversity surveys are lacking for most of the country). In other cases, such as Serengeti, much useful information exists but is more likely to be available to researchers in the rich countries than to the TANAPA staff trying to manage this World Heritage site. A third group of people feel that enough information is available for their wants already, but is difficult to track down and they are looking for better organisation and guidance. Conversely, others expect to check facts against others even from large and respected sources such as FAO. Technology and language problems still dog those trying to coordinate between different groups in developing countries, although the situation is changing fast.

Evidence-based conservation

An overarching theme in this debate is that conservation practices are by necessity becoming more professional and thus need better data. Some high profile attacks on conservationists' claims[57] have hastened a process that was already underway. As companies have responded to pressure from environmental groups, they have asked for information that the latter have not always been able to supply. The result has been a minor crisis in confidence and rapid action to fill these gaps.

Analogies between the healthcare and conservation sectors highlight the way information can be used to ensure best practice[58]. Evidence-based medicine is defined as "the conscientious, explicit and judicious use of current best evidence is making decisions about the care of individual patients"[59] and arose from concerns over the discrepancy between practice and evidence in clinical decision making. Rather than basing decisions on information gained at medical school or in standard text books, evidence-based medicine trains doctors to access, review and interpret primary studies and thus continually update their methods.

Although conservation is a relatively new discipline there are already plenty of examples of practice failing to be led by the available evidence. A University of East Anglia study in the UK showed, for instance, that a UK Government conservation scheme which paid farmers to flood fields in winter to enhance population of breeding waders (a standard conservation practice) kills the earthworms that the waders feed on, information which was already known[60].

The main techniques of evidence-based practices, described in the medical literature, could be equally applied to conservation:

- Convert information into answerable questions
- Efficiently track down best evidence with which to answer the question
- Critically appraise evidence both for its validity and usefulness
- Apply the results of this appraisal
- Evaluate performance[61].

These five steps are predicated on there being the sources of 'best evidence' to track down, and could perhaps be complemented by a sixth step of sharing the results with other practitioners.

Section 5: **Types of information**

There are different needs for data. Some people specifically want access to multiple sources or to raw data for research. (Younger users are often more web-savvy and expect to check and compare multiple sites as a matter of course). Others want advice: i.e. they do not want conflicting opinions or raw data but for someone else to have done the analysis and agreed a credible conclusion. But who makes the decisions? How credible are they? There is a tension between supplying high quality accessible information – which implies a measure of judgement – and the limitations inherent in restricting access to raw data. The users of peer-reviewed and raw data are likely to be different. Table 3 shows some options.

Table 3: **A range of filters on information**

Type of filter	Details	Advantages	Disadvantages
No filter	Anyone can load anything onto the system – like *Google*	A lot of variety and detail	No quality control or standards
		No censorship or ownership	May be overload of information
Controlled access by individual / organisation	Only permitted material included – like *Forests.org*	Possibility of applying standards	Possibility of censorship
		Choice made of good material	Loss of useful information
Controlled by "elected judges" of peers	Judgements made to generally agreed standards – like *SSC Red List*	"One-stop shop" for users	Time-consuming and expensive
		High degree of credibility	Loss of access to much raw data
Discussion groups and dynamic ("blogs" etc)	Anyone can log on and join in discussions	Quick collection of information/opinions	Lots of redundant material
		Useful to avoid censorship / control	No guarantee of accuracy

Managing raw data is relatively easy from a conceptual perspective – they just need to be loaded correctly onto the web. Analysis and judgements are more problematic. Ideally, a group of experts make a collective judgement, which carries enough weight to convince others. The Red List is often cited as an example: a classification of threat to wild species drawn up by voluntary specialist experts using available data. Raw data are needed to make judgements and for those who wish to assess themselves, but most users feel confident to go straight to the Red Data list. The relationship is shown in Figure 3 below.

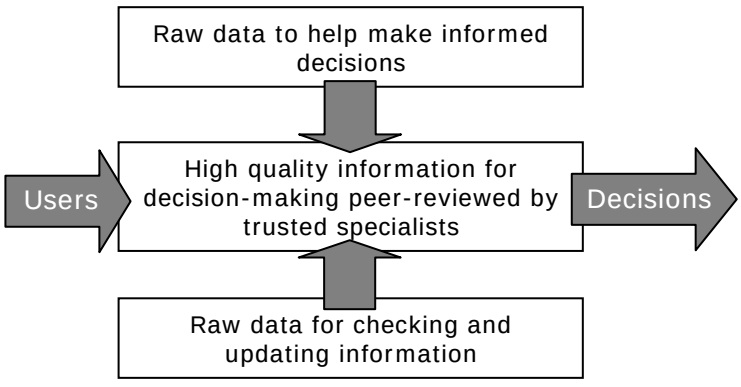


Figure 3: the relationship between raw data and analysed results

Respected data sources change over time. When the World Resources Institute set up Global Forest Watch, it created a new source a spatial data about forest cover that has rapidly become the first location of choice for many organisations

A free market in credibility

Such an approach also implies that scientific credibility must be earned. Data collectors and analysts who fail to convince users of their value will see their role replaced by other sources – such changes have already occurred in the conservation field in the last few years.

Section 6: **Gaps in availability of biodiversity information and datasets**

"*Organisations have been wary of collaborating on the scale of knowledge management because of strongly felt but weakly articulated concerns that reputation and income are at risk. Business concerns are legitimate, but there are even more fundamental obstacles to open sharing of knowledge within the conservation world. The community is not well focused on the needs of users of information, preferring a model where experts supply the information they believe is valuable rather than that which users might want.* "[62]

So far we have talked almost exclusively about material that can be accessed in electronic form from the web. But we already inferred (in Figure 1) that this only represents a tiny proportion of the material available. Table 4 outlines a brief typology of information sources.

Table 4: **Typology of information sources**

Type of information	**Issues**
Personal experience and expertise	Information held in peoples' minds. Hard to extract, liable to become less accurate over time and obviously eventually lost (e.g. experience with field projects)
Community / indigenous / traditional experience	Similar to the above but data held by more than one person. Liable to be lost as cultures change and adapt (e.g. information about medicinal and herb plants)
Field notes	Originally always hand-written or possibly typed up later, now increasingly stored electronically from use of hand-held computers, GPS technology and digital images
Unwritten research	Information in people's minds, but in a more coherent form than random knowledge; with or without notes.
Written up but not published	Dissertations, theses, essays and half-finished papers. Currently almost unobtainable except for those universities that have put their archives online
Project reports	Good reports are a huge repository of knowledge and experience; currently many projects repeat mistakes because past experience is not known or utilised
Journals	A small proportion on the web, although most high profile and auspicious journals are online: access is by payment (although free to staff at universities, organisations etc). 1.2 million peer-reviewed articles published annually[63].
Open access journals	The growing number of papers published in electronic journals or with a commitment to publish freely online. Very accessible
'Grey literature'	A wide-ranging term covering reports from organisations, working papers from research bodies, government and intergovernmental documents and activist literature
Books	Generally of higher standing than grey literature (often without justification), starting to become available online but generally only through libraries and purchase
Periodicals	Newspapers, magazines, journals, electronic journals etc – critical sources of information but notoriously unreliable
Ex-situ collections	Collections held in zoos, herbaria, gene banks and by private individuals. Irreplaceable material some but not all of which can be captured electronically
Data	Observations or measurements recorded and reported in a standard way
Images	Photographs provide records of vegetation change and contemporary records of species, some of which are only known through camera traps. Most still un-digitised.
Maps	Huge source of information though available in a very wide variety of forms: hand drawn, printed and digitised. Techniques of map production are developing fast
Source loaded on to web site	May or may not be easily accessible, much good material remains essentially private (e.g. on intranet systems)
Source loaded on web site which is part of a known network	The most easily accessible information

The interviews, included those quoted above, show some of the data gaps. Most material still remains off-line although the situation is changing. For instance many academics now claim to work almost exclusively online for their research, but by doing so they are confining themselves to a small part of the literature. It is estimated that the total number of periodicals published worldwide in all disciplines is approximately 164,000 and the percentage of these being available on-line is increasing (from 3.3 per cent in 1996 to 16.5 per cent of the total in 2001)[64].

In addition, most information about biodiversity remains unrecorded and unknown, even down to the description of the majority of the world's species (admittedly mainly the smaller ones). Also missing are huge areas of understanding of ecosystem functioning, conservation methodologies and even comparatively simple data like the precise boundaries of national parks and protected areas. Information on the marine environment is particularly lacking[65]. A study carried out by the UK Department for Environment, Food and Rural Affairs (DEFRA) highlighted the main gaps in biodiversity information, which although from a UK perspective could be applied far more widely, as:

- Information on sustainable use and markets for biodiversity
- Information on national implementing legislation, strategies and measures in other countries
- Case studies, good practices and 'lessons-learned' in countries with comparable situations
- Early warning of emerging issues and policy developments[66].

The biodiversity information commons will remain only very partially fulfilled if it confines itself to moving around existing electronic data more effectively. The World Bank's *World Development Report 2003* identifies information flow or transfer as one of the main responsibilities of any country charting a pathway to a sustainable future[67]. A truly democratic and global commons also needs to capture a wealth of experience and information from those out of reach of a keyboard. Key elements in filling in the gaps in the commons, listed in order of increasing difficulty and time, are:

- Converting existing useful published material into electronic form and loading this onto the web

- Capacity building to increase the effectiveness of data collection and research to help build the commons

- Collecting oral experience and similar information in forms that can be transmitted easily (ensuring proper attribution and ownership to those involved)

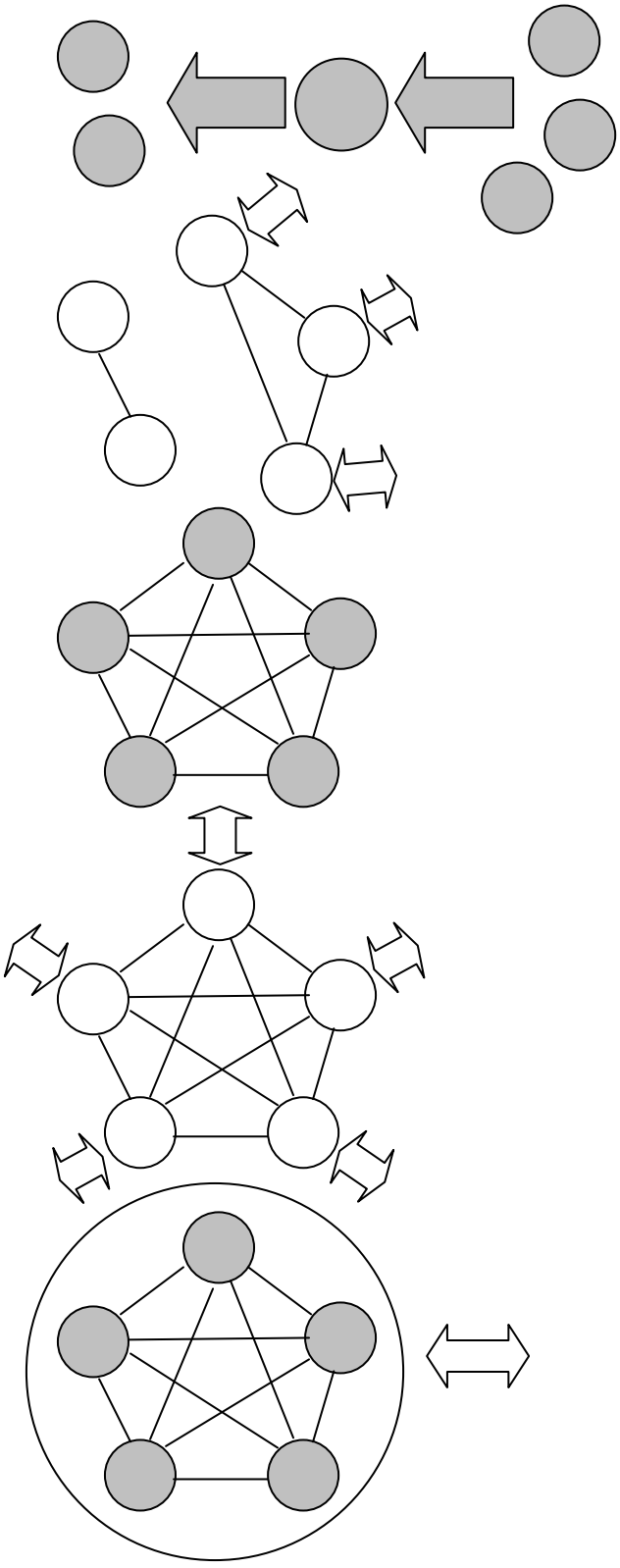
- Collecting raw data and carrying out analysis to fill in remaining gaps

There is not a strict distinction between the four areas listed above. Nor can the project of populating the biodiversity commons ever be complete. But it is clear that a great deal more needs to be done if there is to be sufficient information for informed decision-making and measurement of conservation management in line with national and international commitments.

Section 7: **Future scenarios for biodiversity information sharing**

In the world of biodiversity information, different models have been used to sort and share data. Figure 4 below summarises some options and then these are described in the following pages.

Much of the discussion about the biodiversity commons up till now has centred on organisation. Is this the best way forward? Or has it simply encouraged groups to vie for "control" of data management rather than look at options for sharing and improving this access?



Single data organiser and provider – other data providers feed into this and users draw from the source: e.g. World Database on Protected Areas

Partial networking and sharing information: e.g. the current status of the Biodiversity Knowledge Commons and other similar exercises

Integrated networking between partners leading to agreed data sets and methodologies: e.g. Conservation Measures Partnership (without linking online datasets)

Integrated networking with multiple points of entry: e.g. current proposals for biodiversity commons

Integrated networking between partners with single point of entry: e.g. Red Lists (without linking online datasets – these are planned in the Species Information Service)

Figure 4: Approaches to organising data

There are clearly many options open to those wishing to develop a biodiversity commons. The traditional approach is that one organisation collects information from many different sources and disseminates this to others, either for free or for profit. The UNEP-World Conservation Monitoring Centre and NatureServe are two examples of this model from the NGO sector, while the FAO/UNECE Forest Resource Assessment, where governments combine data on forest cover and condition, shows the possibility of collaboration between governments (which also agree collectively on the questions to be answered).

Organisations have also been linking their databases, initially in a fairly ad hoc way but in some instances more systematically. The attempt by large NGOs to agree on measures of success is an example. Once databases are linked in the way that the Biodiversity Knowledge Commons shows is feasible, two options remain for access:

- Accessing joint databases through any portal
- Accessing joint databases through a single portal, with the option of such information being more systematically assessed and presented

At the moment, the Red List of species' status is an example of collective data available in analysed form from a single source. This represents an ideal for many users (although note that some will continue to check from primary material). However, such systems are costly, time consuming and complicated to set up and it will be many years before such sophisticated systems are available for all areas of the commons. A mixture of the two approaches seems likely to continue. Another layer of organisation is also discussed; the linking of all collective databases, such as the Red List, World Database on Protected Areas, PALNet and others into some "super system" with a single port of entry, as illustrated in Figure 4.

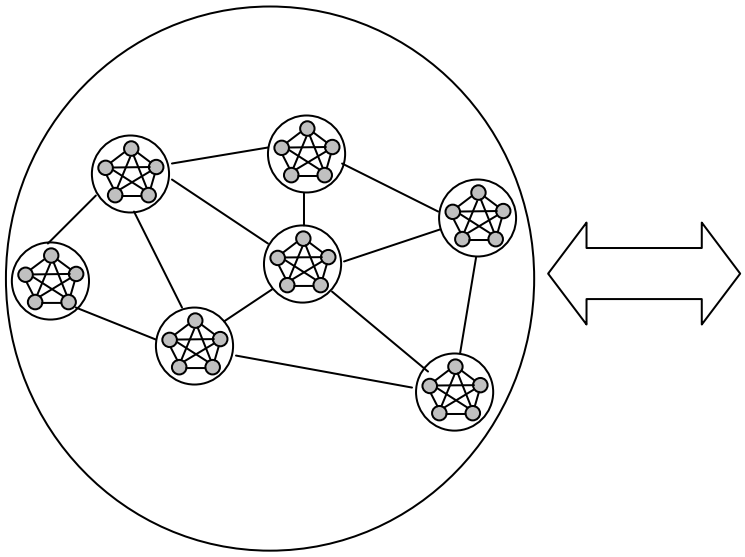


Figure 4: Possible model of a super-system of one portal for all biodiversity information

Such a model is theoretically certainly possible. Whether it is the most urgent task facing those interested in building the concept of the commons is questionable. The key philosophical cornerstone that underpins all these models is the ability for everyone to join in as both providers and users of information. The next section considers some of the key challenges facing those interested in building the commons.

Section 8: **Challenges to building the commons**

"*Essential access to biodiversity data, information and knowledge is often limited by technology, economics, culture and law or by the complex interplay of these elements. A successful strategy to eliminate these barriers to access must address all four elements*"[68].

As mentioned in Section 3, in 2000 Thomas Moritz published an article on the factors that constrain building the Biodiversity Information Commons (see Figure 5). In the light of the review above, we discuss these four elements in more detail below before making recommendations (Section 9) on how biodiversity information might be provided in ways which meet multiple users and providers needs.

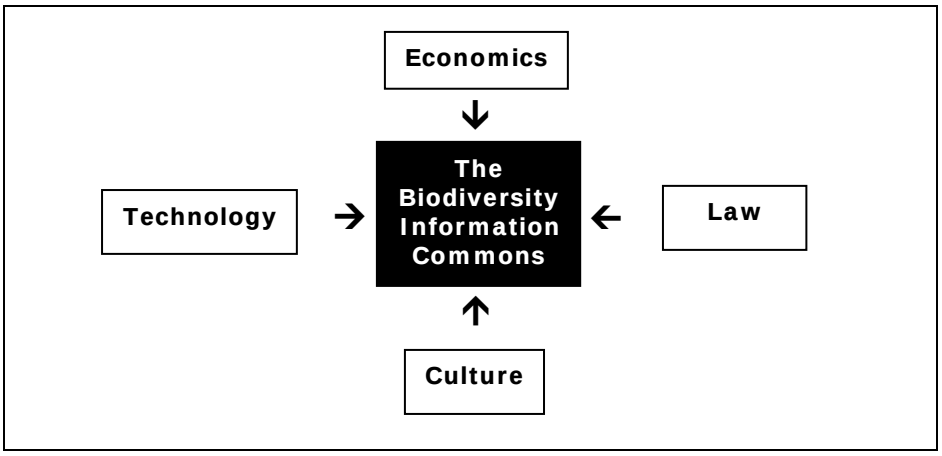


Figure 5: Constraints to open access information (Adapted from Lessing[69] and Moritz[70])

Economics

Of the various constraints to information sharing in developing countries that have been identified, ranging from the poor state of telecom facilities (although this is increasingly being overcome by satellite technology) to inadequate computer equipment, skills and support, the dominator tends to be costs[71]. And these costs go far beyond just having working technology.

Today's policy environment, which favours the free-market approach, can mean that owners of information are encouraged to limit access to information (by, for instance, only charging for access or use). However, as discussed above the phenomena of open access, which has developed from the possibilities created by the internet, is changing the way people look at information sharing. The role of profit-driven publishers is under debate – and perhaps even under siege. They are seen as restricting dissemination of information by pricing it out of the hands of all but the few who can pay (although this need not necessarily be the case, for instance, six leading journal publishers announced in 2001 plans to provide developing countries with free or low-cost electronic access to medical and scientific journals[72]). The average price increase in published subscription journals between 1990 and 2000 was well in excess of inflation[73], whilst the market leader, Reed Elsevier, makes annual profits of around US$290 million[74].

Will the debate on open access extend from academic publishers to the organisations providing data to researchers and companies? Will more questions be asked about benefit sharing from the information suppliers to the information providers?

It seems that pressure is building to create a more widely available information commons in the field of biodiversity. However, providing accessible information does not come without costs, and valid, accurate and timely information does have a value – even if this is not expressed in monetary terms. Biodiversity data providers, such as NGOs and

researchers, could argue that lack of resources, both human and financial, can be blamed for deficiencies in biodiversity data. But the total investment in information gathering (from research and adaptive management projects, through to data management such as libraries and web sites), is very large. If the information generated is to have a value, then it must be shown to be of the highest quality (just as subscription journals sell their content because it is claimed to be of high quality following a rigorous scientific review process). This will only be achieved by increasing the capacity of information providers and the rigour with which information is collected and analysed.

Although providing quality information is clearly not without cost, a more co-ordinated approach to knowledge management could create cost savings and greater efficiency. Sharing of knowledge can avoid expensive duplication and sharing of systems can create economies of scale.

Legal issues

There are also legal implications of information use. Firstly, there is a need to ensure that information in the commons respects national and international law and that the data collected is legitimate, by assuring consistency with applicable laws, regulations and any relevant requirements for prior informed consent. Secondly, once built, there will be a need to ensure that information in the commons is used appropriately.

Available information needs to respect intellectual property (IP) and should also respect indigenous knowledge systems (IKS). Even if, as discussed above, copyrights are waived, as may be necessary with open access information, the circumstances should be clearly articulated. The respect of IKS, which often represent hard-won ownership of information by social groups that have traditionally suffered from their knowledge being expropriated and used by others for profit or other forms of gain, is also important. It should be remembered that the concept of the public domain is not accepted by many indigenous peoples[75]. Although governments of developing countries are legally bound by international IP agreements and treaties, such as the Agreement on Trade-Related Aspects of Intellectual Property (TRIPS) which is mandatory for all World Trade Organization members, these agreements often do not fit into traditional systems of knowledge and knowledge use. Countries who wish to be part of the globally dominant trading systems, however, have no choice but to recognise these mandates over traditional knowledge, even though local IKS can be directly affected[76]. It should be a prerequisite of most information sharing approaches that any benefits gained from should be shared with those who have supplied the information.

Both the benefits and possible negative impacts on biodiversity (which will often relate to illegal use) should also be considered in the development of the commons. For instance, it is probably not advisable to provide full details on the location of endangered species[77] although it may be possible to say where such information is housed to help legitimate researchers and conservation organisations to track down these data. The sort of conditions that can be applied to licences for information use can be found on: creativecommons.org/license/, and are likely to identify types of use, i.e. whether information is being used for profit or not.

Conditions can also be applied to data acknowledgement and attribution and when and how these should maintained in subsequent use. These conditions can include a range of options from totally free and un-credited use of information to information that must be quoted in total and fully referenced, or information that is only available to certain people or groups. Various guidelines exist, for instance, acknowledgements can be referenced in accordance with agreed guidelines such as the ISO 690-2 for standard referencing for *Electronic documents or parts thereof*[78].

Sistema Nacional de Información sobre Biodiversidad (SNIB) is a law mandated initiative of the Mexican Government that requires the National Commission on Biodiversity, CONABIO, to create a permanently updated biodiversity information system to support research for its growth and to use it to provide advice to all sectors of Mexican society. Work includes supporting projects, promoting and creating standards, capacity building, data compilation, data sharing and data distribution.

The culture of information sharing

Cultural issues have several dimensions which need to be addressed before information can be shared with confidence.

One is clearly trust. Users have to trust the information that is being presented to them (in terms of reliability, authenticity and accuracy) whilst providers, if working together towards a common goal, have to trust other partners motives for taking part in the commons (i.e. they need to believe in and agree a shared mission and goal) and trust the veracity of the information being shared. There also needs to be a shared understanding of the benefits and responsibilities of being part of an information commons, for example whether the benefits are for the 'common good' or 'for profit'. Mistrust and the collapse of the commons comes when partners have different and conflicting views of the expected outputs and outcomes of an alliance.

There is also a need to foster collaboration and lesson learning. Conservation organisations are generally unused to collaborating, and tend not to reward staff members for communicating or even capturing learning from their efforts. In many organisations the reward structure is based on completing a task and moving on quickly to the next one, and not reflecting on or communicating what happened and why.

Perhaps even more difficult is the challenge of bringing together into one common approach individuals, groups and governments of widely differing cultural norms. One of the practical and political limitations of current conservation approaches is that many are based almost wholly around western traditions of science and tend to omit the large amount of information accumulated by other cultures or different approaches. Ensuring a wide range of partners and approaches into a 'biodiversity commons' that has itself sprung from the western scientific paradigm will itself take considerable care and negotiation. For instance, just as the technology which allows us to access the internet is supplied by the north, so at present is the information available on it. A 1995 survey revealed that the main index of scientific journals, the *Science Citation Index*, indexed 3,300 journals of the then available 70,000 published worldwide. At that time less than two per cent of the journals were from developing countries[79]. A simple shift in emphasis among the grant-making and donor community, giving greater weight for instance to journals from developing countries and other forms of publication, would make huge changes to the way in which science proceeds. Another possibility is that this inequity of information provision is linked to the issue of capacity building (over a whole range of issues from skills to finances) which impedes a large section of the world from contributing to the scientific literature.

Are scientific journals the right medium for sharing information for everyone – or are they uniquely northern constructs unlikely to ever be able to capture a truly global representation of science? Already, in practice, many of the decisions made about conservation by governments and NGOs draw more on the "grey literature" which is often derided by the conventional scientific community and this trend may continue.

Finally, there is the very culture of sharing itself. Sharing data and information is foreign to ecology, which traditionally views data as belonging to the researcher who collected it, allowing those researchers to repeatedly return to essentially the same data for publications, while the data itself remains hidden. Compare this, for example, to genetics, in which researchers are obligated as a condition of their grants to make their data publicly available upon publication. Indigenous and community organisations are also sometimes reluctant to share their information. This can be due to concern over private companies using information to develop commercial products from biological resources without returning benefits or potential misuse by criminal organisations that buy and sell endangered species[80]. More fundamentally, within indigenous knowledge systems, the misuse of information can lead to "severe physical or spiritual harm to the individual caretakers of the knowledge or their entire tribe from their failure to ensure that the Creator's gifts are properly used[81]."

Technological issues

If a biodiversity information commons is to be successfully built then agreed principles, missions, goals and objectives all need a suitable and sustainable technological foundation. This technology should be broadly available, without any unnecessary impediment to use[82]. The technological foundation should also be adaptable to both changes in technology and users' and providers' needs.

The success of any information commons will be judged by how useful users find it. Although clearly the provision of credible information is crucial, so too is the way that information is organised and can be accessed: even the best information is useless if it cannot be found or easily accessed. Technological aids to access include the interoperability (i.e. the ability of information systems to operate in conjunction with each other) of information sources between partners and the development of agreed descriptive and administrative metadata (i.e. 'data about data'[83]). Economics also play a part in this, as there is usually a direct relationship between the cost of metadata creation and the benefit to the user, as describing each item is more expensive than describing collections or groups of items, but clearly more useful[84]. The technical issues surrounding the creation of suitable metadata protocols have, however, already been explored. Biodiversity information initiatives such as the BCIS[85] have developed metadata standards, whilst more generally, the standards developed by the Open Archives Initiative (www.openarchives.org/) and Dublin Core metadata standards (www.dublincore.org) provide useful reference, as do several software packages available for building and maintaining OAI-compliant archives[86]. Metadata can also be helpful when dealing with the intellectual property rights or sensitive information (i.e. location of endangered species) issues noted above as it allows providers to let users know that they have the information without incurring the risk that it be stolen[87]. Search engines must be able to index the content of websites. Currently most search engines only index the 'surface' web, however the 'deep' web sources store their content in searchable databases that only produce results in response to a direct request. It was estimated in 2000, that the deep Web contains nearly 550 billion individual documents compared to the one billion of the surface Web [88].

Generally, the more information available on the content, the more useful it will be. Where possible, whole reports and data sets should be fully searchable and downloadable; even royalty-based publications which are clearly not able to offer free download can be fully searchable. For example, Amazon.com is collaborating with publishers to provide free full-text searching, but not free full-text reading, thus allowing customers to search the full text inside a book, not just matches to author or title keywords[89]. Similarly, applying standard subject vocabularies and classification schemes is more expensive, but far more useful, than assigning a few keywords[90]. Agreement of terms in relation to biodiversity is therefore a critical technical step in helping to access data from different sources. Much work already done on this by conventions and organisations such as the FAO and recently Foundations for Success has been developing a "Rosetta Stone" of terminology used by large conservation NGOs[91].

As important as the issue of accessibility and compatibility, is the question of longevity. At present there is no equivalent of a copyright library for electronic material[92], and the chances for 'losing' information, as described above in Section 1, are high. One way to overcome this is to catalogue information with a unique identifier in an agreed, well-documented and shared scheme[93]. For example, Crossref, a scholarly search engine detailed in Appendix 3, assigns unique Digital Object Identifier (DOI) to contents which should allow for articles to have a longer 'shelf life' and protect against URL changes.

Section 9: **Recommendations**

"…[the] realization of the vision for a global biodiversity Commons is dependent upon the continuing desire of the biodiversity community to bring it into being"[94]

The critical role of high quality, accurate and accessible biodiversity information in conservation and sustainable development is now almost universally recognised. Furthermore, the cultural shift towards making biodiversity information far more freely available in electronic form is underway and gaining momentum. Concepts of open access are rapidly appearing and are generally to be welcomed, although need to be managed carefully if they are not to disadvantage those with less finances and resources to devote to information gathering and research.

Both producers and users of biodiversity information vary in their needs, their wants and cultures, which has enormous influence on the way in which such information needs to be stored and shared. Some users want access to carefully sifted and analysed data in a form that allows quick decision-making, while others need raw data to compare and analyse. And there are still many people we need to reach to be build public awareness of the issues relating to biodiversity. Credibility in data provision does not accrue automatically but as a result of past record and through implicit or explicit consensus amongst stakeholders.

The level of sensitivity to these issues suggests a need for an agreed framework for information sharing. This should probably be in the form of a series of simple ***principles***, rigorously applied and policed so that the global community can, with luck, build growing trust in the way that information can be shared and used to common good purpose.

Principles for a biodiversity commons

The biodiversity commons is not supposed to be a free for all. But then commons never were. In the UK, the Department of Farming and Rural Affairs says about common land (the origin of our term used here): "*It is a popular misconception that common land is "owned" by everyone. This is not the case. The term "common land" derives from the fact that certain people hold rights of common over the land. There are different types of rights of common which give rise to different entitlements to the product of the soil of the common, e.g. to the pasture, to sand and gravel, to peat. Around 80% of common land is privately owned and, subject to the interests of any commoners, owners enjoy essentially the same rights as the owners of other land.*[95]" Principles for a biodiversity commons would provide clear guidance for what can and cannot be done with the resources of the commons. Discussion of the principles will take place at the workshop; we include some early pointers here[96]:

Principle 1: Timely, high quality biodiversity information has value: the extent to which users would pay for this depends on circumstances (e.g. in general commercial users might be expected to pay)

Principle 2: Providers of information have the rights to control and license this information and users have a responsibility to use it responsibly

Principle 3: Licensing of information sharing must contain enough options to satisfy all potential information providers and thus to remove barriers to information sharing.

Principle 4: A global commitment to capacity building and support is needed to ensure that the full range of knowledge is available within the biodiversity commons

Such principles transcend simple issues of use and ownership, and imply a large effort to redress current inequities in information availability both in terms of access and the ability to generate and collect such information. The ***responsibility*** of sharing also implies capacity building and help to create conditions in which such sharing can best take place.

Key elements in success relate to how information is ***exchanged***, where and if information is accorded monetary or other value, who pays and who benefits. The challenges and sensitivities in such issues should not be under-estimated, but at the same time the biodiversity community is lucky in having access to experience from other fields, where such issues have already been debated and agreed. History suggests that agreement will not be impossible if stakeholders approach this challenge in a spirit of willingness.

Throughout this report we have emphasised the culture of sharing rather than the technical mechanisms that might be involved. Whether or not there is one controlling “portal” for the so-called biodiversity commons is debatable. We suspect that it is already too late to contemplate the development of such a super-system and that some measure of sharing will be more realistic and cost effective. Whether or not such a system is useful, it is far from the most urgent task facing partners: instead issues of principles, capacity building and practical negotiation of benefits should take primacy.

Finally, experience with the internet over the past 10 years has taught us that a successful system also implies a measure of excitement and easy recognition. The “biodiversity knowledge commons” may provide access to the most accurate and cutting edge biodiversity and conservation science available, but the name itself will not set the world’s pulses roaring and may not be distinguishable from other online, sustainable development or conservation initiatives (see Appendix 3). We suggest that consideration be given to identifying a name for the commons that captures the imagination rather than the creation of yet another acronym.

Appendix 1: A history of the Commons

The Commons: tragedy or innovation

The "new Commons" is a relatively recently coined, and vaguely defined term used by some to describe a technology-driven, human-made common pool of resources[97]. This new usage of the term "Common" has spawned a wide range of terms, such as the Intellectual Commons, the Digital Technology Commons, the Information Exchange Commons and the Community Commons.

"…innovation in the ways humans interact, innovation in the ways that culture is spread, and most importantly, innovation in the ways in which culture gets built"

Garrett Hardin's 1968 *Science*[98] article, "The Tragedy of the Commons" is generally cited, and just as commonly criticised[99], as one of the first papers to develop a modern usage of the term commons. The "commons" referred to here are the common resources owned by everyone. The "tragedy" is the result of people being free to maximise their own profit by exploiting the commons. The article contains many examples of the tragedy of overpopulating the commons and our subsequent history of restricting commons through law and regulation.

Lawrence Lessig's 2002 essay for the *Duke Law Journal*[100] developed the term to describe common property from the perspective of information. Lessig hails the internet as "The Architecture of Innovation" and cites the commons it creates as: "*the location of some of the most extraordinary innovation that we have seen. Not innovation in just the dotcom sense, but innovation in the ways humans interact, innovation in the ways that culture is spread, and most importantly, innovation in the ways in which culture gets built*." In this context, information about biodiversity would form a subset of the overall information base and this has become known as the "biodiversity knowledge commons". However, Lessig remains more pessimistic about the way in which the commons might develop in a contracted world[101], where he quotes, for instance, the dramatic rise in US Federal cases related to intellectual property rights (IPR) – from only fourteen in the years 1900–1949 to 1,721 between 1990 and 1999.

The issue of IPR is tackled in a paper by Reichman and Uhlir in 2003[102], which suggests the need for a "contractually reconstructed research commons for scientific data" given today's highly protectionist intellectual property environment. They suggest this requires that "funding agencies and scientific organization must agree to a basic set of ground rules, with the goal of preserving the data commons for research purposes without impeding institutional actors or single researchers from enjoying the benefits of appropriate commercialization in the private sector".

Linking the terms 'biodiversity' and 'commons' in the published literature goes back at least to 2000 when a paper from the US Geological Survey set out the basic requirements for common information on biodiversity[103].

Appendix 2: Naming the Commons

What's in a name

In the Recommendations above we suggest that the 'Biodiversity Commons' initiative be given a 'catchy' memorable name. This however needs to be backed up by a more detailed descriptive sub-title which clearly explains the purpose of this Commons.

In the initiatives mentioned above (i.e. the Biodiversity Knowledge Commons and the Biodiversity Information Commons), the linking words 'knowledge' or 'information' are important. The concept of 'biodiversity commons' is related to contentious issues of the patenting of living organisms, and privatisation of living things and indigenous knowledge[104].

The organisations promoting the Biodiversity Knowledge Commons are not suggesting that controls on countries' ownership of genetic material are relaxed but that information likely to be beneficial to conservation management is shared more effectively.

It is thus worth, perhaps, looking in more detail at these important linking words, which we tend to use imprecisely but interchangeably.

Below are the definitions of these words according to the *Compact Oxford English Dictionary of Current English*[105]:

- **Data**: facts and statistics used for reference or analysis
- **Expertise**: great skill or knowledge in a particular field
- **Information**: facts or knowledge provided or learned
- **Knowledge**: **1** information and skills acquired through experience or education. **2** the sum of what is known. **3** awareness or familiarity gained by experience of a fact or situation
- **Technology**: **1** the application of scientific knowledge for practical purposes. **2** the branch of knowledge concerned with applied sciences.

Appendix 3: Examples of existing biodiversity websites

Appendix 3 contains reference to a random sample of 18 web sites / portals around the world that contain either useful sources of information on biodiversity or have, at least potentially, developed systems and mechanisms for access to data via the web that could be exemplary for any new information sharing initiative.

Although we did not start with the intention of comparing and contrasting sites, it soon became clear that many sites in at least some aspect of their publicly stated aims / mission were offering what sounds like an overview of biodiversity information (a summary of these is given below and more information on these sites can be found in the table following), and that many names are extremely similar, for example: Biodiversity Conservation Information System, Biodiversity Information Service, Biodiversity Information Sharing Service.

We would suggest that to date none of these sites offer anything like a global or regional portal for biodiversity information. Several are basically defunct and even more are looking for funding before becoming operational.

If there are any lessons to be learnt from this brief exercise it we would suggest that:

- Any title or description using the words 'biodiversity', 'information', 'system' or 'service' is likely to be confused with other initiatives.
- Within conservation activities there is often discussion of projects not being seen to make unrealistic promises. When it comes to disseminating data, however, there seems to be much less concern about whether sites can really offer what their titles would suggest (i.e. World Biodiversity Database, World Data Center for Biodiversity)

Sites offering an overview of biodiversity information

1. CBD's Clearing House Mechanism. Goal: **integrating information on biodiversity**
2. **Global Biodiversity Information Facility** (GBIF)
3. Expert Center for Taxonomic Identification **World Biodiversity Database** (WBD)
4. **Biodiversity Conservation Information System** (BCIS)
5. **Biodiversity Knowledge Commons**
6. UNEP-WCMC Proteus a **Biodiversity Information Service** (BIS)
7. National Biological Information Infrastructure (NBII) **World Data Center for Biodiversity and Terrestrial Ecology**
8. **Association for Biodiversity Information** (now NatureServe)
9. Species Information Service SIS: **biodiversity knowledge network and database**
10. EcoPort: The Consilience Engine™ **a "Knowledge Commons" to develop sustainable ways to manage the Earth's natural resources**
11. **Inter-American Biodiversity Information Network** (IABIN)
12. ASEAN Regional Centre for Biodiversity Conservation (ARCBC), **Biodiversity Information Sharing Service** (BISS)

html	Name and summary of aims	Main partners and information sharing policy	Access and quality control	Comments
www.biodiv.org/chm	CBD's Clearing House Mechanism **CHM** The CHM has three goals: 1) Cooperation - the promotion and facilitation of scientific and technical cooperation; 2) Information exchange - the development of a global mechanism for exchanging and integrating information on biodiversity; 3) network development - the development of the CHM Focal Points and their Partners[106].	A network of national Focal Points for the CHM address matters relating to technical and scientific co-operation. There is currently a move to strengthen the role of these Focal Points. 150 of the 188 Parties to the convention have Focal Points and 62 countries have CHM websites.	"The clearing-house is based on the philosophy that broad participation and easy access must be a top priority…Special efforts are made to ensure the participation of indigenous communities, whose unique knowledge and expertise are so important"[107]. CDM is coordinated by the Executive Secretary and overseen and guided by an Informal Advisory Committee (IAC) set up by the Parties to the Convention.	The CBD established the CHM "to ensure that all governments have access to the information and technologies they need for their work on biodiversity[108]". The information available is mainly concentrated on the CBD's official records. Specific initiatives have been added such as the Global Invasive Species Programme (GISP) and the Biosafety Clearing-House.
www.gbif.org	Global Biodiversity Information Facility **GBIF** GBIF came into existence in 2001, following a recommendation from the OECD Megascience Forum, its "..mission is to make the world's primary data on biodiversity freely and universally available via the Internet"[109].	GBIF's MoU is open for signature to any country, economy or recognised international organisation. Currently GBIF has 25 voting participants; 16 associate participants, 16 countries/ participants and 26 organisations (including IUCN). Participants agree to share biodiversity data and to set up one or more GBIF network node(s) to provide access to that data.	GBIF is foreseen as an open-access facility. The Facilities MOU disclaims "responsibility for the accuracy and reliability of the data as well as for the suitability of its application for any particular purpose.[110]"	The GBIF defines biodiversity data as: "scientific information, primarily about biological species and specimens"[111]. GBIF is thus mainly concerned with making available primary data on specimens held in natural history collections, library material and databases.
www.eti.uva.nl	Expert Center for Taxonomic Identification **ETI** ETI's mission is "to develop and produce scientific and educational computer-aided information systems, to improve the general access to and promote the broad use of taxonomic and biodiversity knowledge worldwide.[112]"	ETI is an NGO with operational relations with UNESCO. ETI's core research and development is supported by the Netherlands Ministry of Science and Education, the University of Amsterdam and UNESCO. ETI's World Biodiversity Database (WBD) is a taxonomic database and information system that aims at documenting all presently known species. All data in the WBD is protected by copyright.	Access to the online information system is free of charge for non-commercial use: i.e. scientific and educational purposes. ETI is a joint effort of specialists worldwide who contribute basic taxonomic, ecological and biodiversity data to ETI.	The World Biodiversity Database also refers to taxonomic information on biodiversity. ETI is a member of Species 2000 - www.sp2000.org/: a "Federation" of database organisations, which aims to provide a uniform and validated quality index of names of all known species for use as a practical tool.

html	Name and summary of aims	Main partners and information sharing policy	Access and quality control	Comments
www.biodiversity.org	Biodiversity Conservation Information System **BCIS** Set up in 1995, BCIS aimed to develop a framework for information sharing to allow "to support environmentally sound decision-making and action by facilitating access to biodiversity data and information[113]."	A consortium of 12 NGOs (BirdLife International; Botanic Gardens Conservation International; CI; IUCN The World Conservation Union (and IUCN Commission on Ecosystem Management; IUCN Environmental Law Commission; IUCN Species Survival Commission; IUCN World Commission on Protected Areas); TNC; TRAFFIC; Wetlands International; UNEP-WCMC.) It was stated that data should be managed by the organisation in the best position to do so and that data be managed in accordance with IPR and agreements with data suppliers[114].	The idea of data custodians was developed to ensure important datasets were developed, maintained and accessible to legitimate users. A key principle was that data should be accessed through the custodian rather than from any secondary source. Data access agreements were seen to provide a means for custodians to safeguard their intellectual property, including their investment in building and maintaining the dataset[115].	BCIS suffered from being conceived at a time when technology was changing rapidly – and many of the ideas behind BCIS were quickly outdated. The main output was a series of eight fairly technical handbooks – which although providing a thoughtful structural basis to BCIS also presumably took considerably resources and left little room for updating and innovation in BCIS's development.
i.e. www.conserveonline.org	**The Biodiversity Knowledge Commons** Several organisations now share search facilities via their individual web site, in "a broad-based effort to share data, information, and knowledge [on biodiversity] across the conservation community"[116].	Searches cover the websites and databases of the Conserve Online CABS/KMS, Conservation Biology Abstracts (Society of Conservation Biology), the American Museum of Natural History's Center for Biodiversity and Conservation, the Biodiversity Support Program, Eco-Index (Rainforest Alliance), the US Forest Service, NatureServe and ConserveOnline, Discussion Groups, and GIS systems of TNC. The agreement to join the commons is informal but is predicated on sharing the information currently available on partner's websites.	Access and quality control are in the domain of the individual organisations.	As explored above in Section 3 of the main report, the original idea behind the Biodiversity Knowledge Commons was for a far wider data sharing partnership. The current informal Commons is seen as a first step only, however as such it does serve as a useful model for how informal data sharing partnerships can be formed – which may then evolve into large data sharing initiatives in the future.

html	Name and summary of aims	Main partners and information sharing policy	Access and quality control	Comments
www.unep-wcmc.org	UNEP-WCMC **Proteus** The goal of Proteus is "to develop an electronic Biodiversity Information Service (BIS) that provides accessible, relevant and reliable biodiversity information for practitioners and decision-makers in order to maximise the sustainability of development.[117]"	Proteus is sponsored by Anglo American, TotalFinaElf, BP, Premier Oil, Rio Tinto and Vodaphone. Technical partners are: Oracle Corporation and ESRI GIS mapping and software. Collaborative partners are: HSBC bank and Co-operative Insurance Services The Proteus project document envisages developing partners with other information systems and networks in its Phase 3 (2006-7). Although some of UNEP-WCMC's data is in the public domain, a large part of the Centre's work is based on selling data through individual consultancies or licensing agreements.	"Proteus will be decentralised to the extent that is technically achievable, ensuring that the custodians of information are those institutions best qualified to understand and maintain it.[118]" "End-to-end quality management processes will be in place.[119]" Proteus will focus on decision-makers at the "national, global and regional levels[120]", not the site level.	The project seeks to develop a quality controlled knowledge management system enabling UNEP-WCMC to integrate "disparate information sources internally" and "develop connectivity with external information systems and networks.[121]" Proteus draws on the 1998 WCMC project: Darwin Initiative Training in Biodiversity Information Management, which developed seven handbooks relevant to the use of information in decision-making, data custodianship and management, and the development of infrastructure to support data and information exchange. These handbooks were also the basis of the BCIS handbook series[122].
wdc.nbii.gov	National Biological Information Infrastructure (NBII) **World Data Center for Biodiversity and Terrestrial Ecology**	The web site contains data related to federal, state, non-profit, university and private sector research data and information gathered within the US. A catalogue of data and information is produced annually and data can be accessed through the NBII metadata clearinghouse.	Data is gathered from a network of NBII Regional and Thematic Nodes throughout the country.	Despite the reference to the "World", this is a portal for information from and related to the US. The site does have links to other 'World Data Center Sites' in Australia, China, Europe, Japan and Russia – but these are not all related to biodiversity.

html	Name and summary of aims	Main partners and information sharing policy	Access and quality control	Comments
www.natureserve.org/	**NatureServe** Originally set up by TNC, Natureserve is a non-profit conservation organisation which aims to provide "a trusted source of information about rare and endangered species and threatened ecosystems"[123].	NatureServe represents a network of 74 biological inventories (i.e. conservation data centres) in the US, Canada, Latin America and the Caribbean and some 800 dedicated scientists.	NatureServe aims to produce "objective scientific information about species and ecosystems" and establish "scientific standards for biological inventory and biodiversity data management"[124].	As the name, suggests, NatureServe is primarily a biodiversity service provider. However, when it was established, in 1994, it was known as the Association for Biodiversity Information (AIB) –the membership organisation for the International Network of Natural Heritage Programs and Conservation Data Centers. AIB's web site was developed by TNC and the US Geological Survey's Biological Resources Division as part of the National Biological Information Infrastructure (NBII), which aimed to create: "comprehensive regional, national, and international data products and services related to biodiversity for use by government, industry, scientists, educators, and the interested public"[125].
www.iucn.org/themes/ssc/programs/sisindex.htm	Species Information Service **SIS** SIS aims to become a "globally accessible, biodiversity knowledge network and database meeting the needs of the scientific and conservation community"[126].	SIS is part of the Species Survival Commission of IUCN. Species data sets (i.e. distribution maps, population trends) will be made publicly available through the Internet. Biodiversity analyses and customised products will also be unavailable on request. "SIS will also capitalise on existing partnerships with other conservation organisations and networks holding complementary data and information"[127].	IUCN Species Survival Commission (SSC) has a membership of 7,000 experts on plants, animals and conservation issues, in more than 120 Specialist Groups, most of which focus on groups of species, which guide the work of the SSC and thus the SIS.	The unique feature of the SIS is that it intends not only to hold data on biodiversity but, by using the expertise gained from the SSC and, for instance, the *Red Data List*, to develop a series of indicators to monitor biodiversity. SIS, however, is currently not operational and is looking for funding.

html	Name and summary of aims	Main partners and information sharing policy	Access and quality control	Comments
www.all-species.org/	All Species Foundation **ALL** Formed in 2000, ALL is a non-profit organisation which aims to catalogue every living species on earth within 25 years.	10 US partners, including CI. ALL states that "… tools developed [and] … scientific knowledge, should be transparent, tweakable, easy to improve by enthusiasts, open to change, and universally accessible." However the Principles note that: "Open source does not mean everything is free"[128].	A science board of 12 has been appointed, but we could find no reference to the role of the board. The principles state that: "A scientific sensibility and temperament should be at its core"[129].	This is another initiative in search of funding, and ALL has had to cut back on activities since initial set up funding ran out.
www.ecoport.org/	**EcoPort**: The Consilience Engine™ Ecoports stated mission is to "establish and sustain a "Knowledge Commons" where individuals and communities can work and learn together to develop sustainable ways to manage the Earth's natural resources"[130].	A cooperative effort of the University of Florida (UF), the FAO and the National Museum of Natural History of the Smithsonian Institution. Ecoport states that: "Open, unfettered access to information and procedures to share information are essential …". The sites small print notes that: "The procedures and data are not in the public domain". But that partners sharing information "agree that it may be used freely, but only for non-commercial purposes and not for financial gain" [131].	Ecoport states that its mission is to "ensure data quality through peer review and to preserve and display individual ownership of shared information"[132].	UF describes Ecoport as "one-stop encyclopedia of information on every known plant and animal on the planet"[133].
www.ibin.org	Indigenous Peoples Biodiversity Information Network **IBIN** Aims to exchange information on experiences and projects and to increase collaboration among indigenous groups working on biodiversity conservation.	IBIN is not primarily an information publisher, but a clearinghouse for information that others produce. IBIN plans only to publish information where the source is clearly identified and where it can be verified that the intermediary has the authority to make information publicly available.	The IBIN web site does not have a search facility, but has links to other related web pages and runs forums (some of which are closed). IBIN aims to develop protocols to ensure that links are to reputable sources and organisations "but links do not represent endorsement by IBIN"[134].	IBIN is also in its pilot phase and its web site is being redesigned. The links, which are organised by subject, seem useful, but this 'library index system' is not as useful as a fully searchable site on these issues.
www.scielo.br	The Scientific Electronic Library Online **SciELO** An electronic library covering a selection of Brazilian scientific journals.	SciELO is an electronic virtual library, providing full access to a collection of serial titles, a collection of issues from individual serial titles, as well as to the full text of articles. The access to both serial titles and articles is available via indexes and search forms. The site currently contains 146 journals at present.	The Project envisages the development of "a common methodology for the preparation, storage, dissemination and evaluation of scientific literature in electronic format"[135].	This is one example of several initiatives to provide open access to scientific journals.

html	Name and summary of aims	Main partners and information sharing policy	Access and quality control	Comments
www.ecolex.org/	ECOLEX (incorporating FAOLEX), "is a database providing the most comprehensive, global source of information on environmental law"[136].	ECOLEX is operated jointly the FAO, IUCN and UNEP. It stems from a partnership Agreement signed by FAO, IUCN and UNEP for the integration of their data, and of FAOLEX (FAO's database of references to national legislation) into ECOLEX[137].	"Users have direct access to the abstracts and indexing information about each document, as well as to the full text of most of the information provided"[138].	The strength of ECOLEX is that it is well know database and is based on a formal agreement between three pivotal partners.
www.iabin.net	Inter-American Biodiversity Information Network **IABIN** IABIN promotes a compatible means for the collection, communication, and exchange of biodiversity information relevant to decision-making and education using the Internet by countries of the Americas[139].	34 countries have designated official IABIN Focal Points to coordinate national efforts to implement the network.	IABIN is envisaged as an open, self-sustaining network giving "access to scientifically credible biodiversity information currently scattered throughout the world in different institutions, such as government organizations, museums, botanical gardens, universities, and NGOs"[140].	IABIN is also centred on biodiversity data, although its project implementation plan notes that where the "GBIF focuses on global specimen data…IABIN focuses on broader biodiversity information in the Americas, of which specimen data is a part". The Plan also envisages a whole range of specialised groups who will develop data on subjects such as invasive species, protected areas etc[141]. IABIN is currently raising funds to develop the project from the GEF, World Bank etc.
www.isinet.com/	**Web of Science** (ISI) The *Web of Science* provides access to current and retrospective multidisciplinary information from approximately 8,500 research journals. It has been available in its present form since 1997 and includes a 60-year archive of papers[142].	Web of Science, owned by Thomson ISI of Philadelphia, USA.	The Web is only accessible to subscribers.	It is difficult to assess this site as we are not subscribers. The service is however widely used in libraries worldwide.

html	Name and summary of aims	Main partners and information sharing policy	Access and quality control	Comments
www.crossref.org/crossrefsearch.html	**CrossRef** A new Search Engine, powered by Google, which allows users to search digital versions of all papers held by partner publishers. Unlike the Web of Science and Scopus, which scan through the titles and abstracts of articles, CrossRef Search also searches the full text of papers[143].	CrossRef, is a not-for-profit association 300 member scholarly publishers. Nine members (American Physical Society; Annual Reviews; Association for Computing Machinery; Blackwell Publishing; Institute of Physics Publishing; International Union of Crystallography; Nature Publishing Group; Oxford University Press; John Wiley & Sons, Inc) are taking part in this pilot project. Participating publishers to decide how to make their content available and what to charge, if anything, for submission or access.	CrossRef Search is a 'domain filtered' search of the main Google index, which delivers results from the regular Google index filtered to include only content from the nine publishers participating in the pilot. Crossref assigns unique Digital Object Identifier (DOI) to contents which should allow for articles to have a longer 'shelf life' and protect against URL changes.	
www.arcbc.org/arcbcweb/biss.htm	Biodiversity Information Sharing Service **BISS** Part of the ASEAN Regional Centre for Biodiversity Conservation (ARCBC), BISS is on-line database for species and protected areas in South East Asia[144].	The EU provides ARCBC with the means for networking, applied research, training and technical assistance, while ASEAN provides office space and facilities and support personnel. The BISS also houses three other databases: ASEAN Biodiversity Specialists/Organisation Database and databases on training resources and a library[145].		

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