WCMC Handbooks on Biodiversity Information Management

A DARWIN INITIATIVE PROJECT

WORLD CONSERVATION MONITORING CENTRE

COMMONWEALTH SECRETARIAT

Information Product Design

Volume 3

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World Conservation Monitoring Centre

Series Editor J.H. Reynolds

Commonwealth Secretariat 1998

The **World Conservation Monitoring Centre**, based in Cambridge, UK, is a joint venture between three partners in the *World Conservation Strategy* and its successor *Caring for the Earth*: IUCN – The World Conservation Union, UNEP – United Nations Environment Programme, and WWF – World Wide Fund for Nature. The Centre provides information services on the conservation and sustainable use of species and ecosystems and supports others in the development of their own information systems.

The United Kingdom's **Darwin Initiative for the Survival of Species**, launched at the 1992 Earth Summit in Rio de Janeiro, aims to support the Convention on Biological Diversity by drawing on Britain's scientific, educational and commercial strengths to assist in the conservation and sustainable use of the world's biodiversity and natural habitats. Key tenets of the Darwin Initiative include collaboration and cooperation with local people, capacity building, distinctiveness and complementarity of project initiatives, poverty alleviation, and long-term sustainability. Through training, awareness raising, and research on undervalued areas of biodiversity, Darwin support is particularly aimed at strengthening links between Britain and those countries rich in biodiversity but poor in financial resources.

Under the auspices of its **Environmental Training for Sustainable Development** initiative, the Management and Training Services Division of the **Commonwealth Secretariat** supports short- and long-term training, internships and institution development for environmental policy makers, environmental 'operatives', and environmental information professionals in the Commonwealth, in various areas of the environment including biodiversity and gender. Funding support for training, institution development and publications under the aegis of the Management and Training Services Division is provided by the Fund for Technical Co-operation (CFTC).

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ACKNOWLEDGEMENTS

The generous support of the *United Kingdom's Darwin Initiative for the Survival of Species* has provided for the development of a comprehensive programme of training in biodiversity information management. This programme comprises an international training team, drawing on expertise from collaborating organisations around the world; the preparation of a training resource in the form of a handbook series and related materials; and the development of computer-based demonstration tools. Training is being promoted through the delivery of post-graduate modules, and through regional and national workshops which have received additional support from The British Council, British Airways Assisting Conservation Scheme, and contributions from participating organisations. The programme has been appropriately titled *Darwin Initiative Training in Biodiversity Information Management.*

Development of the handbooks has also benefited from experiences gained through the Biodiversity Data Management (BDM) Project, administered by the United Nations Environment Programme (UNEP) and funded by the Global Environment Facility (GEF), and related initiatives supported through the European Union (EU) and European Environment Agency (EEA). Indeed, Volume 6 draws extensively on one of the key outputs of the BDM Project, the *Guide to National Institutional Survey* (UNEP/WCMC 1998), developed in consultation with participating countries, the BDM Advisory Committee and the UNEP management team. The concept of an information cycle was developed in collaboration with the International Institute for Environment and Development (IIED) with support from the UK Department for International Development (DFID). The handbooks have been published through the generous support of the Commonwealth Secretariat.

Fundamental to the development of this programme have been the partnerships established with training organisations around the world. These organisations have worked collaboratively in hosting workshops, in reviewing the handbook materials, and in providing guidance on how regional and national training needs can be met most effectively. The training programme has significantly benefited from the input of numerous individuals working in the field of biodiversity information management. Among these individuals, particular mention goes to Professor Ian Crain and Gwynneth Martin of the Orbis Institute, Ottawa, Claire Appleby, an independent consultant, and to Drs Jake Reynolds and John Busby of WCMC for their insightful work in developing the handbook series. Thanks are also extended to Laura Battlebury for her tireless administrative and logistical support. The series

editor for the handbooks was Jake Reynolds, while Donald Gordon managed the overall project.

To the many individuals, both within and outside WCMC who have contributed to the development of materials and the delivery of training in biodiversity information management, a profound debt of gratitude is owed. It is through this collaborative effort that a service is being developed to contribute to the conservation and sustainable use of living resources.

BACKGROUND

The purpose of the *WCMC Handbooks on Biodiversity Information Management* is to support those making decisions on the conservation and sustainable use of living resources. The handbooks form part of a comprehensive programme of training materials designed to build information-management capacity, improve decision-making and assist countries in meeting their obligations under Agenda 21 and the Convention on Biological Diversity.

The intended audience includes information professionals, policy-makers, and senior managers in government, the private sector and wider society, all of whom have a stake in the use or management of living resources. Although written to address the specific need for improved management of biodiversity-related information at the national level, the underlying principles apply to environmental information in general, and to decision-making at all levels. The issues and concepts presented may also be applied in the context of specific sectors, such as forestry, agriculture and wildlife management.

The handbooks deal with a range of issues and processes relevant to the use of information in decision-making, including the strengthening of organisations and organisational linkages, data custodianship and management, and the development of infrastructure to support data and information exchange. Experience suggests that some of the greatest challenges in information management today are concerned with organisational issues, rather than technical concerns in the delivery of information which supports informed decision-making. Consequently, topics are addressed at management and strategic levels, rather than from a technical or methodological standpoint, and alternative approaches are suggested from which a selection or adaptation can be made which best suits local conditions. Nevertheless, in adopting this framework approach, we have tried to adhere to recognised conventions and formalisms used in information management and trust that in producing a 'readable' set of handbooks the integrity of the materials has not been compromised.

Overall, the handbook series comprises:

Companion Volume
Volume 1 Information and Policy
Volume 2 Information Needs Analysis
Volume 3 Information Product Design
Volume 4 Information Networks
Volume 5 Data Custodianship and Access
Volume 6 Information Management Capacity
Volume 7 Data Management Fundamentals

Collectively, the handbook series promotes a shift from tactically based information systems, aimed at delivering products for individual project initiatives, to strategic systems which promote the building of capacity within organisations and networks. This approach not only encourages data to be managed more effectively within organisations, but also encourages data to be shared amongst organisations for the development of the integrated products and services needed to address complex and far-reaching environmental issues.

The handbook series can be used in a number of ways. Individual handbooks can be used to guide managers on specific aspects of information management; they can be used collectively as a reference source for strategic planning and project development; they can also provide the basis for a series of short courses and training seminars on key challenges in information management.

The companion volume provides the background to the handbook series. It also assists readers in deciding which handbooks are most relevant to their own priorities for strengthening capacity.

A second series of handbooks is planned to provide more detailed guidance on information management methodologies, including the areas of data and technology standards, database design and development, application of geographic information systems (GIS), catalogues and metadatabases, and the development of decision-support systems. The current series deals only briefly with formal system development methodologies, and for more detailed treatments the reader is encouraged to access the wide range of published and electronic resources available in libraries and on the Internet, some of which are alluded to in individual handbooks and reference sections.

A number of computer-based training tools have been developed to accompany the handbook series and are used in the training programme. These are based on a protected areas database, a tree conservation database, a GIS demonstration tool and a metadata directory. They aim to demonstrate key aspects in the collection, management and analysis of biodiversity data, and the subsequent production and delivery of information. They also illustrate practical issues such as data standards, data quality-assurance, data access, and documentation. Each training tool is supported by a user guide, together with a descriptive manual which traces the evolution of the tool from design, through development to use.

1 INTRODUCTION

The major challenge in sustainable development is to create a 'level playing field' in which environmental goals are given equal status alongside social and economic goals. One way of encouraging this is to provide access to environmental information at all stages of the decision-making process. However, decisions often rely upon a good understanding of just a few key facts or impressions at any point in time. It follows that, to be effective, the information should convey **simple, succinct messages** which clarify otherwise difficult decisions.

Many decision-makers, such as civil servants, company directors, local government officials and individual resource users, are too busy or lack the technical background to process large amounts of data or apply themselves to difficult interpretation tasks. They need brief summaries of complex issues, presented in such a way that they can be absorbed quickly without the need for special tools or expertise. **Timeliness** is also a critical factor in determining whether information will be effective at supporting decisions. The most salient aspects of a decision may not be taken into account if key information is not available at the right time.

By emphasising presentation issues such as clarity, timing and method of delivery, information can be made **useful and usable** by its intended audience. The aim is to take account of the constraints under which decision-makers work, and tailor the information accordingly. The results are often referred to as **information products** rather than sources, reinforcing the idea that they are produced with a specific purpose and user in mind (products which are delivered on a regular basis, perhaps via established procedures and mechanisms, are known as **information services**). Box 1 summarises the main characteristics of an effective information product.

The first step in preparing information for decision-making is to **understand how decisions are made** on the issue under consideration, and use this understanding to deduce the information needs of major stakeholders (see Volume 2 for a full discussion). This enables the information to be made **relevant** to the policy and management goals affecting the issue. Once this consultative exercise is complete, it is possible to create one or more information products which actively help stakeholders to make better decisions (see the 'information cycle' in Volume 1).

Box 1 Characteristics of an effective information product

- Designed for a specific audience and for a specific purpose.
- Relevant to decision-making needs.
- Available when the 'window of opportunity' for decision-making arises (i.e. timely).
- Easily and quickly understood.
- Obtained through recognised channels.
- Based on objective scientific principles and high-quality data.
- Areas of uncertainty and their significance clearly identified.
- Accompanied by full acknowledgement of data sources and intellectual property.
- Cost-effective in terms of time, money and administrative overheads.

Two underlying features of the information cycle are examined in the following sections: product **design** and product **development**. The first of these — design — is divided into two further parts, concerning product definition and analysis, respectively.

2 DESIGN 1: DEFINITION

2.1 Overview

Many factors determine whether information will be successful in supporting or influencing decision-making, including its content, complexity, structure, layout, timing and method of delivery. All of these may need to be examined during the design process. The goal is to specify an information product in such a way that it can be readily implemented by developers.

The design specification is conceptual in nature and does not necessarily say how the product will be generated in practice (i.e. it is independent of the manual or computerised data processing techniques which are employed). The specification may vary in size from a short concept note to a detailed project proposal, depending on the scale of the product and the degree of detail required by its developer. In most cases, it will contain the following elements:

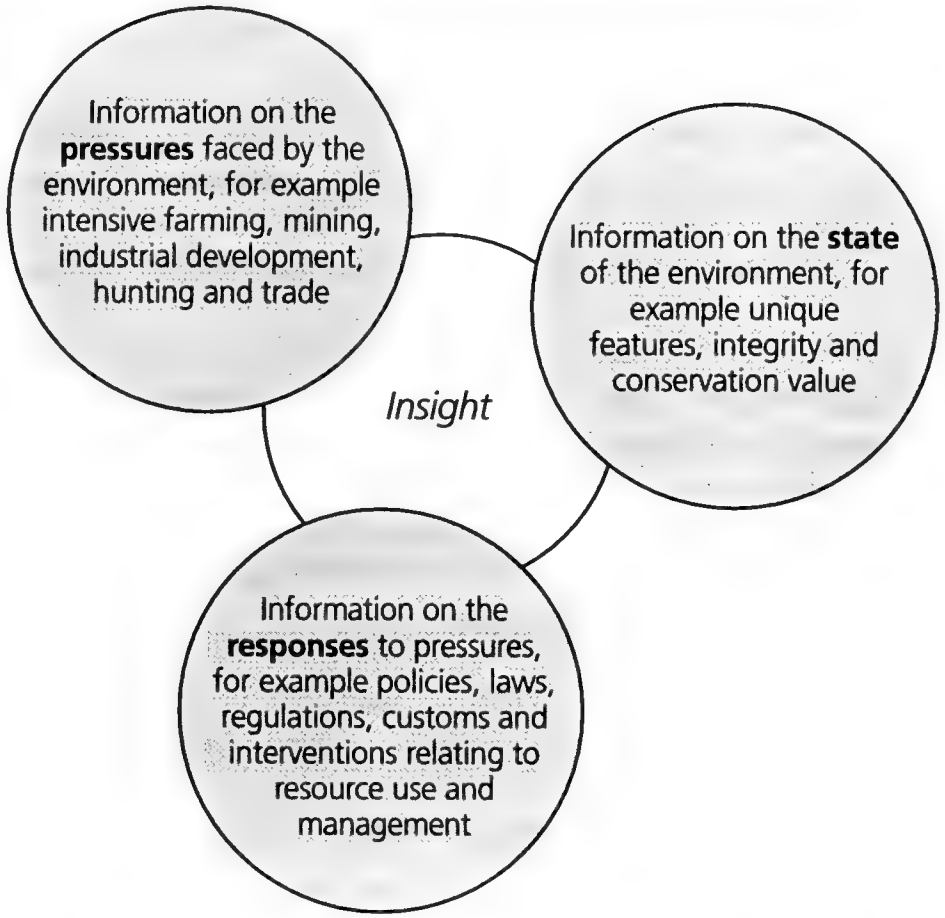
- a preamble discussing the function of the product, including who the product will be used by and how it will help them to arrive at better decisions;
- a definition of its content, complexity, structure, layout, timing and method of delivery;
- the roles and responsibilities of the team charged with its development; and
- an indicative budget and time-scale for product development.

Additional technical details may also be included, such as a survey of required datasets, entity-relationship (E-R) diagrams depicting the inter-relationships between key datasets (see Volume 7), and descriptions of the main processing and production techniques to be applied.

2.2 Content

Users require information for a wealth of reasons, and the assessment of what constitutes good or bad information content depends entirely on their individual perspectives and needs. Nevertheless, in considering some of the commonest decisions which need to be made in the environment and development area, such as

Figure 1 Insight as the fusion of three types of information



the selection of routes for transport or pipelines, strategies to employ in managing conservation areas, and the identification of land for housing or agricultural development, it becomes clear that a very wide range of information sources are involved. For decision-makers to weigh up options and plan activities which balance economic, social and environmental goals, a degree of **insight** is required into the issues, not simply further sources of information (see Volume 1).

Not surprisingly, most models which have been proposed to guide the identification of information content reduce to the same basic elements, namely:

- information on the **pressures** faced by the environment, notably from human activities;

- information on the **state** of the environment, in terms of the extent, condition and uniqueness of its features; and

- information on human **responses** to the pressures, for example policies, laws and interventions.

These elements can be represented in the form of a 'pressure-state-response' model, as shown in Figure 1 (Bakkes *et al.* 1994). Insight is depicted as the fusion of information on the three elements — state, pressure and response — which loosely correspond to the questions 'what is happening?', 'why is it happening?', and 'what are we doing about it?', respectively (Hammond *et al.* 1995).

Information on pressures is often deemed to be the highest priority since, from a policy perspective, pressures represent the underlying causes of environmental concerns and are therefore most cost-effective to address. Also, pressures are easier and cheaper to measure since they mainly result from recordable human activities.

Box 2 presents an example information briefing designed for a senior forest policy advisor. The briefing, which is just one of many types of information product, describes the background to an increase in timber utilisation in a forest reserve, including the underlying reasons for the increase and its consequences. Two graphs are provided for the advisor. The first illustrates the state of the resource (in this case timber) in terms of the standing volume of high-value species under threat; the second illustrates the chief pressure on the resource in terms of the size of the annual harvest.

This enables the user to understand what is happening to the resource, and why it is happening. The second graph illustrates how current policy is failing to check the increase in harvesting rate, which has now risen well above a sustainable level. In order to clarify what response is necessary to address the problem, the graph contains targets for reducing harvesting rate to a sustainable level. Finally, the product contains recommendations for both policy-makers and forest managers.

2.3 Complexity

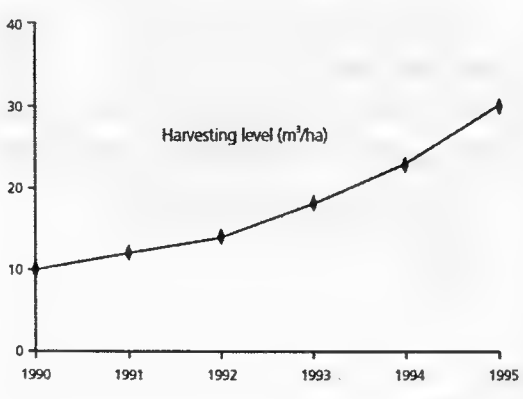
In their original form, scientific research results are notoriously inaccessible by many groups of decision-maker due to their level of complexity, sheer volume and focus on scientific rather than policy issues. This is quite understandable, since the results may never have been intended for use in policy-making, resource management or by the general public. Nevertheless, much scientific information could be of great value to lay audiences if it was presented in alternative ways.

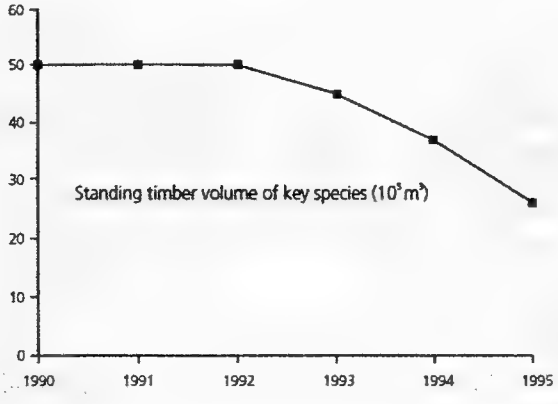
Box 2 Example information briefing

Issue: Over-exploitation of high-value timber species in a forest reserve.

Background: For decades, the forest has supported local demands for timber and other forest products which have been available to local people through licences obtained from the local administration. Recently opened international markets have triggered outside interest in the forest's assets, leading to an increase in harvesting of just a few high-value species. Local resentment of the outside interests is building, although this is partially offset by money obtained through working for the newly arrived companies. Recent research from the government Forest Officer, charged with implementing the forest's management plan, reveals that the harvesting rate of high-value timber species has been unsustainable since 1992 and is causing long-term damage to the health of the forest and the economic prosperity of its surrounding community.

Research results: Based on the Forest Officer's data, the graphs below illustrate the trends in typical harvesting level and standing timber volume of key timber species since 1990. Only legally harvested logs are included (illegal logging is thought to account for an additional 10–20% off-take). Standing timber volume was assessed using government-approved forest inventory procedures.



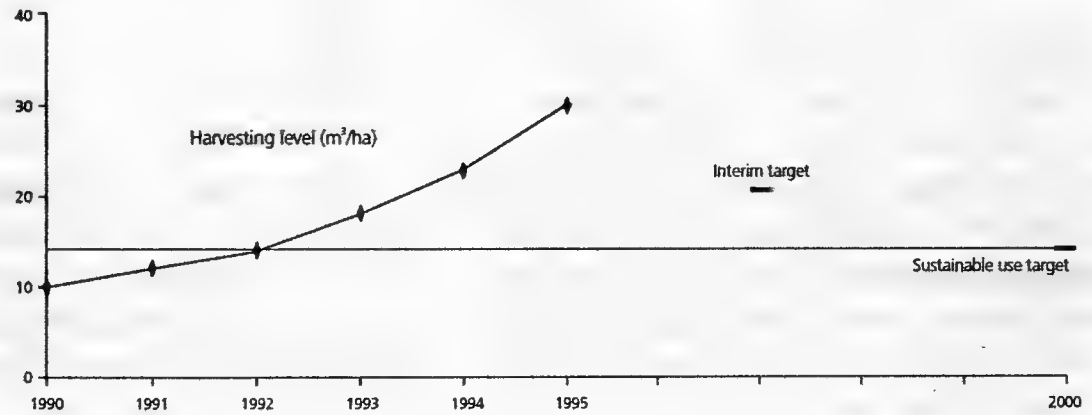


Techniques for translating scientific understanding into 'policy-relevant' information for decision-makers are currently very poorly developed in many countries. This is partly due to the traditional 'stand off' between the scientific and policy-making communities, fuelled by mutual suspicion of each other's goals and methods, which leads to sentiments such as 'the government never use my data' (scientist) or 'the information was too detailed' (government). The interface between

Box 2 Example information briefing (cont.)

Policy implications: The current harvesting level of over-exploited species needs to be reduced. Potential solutions include diversification to other species, greater taxes and licence fees for non-local companies, or a temporary moratorium on logging operations (this has proved to be extremely effective in other similar situations). The cost to the local community of a degraded forest reserve must be fully reviewed, since this could develop into a serious socio-economic problem. Regeneration schemes could be introduced to boost the forest's recovery, perhaps as a partnership between the Forest Officer, local community and logging companies.

Management implications: The graph below (also based on the Forest Officer's data) sets interim and long-term (sustainable use) targets for harvesting of the over-exploited species. These should be rigorously met through agreement of fixed quotas for logging, encouragement of the use of a broader range of timber species, and curtailment of illegal logging operations.



science and policy is ripe for innovation of all kinds, and one growing area of cooperation between the two communities is the growing use of **environmental indicators** in policy-making.

Indicators are highly refined (and therefore easily interpreted) information products representing complex phenomena, such as the status of a living resource, the growth of a pressure, or the performance of a policy (see Hammond *et al.* 1995 for a more detailed discussion). In the extreme case, indicators can be presented in the form of **single time-varying numbers** which, when properly communicated, can

become popular and influential markers of progress towards policy targets. Well known examples from the financial world include the Dow Jones and FTSE indices from the New York and City of London stock exchanges respectively. Another example is GDP (Gross Domestic Product), which has been used to represent nations' economic performance for many years.

One difficulty with representing ecological information in the form of indicators is that the subject of study — human interaction with nature — is complex and does not lend itself to simple or regular assessment. There is, of course, the danger that simple indicators of complex phenomena could prove misleading. However, the need for clear and simple information on such topics is growing rapidly, and new monitoring and assessment techniques are continually being developed.

For example, a major review of environmental pressure indicators is currently being undertaken by the European Commission as part of a scheme for monitoring the performance of environmental policy under the European Union's Fifth Environmental Action Programme (EC 1993). Basic indicators are being defined in ten environmental policy areas, with the aim of 'greening' traditional economic indicators in European Union states[1] (EC 1996).

Two processes guide the extraction of information from their underlying data: **abstraction** and **summary**. Abstraction removes unnecessary information by using selected observations as surrogates for the behaviour of entire systems. This is vital in situations where the subject of study, for instance the integrity of an ecosystem or the impact of an industrial process, is too complex to describe completely. For example, the ratio of a forest's perimeter to its overall area may be used as a simple measure of forest integrity, since the ratio varies according to its level of fragmentation. Similarly, the ratio of waste to output in an industrial plant can be used as a simple indicator of environmental performance.

Unnecessary information can also be removed by summarising observations in simple ways, such as sums, averages, densities and so on. Environmental data are

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1 The assessment of a nation's performance in purely economic terms encourages environmentally- or socially-destructive growth to be recorded as progress by policy-makers. More balanced performance indicators take into account environmental and social impacts, such as the consumption of natural resources, the production of waste and pollution, and the welfare of those affected by 'development'.

particularly well suited to spatial summary since, by definition, they originate from different points in the physical environment. Variations in natural phenomena can therefore be summarised over political, administrative or natural geographical units such as watersheds and ecoclimatic zones with relative ease. For example, measurements of pollution levels, ecosystem integrity, or ratio of native to introduced species, can be averaged in space to provide decision-makers with estimates of policy performance in different locations.

2.4 Structure and Layout

Information is traditionally produced as reports, maps, papers, pamphlets, brochures and other media, including Internet, video, audio, slides and posters for large audiences. As well as content, good information products benefit from attention to a range of structural and layout issues. For instance, reports are most easily absorbed if they are structured logically; have a well-defined beginning, middle and end; contain a brief summary at the start (e.g. an 'executive summary'); have excess detail consigned to annexes or less visible areas, or left out; and make extensive use of navigation aids, such as tables of contents, page numbering, references, and an index.

With respect to layout, information products which contain clear, simple information, with plenty of space and features surrounding the body of the message, are easiest to digest. This is as true for a web-page as it is for a written report. Ideally, they should be presented with attractively designed pages which guide the reader through the information presented. Judicious (but not excessive) use of shading, colour and fonts is useful, as are diagrams, tables, maps, charts, graphs, photographs, images, and other 'features' which enhance key messages and break up text. Boxes containing summaries of key facts or supplementary information add further value, and examples and case studies help illustrate and consolidate messages.

2.5 Timing

Decisions are often made over extremely short time-scales. Thus, if vital information is not obtained within the brief 'window of opportunity' available, it may fail to have any effect on the outcome of the decision. In some respects, **timeliness is the most important factor** determining the effectiveness of an information product. Events such as policy reviews, planning exercises, and press conferences, simply may not be able to wait for improved information. The implication is that information product

designers should understand fully the decision-making process they are trying to support, particularly the time constraints of the various stakeholders.

2.6 Method of Delivery

Selecting an appropriate method for delivering information is extremely important. For example, there is no apparent reason why information downloaded from the Internet should have less value than that obtained from a colleague or official source. Yet it is often the case that information of exactly the same content is treated differently according to its source.

There are many ways to deliver information to its intended audience. These vary from covert transfer of information between organisations and people, to release of information into the public domain where all stakeholders, including the target audience, can receive it. Whatever form of delivery is used, steps may be taken to ensure that the target audience is aware of the product, and knows how to obtain it if not provided with it directly. Release of information into the public domain can prompt **decision-making by disclosure**, in which decisions are forced upon certain groups by embarrassing them into action. A good example of this (introduced in Volume 1) was the release of national 'greenhouse gas' emission statistics by the World Resources Institute in 1990. All major countries were ranked according to their level of emissions, causing immediate attention to be paid to emissions policy and, in some cases, rapid alteration of policy.

Decision-making by disclosure can work positively in some situations but can be ineffective or counter-productive in others. An understanding of the political climate and cultural values of the country is necessary before deciding on the most effective means of conveying information to decision-makers. For example, a campaigning organisation which releases information to embarrass governments may be quietly ignored in governmental circles; but when a governmental committee arrives at the same conclusions, a rapid policy-shift may occur. Similarly, many companies demonstrating leadership in environmental management do so on the basis of their own insights and predictions, rather than public criticism.[2]

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2 For example to avoid fines, legal action or unfavourable media coverage; or to gain a market advantage through being seen to respect the environment.

2.7 Special Considerations for Web-based Products

Because of the relative ease with which information can be made available using the Internet, the importance of good design in developing products is often overlooked. In fact, all of the preceding advice concerning content, complexity, structure, layout, timing and delivery is entirely relevant.

Nevertheless, there are other aspects of information product design that are specific to electronic products, in particular the ability to make direct 'active' links between related items, allowing users to jump directly from one piece of information to another interactively (e.g. via hyperlinks).

3 DESIGN 2: ANALYSIS

3.1 Overview

Having defined the information product, the next step is to analyse what datasets and processing techniques are required to develop it. This exercise is an integral part of the design process.

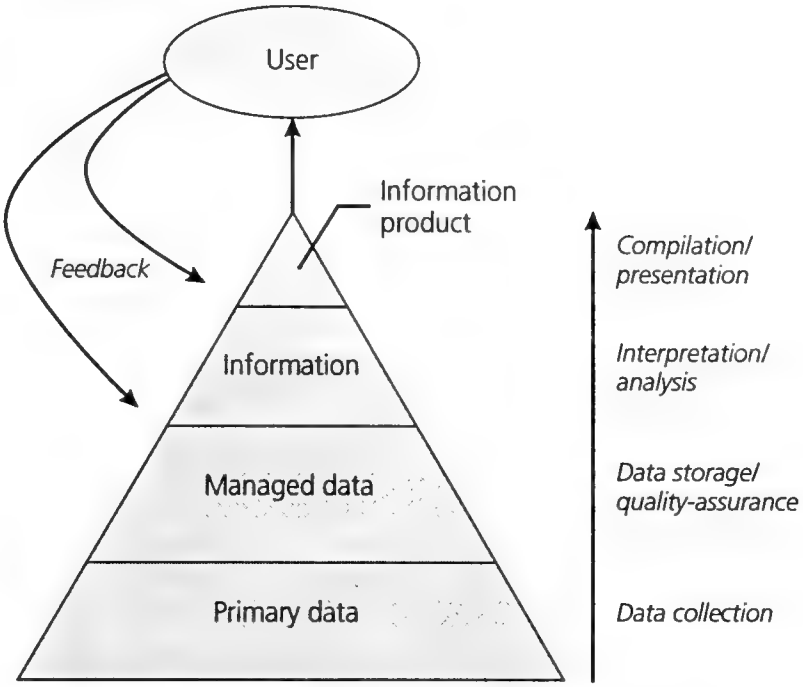
3.2 Analysing Data Needs

Figure 2 illustrates the life cycle of an information product in the form of an 'information pyramid'. The cycle begins with **primary data**, which are obtained from the environment through research and monitoring activities. There follows a transition into **managed data** as the primary data are stored, quality-assured and otherwise brought into a secure, accessible medium. The next transition is into **information**, which is achieved by analysing and interpreting the data in line with user needs. Finally, specific items of information which are required by a specific user (or group of users), at a specific time, for a specific purpose, are compiled into an **information product** and delivered to their user. Feedback from users with respect to the value of the information they receive, and their future requirements, enables the provision of a progressively improving service (see Figure 2).

The information pyramid portrays a 'bottom up' process in which primary data from research and monitoring activities are transformed into information products for specific users. In reality, information production works in the reverse direction since, for any particular issue which users are interested in, the first step is to determine what information is needed, how it will be used, by whom and when it is needed (see Volume 2). This gives the product designer a clear vision of what is required by the user. The next step for the designer is to work down the pyramid to determine which datasets are necessary to build the product and, ultimately, what research and monitoring activities these require. In summary, information needs dictate data needs, not the other way around (this is equivalent to saying that information production should be demand-driven, not supply-led).

The process of distilling data needs from information needs is illustrated in Table 1. In this form of analysis, each **issue** demanding information (denoted by the letter I) is broken down into a series of **information needs** (denoted by the letter N); and each

Figure 2 The information pyramid



of these is broken down into a series of **data needs** (denoted by the letter D). Although every issue gives rise to its own information pyramid, many of the underlying data needs can be seen to be shared (e.g. D_2 and D_3). In theory, then, it is possible to deduce a core set of datasets which will be in frequent, if not continuous, use, based on anticipated user requirements (see Figure 3). These are known as **essential datasets**. A good example is a map of a country's administrative boundaries, which may have application in any product illustrating the variability of an indicator across administrative zones.

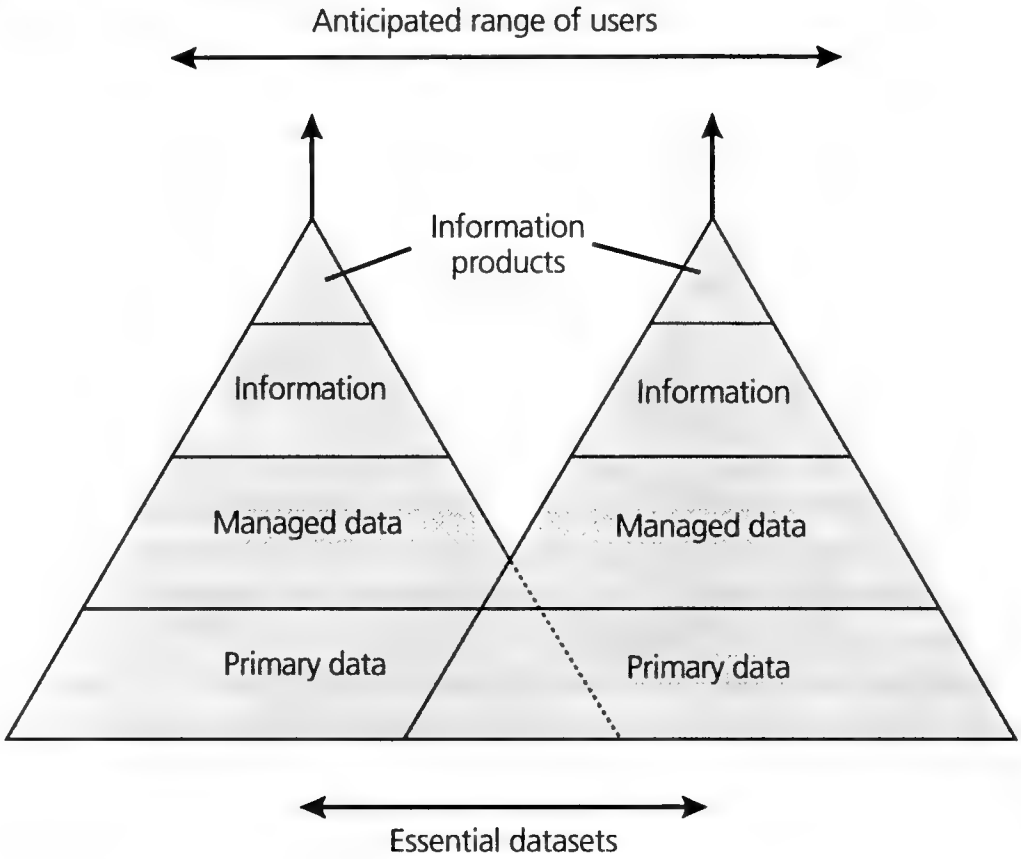
Table 1 Data needs analysis

Issue	I_1	I_2	I_3	...
Information needs	N_1 N_2 N_3	N_4 N_5 N_6	N_7 N_8 N_9	...
Underlying data needs	D_1 **D_2** **D_3** D_4	**D_3** **D_5** D_6 D_7	**D_2** **D_3** **D_5** D_8	...

overlap

The identification of essential datasets should be a priority for every organisation, so that steps can be taken to make sure they are properly managed and accessible. If this

Figure 3 Essential datasets



does not occur, then it could mean that extensive preparatory work is required *every* time an information product is created, which would be very inefficient and costly. To avoid this, as a general principle data should be **stored and quality-assured only once, but made available many times for many purposes** (UK Government 1995). In this way, a diverse portfolio of information products can be created from a core group of datasets and processing techniques.

In many cases, it may be impractical or undesirable for a single organisation to manage all the essential datasets it requires. For instance, it would be inefficient for every organisation to prepare its own map of administrative boundaries. This would result in proliferation of many different versions of the same map, which would frustrate data sharing and comparison of results. The alternative is to develop partnerships with the organisations who are best placed to manage the datasets concerned (see Volumes 4 and 5). In the case of administrative boundaries, this may be a government department mandated with the task of keeping such a map up to date. Real efficiencies can be gained by sharing data with other organisations. Indeed, the

formation of information partnerships, linkages and networks is central to the production of information on living resources.

3.3 Analysing Processing Needs

The information pyramid (refer to Figure 2) illustrates how primary data, obtained through research and monitoring activities, are transformed into managed data, information and then information products. The processes associated with these stages are data collection, data storage/quality-assurance, interpretation/analysis and compilation/presentation respectively. Each has a processing requirement, or set of tasks which need to be applied to the data in order to facilitate progress to the next stage. The types of technologies and skills needed to undertake the tasks should be analysed as an integral part of the product-development process. Some pointers for this procedure are given below.

- **Data collection**

  This involves obtaining primary data from the environment through recording and measuring techniques. The equipment and expertise needed depends very much on the specific data being collected. For example, amateur naturalists have proved to be reliable sources of bird distribution data in many countries; the equipment needed is relatively cheap (pair of binoculars, identification guide and transport), and the level of public enthusiasm and expertise very high. However, measurements of water quality cannot be achieved so easily by the public, since they involve standard measurement procedures, specialised sensors and professional training.

  The main skill required is experience with the particular measurement procedures adopted. Typical technologies for data collection include recording and measuring equipment, preservation (e.g. of biological or chemical specimens), storage, and transportation.

- **Data storage/quality-assurance**

  This involves bringing primary data into a *managed* form through computerisation or other technique for storing and manipulating data. The aim is to manage data in ways which enable them to be applied to a wide range of purposes, for instance

through attention to their currency, validity, compliance with standards, documentation and accessibility (see Volumes 5 and 7). This is particularly challenging in situations where it is necessary to integrate multiple datasets for complex interpretation tasks, for instance analysis of the inter-relationships between living resources and the pressures they face from human activities. Common tasks include capture and validation of primary data, conversion between different formats and media, everyday maintenance and documentation.

The main skills required are logic, consistency, attention to detail, knowledge of computers and related equipment, and an appreciation of the constraints and needs of data collectors, data analysts and information users. Typical technologies for data storage include filing systems, computer hardware and software, data input and output devices (e.g. scanners, digitising tables, printers and plotters) and communication facilities.

- **Interpretation/analysis**

The purpose of interpretation is to refine data into information or, from a user's perspective, extract information from data. A huge variety of analytical techniques can be applied, depending on the nature of the underlying data and the form of information output required. These range from simple methods of abstraction and summary (e.g. estimation of conservation value on the basis of observed species diversity) to statistical inference (e.g. prediction of water toxicity using time-series analysis), pattern recognition (e.g. interpretation of vegetation types from remotely-sensed imagery) and ecosystem modelling (e.g. simulation of the viability of a rare species or the effect of sea-level rise on coastal breeding habitats). All techniques have one feature in common: they filter out unnecessary detail, enhance salient features, and otherwise refine information content.

Key skills include a firm grasp of the purpose of the analysis (e.g. the policy issue being addressed, the ecological assumptions, the intended uses of the information), plus proficiency in mathematics, statistics, data management and computer software and programming languages. Typical technologies for data interpretation/analysis include computer hardware and software (e.g. databases, statistics, GIS and image-processing packages), and programming languages which enable the design of custom analytical and modelling techniques (although useful, computers are by no means essential).

- **Compilation/presentation**

  Compiling information for non-technical audiences is often neglected by product developers who are absorbed with the more technical aspects of the data. However, this last process is essential since it forms the bridge between information professionals and the vast majority of users. Typical activities range from editorial control to production, marketing and distribution. Although extensive facilities may be required to integrate information sources and to perform editorial functions, it is important for the process to remain people- not technology-driven. An appreciation of the constraints under which users work, including their priorities for information, helps to ensure that the information produced is useful.

  The main skills required are writing, editing, graphic design, marketing and distribution. Typical technologies include hardware and software to support desk-top publishing, multimedia and GIS applications, plus printing facilities and electronic communications.

3.4 Special Considerations for Web-based Products

When information is made available on the Internet, or via other electronic media such as diskette or CD-ROM, it is possible to embed 'links' into individual items of information (e.g. graphs, text, maps) such that the underlying sources of data used to construct them are made explicit to the user.

There is also the option of dynamically updating the information product as fresh data become available. Such data could be collected and managed by another organisation, with a 'live' Internet link providing the update – cooperation in action!

4 PRODUCT DEVELOPMENT

4.1 Overview

The design process should result in a specification or blueprint for product development, which is used here to mean the physical production, marketing and distribution of the product. However, products should not be developed in isolation: it is important to ensure that synergies and efficiencies between them are fully exploited during the development process. For example, it may be that several products for different audiences are all derived from the same underlying datasets, in which case the overhead for managing such datasets could be shared.

Key questions for managers to address during the development process include the following:

- Who is leading the product's development?
- Are they fully resourced in terms of data, expertise, facilities and funding?
- Which other organisations are contributing to the product's development, and have appropriate institutional arrangements been made?
- What synergies and efficiencies can be exploited with other products?

In addition to these management issues, a number of technical topics are worthy of special attention for product developers. These topics are amplified in the following sections.

4.2 Data Development

The analysis stage identifies which datasets are necessary to build an information product. Ideally, this results in a list of datasets which are either available immediately at the right level of quality within the organisation, or accessible through data management partnerships with other organisations (see Volume 4). However, in some cases, the necessary datasets may not be accessible at the right level of quality, or in existence at all.

For instance, a government scientist wishing to predict how climate change will affect the distribution of wetland habitats for migratory birds, may find that only rudimentary, perhaps conflicting, research data are available. Even where good data are available, the facilities needed to analyse them may be too costly to install, or the expert staff needed to operate them not available.

When planning how to address essential data needs, a useful first step is to identify and prioritise data development tasks. Table 2 illustrates one method of achieving this. A development priority (useful, important, essential) is assigned to each dataset (denoted by the letter D) on the basis of how essential it is to information production (a higher priority would be accorded to those datasets which are necessary for multiple information products — see Table 1). The current status of each dataset is then described, and the tasks needed to bring it up to a sufficient level of quality are outlined. Finally, organisations which may wish to work as partners in the development of the datasets are identified.

Table 2 Prioritising data development

Dataset	D_1	D_2	D_3	...
Priority	Useful	Important	Essential	...
Current status	Non-existent	Actively managed	Under development	...
Development tasks	Build from scratch	Update	Update, extend, quality-assure, document	...
Partners	P_2 P_5	P_4	None	...

4.3 Prototyping

Users often refine their needs for information during the development process, making it essential to maintain a dialogue with them on a regular basis. If this does not occur then there is always the risk that major revisions of the product will be necessary at a later stage. These concerns have led to the introduction of interactive approaches to product development, one of which is known as **prototyping**. This approach works as follows:

- a prototype or 'mock-up' of the final product is built;

- users are invited to examine the prototype in order to provide feedback; and
- the required changes are made easily and cheaply, well in advance of the final product.

The principal advantage of prototyping is that product developers can quickly verify whether their interpretation of the user's needs is correct. This allows problems to be identified and corrected early on in the development process, before too many resources have been spent.

4.4 Strategic Product Development

Depending on the availability and quality of essential datasets, the time it takes to develop an information product can vary from a few minutes to months or even years. For instance, the development of a national protected areas policy may require a map identifying areas of highest conservation priority, which might depend, in turn, on the existence of a national vegetation dataset. If this is out of date, unreliable, or compiled at the wrong scale, the conservation priorities map might be delayed until it has been updated, replaced or a suitable substitute has been identified.

Similarly, the degree to which individuals within organisations, and the organisations themselves, are able and willing to cooperate on information issues can affect product development time-scales significantly. Potential constraints include poorly-developed data access policies and procedures, lack of data and technology standards, concerns over data quality, and limitations in expertise, facilities and financial resources (see Volumes 4, 5, 6 and 7). Box 3 identifies three categories of information product, deliverable over progressively longer time-scales.

Far-reaching, **strategic** products may take several months or years to develop and may require substantial investment in data, expertise and facilities (see Box 4 for an example). To overcome the fatigue which can occur during the development of such products, they can be developed as a series of **immediate** and **interim** products which act as milestones en route towards longer-term information objectives. This approach, which is consistent with the continuous improvement loop introduced in Volume 1, encourages strategic objectives to be reviewed on a regular basis, thus reducing the risk of becoming 'locked in' to inflexible long-term plans. It also ensures that senior managers continue to be engaged with the process, thus minimising the chance that they will lose confidence and withdraw resources.

4.5 Marketing

Even the most expertly-designed information products will fail to achieve their goal unless attention is paid to marketing. There is a growing abundance of publicly-available information, and users are finding it increasingly difficult to **discriminate between sources**. Good marketing and distribution helps persuade users that it will be cost-effective to use particular sources of information. There is much to learn from the publishing industry in this regard. For example, it is unlikely that a commercial publishing company would neglect to market their books or journals. They understand that, unless a product is advertised, attractive and easily available, it will not fulfil its maximum audience. Ensuring that information is professionally packaged, that it is available without heavy cost or bureaucratic hurdles, and that its anticipated users are fully aware of its existence and availability (if not its detail), all help to increase the extent to which the information will be used.

Box 3 Time-scales for information product development

- **Immediate** (<3 months): no significant constraints; product development can begin as soon as resources are allocated.
- **Interim** (3 months–1 year): minor constraints; some data development, expertise or facilities required; product development can begin following removal of these constraints.
- **Strategic** (>2 years): major constraints; essential datasets non-existent, inaccessible, or of insufficient quality; further research and/or monitoring required; overall level of information management capacity low; product development on hold until data become available, research/monitoring completed, capacity enhanced and data management partners organised.

Box 4 Example product design and development

Aim: To produce a report for European environment ministers at their meeting in Aarhus, Denmark, in 1988, to assess progress on addressing the environmental issues presented at their meeting in Sofia, Bulgaria, in 1995.

Background: This product had a clear aim, there was a political mandate for its development and publication, and there was an undisputed lead agency – the European Environment Agency (EEA published the previous assessment *Europe's Environment* (Stanners and Bourdean 1995), and were charged with compilation of the follow-up report and were resourced accordingly).

Product design: EEA further refined the aims, scope and objectives of the report, based on advice from various stakeholders and previous experiences. They aimed to produce a report which:

- identified progress on key issues covered by the previous report, including *inter alia* changes in driving force, pressure and state of the environment;
- assessed the contribution of each economic sector to each of the environmental issues;
- covered the 'prospects' (including emerging problems) for change/action to support the discussion and re-orient priorities for action; and
- paid special attention to transboundary issues.

Box 4 Example product design and development (cont.)

EEA collaborated with the Danish National Environmental Research Institute in identifying what information to include in the report (NERI 1996), and reviewed this within the EEA network of national focal points and topic centres (EIONET). There was a clear agreement on content based on what was feasible in meeting a set of clearly stated requirements.

Product development: Guidelines for data collection were developed and distributed to national focal points and topic centres, and to a number of international organisations. These provided a basis for:

- development of questionnaires for collecting data from national focal points and countries outside the EEA network;
- capturing data from topic centres and international databases; and
- developing aggregated databases at the EEA.

There was a clear, though ambitious, timetable for compilation of the data and drafting of the report. The manner of collecting and managing the data ensured that the product was acceptable to its target audience, and a review process was put in place to ensure good use of the data.

Product launch: The Ministerial meeting for which the report was produced provided a major platform for ensuring wide interest in the report and, consequently, wide dissemination.

5 CASE STUDY: WORLD FOREST MAP

5.1 Overview

In collaboration with the World Wide Fund for Nature (WWF) and the Center for International Forestry Research (CIFOR), WCMC compiled the *World Forest Map* in 1996 – the first digital forest map showing the extent and protection of the world's forests. The digital data are being maintained at WCMC and the intention is to compile subsequent versions of the map as data are improved and updated over time.

5.2 Design

The map was initially prepared at the request of WWF, to serve as a frontispiece to the *Forests for Life* Campaign, a global campaign for forest conservation, with the following principle Target Driven Activities (TDAs):

1. to establish an ecologically representative network of protected areas covering at least 10% of the world's forest area by the Year 2000; and

2. to ensure the independent certification of 10 million hectares of sustainably-managed forest by 1998.

The requirement was a global map, which could be reproduced in a range of formats, showing the distribution of the world's remaining forests, classified into major forest types, together with their current level of protection. Its purpose was to launch the campaign by showing the present status of the world's forests and to provide a baseline for future monitoring.

5.3 Data Needs

WCMC has been gathering and compiling spatial data on the extent and conservation status of forests since 1987. Initially the focus was on the moist tropics, but this has extended to temperate and boreal forests in recent years. The data are stored in a geographic information system (ArcInfo in this case) and are based on detailed maps and digital files from a range of national and international sources, compiled mainly between the early 1980s and early 1990s.

A key challenge when compiling the map was how to combine the great variety of datasets (more than 75), many of which used different classification systems for forest types, into a meaningful and easily-understood product. A broad, pragmatic forest-classification system was applied in order to harmonise all forest categories into one of five groups: *Temperate Needleleaf, Temperate Broadleaf and Mixed, Tropical Moist, Tropical Dry and Mangroves.* Adopting a global classification system inevitably led to some arbitrary divisions being made, and it was not possible to be entirely consistent. For example, in some areas data for open dry woodlands was not available, and thus was not mapped.

In addition to information on forests, all protected areas in categories I-V identified by IUCN (The World Conservation Union), greater than 1,000 ha in extent and covering at least some forest, were shown on the map.

Whenever the map is published it includes a disclaimer. This explains that whilst the best available data have been used, they have been taken from sources which vary in accuracy and currency, and which may lead to inconsistencies which will be addressed in future versions of the map.

5.4 GIS Analysis

By overlaying maps of protected areas and forest cover it was possible, using GIS, to analyse the proportion of forest area under protection for each of the forest types. Globally, this produced a figure of 6% of the world's total forest area protected.

5.5 Presentation

For the purposes of the WWF campaign, the map was entitled 'WWF World Forest Map 1996', and included the simple headline message '94% of the world's forests unprotected' to draw attention to the low level of protection afforded to forests (a target of 10 % of forest protected by the year 2000 was recommended). A table showing the level of protection in each of the five types of forest was also included.

The map was released at an international press conference in September 1996, both as a large format poster and on the Internet. In order to draw attention to the campaign, copies of the poster were sent to all Heads of State. In addition to being made available on the *Forests for Life* web site, the digital format of the data made it

possible to include slide transparencies in press packs sent to all major news agencies around the world. The map was also featured on a video news release. As a result, the launch of the campaign attracted huge media interest with versions of the map reproduced in a large number of national newspapers.

In addition, more than 80 national maps showing forest cover and protected areas were prepared and presented on the web site via a simple-to-use graphical interface. These were also produced as A3 paper maps by order from WWF.

5.6 Product Development

As mentioned earlier, the digital data are being improved and updated as new data become available. As a follow up, WWF released a series of regional maps a year after the first launch, this time showing the estimated extent of original forest cover, prepared by WCMC from maps of potential vegetation. This was intended to show the distribution of closed forest world wide prior to the impact of modern man, as a baseline from which to calculate total forest loss in the present day. Again, GIS analyses produced figures which gave an indication of current forest cover remaining as a proportion of original forest cover, and the proportion of remaining forest which was protected. These maps were produced as A1 posters and in digital format for a subsequent press launch, and the maps were once more used widely by the media.

5.7 Wider Applications

As well as providing the basis for WWF's campaign work, the data underpinning the World Forest Map have been used by WCMC and others as a backdrop for a series of related maps presenting information on the status of the world's remaining forests. For example, WCMC and CIFOR have carried out a detailed global analysis of forest conservation using the data, with the results being available on the Internet. The actual GIS files employed are available on CD-ROM for use by researchers and as an educational tool.

The base map has also been used to produce regularly-updated maps showing the locations of independently-certified forests which have been accredited by the Forest Stewardship Council (FSC). Again, these have been made available as paper maps and on the Internet. The base map has also been used as a backdrop for posters showing the locations of major projects for both WWF and the UK Department for

International Development (DFID), for use in internal planning and external communication.

It was emphasised that the map is updated regularly, rather than being treated as a 'one-off' product. For example, it is currently being updated for the World Commission on Forests and Sustainable Development (WCFSD), to include the best available data for open dry woodlands, and to provide a yet more comprehensive picture of the current extent of the world's forest cover.

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