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CONVENTION ON BIOLOGICAL DIVERSITY
HYDERABAD INDIA 2012

National Biodiversity Information Outlook (NBIO)

October, 2012

जहाँ है हरियाली।
वहाँ है खुशहाली॥

राष्ट्रीय जैव विविधता प्राधिकरण
National Biodiversity Authority, India
2003

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

Citation

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DRAFT FOR PUBLIC REVIEW

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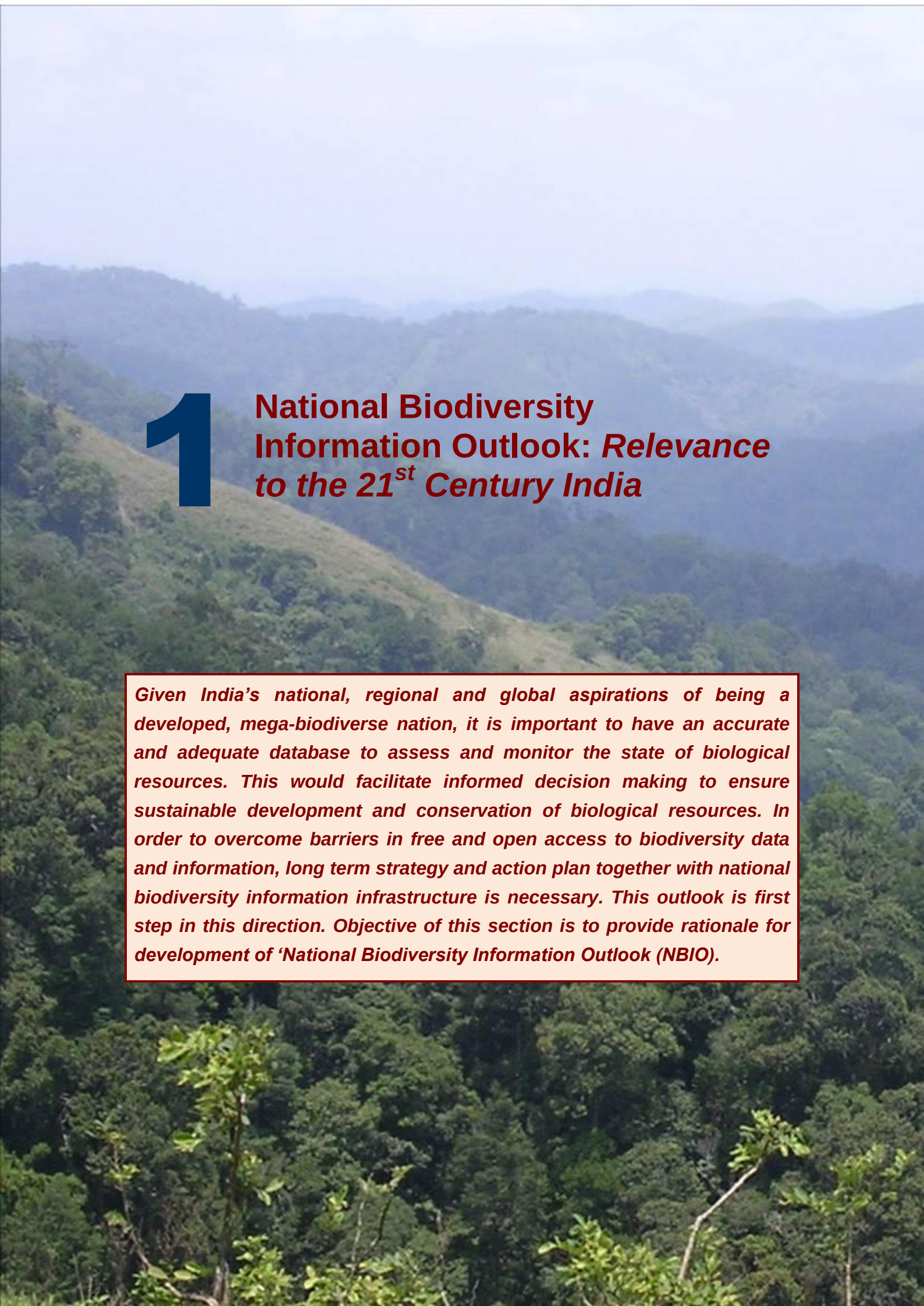


1 National Biodiversity Information Outlook: *Relevance to the 21st Century India*

Given India's national, regional and global aspirations of being a developed, mega-biodiverse nation, it is important to have an accurate and adequate database to assess and monitor the state of biological resources. This would facilitate informed decision making to ensure sustainable development and conservation of biological resources. In order to overcome barriers in free and open access to biodiversity data and information, long term strategy and action plan together with national biodiversity information infrastructure is necessary. This outlook is first step in this direction. Objective of this section is to provide rationale for development of 'National Biodiversity Information Outlook (NBIO).

India is one of the 17 mega-biodiverse countries in the world and supports an estimated total of 7-8% of the globally documented species (NBA Annual Report 2009-2010). It has a rich assemblage of traditional and indigenous knowledge, both oral and documented. Today, India's biodiversity is experiencing high levels of pressure and conservation challenges (Nagdeve, 2002) *inter-alia* due to rising human population's demand for food, water, fuel and raw materials, along with the changing climate (Gaikwad and Chavan, 2006). It is predicted that India in 21st century will emerge as a global super power due to sheer size and vibrancy of its economy. It is advancing as a potential global economic powerhouse (Schaffer *et al.*, 2005). Indian biodiversity researchers, governmental agencies, policy makers and even citizens are faced with challenges such as how to optimize food and water security together with sustainable biodiversity (MoEF, 2011; MoEF, 2012). Thus, it is vital that India nurtures its bioresources in a sustainable manner so as to ensure continued growth as a 'true global power' in all aspects of economy and biodiversity conservation. Both environmental protection and economic development are important and require timely discovery, efficient access to pertinent information and knowledge on the status of bioresources and the impacts of human centered development on natural resources.

Natural resources have huge economic value and the challenge is to sustain it while promoting economic growth. Although it is recognized that the economic progress and health of ecosystems and biodiversity are inextricably linked, the economic forces themselves have become a foremost reason for biodiversity loss in recent times. If mismanaged, it will become impossible to regenerate and replicate these natural resources and ecosystems that harbor unique and varied biodiversity. Thus, it is essential that we develop an informatics supported mechanism to efficiently manage and use these natural resources by recognizing it as our national natural capital asset.

Although studies relating to India's vast biodiversity are geographically limited, huge amount of data has been generated over the years. While a plethora of biodiversity data and information is available and being generated, it's adequate accessibility and use is limited due to scatteredness in diverse languages and digital and non-digital formats with researchers, institutions, universities and organizations (Chavan *et al.*, 2004). In the recent past, biodiversity professionals in India have begun exploiting the power of information technology as a tool for organizing, disseminating, analyzing, exchanging, publishing and discovering of biodiversity data and information (Chavan *et al.*, 2004; Chavan and Krishnan, 2003; Narwade et.al., 2011; Gadgil *et al.*, 1996; ATREE; Roy *et al*., 2005; Lele and Joshi, 2009; FRLHT).

The available data is dispersed and distributed amongst various agencies and individuals within and outside India (Chavan, 2007). Most of the public domain

biodiversity data is available from international agencies located in developed world and over 99% of it is in English. On the other-hand considerable amount of non-English vernacular language data and information, available or produced by agencies and citizens within India, is behind strong cultural barriers of exchange and sharing. This opaqueness has resulted in the duplication of efforts on the one hand while widening the gaps in knowledge associated with the true state of India's biodiversity on the other (Gaikwad and Chavan, 2006). It is very likely that the perception and understanding of overseas experts and institutions about India's conservation priorities could get skewed due to the lack of access to available data and information in various vernacular languages, leading to a content divide. This potentially emerging knowledge catastrophe can only be prevented if biodiversity informatics is considered as a cornerstone of natural resource conservation, its sustainable use and social well-being in India (Chavan 2007).

Biodiversity Informatics is a developing discipline that applies information technology tools and techniques in collection, collation, analysis and dissemination of enormous volume of biodiversity data. During the past 10 years significant progress has been made by many regional and global initiatives, especially the Global Biodiversity Information Facility (GBIF).

GBIF: A Global Information Infrastructure for Biodiversity

The GBIF (www.gbif.org) is an inter-governmental initiative established in 2001 with a mission to facilitate free and open access to global biodiversity data. At present, 56 countries and 46 international organizations are members of the GBIF. Since its establishment the GBIF network and its participants (both countries and international organizations) have developed capacities in various areas of biodiversity informatics. These includes (a) discovery, digitization, and publishing of biodiversity content, (b) distributed, decentralized, and interoperable information infrastructure, (c) engagement, cooperation and partnerships with relevant stakeholder, publisher and user communities both nationally and globally, (d) building and strengthening human, technical, and infrastructural capacity of the network, and (e) assessment and deliver needs of stakeholder and user communities of such a national facility. India is an Associate Member of the GBIF.

Source: http://www.gbif.org/

However, we lack national biodiversity information infrastructure that can enhance the discovery, accessibility and usage of available biodiversity data by creating interoperable framework of exchange and sharing (Chavan, 2007). This is irrespective of the fact that India has emerged as a global powerhouse of information technology. Information technology has further changed the ways biodiversity research is

conducted, and has paved way for a new multidisciplinary field called 'biodiversity informatics' (Buneman, 2005; Bisby, 2000). Thus, in our opinion, biodiversity informatics is essential element of India's economic, environment and social well-being (Chavan, 2007; Mathur and Pande, 2011).

In order to build consolidated and comprehensive as well as distributed and decentralized' information infrastructure to serve the national interests and to provide interoperability with regional and global initiatives setting-up of adequate infrastructure is necessary.

The National Biodiversity Information Outlook (NBIO)

Establishing national biodiversity information infrastructure requires broader consultation with key stakeholders, beneficiaries, and national funding agencies. In order to develop consensus roadmap with stronger commitments from across the board calls for the development of the 'National Biodiversity Information Outlook (NBIO)'. The first step for establishing the infrastructure is the development of a strategic vision document *i.e.* the National Biodiversity Information Outlook (NBIO). The goal of the NBIO is to provide a tool for use by biodiversity stakeholders, data custodians/publishers and users to:

1. assess the *state-of-the-art* of the biodiversity information in India,
2. identify barriers to facilitate and encourage progress in biodiversity informatics,
3. assist prioritizing acquisition, discovery and publishing of biodiversity information by relevant stakeholders/players and
4. communicate progress and advocate needs to decision-makers in the form of a National Biodiversity Informatics Roadmap during the United Nations Decade of Biodiversity.

The users of the NBIO are principally key stakeholders who either produce and/or use biodiversity information. The stakeholders range from biodiversity researchers, academicians, ecologists, conservationists, natural resource managers, planners, policy makers and people at large.

The NBIO is conceived as a mechanism for updating assessment of our progress in biodiversity informatics. As indicated in box below, such an exercise is likely to provide an assessment of various aspects that influences our progress in the area of biodiversity and ecosystem informatics. From the policy makers and national investors' point of view, the NBIO will provide an opportunity to make prioritized and demand-driven investment in biodiversity science itself.

NBIO: A mechanism for updating assessments

The NBIO shall provide an up-to-date assessment of the status of:

- Management as well free and open access to biodiversity information
- Informatics infrastructure
- Standards, tools and processes in biodiversity informatics
- Socio-cultural and economic challenges in biodiversity informatics
- Capacity building in biodiversity informatics
- Use, reuse of biodiversity information for informed policy and decision-making and governance
- Incentives, Impact and metrics for encouraging and accounting progress in biodiversity informatics
- Networking, engagement and outreach to foster & further biodiversity informatics

Source: Chavan et.al. (2012) Current Science, 10 October 2012 (in press)

Further, as depicted in **Figure 1**, NBIO will establish the currently broken link between the biodiversity and ecosystem researchers, stakeholders, policy makers, and information managers. NBIO will emphasize the need for efficient and cost-effective management of biodiversity data through National Biodiversity Grid (NBG), and its implementing arm - the Indian Biodiversity Information Facility (InBIF). As and when InBIF becomes operational and initiate discovery and free and open access to biodiversity and ecosystems data, future NBSAPs (CBD website, NBSAPs) will be enriched and based on accurate and appropriate data and information. In the long term, increased accessibility to the biodiversity data will help develop NBSAPs that are informed and accurate (Chavan et.al., 2012, in press). Thus, we will be able to demonstrate significance progress towards global goals such as CBD Aichi targets (CBD website, Aichi targets).

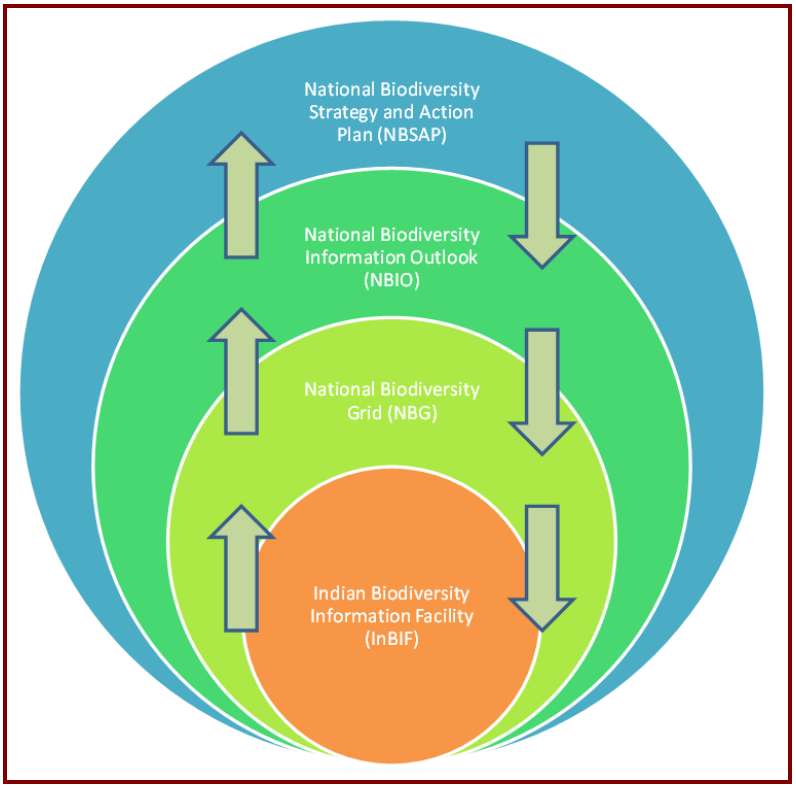
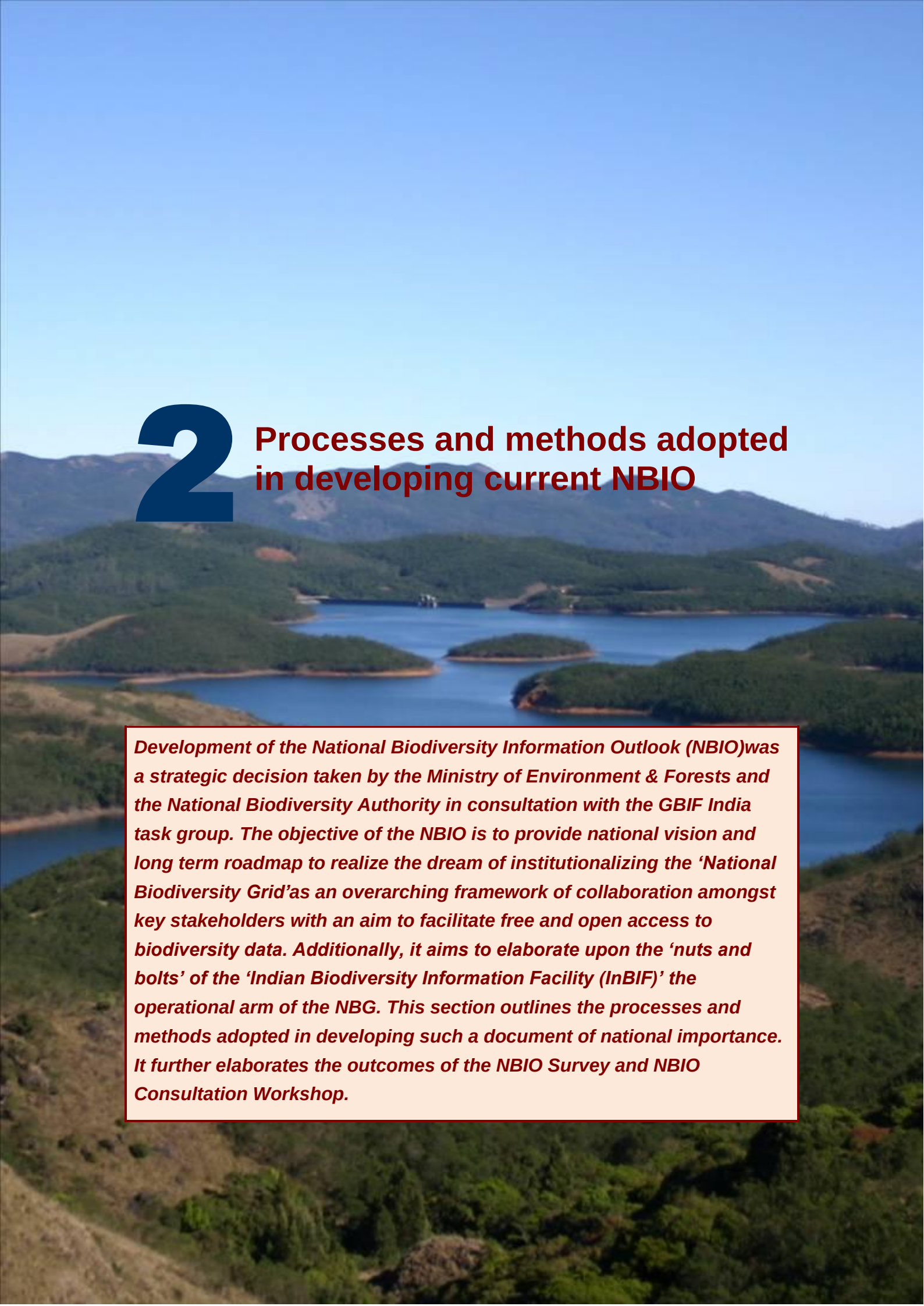


Figure 1. NBIO will influence free and open access to biodiversity data through institutionalization of NBG and InBIF which will enrich the NBSAP processes

It is also envisaged that the NBIO will provide roadmap for making comprehensive progress in biodiversity informatics, such that investments in this new emerging area are scientifically, ecologically, socially and economically relevant. It is imperative to have a sound rationale for every rupee investment that is envisaged towards the NBII (Chavan et.al, 2012). Such an investment shall help us in addressing national challenges both in medium and long term. Thus, the NBIO is fundamental for sustenance and relevance of the NBG.



2 Processes and methods adopted in developing current NBIO

Development of the National Biodiversity Information Outlook (NBIO)was a strategic decision taken by the Ministry of Environment & Forests and the National Biodiversity Authority in consultation with the GBIF India task group. The objective of the NBIO is to provide national vision and long term roadmap to realize the dream of institutionalizing the 'National Biodiversity Grid'as an overarching framework of collaboration amongst key stakeholders with an aim to facilitate free and open access to biodiversity data. Additionally, it aims to elaborate upon the 'nuts and bolts' of the 'Indian Biodiversity Information Facility (InBIF)' the operational arm of the NBG. This section outlines the processes and methods adopted in developing such a document of national importance. It further elaborates the outcomes of the NBIO Survey and NBIO Consultation Workshop.

In the recent past need for a *'National Biodiversity Information Infrastructure (NBII)'* has been felt by cross-sectional stakeholder communities.As a result of which several experts groups (e.g. NBA expert group on biodiversity and traditional knowledge databases) and initiatives – Peoples Biodiversity Registers' (Gadgil *et al.*, 2000; 2006) were commissioned by agencies dealing with biodiversity together with information and communication technology institutions. Recently several institutions under the Chairmanship of the Principal Scientific Adviser (PSA) to the Government of India has discussed the feasibility of establishing National Biodiversity Grid (NBG) (Office of PSA, 2012). For an in-depth understanding of current *state-of-the-art* and challenges, and potentials in making sustained progress in this area developing of comprehensive NBIO is required. Setting up of milestones those are ambitious and yet achievable is also essential.

Thus, it was essential to adopt the processes and methodologies that are usually adopted in developing such vision documents. Most important component of such processes is to ensure that consultations happen with cross-sectional stakeholder communities at every single step. Considering this a five phase process was adopted in developing current version of the NBIO. As depicted in **Figure 2**, these phases included: (1) NBIO Concept Note, (2) NBIO Survey, (3) NBIO Consultation Workshop, (4) Development of NBIO draft for feedback, and (5) Release of final NBIO.

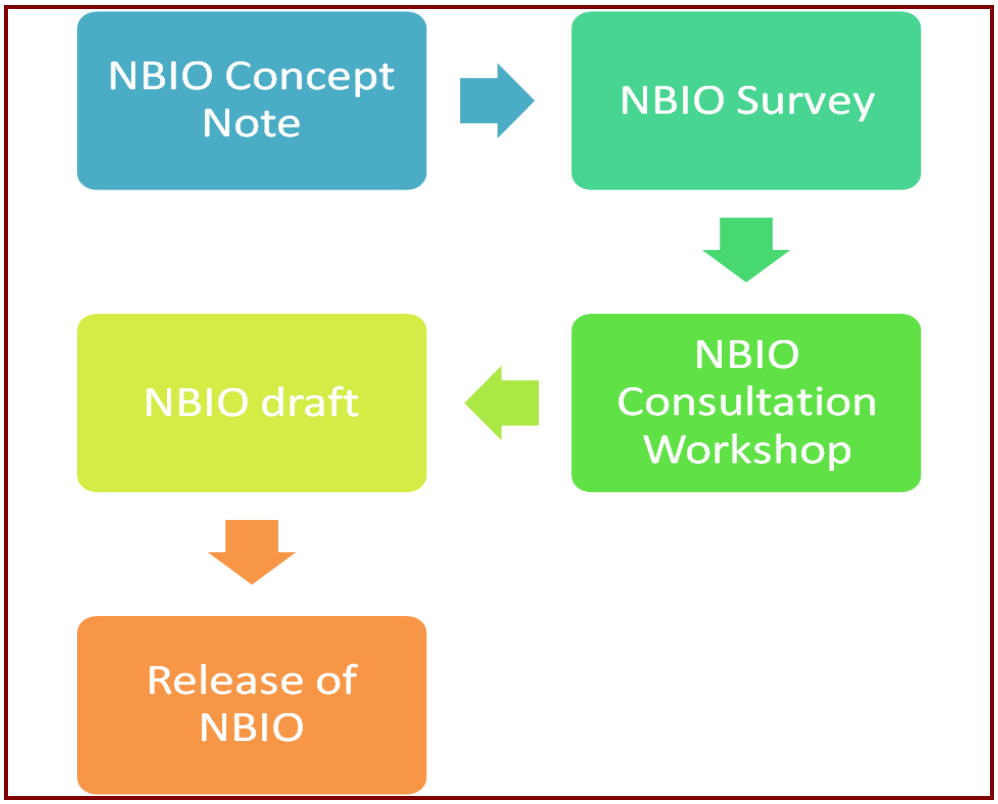


Figure 2: Phases of NBIO development

Towards NBIO

India being a signatory to the Convention on Biological Diversity (CBD) is committed to develop a national clearing-house mechanism to facilitate access to biodiversity information both nationally and globally (respecting national regulations and aspirations). As a result, during past 3-4 decades, several initiatives have been undertaken to realize this dream and comply with the international obligations. One such step was to join the Global Biodiversity Information Facility (GBIF), a multi-governmental network that aims to facilitate free and open access to the world's biodiversity data. Although India signed to the GBIF Memorandum of Understanding in 2003, it remained dormant till 2007-08. In 2008, the Council of Scientific & Industrial Research (CSIR) handed over the baton of Indian leadership in the GBIF to the Ministry of Environment & Forests (MoEF), which is the nodal ministry to deal with aspects of biodiversity and environment. The MoEF designated the Wildlife Institute of India (WII), Dehradun, as a nodal implementing institution. It further nominated the Botanical Survey of India (BSI), Zoological Survey of India (ZSI), Foundation of Revitalization of Local Health Traditions (FRLHT), and National Biodiversity Authority (NBA) as thematic nodes. During its early meetings, the GBIF-India task group realized a need for strategy and action plan for making progress in the field of biodiversity informatics in India. As a follow-up of its realization, a proposal to develop the 'Indian Biodiversity Information Facility' was submitted to the MoEF in 2010. Developing national strategy and action plan for demand-driven progress in biodiversity informatics was major component of this proposal, which was improved *in-principle* by the MoEF owing to various factors it could not be supported.

During early 2012, the National Biodiversity Authority expressed an interest in supporting the major component of this proposal, *i.e.* developing national strategy and action plan for biodiversity informatics. It was realized that developing comprehensive strategy and action plan development may not be feasible because of sheer complexity and dynamics of the processes and number of stakeholders. On the contrary it was felt that vision document together with roadmap is what is essentially needed in this endeavour. Therefore, such a document of national interest called as the 'National Biodiversity Information Outlook (NBIO)' was suggested.

NBIO Development Process

As a first step towards kick starting the NBIO development process, a concept note (**Annexure 1**) was circulated to the key stakeholders both nationally and internationally. In addition to elaborating the rationale behind NBIO, it outlined the process to be followed for developing such a document.

The concept note formed the basis of consultations through the NBIO survey and NBIO consultation workshop. In addition to this, a news item (Chavan et.al., 2012, in press) '*National Biodiversity Information Outlook – a roadmap for developing national biodiversity information infrastructure in India*' was sent for publication in Current Science so as to reach wider audience (**Annexure 2**).

NBIO Survey

The users of the NBIO are key stakeholders who either produce and/or use biodiversity information. These stakeholders range from biodiversity researchers, academicians, ecologists, conservationists, natural resource managers, planners, policy makers and people at large. Before embarking on the development of the NBIO, consultations with key Indian biodiversity stakeholders were necessary. Towards this, a broad online survey was conducted across the biodiversity stakeholders in India to know how people use, exchange and share biodiversity data and information. The survey also aimed to identify major impediments for effective use of biodiversity information; bottlenecks hampering the development of the biodiversity informatics discipline in India and crucial issues that require to be addressed in the coming decades.

Considering the broad scope and goals of the NBIO, a questionnaire was developed to aggregate the views and opinions of the biodiversity stakeholders. To make the survey less onerous the questionnaire consisted of descriptive and objective type questions, arranged under five sections (**Annexure 3**). The objective type questions were directly related to the goals of the NBIO while the descriptive type questions gave participants an opportunity to broadly comment and share their experiences and perspectives associated with the use of biodiversity data and information. Invitations to participate in the survey were sent to over 100 potential biodiversity stakeholders along with the NBIO concept note, developed earlier, outlining the rationale. The NBIO survey was conducted using free online survey website SurveyMonkey (www.surveymonkey.com). In total, 67 biodiversity stakeholders participated in the survey out of which 97% were the users of biodiversity data and information. The survey responses formed the basis for conducting further in-depth face-to-face consultation with key biodiversity stakeholders during the NBIO consultation workshop in New Delhi. The key observations of the online survey based on the responses from 67 participants are grouped in four categories, viz., (a) call for NBIO, (b) revelations, (c) stakeholder needs, and (d) call for NBII. These are summarized in table below.

Outcomes of the NBIO Survey	
Call for NBIO	• NBIO is essential to provide a vision and roadmap for making constructive and comprehensive progress in the field of biodiversity informatics and establishing cost-efficient NBII.
Revelations	• Supply and demand ratio of biodiversity information is disproportionate. • Data diversity (heterogeneous content, scales, formats and quality) and lack of free and open access limits the optimal use of data into decision making processes. • Lack of policies and incentives for data sharing, exchange and publishing are hampering the effective use of biodiversity information.
Stakeholder needs	• Easy and timely access to pertinent multidisciplinary data from species-molecules-ecosystem level is critically required. • Strong incentives, metrics, publishing framework and substantial and sustained funding are required to encourage biodiversity data publishing.
Call for establishing the infrastructure (NBG)	• For addressing the conservation challenges in India an early development and implementation of the National Biodiversity Grid (NBG) is vital and urgently required. • NBG is envisioned as a comprehensive framework that addresses technical, infrastructural, socio-cultural, policy-political, legal barriers that influences free and open access to biodiversity data. • Demand-driven strategic action plans, sufficient funding, trained manpower, state-of-the-art infrastructure, collaboration, and sustained capacity building efforts are essential components of NBG. • Enhanced collaborations by stakeholder communities, funding agencies, policy makers, NGOs, GOs are a must. • Academic courses at graduation and post graduation level need to be commissioned to have a rapid turn-out of trained man-power in the area of biodiversity informatics. • Comprehensive metadata, use of interoperability standards, tools and processes are essential characteristics of NBG. • Building on existing initiatives and learning from past mistakes is crucial. Leveraging upon advances of other regional and global initiatives will help prevent duplication of efforts.

NBIO Consultation Workshop

As evident from the outcomes and interpretations of survey inputs, it became essential to hold wider yet focused consultation to further crystallize the objectives, goals and anticipated outcomes of the NBIO. To facilitate such a consultation with key and representative stakeholders, the NBIO Consultation Workshop was organized during 20-21 August 2012 in New Delhi. In order to ensure optimal productivity key stakeholders together with 13 of the 67 respondents to the NBIO Survey were invited for this workshop. While the participants ratified, endorsed and seconded the outcomes of the NBIO Survey, in-depth discussion was held on aspects of incentives and metrics needed for encouraging publishing of biodiversity data.

Key recommendations of the consultative workshop in addition to those identified by the NBIO Survey are listed in a table below. These recommendations are grouped in four categories viz., (a) proactive measures and expedited actions, (b) data publishing framework, (c) standards and tools, and (d) Indian Biodiversity Information Facility.

Recommendations of the Consultative Workshop on NBIO	
Proactive measures and expedited actions	• Key data custodians such as the Botanical Survey of India, the Zoological Survey of India and others must expedite digitization of data and its free and open access publishing. • Fellowships/internships or exchange programmes be initiated to ensure exchange of data of Indian origin housed in museums and information centers abroad. • Demand-driven approach to data mobilizations on the basis of user needs and in-depth gap analysis is critical. • Capacity building of cross-sectional stakeholders (publishers and users) is essential.
Data Publishing Framework	• Defined and recognized mechanism to provide appropriate attributes, credits and incentives to biodiversity data publishers is essential. • Metrics to assess the impact of publishing (by individuals and institutions) must be well defined and should form part of NBIO and implemented as basic operational principles of NBG. • Data Usage Index for assessing impact of publishing, data citation mechanism and data papers be institutionalized to elevate data publishing on par with scholarly publishing.

Recommendations of the Consultative Workshop on NBIO	
Standards and Tools	• Interoperability mechanism needs to be evolved, adopted and implemented so that data meets global standards and national requirements. • Mechanism to integrate plethora of multi-disciplinary legacy, existing and upcoming data is critical (e.g. from species-genome-ecosystem-geospatial). • Development and adoption of structures as well non-structured standards and protocols is the key to ensure flexibility in data publishing, and accommodating variety of stakeholders and/or data custodians.
Indian Biodiversity Information Facility (InBIF)	• Participants recognized that the NBG is a comprehensive framework facilitating technical, infrastructural, socio-cultural, policy-political, economic, and legal investment to recognise the dream of free and open access to biodiversity information. • Indian Biodiversity Information Facility (InBIF) will be operational and implementing mechanism that encompasses, interlink and collaborate with existing and upcoming (national, regional and global) information systems, networks. InBIF should be looked as institutional set-up for realizing NBG dream. • InBIF should be able to address national needs and aspirations, while it should be implementable at local scale through existing infrastructure and skillsets. • Given the geographic spread and linguistic diversity of the nation, InBIF should be multilingual in publishing and using biodiversity information. • Multi-agency and stakeholder participation is essential for ensuring success of InBIF. • InBIF should be build upon existing national infrastructure such as data Grid , and similar initiatives. • Sufficient and sustained federal, state and private funding is essential for InBIF implementation.

NBIO Draft

On the basis of these inputs (NBIO Survey and Consultative Workshop), and review of global advancement in biodiversity, informatics current NBIO draft has been developed. It is coincidental that the Global Biodiversity Information Facility (GBIF) is leading GBIO, the Global Biodiversity Informatics Outlook (GBIF, 2012, GBIF-GBIF, 2012). Senior author of the drafting group being part of the GBIF Secretariat has been involved in this effort, and thus NBIO draft has benefitted from the global insights and investigations. Further, this has helped in aligning national priorities in this area with global plan of work. However, this version should be treated as near final draft for another round of Public Review that would help in building a road-map for development of biodiversity informatics in India.

Release of NBIO

It is planned to release the 'National Biodiversity Information Outlook' at the 11th Session of Conference of Parties of the Convention on Biological Diversity (CoP of CBD) in Hyderabad during October 2012. While, we recognize that it is an important venue to release the document of this nature, we are of the opinion that it should be released as a draft. This will facilitate Public Review of the document that will probably help to refine the national outlook and approach to research, monitoring and management of biological resources. Upon successful completion of such a Public Review, final version would be developed and adopted after due considerations and treatment of concerns and suggestions. While the drafting team is confident that all essential and ancillary aspects are covered in existing version of the document, another opportunity of consultation with key stakeholders will only enhance the ownership and utility of this key national vision document.

3 Roadmap to the National Biodiversity Information Infrastructure (NBII) and Action Plan for implementation of the Indian Biodiversity Information Facility (InBIF)

The National Biodiversity Grid (NBG)is an overarching framework for encouraging national investments and collaboration by key stakeholders with an aim to facilitate free and open access to the nation's biodiversity and ecosystems data. The NBG envisions contributing towards economic growth, ecological sustainability, and social wellbeing through increasing availability, utility and completeness of existing and new biodiversity and ecosystem information resources. The NBII will encourage a technical, infrastructure, socio-cultural, policy, political and legal as well economic framework and will be implemented through establishment of the 'Indian Biodiversity Information Facility (InBIF)'. This section provides further insights into NBII and its implementation arm the InBIF.

Indian biodiversity information domain is vast and complex but critically important to the society. At present existing biodiversity and ecosystem information is neither readily accessible nor fully useful and there have been few sporadic, isolated efforts made in recent past to address this situation. Therefore, '*National BiodiversityGrid (NBG)* ' is urgently required for economic, ecological and social well-being.

NBG is an overarching framework for encouraging national investment and collaboration by the key stakeholders with the aim to facilitate free and open access to the nation's biodiversity and ecosystems data. The NBG envisions contributing towards economic growth, ecological sustainability and social wellbeing through increasing utility, availability and completeness of existing and new biodiversity and ecosystems information resources. NBG being an overarching framework would encourage technical, infrastructure, socio-cultural, policy, political, legal as well as economic investments by key stakeholder communities and it would be implemented through establishment of the '*Indian Biodiversity Information Facility (InBIF)*'.

Indian Biodiversity Information Facility (InBIF)

Given the fact that there exists few networks (e.g. IBIN – Indian Biodiversity Information Network, ENVIS – Environmental Information System, and BTISNet of the Department of Biotechnology, etc.) and information systems that deal with biodiversity information, InBIF will be a network of networks. Mission of InBIF is to promote and enable free and open access to Indian biodiversity data through distributed and internet based network of networks of data custodians and publishers to underpin science, conservation and sustainable development. Thus, InBIF is an attempt to develop much needed 'national biodiversity information infrastructure' that will harmonize in-country capacity in the area of biodiversity and ecosystems informatics. This will ensure free and open access to the nations' biodiversity and ecosystems data at anytime, anyplace, to anyone under and agreed framework.

InBIF cannot achieve the above stated vision by being a single institution or group of individuals since data itself is isolated, dispersed, distributed and in heterogeneous forms and format. Considering this, InBIF will be network of networks that will work on following principles of operations:

- To work closely with all custodians and publishers of biodiversity and ecosystems data and information.

- To seek interoperability amongst biodiversity and ecosystems databases and other associated datasets including molecular sequences, geological, climate, economics and traditional knowledge.
- To be established as a free-standing national entity in the form of a federated consortium of potential data publishers, users, and stakeholders to fulfill the obligations of Biodiversity Act 2002 (Gadgil, 2003).

Key features of InBIF are depicted in **Figure 3**:

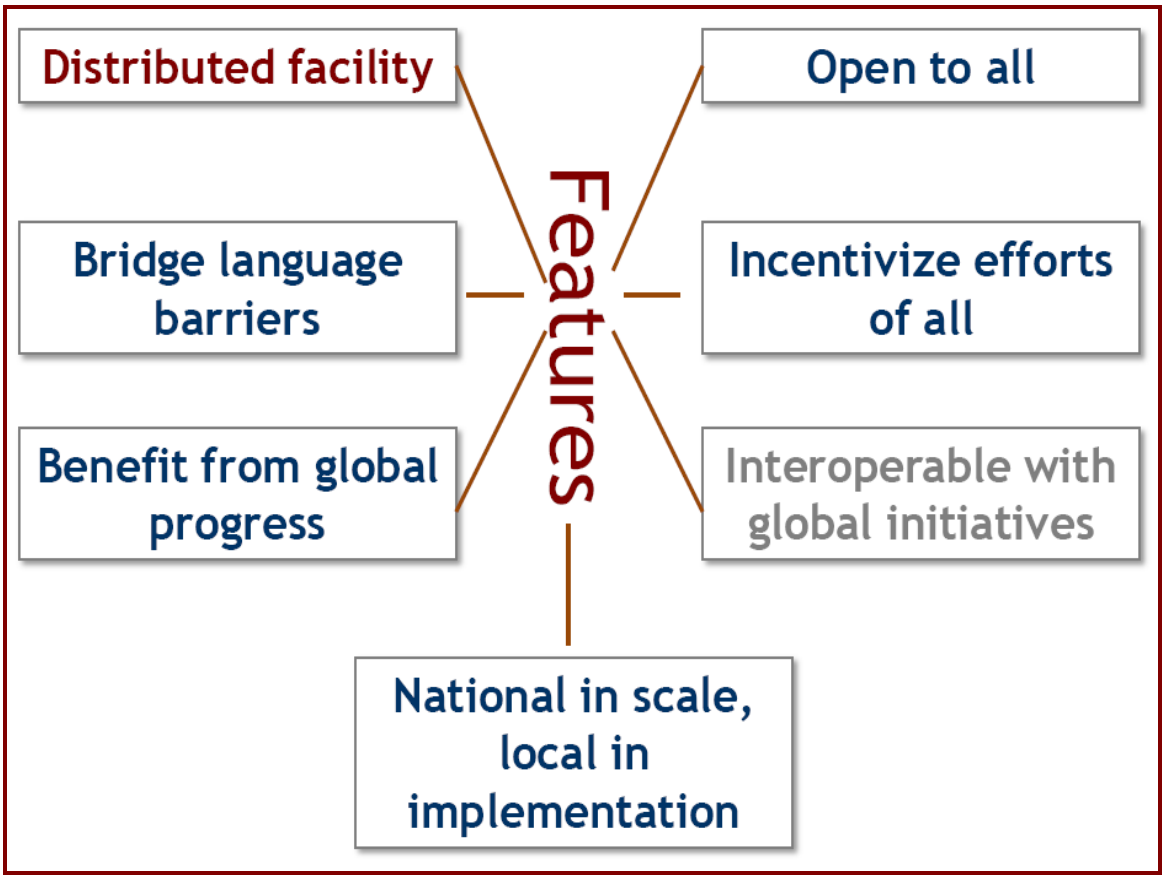


Figure 3: Features of InBIF

In addition to these features InBIF will operate on the principles of co-operation, coherence, inclusiveness, interoperability and scalability. While its goal is to facilitate free and open access to nations' biodiversity data it will respect and fulfill national aspirations such as intellectual property rights, bio-security, economic wealth and social wellbeing. It will be interoperable with regional and global initiatives facilitating exchange/sharing of data with these information systems / networks. InBIF will leverage upon existing national and global progress in the area of biodiversity informatics through initiatives such as GBIF, TDWG – Taxonomic Database Working Group, EoL- Encyclopedia of Life etc., to prevent '*re-inventing of wheels*'. It will facilitate data discovery through registry. InBIF will be sustained through distributed

capacity enhancement, sustained sources of funding, and ownership by the stakeholder communities. While InBIF will adopt decentralization approach for its implementation, it will be based on innovative mechanisms for incentivisation.

Strategic initiatives of InBIF

For addressing and meeting national challenges in the field of biodiversity informatics the InBIF requires working parallel manner on five strategic initiatives (**Figure 4**) for a period of next 5-10 years.

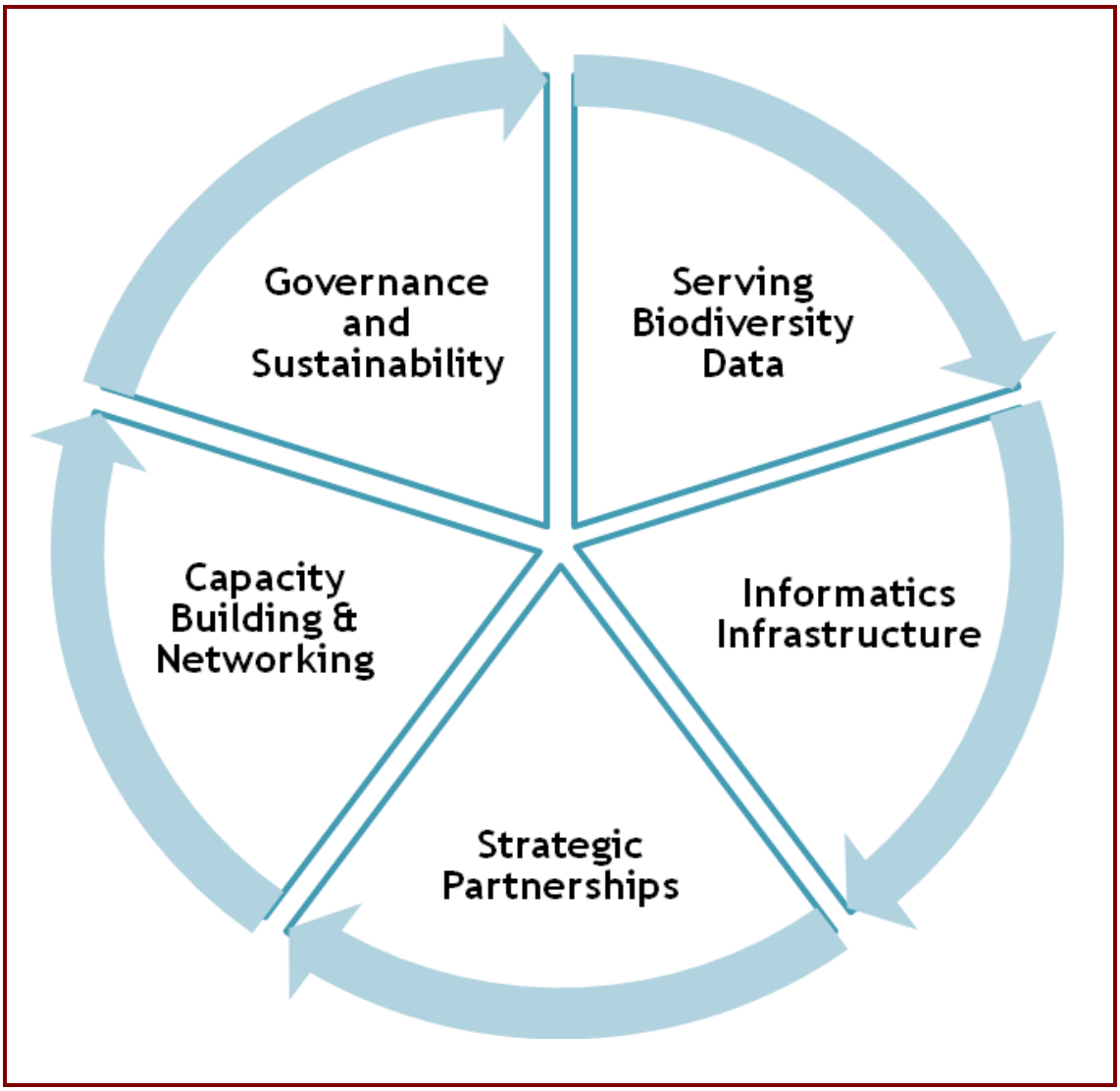


Figure 4: Proposed Strategic Initiatives of InBIF (when commissioned)

1. Serving Biodiversity data: Content for Science and Society

For InBIF to be socially, scientifically, ecologically and economically relevant it should be able to facilitate discovery and access to authenticate, appropriate and fit-for-use biodiversity and ecosystems data.

INBIF approaches will be demand-driven and will remain responsive to the needs of its users. It will focus on publishing data that are of appropriate richness, quality, type and relevance to its users in the science community and in the broader society. These needs change over time, so INBIF will allocate capacity to assess and document these needs and develop examples of how these needs can be addressed using INBIF data. This will be achieved through activities such as:

(a) Assess the user needs and develop demand-driven approaches to discovery and publishing of data:

- Mapping the InBIF network community from data publishers to data end-users;
- Assessing user needs and define priority activities for enabling data discovery, mobilization, publishing and use;
- Analyzing the scientific usage of the InBIF mobilized data, document use cases and identify key strategic areas of development for InBIF;
- Developing demand-driven strategy and action plans for discovery, digitization and publishing of primary biodiversity data (GBIF, 2010) by engagement with potential communities of data custodians, and data publishers;
- Promoting best practice guidelines for demand-driven data discovery and on data publishing strategies and action plans to increase in-country, regional and thematic investments (Berents et.al., 2010);
- Develop and promote strategies towards discovery, digitisation and publishing activities for multilingual data resources across the InBIF network;

(b) Incentivise data publishing through promoting recognition of data publishing as a valid academic publication:

Develop 'data publishing framework' to incentivize efforts of data publishers, and measure the impact of accessibility and usability of data. Institutionalizing Data Publishing Framework includes addressing socio-cultural, technical-infrastructural, policy-political and legal aspects, as well as resourcing various activities of the data publishing cycle (Chavan and Ingwersen, 2009), including:

- Promoting 'data citation mechanisms' (GBIF 2012) and 'data citation services'. GBIF and other professional groups such as CODATA are

devising such a mechanism. InBIF will build upon such services based on the consensus approaches adopted by the international communities.

- Evaluating the potential use of a 'Data Usage Index' (Chavan and Ingwersen, 2009, Ingwersen and Chavan, 2011) as a mechanism to measure the usage impact of primary biodiversity data published through InBIF;
- Promote the publishing of enriched metadata of data resources to improve discovery mechanisms, including 'Data Papers' in printed media form (Chavan and Penev, 2011);
- Guide the implementation of these practices through the InBIF Informatics Infrastructure.

(c) In-country content development

The focus of this effort will be to generate quality taxonomic and biodiversity information in collaboration with international networks of specialists to achieve unified electronic publications. The assurance of quality information will be secured through competitive grants. The grants will be of three categories for data sharing through InBIF: a large grant that facilitates large Institutional collections to be digitized and shared; a medium grant that facilitates specialized data repositories in Institutions to be digitized and shared; and small grants that facilitates individuals to mobilize their data to be digitized and shared. Such a grant-in-aid process would be open, transparent and competitive in nature. An annual call for proposals followed by rigorous review and selection process would be adopted for choosing high quality, cost effective proposals.

Expedite digitization of legacy data such as natural history collections within the country

To expedite digitization of Natural History Collections, ensure priority coverage, documentation and quality of scientific data content, competitive grants (large, medium and small) will be announced by the InBIF each year.

Criteria for the selection of taxonomic groups and collections, priorities and user groups will include Herbaria and natural history museums that have set as their priority digitizing of data and making it available; recent taxonomic revisions, taxonomic groups that have been recently curated and the presence of research groups to work the material. Institutions involved in developing information systems and have willingness to share data and information will be

included in this initiative. A collection could also be selected based on the taxonomic and regional scope of a collection. While the large grants clearly focus on digitizing natural history collections data, the medium and small grants would also focus on digitizing other types of primary biodiversity data (e.g. observational data).

(d) Repatriation of data of Indian origin

It is estimated that around 6500 natural history museums throughout the world house around 3 billion specimens of Indian origin. However, access to these specimens of Indian origin held in the overseas museums to the Indian researchers, when needed most, is both time consuming and expensive. In the last two decades, many natural history museums in developed nations have digitized specimen collections that they are holding. Several ongoing global and regional biodiversity informatics initiatives for sharing data about these specimens with the countries of origin are gaining momentum.

However, it is equally important that India, being the country of origin too initiates appropriate steps, and share responsibilities that would be complementary to these initiatives. A step in this direction would be to support repatriation of data of Indian origin from select natural history museums in different parts of the world, particularly in UK (Natural History Museum, London; Kew Botanic Garden, London) and France (Natural History Museum, Paris) and rest of the Europe (especially museums and botanic gardens in The Netherlands, Germany, Portugal, Spain, etc.). This will be achieved through competitive fellowships. It is proposed to award 30 fellowships for this purpose during the span of 5 years (or 60 fellowships in a span of 10 years). These fellowships will facilitate an Indian researcher to visit the collection and take the help of the host museums' curators to digitize and repatriate the collection data for specimens of Indian origin. These fellowships will also cover cost of digitization in the museum. Priority areas for repatriation of biodiversity data will include taxonomic data and conservation related data.

(e) Extend taxonomic, geographic, and temporal coverage of content

- Support mechanisms for extending core published data types to match end-user scientific needs and engage data publishers to increase priority content (e.g. covering not only conventional primary biodiversity data but also linking with trait data, genomics, genetics and ecosystem data types);

- Expanding the scope and richness of the primary data index and taxonomic meta-catalogue through partnerships with thematic scientific networks and whenever possible engaging them through strategic and innovative applications;

- Supporting scientific information networks in publishing richer data types and meeting their specific needs *e.g.* through the development of vocabulary extensions;

- Expanding priority geographic, taxonomic, and temporal coverage of data content and define priorities and strategies for the mobilization of additional content from new data publishers for spatial, taxonomical and temporal data types with a particular focus on biodiversity rich organizations.

- This will be achieved through competitive grants (especially medium and small grants) as described in the section dealing with in-country content development.

(f) Improve data quality and fitness-for-use

- Improve quality and fitness-for-use of primary biodiversity data through enriched metadata and user annotations;

- Develop and provide robust indicators relating to data coverage/gaps, quality, and interoperability and usage patterns;

- Support quality improvements of data served through the GBIF network by enabling and supporting network-wide quality-assessment and annotation mechanisms as well as through improved engagement with existing and new data publishers;

- Design a set of robust and authoritative name resolution services to support unambiguous and persistent resolution for taxa and associated data.

(g) Establish and broaden inter-disciplinary linkages of primary biodiversity data:

Initiatives in the fields of genetics, genomics, ecology, climate change and impact assessment for developing standards for linkages with primary biodiversity data, publishing richer content and using it for scientific purposes will be launched.

2. Build, Consolidate and Expand Informatics Infrastructure

At its core, InBIF is an information infrastructure developed through agreement and common understanding to support publication, discovery and access to the primary biodiversity and ecosystems data required to assess, monitor and manage the nations' biodiversity. This infrastructure will be built, consolidated and expanded through following activities (**Figure 5**):

(a) Core and Infrastructure Services

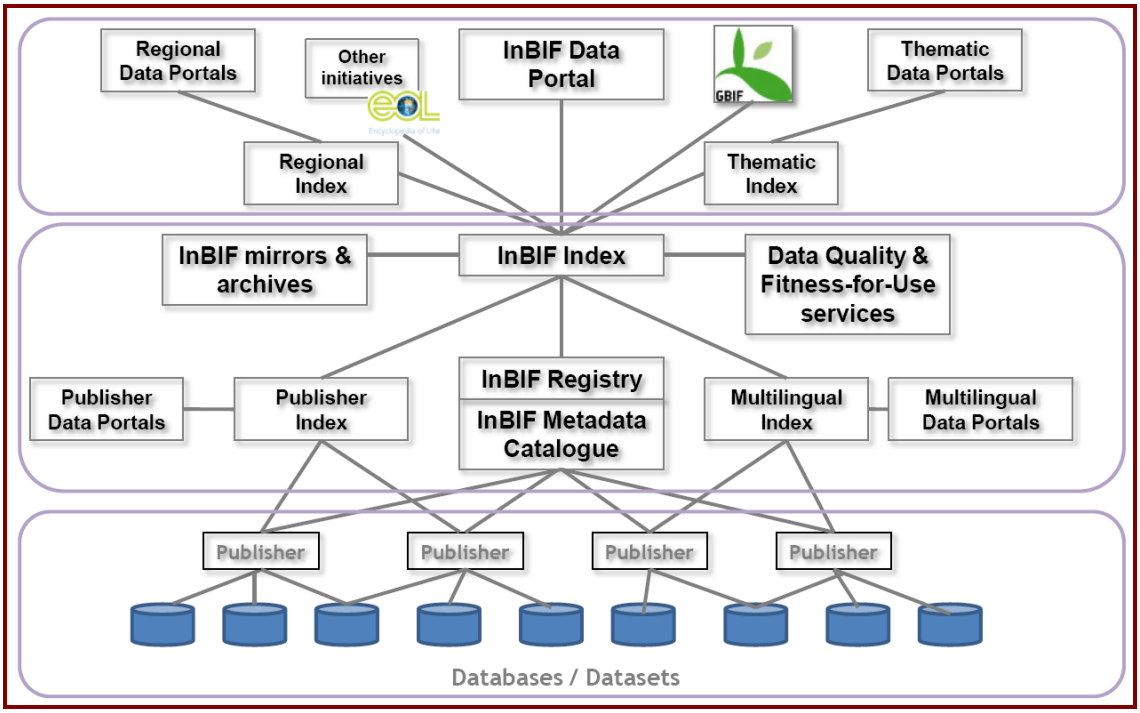


Figure 5: The Core and Infrastructure services of the InBIF (modified from Chavan and Krishnan, 2006; Chavan, 2007)

The InBIF will maintain an (a) Registry, (b) Metadata catalogue, and (c) Index.

i. The InBIF Registry is an identifier of the information and its contents *per se* and will be located at the National Node. As part of the Registry InBIF will adopt and implement GUID, the Global Unique Identifiers assignment and resolution service. There are several types of GUIDs are in practice, however, given the experience we recommend that InBIF adopt the tried and tested Digital Object Identifier (DoI) as the GUID system.

ii. The national indexing facility will be at the National Node. This facility will provide an accession for the entire database of information that will be made available to the Portal from any of the sources in the network. Other catalogues include Publisher Index and Multilingual Index. The Multilingual Index has been

included with the view that sharing of information in different Indian languages could be facilitated. This Index will also help in hosting a Multilingual Data Portal at a later stage. Thematic Nodes and the Individual data publishers will have their respective Index facilities and will lead to the development of their respective portals.

iii. In order to make sufficient space for the processing of information and also ensure data security, mirroring and archiving facilities will be established at the National Node. All incoming information will subject to screening for quality checks and this will be coordinated at the National Node.

(b) Distributed discovery and publishing infrastructure to engage heterogeneous data publisher, and user communities belonging to all walks of life

InBIF will create a customized distributed infrastructure to participant nodes to enable the construction of customized Participant Biodiversity Information Nodes (BINs). The Participant BINs are the key components whereby the Participant's data, technical and scientific capacity for building and expanding the capabilities and services of the InBIF initiative will be mobilized. The key challenge to a successful InBIF distributed architecture is to provide a common yet adaptable infrastructure platform for BIN construction whilst ensuring coherence in network connectivity and decentralized ownership. Distributed infrastructure with decentralized implementation does not mean disconnected infrastructure and abandoned users. Rather, it focuses on extending the common infrastructure to reach more users in ways those users want.

InBIF Portal and participants nodes Portal would be developed to facilitate digitization and publishing of data on the Internet through provision of a coherent data publishing infrastructure. This infrastructure will include easy-to-use tools and processes, including annotation services to enable parties to collectively improve the content and provide fitness-for-use indicators on digital objects accessible through the network. Particular attention will be given to the development of incentivisation services including data citation mechanisms and services, and data usage indices to ensure data usage can be correctly and formally cited, and indexes of usage developed. Additionally, Biodiversity-data Journal Infrastructure will be set up to allow participants to publish data papers. Backup, archiving and mirroring requirements will be of prime importance. Such a comprehensive platform will be achieved using state of the art hardware, software and dedicated broadband internet connectivity.

(c) Construct discovery, digitization, and publishing infrastructure for data resources registry, metadata, taxonomic names and occurrence data.

InBIF will enable a framework for discovery of, and access to, published data on a global scale through a discovery system based on an enhanced registry, metadata catalogue, names and primary biodiversity data stores. Increased access to data published via the InBIF network will be provided through the GBIF data portal and geospatial standards conforming services. InBIF will support an enriched data model with well-defined classes of content reflecting the content needs identified through the 'Content for Science and Society' activities and enabling, for example, linkages from genomics to ecosystems level data. InBIF will improve and expand the set of core informatics infrastructure services through consolidating investment in the existing data portal and increasing reliability, stability, quality and responsiveness, reducing indexing latency, and offering advanced reporting capabilities. Improvements in the GBIF infrastructure will be achieved through adopting the relevant, successful technologies, including, where appropriate, those from industry leaders such as Google, Amazon, Microsoft, C-DAC, etc. Overall access and the ability for specific user communities to define specific search capabilities will be improved through:

- Improved taxonomic and nomenclature;
- Improved primary biodiversity data discovery and access services through global registry services, distributed metadata catalogues, global as well as thematic /national data portals, and a variety of geospatial services;
- Embedding in the InBIF architecture persistent identifiers for digital objects accessible through the network, and provision of services to support their use;
- Services to produce customized map visualizations of content;
- Access to shared computing facilities to perform data mining and derive metrics.

(d) Uptake and implementation of global interoperability standards and tools such as those promoted by GBIF, TDWG etc., and development where such standards do not exist.

InBIF's informatics infrastructure will implement the agreed standards that enable interoperability, and ensure, in particular, that a common mechanism for the governance, development and maintenance of vocabularies and ontologies necessary to enable linked data, the semantic web, and advanced data integration across domains (e.g., genomics and ecosystems) are in place and supported by all constituents. Development of standards will be driven by the need to support the 'Content', and will include:

- Promoting the development and adoption of data and interoperability standards required by the biodiversity informatics community at large as well as existing standards organizations (e.g. TDWG, GenBank, OGC, NSDI,IBIN, etc.) to ensure that requirements of biodiversity informatics practitioners are met;
- Promoting the use of standards and (community experts-supplied) vocabularies for Names;
- Supporting the adoption and use of persistent identifiers to uniquely identify biodiversity data objects across domains including for example, genetics, genomics and ecosystems;
- Supporting the development, documentation and use of essential vocabularies and ontologies utilized in describing biodiversity data objects;
- Guiding the implementation of these standards by the 'Informatics and Infrastructure' strategic activity.

(e) Use and integration with existing Data Grids and National Biodiversity Grid for long term archival, mirroring and replication of data services.

Over the years significant investments have been made nationally to build *state-of-the-art* informatics infrastructure. It would only be in the interest of InBIF that it uses this infrastructure rather that attempt to build something on its own. These infrastructure services includes (a) nation-wide communication network of National Informatics Centers (NICs), (b) GARUDA, the data Grid network established by the Centre for Development of Advanced Computing (C-DAC), (c) BTISNet of Department of Biotechnology, (d) IBIN of the Department of Biotechnology, and (e) ENVIS of the Ministry of Environment &

Forests amongst others. In addition, many scientific departments at national and state levels, as well as agencies such as University Grants Commission, Defense establishments too have established their data networks and infrastructures. Where possible and feasible, InBIF should attempt to leverage upon the existing investment to expedite its progress as well to consolidate itself into national mainstream of informatics infrastructure.

It is envisaged that as InBIF reaches in operational phase within its first 5 years, millions and billions of records would be served through hundreds of BINs. The data publishers would announce availability of increasing quantum of data in the InBIF registry. InBIF data portal will index the data records as well offer a user interfaces for searching, browsing, visualizing and downloading the data. Operating such a complex yet dynamic services both at InBIF national portal levels, or at thematic, regional, and lingual portals has high availability requirements in terms of data infrastructure and data services. Thus, InBIF needs to address the issues of long-term archival of data, mirroring, replication of services, dynamic translation and/or transliteration of data, etc. These data networks and infrastructures can be used for variety of purposes ranging from (a) archival of data, (b) mirroring of data resources and data indexes, (c) replication services, (d) data analysis and modeling, (e) development of regional, thematic and lingual portals, (f) training and capacity building etc. Such an approach will facilitate addressing issues such as redundancy, load balancing, speed of access, indexing, help-desk services, localization as well ownership and buy-in of the network itself.

(f) Thematic, Regional, Lingual data services and Portals

Given the multicultural, multilingual dynamism in the country and distribution of specialized ecosystems and biogeographic zones, it is essential that data services ranging from publishing to access of data be available according to the themes, regional priorities and/or ambitions and in local languages. Thus, InBIF shall encourage the concept of thematic, regional and lingual data portals. These would have several benefits such as (a) publishing and showing the relevant to theme/region, (b) customizable for thematic or regional needs such as languages, (c) easy to use and most effective way of marketing InBIF in the region or thematic community, and (d) technically it serves as test bed for user interface component for the national data portal.

BINs, if desired, can undertake hosting of region, theme, and language specific data portals. However, not all BINs will have an adequate skill-sets and

infrastructure needed for the purpose. In such situations, existing infrastructure and initiatives can be leveraged upon. For instance, the Goa State Biodiversity Board as a BIN, may tie-up with the National Institute of Oceanography (NIO) or C-DAC to establish and operate the Goa specific regional portal in Konkani.

R&D and academic institutions or NGOs with proven domain expertise are natural choice for establishing the thematic portals. In majority of the occasions, a single institution may not be equipped to establish such thematic, regional or lingual data services. In such cases, institutions and agencies working on similar aspects can join together to establish the BIN and its services.

3. Strategic Partnerships: Engagement and Cooperation

Beyond its initial phase InBIF will comprise of complex, diverse network of data publisher institutions, individuals and stakeholders seeking interaction with - and within - the organization for a variety of reasons and resulting in various levels of involvement. Thus InBIF will have to evolve as a more decentralized yet better connected structure for which an evolving shift is required for multi-dimensional “active engagement with” the diverse network components, both within and outside InBIF. Thus partnerships and targeted outreach to relevant players, based on the complementarities in mission and ability is crucial. InBIF will increase its engagement across the network by establishing a greater sense of ownership of, and commitment among its range of participants and stakeholders.

(a) Strategic Partnerships

- InBIF will invest in Strategic Applications (i.e. projects leading from Data to Decision Support) with partner nodes using InBIF mediated data.
- Enabling participants to participate in projects in strategically relevant areas using InBIF mediated data.
- Investment in applications with partners to demonstrate how the InBIF network data and/or online database interoperability can be used to provide answers to address some of the key conservation and biodiversity-related socio-economic questions faced by participants.
- As InBIF matures and participants increasingly mobilize data, take up the tools and identify new applications requirements, it is imperative that InBIF be able to respond to expressed user needs for testing or

designing new analytical functions and/or online database interoperability and integration.

- InBIF will identify appropriate partnerships with other global/national initiatives across the biodiversity, conservation, genetic/genomic and ecosystem realms. In order to be optimally effective, the partnerships must be based on recognition of InBIF's unique role in providing services to access primary biodiversity data and infrastructure. Partners will be significant data holders/publishers, Benchmarking, Accreditation organizations (QCI), standards and protocols bodies, technology developers/providers, scientific users, EIA practitioners, PAs, NGOs, and/or funders/implementers of elements of the InBIF Work Programmes, etc.
- In these partnerships InBIF will seek to invest in innovative ideas in areas that underpin our strategic imperatives (e.g. covering data gaps, improving data quality etc.). Activities could include the exchange of personnel and building infrastructures based on INBIF standards and tools.
- During the 1st phase of the InBIF 25 such strategic partnerships will be initiated (5 each year).

(b) Annual Biodiversity Informatics Conference

Engaging the scientific community through convening strategic events such as conferences, InBIF will seek to consolidate the mechanisms for regional engagement and interaction, as a way to respond better to regional needs and priorities whilst drawing on regional capacity and expertise. Participant nodes will play a key role in making this a reality through the provision of cross-cutting facilities. This focus on engagement will be complemented by providing opportunities for collaboration and communication at the national level, including regular meetings, science symposia, etc.

(c) International Collaboration

Similar to in-country collaborations and engagement, international collaborations are critical in ensuring that InBIF is interoperable with global initiatives. This may be achieved by becoming GBIF Voting Participant which opens door of collaboration with 102 GBIF Participants (56 countries and 46 International organizations).

4. Capacity Building and Networking

Building of biodiversity informatics capacity and promoting collaborations will be at two levels - firstly among InBIF participants and secondly InBIF with other regional and global initiatives. This will ensure that InBIF gains full benefits from its national as well international engagements. This is essential for establishing, consolidating and expanding in-country regional or thematic Biodiversity Information Facilities (BIFs).

This will be achieved through activities such as assessment of participant capacity and needs, train the trainer activities, in-country mentoring for capacity enhancement, seeking mentorship from advanced global initiatives and countries, best practice guides, publisher and user driven training programs and e-learning programs, software and community build tools, distributed helpdesk, empowerment of key publishers and stakeholders, etc.

(a) Training

InBIF will provide a comprehensive portfolio of training initiatives to ensure appropriate adaptation of formats and contents to address regional context and needs. InBIF will also leverage on international network of experts from the GBIF community to provide the expertise and the human resources to successfully implement this initiative. The progressive incorporation of more electronic learning components in the training portfolio will continue to expand the reach to existing and new potential audiences. Wherever possible, the 'train-the-trainers' principle will be adopted and implemented. During 1st phase of InBIF 25 training programmes (5 each year) will be held ensuring development of a fleet of 625 'train-the-trainers' in various aspects of biodiversity informatics.

(b) Mentoring

Capacity enhancement programme will be initiated as a framework for collaboration between participant nodes, strategic partners and InBIF participants to invest in capacity building activities. InBIF will promote the use of this framework and will work directly with the interested organizations and donors in their planning, formulation, funding and implementation of mentoring projects. InBIF will focus its contribution on providing start-up packages of tools and documents to support the early stages of development of participant nodes, as well as on facilitating further training and collaboration opportunities for the

organizations involved. During 1st phase of InBIF 25 mentoring projects will be initiated (5 each year).

(c) Distributed Helpdesk

Coordinated by the Project Management Unit (PMU) in collaboration with other Nodes, experts throughout the participant network will comprise a 'distributed helpdesk' to assist rapidly InBIF participants and stakeholders through simple collaboration mechanisms when they experience problems. They will help to build local and regional capacity, continually expanding the groups of experts on each topic of interest to the InBIF and wider biodiversity informatics community. Support from the 'Content' and 'Informatics Infrastructure' strategic imperatives will be provided according to the target communities addressed.

(d) Advanced Diploma in Biodiversity Informatics

InBIF will initiate Advanced Diploma Course covering different aspects of biodiversity informatics including biodiversity data capture, digitization, discovery, publishing, use etc. During 1st phase, collaborations will be established with two universities each hosting 1 year Advanced Diploma in Biodiversity Informatics. These two centers of excellence are expected to develop fleet of nearly 200 'biodiversity informaticians' over a period of five years.

(e) Biodiversity Informatics Young Researcher Awards

"Students are the future of the biodiversity research community". To have more researchers in biosystematics and biodiversity informatics using InBIF enabled data, greater involvement with students and academia is needed and these awards will serve as an incentive towards that goal. The objective of the Young Researchers Award (YRA) would be to foster innovative research and discovery in biodiversity informatics by graduate students in masters and doctorate programmes at institutions/ universities participating in the InBIF network. The award has been put in place to stimulate use of InBIF enabled data by graduate students developing new research in biodiversity informatics and also to serve as an outreach mechanism to universities. During 1st phase of InBIF nearly 25 such Awards will be granted.

(f) Products

Design, Development & validation of Best Practice Guides, Position Papers, Outreach material, Development of Training Resources, MoU, MoA, Data Sharing, Data Publishing, Data Use agreements, Licensing & IPR & E-learning resources (technical recommendations, tutorials, and software documentation) are envisaged as products. Product may also include digital versions of promotional materials, meeting reports and other relevant documents contributed by the community. These resources will be continually updated and customized to ensure easy access and uptake by a wide range of users, from data managers and technicians, to experts and decision makers in charge of planning the implementation of large or complex biodiversity information networks and facilities.

(g) National Biodiversity Information Outlook

From the experience of developing this vision document and lessons learnt during its development need has been felt for repeating this exercise at a regular interval (say every 5 years) to assess the national progress in biodiversity informatics as against the national priorities and ambitions. This will align the efforts to meet the demands of multitude of stakeholder communities.

5. InBIF Governance

Given the multitude of stakeholders to be involved, range of strategic initiatives, potential dynamics and complexity of the network; it is crucial that flexible governance model be adopted to ensure success of InBIF. National and international partnerships, distributed and decentralized mode of operations of InBIF needs a stronger business approach in order to meet user requirements and to address the challenges of biodiversity loss. Thus, InBIF will require to be built by leveraging globally agreed tools, standards and interoperability principles. However, it will need to evolve ‘in-country’ governance model so that biodiversity informatics integral part of any biodiversity and environmental investigation/expedition so that expenses to be incurred on data collation and publishing are part of each such activity. It is only then real-time data discovery and publishing will happen coinciding with completion of such projects.

There are several governance models that have been adopted by the existing information infrastructure both nationally and globally. After reviewing them, and considering advantages and potential challenges in Indian scenario the following governance model is proposed. We propose that InBIF be established as a free-standing national facility with close linkages with the Ministry of Environment & Forests, National Biodiversity Authority and National Planning

Commission to fulfill the obligations spelt in Biodiversity Act 2002. It will constitute of Board of Consortium, Science Council, Advisory Committees, Task Groups, and small secretariat to run the central operations and services as well to support the governance structure.

(a) Validity, Authority and Jurisdiction of InBIF

- The InBIF shall come into existence through the ordinance or executive order of the Government of India to fulfill the expectations of Biological Diversity Act 2002. This would provide much needed legality, and authority to collaborate with various institutions and agencies which are likely to be part of the 'Board of Consortium' (**Figure 6**). This would facilitate InBIF to operate across ministries and agencies.
- The Board of Consortium is established through memorandum of understanding with key national players for self governance and future sustenance of its operations,
- The Board of Consortium will be a forum through which the InBIF partners make collective decisions on all matters relating to InBIF.

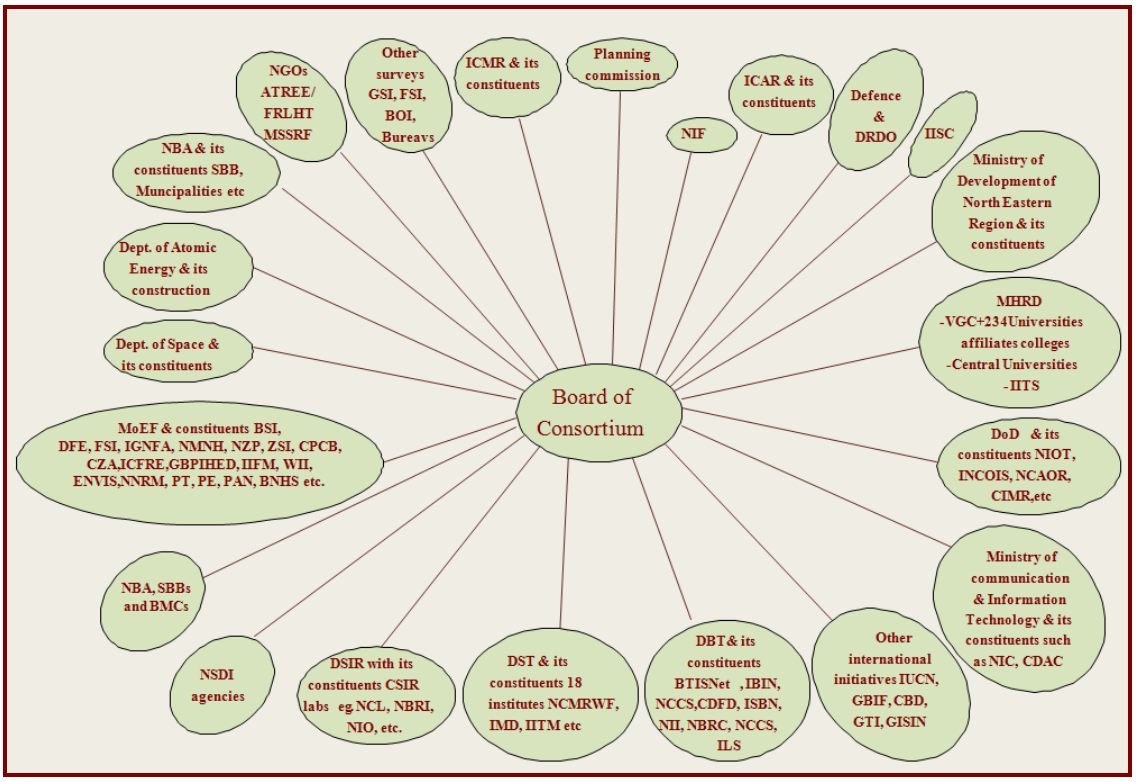


Figure 6: InBIF Board of Consortium will represent Ministries, agencies, institutions and NGOs working in the areas of biodiversity and ecosystems

- The Board of Consortium will be a forum through which the InBIF partners make collective decisions on all matters relating to InBIF.

- Science Council: The Science Council would be responsible for overseeing the scientific and technical integrity and currency in the development and progress of the InBIF strategic initiatives and makes recommendations to the Board of Consortium and the InBIF Secretariat.

- Advisory Committees and Task Groups: InBIF advisory committees and task groups will constitute of national and international experts in the area of biodiversity and ecosystems informatics. These committees will provide overarching directions and guidance as needed at a specific time to further the biodiversity and ecosystems informatics. The task groups will assist the Science Council on specific thematic, regional, computational and lingual aspects that may arise from time to time. These will be time-limited group that would dissolve once its objectives are met.

(b) Funding model

It is beyond doubt that initiative of such a magnitude with potential of long ranging impacts, investment would be in multiples of 100's of crores. It is envisaged that InBIF would require investment in an incremental manner during the next decade. Needless to say, investment of such a magnitude makes InBIF an expensive proposition to be established in first place. However, this estimate is based on through analysis and review of the investment attracted by similar initiatives in other regions of the world.

For instance, in mainstream bioinformatics initiatives such as National Center for Biotechnology Information (http://www.ncbi.nlm.nih.gov/) with approximately 46,400,000 sequence records in its possession has a recurring budget of US$ 50 million per annum. Protein Data Bank (PDB) with over 31000 annual records has recurring budget of US$ 5 million (GBIF, 2006). In the field of biodiversity informatics, Species2000-ITIS Catalogue of Life (CoL) which has recently documented over 1 million of the known 1.8 million species needed an investment of UK £ 11 million during 1994 – 2001 for central operation alone. This is in addition to UK £ 77 million invested during the same period for 47 GSDs that constitute Species2000-ITIS CoL (Bisby, 2007, pers. comm, 2007) At regional scale, IndOBIS, Indian Ocean Node of OBIS alone needed US$150,000 to kick start its 2 year moderate operations, and if its operations

have to deliver the goal of documenting known life from Indian Ocean, it would need an investment of over US$500,000 per annum for a period of next 10 years.

The GBIF in its first 5 years of operations invested approximately US$3.5 million per year in order only integrate over 80.5 million data records from distributed data providers. This is in addition to an average US$ 20 million per annum spent by each of the 13 member countries, and organizations surveyed (GBIF, 2005). During its next phase, GBIF would require on an average US$ 5 million per annum for running its current operations, and additional US$5 million per year to add up new modules to its work programmes as envisioned in its 2007-2011 strategic plan (GBIF, 2006). Thus, considering the scope and magnitude of involved, investment anticipated in NBG is not too much. Recently launched Encyclopedia of Life (EoL) is seeking an investment of US$50 million over next 10 years (EoL, 2007).

Thus relevant investment to realize the dream of NBG through InBIF is needed. However, such a requirement needs to be carefully planned, and evolved.

The NBG and InBIF Roadmap

- Transforming a 500 year tradition of (slow) information transfer by lines of type on paper into a digital (rapid) interchange among thousands of distributed, heterogeneous, and multilingual databases, while at the same time dealing with complexities of the information itself as well as the means of handling it, is no simple task, nor can this task possibly be accomplished in only 5-10 years. This is why NBG and InBIF as its implementation arm would certainly prove itself as a mega-science activity.

- While, nation would start enjoying benefits of accessing and using data information pulled together by NBG in next 5-10 years, the demands of data use cases, data use patterns, data synthesis and analysis tools, decision support system tools are bound to explode, as people's imagination would suddenly be boosted.

For mega-biodiversity developing nation such as India, which is aspiring to be major developed super-power, it is essential to have data enriched "National Biodiversity Grid", for its economic, ecological and social well-being. NBGneeds to be developed as distributed facility, with open participation by potential data providers, in order to leverage on existing investment. For the magnitude and scale of biodiversity and

associated data that exists and is being generated, web services architecture is best suited as technological framework for implementing NBG. Exchange of data is one of the major challenges for realizing the dream of NBG, The current political, social, and economic scenario provides excellent opportunities to pursue this dream. With guaranteed core funding support and mandate from the appropriate functionaries of the Government of India, NBG is not impossible to implement. Thus initiative would lead to liberating biodiversity data, making it available to anyone, anytime, anywhere respecting the intellectual property as well as ecological sensitivity and national security.

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Concept Note on

National Biodiversity Information Outlook (NBIO)

Abstract:

Biodiversity information is crucial to a wide range of scientific ecological, economic, and social endeavors. It is also a key element for making informed decisions and developing sustainable strategies for conserving bioresources. However, relevant information is difficult to access and thus limiting its usability. The growing realization and recognition of these facts has resulted in the development of a new discipline, 'Biodiversity Informatics' which uses information technology to store, manage, disseminate and analyze vast amount of biodiversity data . Large and increasing volume of biodiversity data in varying quality, formats and physical distribution makes it difficult to access pertinent information. This calls for a comprehensive assessment of the biodiversity information and factors influencing its easy accessibility. The National Biodiversity Information Outlook (NBIO) is an initiative for providing the assessment of biodiversity information and a roadmap for achieving strategic goals and objectives in biodiversity informatics. India is hosting the CBD CoP 11 in October, 2012 and the NBIO is planned to be released in a side event.

Introduction:

India is designated as a mega-diverse country with its unique biodiversity and a rising global power due to its economic growth. However, it is vital that India uses its bioresources in a sustainable manner so as to ensure continued growth as a 'true global power' in all aspects of socio-economy and biodiversity conservation. The knowledge related to our biodiversity is most important to a wide range of scientific, educational, commercial and governmental activities. Easy and quick access to biodiversity data is essential for efficient sustainable conservation and making informed decision in many realms. Biodiversity Informatics is a developing discipline that applies information technology tools and techniques in collection, collation, analysis and dissemination of enormous volume of biodiversity data.

Twenty first century India faces major challenges which are strongly linked with sustainable use of bioresources. These include (a) exponential growth of human population; (b) natural resources based economy, and (c) large volume of biodiversity information.
Meeting these challenges, without timely discovery, efficient access to pertinent information and knowledge on the status of bioresources and the impacts of human centered development on it, is an uphill task.
However, relevant information is geographically scattered in diverse languages and digital and non-digital formats with researchers, institutions, universities and organizations due to paucity of '***national biodiversity information infrastructure***', which creates conducive framework for discovery and publishing of this data. Therefore, it is imperative that India recognizes biodiversity informatics as a corner stone of its economical, environmental, and social well-being.

During the past 10 years significant progress has been made by many regional and global initiatives, especially the Global Biodiversity Information Facility (GBIF). The GBIF (www.gbif.org) is an inter-governmental initiative established in 2001 with a mission to facilitate free and open access to global biodiversity data. At present, 56 countries and 46 international organizations are members of the GBIF. Since its establishment the GBIF network and its participants (both countries and international organizations) have develop capacities in various areas of biodiversity informatics. These include (a) discovery, digitization, and publishing of biodiversity content, (b) distributed, decentralized, and interoperable information infrastructure, (c) engagement, cooperation and partnerships with relevant stakeholder, publisher and user communities both nationally and globally, (d) building and strengthening human, technical, and infrastructural capacity of the network, and (e) assessment and deliver needs of stakeholder and user communities of such a national facility.

Indian Biodiversity Information Facility (INBIF): A need of a 21st Century India

In order to build 'distributed *and decentralized information infrastructure*' to serve the national interests and also provide interoperability with regional and global initiatives it is urgently

required to set up the Indian Biodiversity Information Facility (INBIF). The purpose of the INBIF as a national information infrastructure dedicated to biodiversity can be summarized through vision statement and set of objectives.

Appendix 1 outlines vision, mission and key features of such a facility. However, it requires broader consultation with key stakeholders, beneficiaries, and national funding agencies. In order to develop consensus roadmap with stronger commitments from across the board calls for the development of the 'National Biodiversity Information Outlook (NBIO)'.

National Biodiversity Information Outlook (NBIO)

The first step for establishing the INBIF is the development of a strategic vision document for the National Biodiversity Information Outlook (NBIO). The goal of the NBIO is to provide a tool for use by biodiversity stakeholders, data custodians/publishers and users to:

- assess the *state-of-the-art* of the biodiversity information in India,
- identify barriers to facilitate and encourage progress in biodiversity informatics,
- assist prioritizing acquisition, discovery and publishing of biodiversity information by relevant stakeholders/players and
- communicate progress and advocate needs to decision-makers in the form of a National Biodiversity Informatics Roadmap during the United Nations Decade of Biodiversity.

The users of the NBIO are principally key stakeholders who either produce and/or use biodiversity information. These stakeholder ranges from biodiversity researchers, academicians, ecologists, conservationists, natural resource managers, planners and policy makers.

The NBIO shall provide an up-to-date assessment of the status of (a) biodiversity information, (b) informatics infrastructure to acquire, manage, store, disseminate and analyze biodiversity data, (c) use, implementation, and need for standards, tools and processes in biodiversity

informatics, (d) socio-cultural and economic challenges for and of biodiversity informatics, (e) capacity building, (f) use of biodiversity information for informed decision-making and governance, (g) incentives, impact and metrics needed for encouraging and accounting progress in biodiversity informatics, and (h) networking, engagement, and outreach to foster and further the biodiversity informatics.

It is also envisaged that the NBIO will provide roadmap for making comprehensive progress in biodiversity informatics, such that investments in this new emerging area are scientifically, ecologically, socially and economically relevant. It is imperative to have a sound rationale for every rupee investment that is envisaged towards the INBIF. Such an investment shall help us in addressing national challenges both in medium and long term. Thus, the NBIO is fundamental for sustenance and relevance of the INBIF.

Annexure 1

Indian Biodiversity Information Facility: A need of a 21st Century India

In order to build a '*distributed and decentralized information infrastructure*' to serve the national interests and provide interoperability with the GBIF and other global initiatives it is urgently required to set up the Indian Biodiversity Information Facility (INBIF). The purpose of the INBIF, as a national information infrastructure dedicated to biodiversity is summarized through vision statement and set of objectives.

Vision: *INBIF shall contribute towards ecological sustainability and economic growth and through increasing and improving discovery, accessibility, completeness and utility of existing and new biodiversity data and information.*

Thus, the INBIF is an attempt to develop much needed 'national biodiversity information infrastructure' that will ameliorate in-country capacity in the area of biodiversity informatics. This will ensure easy access to nations' biodiversity data at anytime, anyplace, to anyone under an agreed framework.

Mission: *The mission of the INBIF is to promote and enable easy access to Indian biodiversity data through distributed and internet based network of data custodians and publishers to underpin science, conservation and sustainable development.*

Key features: The INBIF will:

- be a distributed facility, while encouraging co-operation and coherence;
- be national in scale, though implemented by variety of local to national level players;
- be open to participation by individuals, communities, agencies, institutions, from all walks of life, and offering potential benefits to the entire nation and its constituents;
- assist bridge human language barriers by promoting standards and software tools designed to facilitate their adoption in multiple languages, character sets, and computer encoding;

- serve to disseminate technological capacity by drawing on and making available scientific, technical, and social information;
- incentivize efforts of data publishers, acknowledge and fulfill national aspirations such as intellectual rights, economic wealth, bio-security, and social wellbeing;
- be interoperable with regional and global initiatives facilitating exchange/sharing of data with these information systems/networks;
- leverage global progress in the area of biodiversity informatics through initiatives such as the Global Biodiversity Information Facility (GBIF) to prevent duplicating efforts;
- will facilitate data discovery through registry;
- focus on interoperable and scalable development;
- will have a decentralized implementation;
- will be sustained through distributed capacity enhancement, sustainable funding sources, and ownership by the stakeholder communities;
- based on innovative mechanisms for incentivization; and
- have an inclusive and holistic approach during implementation.

National Biodiversity Information Outlook – a roadmap for developing national biodiversity information infrastructure in India

Twenty-first century India provides several unique opportunities and challenges. Being one of the 17 megabiodiverse countries, it is supporting an estimated total of 7–8% of the globally documented species[1]. It is also advancing as a potential global economic powerhouse[2]. In the wake of its growing human population, India is experiencing increasing pressure on its bioresources and ecosystem services[3] due to high demand for food, water, fuel and raw materials[4]. Indian biodiversity researchers, governmental agencies, policy makers and even citizens are faced with challenges such as how to optimize food and water security together with sustainable biodiversity[5,6]. As a consequence, these stakeholders are acknowledging that it is essential to use and manage India's bioresources in a sustainable manner so as to ensure continued growth as a 'true global power'.

This has resulted into ever-increasing demand for timely discovery of and quick access to biodiversity data and information, as good data depicting the state of the biodiversity are vital to support responses to key issues related to biodiversity conservation and sustainable use of bioresources. While a plethora of biodiversity data and information are available and being generated, their adequate accessibility and use is limited due to scatteredness in diverse languages and digital and non-digital formats with researchers, institutions, universities and organizations[7]. In the recent past, biodiversity professionals in India have begun exploiting the power of information technology as a tool for organizing, disseminating, analysing, exchanging, publishing and discovering of biodiversity data and information[7–14].

However, we lack national biodiversity information infrastructure that can enhance the discovery, accessibility and usage of available biodiversity data by creating interoperable framework of exchange and sharing of these resources[15]. This is irrespective of the fact that India has emerged as a global powerhouse of information technology. Information technology has further changed the ways biodiversity research is conduced, and has paved way for a new multidisciplinary field called 'biodiversity informatics'[16,17]. Thus, in our opinion, biodiversity informatics is the essential cornerstone for India's economic, environment and social well-being[15,18]. Therefore, a decentralized and distributed national biodiversity information infrastructure, the Indian Biodiversity Information Facility (INBIF) is urgently required. This will provide the much needed inter-operability mechanism as well as a exchange and sharing framework with several national and international biodiversity data initiatives. However, establishing such an infrastructure calls for consensus roadmap with stronger commitments from key stakeholders, beneficiaries and national funding agencies. The National Biodiversity Information Outlook (NBIO) has been initiated as a first step in this direction.

It is expected that the NBIO will help in providing up-to-date assessment on the status of: (a) biodiversity data and information in India; (b) use of biodiversity data for informed decision-making and governance; (c) informatics infrastructure to acquire, manage, store, disseminate and analyse biodiversity data; (d) use, implementation and need for standards, tools and processes in biodiversity informatics; (e) socio-cultural and economic challenges for and of biodiversity informatics; (f) capacity building, incentives, impact and metrics for furthering and accounting progress in biodiversity informatics, and (g) networking, engagement and outreach to foster and advance the science and practice of biodiversity informatics.

Further, it is also envisaged that the NBIO will provide the roadmap for making comprehensive progress in biodiversity informatics so as to ensure that investments in this new emerging area remain ecologically, socially and economically relevant. It is imperative to have a sound rationale for every rupee invested in the planning and operationalization of INBIF. Such an investment will assist in addressing national challenges both in medium and long term. Thus, the NBIO will be fundamental for sustenance and relevance of the INBIF.

In view of the increasing attention to biodiversity conservation, and a similar global initiative to develop 'Global Biodiversity Informatics Outlook (GBIO)' undertaken by the Global Biodiversity Information Facility, NBIO development is a timely initiative. Thus, as a first step towards this, the Ministry of Environment and Forests and the National Biodiversity Authority (NBA), Government of India, and the Wildlife Institute of India, Dehradun have been assigned the task to prepare a strategic vision for the development of the NBIO. The NBIO will be released during the 11th meeting of the Conference of the Parties (CoP) to the Convention on Biological Diversity (CBD) in Hyderabad, in October, 2012. The NBIO team has launched a national survey to identify; (a) major obstacles constraining the use, exchange and sharing of biodiversity data; (b) barriers hampering progress in biodiversity informatics, and (c) crucial issues related to biodiversity data and information needs to be addressed over the coming decade. Based on the responses to the survey questions by the key stakeholders, a draft NBIO will be formulated by early August 2012. This will then form the basis of further national consultation through a brainstorming workshop on the NBIO, involving key researchers, policymakers, and government representatives during 20–21 August 2012 at New Delhi. The results from the survey and brainstorming session will be used for developing and finalizing the NBIO 2012. The authors would like to urge biodiversity stakeholders to participate in this initiative (https://www.surveymonkey.com/s/NBIO) and provide their valuable feedback for the development of a comprehensive vision document for ensuring effective progress in biodiversity informatics and in achieving CBD Aichi targets[19].

In the short term, the NBIO will help develop the roadmap for establishment of INBIF. In the long term, increased accessibility to biodiversity data will help develop national strategy and action plans (NBSAPs) that are informed and accurate. Such NBSAPs will go a long way in ensuring sustainable management of our precious biodiversity resources.

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National Biodiversity Information Outlook (NBIO) survey

Rationale

Biodiversity data and information is crucial to a wide range of scientific ecological, economic, and social endeavors. It is also a key element for making informed decisions and developing sustainable strategies for conserving bioresources. However, relevant information is difficult to access and thus limiting its usability. The growing realization and recognition of these facts has resulted in the development of a new discipline, **'Biodiversity Informatics'** which uses information technology to store, manage, disseminate and analyze vast amount of biodiversity data.

Large and increasing volume of biodiversity data in varying quality, formats and physical distribution makes it difficult to access pertinent information. This calls for a comprehensive assessment of the biodiversity data and factors influencing its easy accessibility. The **National Biodiversity Information Outlook (NBIO)** is an initiative for providing the assessment of biodiversity information and a roadmap for achieving strategic goals and objectives in biodiversity informatics.

We are conducting a broad survey across the biodiversity stakeholders in India and are interested to know how people use, exchange and share biodiversity data and information. We would appreciate if you would respond briefly to the questions. The results from this survey will assist us in developing a strong and effective National Biodiversity Outlook 2012.

PLEASE NOTE:

1. Please *read* the survey questions before you start responding.
2. Survey will take approximately *20-30 minutes* to complete.
3. Questions marked with *asterisk (*)* are *mandatory*.
4. The survey consists of both *multiple choice* and *descriptive* questions.
5. *Tick* the appropriate boxes and write your response in the provided text boxes.

For feedback, comments contact: vbm@wii.gov.in, mousumi@wii.gov.in

National Biodiversity Information Outlook (NBIO) survey

A. Respondent information

***1. Name of the participant**

***2. Designation**

***3. Contact details of the participant**

***4. Affiliation**

National Biodiversity Information Outlook (NBIO) survey

B. Use of biodiversity data and information

Your response to below mentioned questions will enable us to identify what type of biodiversity data is created, used, and exchanged in your work and study. The results will assist us to address issues associated with the use of biodiversity data and information while developing the NBIO 2012.

5. Does your institution, organization, department, faculty or laboratory use biodiversity information?

- ◯ Yes
- ◯ No

6. What core biodiversity data is frequently used by your institution, organization, department, faculty or laboratory?

Choose relevant single or multiple options.

- ☐ Occurrence data
- ☐ Taxonomic names and authoritative taxonomic classifications
- ☐ Multimedia (sketches, images, photographs, video, audio, etc.)
- ☐ Animal and plant descriptions keys
- ☐ Species lists
- ☐ Distributions maps
- ☐ Threatened/endangered status
- ☐ Trends over time (For example, Impacts of climate change on phenology and ecophysiology)
- ☐ Feral
- ☐ Weeds
- ☐ Invasive species
- ☐ Gene/Protein
- ☐ Pathogens
- ☐ Diseases
- ☐ Pets

Other (please specify)

National Biodiversity Information Outlook (NBIO) survey

7. What biodiversity data do you or your institution, organization, department, faculty or laboratory create?

Choose relevant single or multiple options.

- [ ] Occurrence data
- [ ] Taxonomic names and authoritative taxonomic classifications
- [ ] Multimedia (sketches, images, photographs, video, audio, etc.)
- [ ] Animal and plant descriptions keys
- [ ] Species lists
- [ ] Distributions maps
- [ ] Threatened/endangered status
- [ ] Trends over time (For example, Impacts of climate change on phenology and ecophysiology)
- [ ] Feral
- [ ] Weeds
- [ ] Invasive species
- [ ] Gene/Protein
- [ ] Pathogens
- [ ] Diseases
- [ ] Pets

Other (please specify)

National Biodiversity Information Outlook (NBIO) survey

C. Challenges to access & publish data and information

The capacity and ability to quickly access, synthesize analyze and publish biodiversity data is essential for addressing the scientific, management and planning challenges that climate change and associated anthropogenic impacts pose.
The response to these questions will enable us to identify key challenges while accessing and publishing biodiversity data and information in your work and study. The results will assist us to address challenges associated with the accessibility and publishing of biodiversity data and information, while developing the NBIO 2012.

8. When looking for biodiversity information where do you tend to go?

Choose relevant single or multiple options.

- ☐ Experts
- ☐ Secondary source (Books, reports, articles, journals etc)
- ☐ Museums
- ☐ Community (Parataxonomist, Indigenous communities, non-Indigenous people etc.)
- ☐ Microorganisms culture collections
- ☐ Herbaria
- ☐ Online data portals (e.g. GBIF, NCBI etc.)

Other (please specify)

9. Does your institution, organization, department, faculty or laboratory use biodiversity informatics standards and protocols?

- ◯ Yes
- ◯ No

10. What are your institution, organization, department, faculty or laboratory policies regarding exchange, sharing and publishing biodiversity data?

Max 50 words.

11. What are the core challenges' encountered by your institution, organization, department, faculty or laboratory for accessing, sharing and publishing biodiversity data?

Max 50 words.

National Biodiversity Information Outlook (NBIO) survey

12. How you or your institution, organization, department, faculty or laboratory has overcome those challenges?

Max 50 words.

National Biodiversity Information Outlook (NBIO) survey

D. National Biodiversity Information Facility (InBIF)

Today, it is a challenge to have efficient access to pertinent information and knowledge on the status of bioresources and the impacts of human centered development on it. However, relevant data and information is geographically scattered in diverse languages and digital and non-digital formats with researchers, institutions, universities and organizations due to paucity of 'national biodiversity information infrastructure', which creates conducive framework for discovery and publishing of this data.
Your responses to the following question will enable us to understand how such information infrastructure will ameliorate in-country capacity in the area of biodiversity informatics and ensure easy access to nations' biodiversity data at anytime, anyplace, to anyone under an agreed framework.

13. Do you acknowledge that easy access to up-to-date biodiversity data and information from species to molecular level is important for improving the outcome of scientific studies and conservation policies in India?

- ◯ Yes
- ◯ No

14. Do you think in India biodiversity information is optimally available and used by scientific community, policymakers, stakeholders and citizens for protecting and conserving biodiversity?

- ◯ Yes
- ◯ No

15. Do you think India needs national biodiversity information infrastructure to promote sharing, discovery, publishing, integration, analysis and easy accessibility of biodiversity data and information for scientific studies, developing sustainable strategies and conservation efforts?

- ◯ Yes
- ◯ No

16. Do you think there is a need for all stakeholders, funding agencies and policy makers in India to come together for developing national biodiversity information infrastructure?

- ◯ Yes
- ◯ No

17. What are the crucial scientific breakthroughs that you see as a result of national biodiversity information infrastructure?

Max 50 words.

National Biodiversity Information Outlook (NBIO) survey

E. National Biodiversity Informatics Outlook (NBIO)

The goal of the NBIO is to provide a tool for use by biodiversity stakeholders, data custodians/publishers and users. Your brief responses to the following questions will provide an opportunity to *(a) assess the state-of-the-art of the biodiversity information in India, (b) identify barriers to facilitate and encourage progress in biodiversity informatics, (c) assist prioritizing acquisition, discovery and publishing of biodiversity information by relevant stakeholders/players and (d) communicate progress and advocate needs to decision-makers in the form of a National Biodiversity Informatics Roadmap during the United Nations Decade of Biodiversity.*

18. Briefly mention the incentives and metrics needed to encourage publishing of biodiversity information?

Max 100 words.

19. How much investment do you think, within your institute over a period of 5 – 10 years, will be required to mainstream biodiversity data publishing framework?

Max 50 words.

20. Do you think biodiversity informatics courses are required in the Universities for developing biodiversity informatics capacity to address challenges faced while protecting the Indian biodiversity?

- ◯ Yes
- ◯ No

21. In short, what initiatives and strategies do you think are crucial for enhancing the growth of biodiversity informatics in India?

Max 50 words.

22. Do you think the development of National Biodiversity Informatics Outlook will provide a vision and a roadmap for making comprehensive and constructive progress in biodiversity informatics?

- ◯ Yes
- ◯ No

National Biodiversity Information Outlook (NBIO) survey

23. What are the crucial aspects you would like to include as a part of shared vision and roadmap while developing the National Biodiversity Informatics Outlook?

Max 100 words.

24. What are the information infrastructure challenges that you think would arise from the expected data growth?

Max 50 words.

25. What are the social, cultural, economic and societal changes required for realizing such a scientific breakthrough?

Max 50 words.

26. What necessary steps are required to enhance the quality of biodiversity information for using it efficiently?

Max 50 words.

National Biodiversity Information Outlook (NBIO) survey

Feedback

We would like to thank you for taking out the time to participate in this survey. You may have suggestions, comments or advice for us regarding this survey and/or the NBIO 2012 . We encourage you to provide us with your valuable feedback.

Alternatively, you can also send your feedback on this email address: vbm@wii.gov.in

27. Enter you feedback, comments or advice below.