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## **Ghana's Taxonomic Needs**

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### **The information and expertise required to support Agriculture, Biodiversity, Environment, Fisheries and Forestry Management**

Compiled by:

**Professor Alfred Oteng-Yeboah**

Department of Botany, University of Ghana, Legon, Accra, Ghana (previously with the Health and Environment Sector, Council for Scientific and Industrial Research)

**Dr Peter Kwapong**

Department of Entomology & Wildlife - International Stingless Bee Centre, University of Cape Coast, Cape Coast, Ghana

**Ms Millicent Asaaba Cobblah**

Department of Zoology (Now Department of Animal Biology and Conservation Science)  
University of Ghana, Legon

**Dr Richard Smith**

Director, BioNET-INTERNATIONAL Secretariat, Egham, UK

**Dr Christopher H C Lyal**

UK National Global Taxonomy Initiative Focal Point, The Natural History Museum,  
London, UK

# Taxonomic Needs Assessment for Ghana

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# 1 Executive Summary

Taxonomy is the science of naming, describing and classifying organisms. Taxonomy is the tool by which the components of biological diversity are identified and enumerated, and therefore provides basic knowledge underpinning management of biodiversity. Accurate Identifications may be critical for protection of crops, applications of herbal remedies, trade, conservation and protection of Ghana's rights. Taxonomists have named and described some 1.78 million species of animals, plants and microorganisms, which is only a fraction of the estimated 5 to 30 million species on Earth. Most of the unknown species are in tropical countries such as Ghana.

The Taxonomic Needs Assessment of Ghana is in response to CBD COP Decisions under Article 7, which call for such assessments to be carried out. It is intended also to inform Government of Ghana, and other relevant institutions, initiatives and individuals of priority actions.

The Assessment was carried out with input from a wide variety of people from different sectors of Ghanaian science, environmental management, agriculture, forestry and education, including people at senior and comparatively junior levels. Coupled with previous work and other research, this enables a good oversight of the situation and needs of the country for taxonomic capacity to manage its biodiversity sustainably, conserve it and benefit from its genetic resources, as well as manage agricultural and forestry resources. The results are intended to complement and build on the National Biodiversity Strategy and Action Plan (NBSAP), and provide support for its revision.

Thirty-one recommendations are made, under the general objectives to increase awareness and build communication, support and develop training, develop biological collections, improve capacity for data management and analysis, provide targeted taxonomic information in a timely manner, provide access to identification services and tools, and facilitate access to ecological and distributional information.

## **Summary of Recommendations (see Section 6 for full text)**

### **Overarching vision**

By the end of 2010 and beginning of 2011:

1. A special coordination mechanism for biodiversity should be created at the national level.
2. Biodiversity should be fully integrated into all the sectors of Ghanaian economy, with MEST promoting inter-ministerial co-ordination.
3. The majority of Ghanaians should be adequately informed about biodiversity and ecosystem services for human well-being.

### **Increasing awareness and building communication**

4. Develop an Action Plan to take forward the recommendations in this Assessment
5. Create a directory of taxonomists and their expertise.
6. Strengthen communication between the Ghanaian Government, the taxonomic community and others on policy needs identified by the CBD on GTI and other relevant thematic areas and cross-cutting initiatives, and of the efforts made to implement these policies.
7. Improve communication between different sectors with responsibility for biodiversity.
8. Encourage taxonomists and others to engage more with the public and other stakeholders.
9. Hold cross-disciplinary workshops.

### **Improving creation and delivery of taxonomic information through capacity-building**

10. Increase provision of training resources to educational establishments.
11. Establish a Consortium of Experts within the Country or Region, with the responsibility to: (i) identify necessary elements of taxonomy to be taught at different educational levels; (ii) to provide a recommended list of resources and where to obtain them;
12. Create and deliver a short refresher course on taxonomy and taxonomic tools, aimed at practicing taxonomists and those that teach or lecture on taxonomy.

### **Developing Collections**

13. Create a National Biological Collection on one or more sites, with a statutory duty to maintain the collection for the benefit of Ghana and as a regional resource.
14. Improve the ability of collection-holding institutions to employ sufficient staff to manage collections and provide an expert resource.
15. Develop a network of biological collections within Ghana.
16. Create an inventory of the holdings of biological collections within Ghana at collection level.
17. Build capacity to capture data from specimens held within Ghanaian collections.

### **Data management and analysis**

18. Build and enhance capacity within collection-holding and other relevant organisations in data and information management.
19. Ensure delivery of training in bioinformatics.

### **Provision of taxonomic information through institutional capacity-building**

20. Build identification system within Ghana, integrating local level services such as extension workers with regional and national centres.
21. Develop a range of cheap and user-friendly identification guides to priority groups and ecosystems.
22. Improve contents of and access to specialists libraries within Ghanaian taxonomic centres.
23. Create authoritative and accessible set of images of key Ghanaian species.
24. Ensure taxonomic identification and assessment capacity is available to carry out inventory work in priority areas, and to identify biodiversity hot spots.
25. Develop capacity to protect fruit production by monitoring fruit fly across Ghana.
26. Develop capacity to protect crop production by monitoring pollinators across Ghana.
27. Seek collaboration with local and external institutions in information exchange, science and technology.
28. Develop and maintain a list of all Ghanaian species of plants, animals and microorganisms.
29. Engage taxonomic support for the building of a Red Data List of threatened and extinct species.

### **Ecological and distributional information**

30. Develop a sustainable resource for sharing distributional and ecological information.
31. Create distribution maps for priority species in conservation.

## 2 Introduction

This document presents the results of a Taxonomic needs assessment. It is designed to identify the needs of institutions and personnel across the country in managing, sustainably using, and benefiting from Ghana's biodiversity, as they rely upon the provision of taxonomic information. Ghana's National Biodiversity Strategy and Action Plan notes "undeniable weaknesses in the capacities and capabilities of some institutions" and "Lack of baseline data and deficiencies in information management constrain resource management". The intent of this assessment is to identify where taxonomic capacity can alleviate weaknesses, provide data and improve relevant information management.

### 2.1 'The Taxonomic Impediment'

Currently<sup>1</sup> there are 191 Parties to the Convention on Biological Diversity; Ghana ratified the Convention on 29<sup>th</sup> August 1994. All of the Parties have made commitments on conservation, sustainable use, and fair and equitable access to the genetic benefits of biological diversity – the three aims of the Convention. In order to meet these commitments, and manage their biodiversity, they need to be able to identify what that biodiversity is made up of. This process needs taxonomy – the identification, naming and classification of organisms.

For most countries in the world, there is simply too little taxonomic expertise, information and infrastructure available to enable them to work with their biota in the way they need. This deficiency is known as the 'Taxonomic Impediment' to implementing the Convention on Biological Diversity. The Taxonomic Impediment is therefore specifically about the taxonomic needs of non-taxonomists: conservationists, environmental managers, quarantine officers, foresters and so on. It is, of course, not an issue restricted to CBD implementation alone, but is also pertinent to other health and environmental issues.

Understanding the Taxonomic Impediment in a country or region so that it can be removed can only be done by working with the users of taxonomy in these other fields, and identifying their taxonomic needs and the way they use taxonomy. This process is known as a Taxonomic Needs Assessment.

### 2.2 *The Convention on Biological Diversity and the Global Taxonomy Initiative*

The Convention on Biological Diversity is a global policy response to the threats to biodiversity. It entered into force on 29 December 1993, with 3 main objectives:

- *the conservation of biological diversity,*
- *the sustainable use of its components and*
- *the fair and equitable sharing of the benefits arising out of the utilization of genetic resources*

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<sup>1</sup> as of July 2009

The Parties to the CBD, having acknowledged the existence of the ‘taxonomic impediment’, developed the Global Taxonomy Initiative (GTI) as a ‘Cross-cutting Issue’ of the Convention to:

- *identify taxonomic needs and priorities;*
- *develop and strengthen human capacity to generate taxonomic information;*
- *develop and strengthen infrastructure and mechanisms for generating taxonomic information, and for facilitating the sharing of and access to that information; and*
- *provide taxonomic information needed for decision-making regarding the conservation of biological diversity, sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources (the three objectives of the CBD).*

The CBD Parties developed a ‘Programme of Work’ for the GTI, with 19 planned activities. The first three of these relate to assessment of taxonomic needs at national, regional and global levels.

The fourth planned activity addresses public awareness and education. There has been some implementation of this activity, and more is expected including through the Global Initiative on Communication, Education and Public Awareness (CEPA) under the Convention.

The fifth and sixth planned activities address capacity-building to support access to and generation of taxonomic information, and strengthening of networks for regional cooperation. In spite of many efforts and initiatives that contribute to capacity-building, it is well-established that the world’s taxonomic expertise is shrinking. Regional cooperation has been fostered to some extent, but more needs to be done and cooperation alone will not alleviate the need for increased capacity.

The seventh planned activity envisages development of a coordinated global taxonomic information system. In this regard, the Global Biodiversity Information Facility and others have made considerable progress in improving inter-linkages and in harmonizing approaches so that information can be shared.

The remaining 12 planned activities address the role of taxonomy in supporting work under the CBD on thematic areas and (other) cross-cutting issues. The GTI is itself a cross-cutting issue, and the use of taxonomy is necessarily driven by user needs, so it is appropriate that the programme of work focuses on users. The specific planned activities address the following:

- *Marine and coastal biodiversity;*
- *Agricultural biodiversity*
- *Forest biodiversity;*
- *Inland waters biodiversity;*
- *Dry and sub-humid lands biodiversity;*
- *Mountain biodiversity;*
- *Island biodiversity;*
- *Access to genetic resources and benefit-sharing;*
- *Invasive Alien Species;*
- *Traditional knowledge, innovations and practise;*
- *Ecosystem approach, impact assessment, monitoring and indicators; and*
- *Protected Areas.*

The Conference of the Parties, which is the governing body of the CBD, develops and refines the GTI, with support from various mechanisms and actors, including the CBD secretariat, the Coordination Mechanism for the GTI, national focal points, and the Subsidiary Body on Scientific, Technical and Technological Advice. Responsibility for implementation of the GTI lies with many actors, in particular national governments, but also relevant organizations, funding agencies, and taxonomists themselves along with their institutions. Implementation of the GTI is facilitated and/or monitored through several means including national biodiversity strategies and action plans, national reports, and various outreach activities and initiatives.

Implementation of the GTI depends largely on funding, not only for projects and initiatives specific to taxonomy but also for biodiversity-related projects and initiatives with a taxonomic component.

### **2.3 Taxonomic Needs Assessments**

The Parties to the Convention on Biological Diversity (CBD) have repeatedly identified the importance of National Taxonomic Needs Assessments. The GTI Programme of Work suggests that National Governments, with the support of national and international organizations and institutions as needed, should play a leading role in carrying out assessments. Some countries have used national biodiversity strategies and action plans (NBSAPs) as well as national reports under the Convention to indicate their need for taxonomic capacity, but few details have been provided. So far, national needs assessments have been or are being carried out by a few countries, for example UK and South Africa. In each case the assessment does not cover all possible stakeholders with an interest in taxonomic information, since resources have been too few to allow such a comprehensive process.

Understanding what taxonomic information is required in order to meet CBD-related needs is vital for good management and of great importance in building National Biodiversity Strategies and Action Plans. Once the needs are known the available resources can be assessed and the results used to set goals and priorities for building necessary capacity. If countries are involved in regional taxonomic networks needs can also be assessed within the context of meeting obligations to those collaborations, especially when participation may include complementarities and sharing of research effort. For Ghana, the partnership with other countries of the WAFRINET LOOP of BioNET-INTERNATIONAL is of potential importance in this regard.

As with so many Convention-related activities, a taxonomic needs assessment has both policy and implementation outputs. For policy, assessments should state clearly if and how lack of taxonomic capacity and / or information impedes implementation of NBSAPs. The needs assessment is also a working document which can be used to inform taxonomists and funding bodies of the taxonomic input required. The process of conducting a needs assessment itself can be used to raise awareness of the CBD and of taxonomic needs.

Assessing the *taxonomic needs* of a country are quite distinct from assessing the *taxonomic capacity* of a country, which refers to what taxonomy can be done, and the levels of expertise, information and infrastructure, without considering needs. The taxonomic capacity is very important to understand, but can only be assessed in the context of the needs identified. In the current study both the needs and capacity are discussed.

### **2.3.1 Examples of taxonomic needs**

There are a very large number of taxonomic needs that exist globally. They can, however, be refined to a relatively small number of classes. One example arises from the monitoring programmes for biodiversity at the species level as discussed in CBD Article 7. Ghana is running some such monitoring activities but has only incomplete data on the number of species (3<sup>rd</sup> National Report to the CBD). The provision of these data require development of standardised monitoring systems (many of which have been developed by taxonomists), means of sorting the specimens collected (observation is sufficient only for taxonomic groups which are simple to identify such as large mammals or birds; most groups, such as invertebrates and many plants, require collection of specimens), identification of those specimens and provision of up-to-date names for the species. These are taxonomic needs of the monitoring programme. How these needs are most effectively met is a question that arises from the needs identified.

### **2.3.2 History of Assessments**

The concept of Taxonomic Needs Assessments was first discussed in detail in the DIVERSITAS/Systematics Agenda 2000 Workshop (Anon., 1998). This methodology was extended in the Guide to the Global Taxonomy Initiative (SCBD, 2008), a draft copy of which was available to the Ghanaian Taxonomic Needs Assessment team. A number of assessments have been carried out (see <http://www.cbd.int/gti/needs.shtml>), although many of these are more of capacity assessments than needs assessments. The most relevant of these to the current study are discussed briefly below.

#### **2.3.2.1 UK Assessment**

The UK assessment was the first to use the methodology developed for the Guide to the GTI, and provided a model for the Ghanaian assessment. It selected Conservation as a focal area, since it was felt that this was both the major issue facing UK biodiversity and broadening the assessment beyond this would lose a focus that could be dealt with effectively during the assessment and by policy and implementation after the report. The report itself is available at <http://www.cbd.int/doc/programmes/cro-cut/gti/gti-needs-uk.pdf> Recommendations from the report were considered by UK government and are used regularly within the UK. Members of the UK team worked with Ghanaian partners on the current report.

#### **2.3.2.2 The 2001 African Meeting**

In 2001 a workshop was held in Kirstenboch, South Africa: 'The Global Taxonomy Initiative: documenting the biodiversity of Africa'. There were 43 delegates at the workshop, from 32 countries (23 of them African countries) and 36 institutions or organisations. Ghana was not present at the workshop

but other member countries of BioNET-WAFRINET (see below) were present. The workshop attempted to produce a taxonomic needs and capacity assessment for the continent, and information on Ghanaian taxonomic capacity was collected and published (Klopper et al, 2001).

In the same year an 'Assessment of status of herbaria and capabilities in taxonomy and systematics for natural resources inventory in sub-Saharan Africa' was published (Kabuye, 2001). This includes information on Ghanaian capacity.

## **2.4 Assessment Methodology**

The methodology used was based on that used successfully in the UK needs assessment. The project initially developed a 'Resource Pack' (see Annex 1) containing the basic information required to develop the Assessment. The full methodology and argumentation is not repeated in this part of the text, but basically the process can be seen as a seven-step operation:

- a) Selection of Assessment focus;
- b) Assessment of national user needs and priorities for taxonomic information;
- c) Assessment of existing taxonomic knowledge about national biodiversity, its availability to and employment by users, and the sustainability of these sources;
- d) Assessment of current national taxonomic infrastructure;
- e) Assessment of current national human resources in taxonomy;
- f) Analysis of results; and
- g) Recommendations for action.

For the Ghanaian assessment the focus selected by the in-country team was primarily food production, although there was a subsequent extension into other areas as similar needs were identified during the assessment, following discussion with a variety of users of taxonomic information. The team attempted to obtain information over a wide spectrum of users of taxonomy, from the level of government research and implementation agencies to educational establishments.

The assessment commenced with a two-day workshop. This served to launch the project within Ghana and to start testing questionnaire contents and, with the aid of the expert participants, explore some of Ghana's taxonomic needs. The workshop participants are listed in Annex 2, Table 2.

The workshop was followed by a questionnaire that was distributed widely within the country. In many cases respondents had to be guided through before the questionnaires were left with them. Telephone calls were also made to clarify aspects that were not clear. Additionally, follow-up questions were provided in order to provide explanation on the potential of taxonomic information to the respondents. The feedback from that questionnaire are included below.

The assessment also included a paper exercise to establish current capacity within the country. This drew on documentation provided to the first African Workshop on the Global Taxonomy Initiative (Klopper *et al.*, 2001) and other published and unpublished reports (including Kabuye, 2001, Ayertey & Padi, 1996 (as reported in notes from a subsequent BioNET-WAFRINET meeting),

reports from African Pollinator Initiative, barcoding meetings and National Reports to the CBD).

The Assessment concluded with a four-day workshop in which the findings were reviewed by specialists from many biodiversity-related disciplines across Ghana, and with BioNET-WAFRINET representatives from Nigeria, Togo and Benin. This group was able to clarify issues and identify further needs and means of addressing them.

In addition to the work done within the Assessment, the Ghana National Biodiversity Committee has organized series of workshops to determine elements of current Ghanaian taxonomic capacity.

### **3 Ghanaian needs and priorities for taxonomy**

#### ***3.1 Organisations contributing information***

This part of the study was carried out from May to July 2007. Out of the over 500 questionnaires that were sent out, 96 were received by the end of the period (Annex 2, Table 3). The respondents to the questionnaire were from 7 categories of organizations (see Annex 2, Table 4, Fig. 14) although some fell into more than one category.

Agencies established by law, Government departments and Research and Educational Institutions formed the bulk of organizations that responded to the questionnaires. Only one Professional Association, and none of the Co-operative organizations and Community Based Organisations, responded to the questionnaire.

#### *Ecosystem type covered by questionnaire respondents*

The ecosystems (equivalent to CBD Thematic Areas) to which the activities of respondents relate 'most', are shown in Annex 2, Table 5 and Fig. 15. Activities of some of the organizations relate to more than one ecosystem. About 50% of respondents do work related to Agricultural and /or Forest biodiversity. About 25% of respondents work on Inland Water and/or Marine and Coastal ecosystems whilst only 8 undertake Island biodiversity studies. Activities of majority of organizations in the survey are therefore more related to terrestrial ecosystems.

Out of the 54 respondents whose activities related to Agricultural biodiversity, almost two-thirds considered that to be the most important part of their work. A little over two-thirds of the 48 respondents whose work related to Forest biodiversity also described it as the main activity. About equal proportions of those who work on Marine and Coastal biodiversity and/or Inland water biodiversity related issues considered that such ecosystems form the greater part of their activities. Interestingly, all the 8 who even indicated that their activities relate to Island biodiversity did not rank it as the most important ecosystem in which they work. Only 3 of the 15 respondents whose work related to Mountain biodiversity did indicate that their activities relate most to it.

The diversity of activities covered by each of the respondents make it difficult to relate their taxonomic needs to particular ecosystem studies. However, there is clear emphasis on ecosystems relevant to agriculture, forestry and fisheries are predominant.

#### *CBD Cross-Cutting issues covered by respondents.*

Annex 2 Table 6 and Fig. 16 shows the CBD cross-cutting issues to which activities of organisations relate. The activities of all the respondents relate to one or more of the CBD cross cutting issues listed in the questionnaires.

About half of the responses were from organizations with a primary mission dealing with Public education and awareness and/or traditional knowledge, innovations and practices, and/or sustainable use of biodiversity. At least 30% of the respondents were involved in issues relating to Access to genetic resources and benefit sharing, technology transfer and cooperation, Biodiversity and tourism, and/or Invasive alien species.

Even though 57 out of 98 had a major interest in vascular plants (see Annex 2, Table 7), just about 30% of these were involved in the CBD cross-cutting issue Global Strategy for Plant Conservation. Refreshingly however, a reasonable number of 46 were concerned with sustainable use of biodiversity. (Annex 2, Table 6). The two CBD cross-cutting issues, Global Strategy for Plant Conservation (GSPC) and Impact Assessment, relate to activities of equal numbers of respondents and a very small percentage of the responses were attributed to 'Economics, trade and incentive measures'. The CBD cross-cutting issue to which least activity related to among the respondents was 'Indicators'.

With regard to which of the CBD issues relate 'most' to or 'some' aspect of their activities the responses were quite general as shown in Annex 2, Table 6.

For the numbers who responded to particular CBD cross-cutting at least 50% of their activities relate 'most' to 8 out of the 17 issues listed.

Of the remaining issues, the respondents described GTI, Economic Trade and incentives measures and Indicators as issues to which their activities relate less. It was only in one case that the 2 options were ranked equally.

This type of response is not unexpected, since the essence of the cross-cutting issues is that they apply to the whole range of CBD-related policy areas and activities. However, it does indicate that the issues faced in informing there relevant people of both activities and policies in these areas can be considerable, both because of the large number of actors and also because of the large number of relevant policy elements.

#### *Types of organism covered by respondents*

The groups of species that organizations are concerned with are shown in Annex 2, Table 7 and Figs 17-19. The responses are presented in relation to the broad ecosystem involved, and show that some respondents have an interest in more than one group of organisms. The work of the majority of the respondents was concerned with terrestrial species followed by Marine and then freshwater species.

At least 51 respondents were concerned with either terrestrial mammals or vascular plants. More respondents had an interest in insects and spiders than birds. The areas of least interest to the respondents in terms of numbers of responses regarding terrestrial species were the invasive alien species and reptiles.

As anticipated, about 30% of respondents indicated that their major concern is with freshwater and/or marine fish. These are major sources of protein in Ghana and also important components of the economy. Studies of at least 12 respondents were focused on freshwater or marine plants, invertebrates and/or vertebrates. Marine microorganisms were the least studied group.

The responses seemed to reflect our knowledge of the various taxonomic groups, their importance to man and possibly the ease of working in particular ecosystems. The taxonomy of mammals undoubtedly is better understood than that of other groups, in addition to this group being a major source of human food in Ghana. The reptiles are not a preferred group for studies even among University students, apart from the general phobia people have for these vertebrates.

Invasive alien species are an emerging area for studies in Ghana and the data reflects this.

#### *Types of activities of respondents*

Annex 2, Table 8 shows the different types of activities in which the respondents were involved.

Organizations were engaged in more than one type of activity with 50% of the respondents actively involved in providing information to inform government, with a smaller number being engaged in identification, assessment and monitoring. Between 20 and 30 respondents were involved in ecotourism, managing protected areas, habitat restoration, and/or environmental research, among others. Even though about 50% of organizations indicated that they work in the forestry biodiversity ecosystem (Annex 2, Table 5), only 8 were involved in developing reference collections. The areas of least involvement were identification of wild relatives, selecting/designation protected areas, CITES and Convention on Migratory Species (CMS). Only 2 responses were given for Indicator Species taxonomy.

The results clearly bring to the fore a problem of the taxonomic impediment in Africa with particular reference to Ghana. The lack of names of species and understanding their role in the ecosystem or environment made it difficult for attention to be focused on species level work as well as assessing, monitoring or restoration of habitats and species.

Notable was the fact that only 12 and 13 respondents indicated that their work included development of reference collections and basic taxonomic training respectively.

#### *Relationship of respondents to Government*

Even though many respondents were not involved in thematic areas such as CITES, CMS, Climate change monitoring, Development of ecological indicators and Indicator species taxonomy, at the same time, providing

information to inform government and Public education and awareness were the activities of about 50% of respondents.

## **3.2 Assessment responses**

### **3.2.1 Classes of taxonomic information**

In order to understand the needs of the users they were asked about different types of taxonomic information, the importance they gave to these types, and how they accessed the information currently.

#### **3.2.1.1 Species Lists**

Lists of species come in a number of different forms. They may be scientific names or common (vernacular) names. If scientific names, they may include synonyms (i.e. other names for the same species that are no longer used, for a variety of technical reasons) or not. The availability of synonyms can be important because the status of users' understanding of up to date taxonomic names may differ, so that people in one country may be using a name that in other places is known to be a junior synonym and no longer used. This can be important, for example, when names are used for invasive species, or lists for quarantine, or in the context of Access and Benefit-Sharing legislation.

This latter issue was picked out particularly by attendees at the workshop. A point made by several people was the need to keep lists of scientific names up to date, since this enabled them to link knowledge about Ghanaian biota to information about biota outside the country, for example, or ensure that new treatments for pests such as bacteria or viruses were recognised as appropriate to Ghanaian problems. Common names can also be very important and were cited by workshop attendees as important for communication with local people and aid identification. However, local names can in some instances refer to different species in different localities. In a country such as Ghana with a number of different languages different common names can apply to the same species in different languages.

Names can be grouped according to various criteria. These include taxonomic (systematic) position (e.g. birds, mammals, Diptera) geographic (e.g. 'West African', 'Ghanaian'), ecotype (e.g. 'forest insects') and functional (e.g. 'forest pests', 'medicinal plants', 'white list' (for quarantine), 'invasive'). Workshop participants cited as lists they used: forest, savannah, exotic, crop pest, weed, beneficial, quarantine, conservation status, endemic, invasive, medicinal, horticultural, 'high-demand' and 'low-demand' species, bio-indicators, vertebrates, grasses, parasites, birds, marine plants, small ruminants, insects, viruses, fisheries, and plants by habit (climbers, shrubs, herbs etc). Workshop participants and questionnaire respondents called for a variety of lists (Table 1), although this is by no means a complete set of lists that will be of importance to Ghana.

One list that was called for by a number of participants was a Red-List of Threatened and Endangered species of Ghana, to provide a reference point for Government Bodies, particularly the EPA. More generally, a complete list of Ghanaian animals, plants and micro-organisms was called for by many people.

Sector	List required
Agriculture:	Bacteria attacking crops
	Crops (all), with their pests and diseases
	Crops (forage crops)
	Crops (global distribution)
	Crops (indigenous)
	Crops (introduced)
	Crops (strains)
	Parasites (endoparasites and ectoparasites) of livestock
	Poisonous plants (impact on cattle)
	Pollinators of cocoa
	Useful bacteria in lumen of ruminants
	Viruses of plants (to keep up to date so correct chemicals can be applied)
Forests:	Important forest pests
Aquatic:	Aquatic spp. (Freshwater and marine; all species)
	Aquatic weeds (with pictures)
Health	Parasitic worms (Human parasites)
	Poisonous snakes
	Toxic invertebrates
General:	Animals and pests
	Animal species outside Protected areas
	Birds (for tourism)
	Butterflies, with their location in the country and host plants (for tourism; could take the form of an electronic list)
	Threatened and endangered species of Ghana (Comprehensive consolidated list from scattered lists) [EPA noted the need for this, and CSIR has a preliminary version]. Ideally with pictures.
	Host plants (of insect herbivores)
	Invasive species
	Local and common names for all plants and animals in Ghana
	New spp. (useful)
	Organisms that assist regeneration of degraded lands
	Organisms to use for bio-indicators
	Parasitic hymenoptera and their hosts
	Plants (All Ghanaian species)
	Plants (for horticultural use – landscaping, public parks, recreational and residential space)
	Pollinators of particular crops
	Quarantine list (complete)
	Up to date lists of all biota

**Table 1.** Lists of species and other taxa identified as important by workshop participants and questionnaire respondents. The assignment to sectors is *ad hoc*, and some of the lists under ‘General’ apply to one or more of the other sectors.

Clearly there are many needs, which might be met by a master list with appropriate fields and metadata.

The sources of types of name lists used by the questionnaire respondents are given on Annex 3: Table 10, together with the numbers of respondents using them.

### *Importance*

Both workshop participants and questionnaire respondents felt that all types of species lists: scientific names, common names, name changes (i.e. including synonyms), lists of protected animals and lists of species in other countries are **very important**, although not all had the same priorities between them (Fig. 1). Lists of invasive species were seen as less important overall, but this may reflect a poor representation and understanding of respondents in the needs of that sector; considering that only nineteen respondents did state that such lists are very important for their work. Ghana is one of the countries taking a lead on Invasive Species and CSIR has a project on IAS, which suggests that needs are high within the institutions that are aware of the problem. Lists of species in other countries were overall seen as unimportant to the respondents' work, but again this may be due to different understanding of the importance of these to addressing problems such as invasive species or managing Ghanaian rights under Access and Benefit-Sharing provisions.

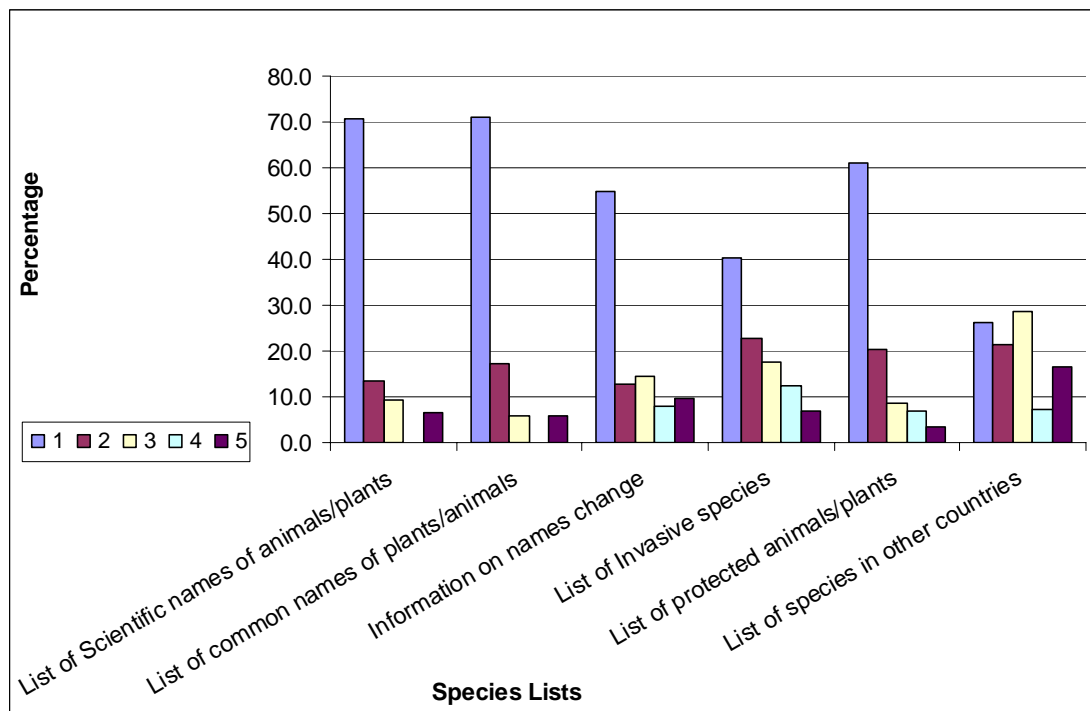
The workshop participants believed that both scientific and common names were required, and identified a number of uses for lists of names:

- Appropriate decision making
- Awareness creation
- Constant evaluation of conservation status
- Effective communication
- Facilitate collaboration with local communities and for education purposes and extension
- Facilitate Conservation
- For easy identification of beneficial and destructive organisms
- For effective management and control practices
- Quarantine purposes
- Point of reference for Government bodies
- Research
- Support environmental impact assessments
- To facilitate trade
- To manage patents based on Ghanaian species

They also noted that such lists could help national policy review and providing policy advice, and identified ways in which they fitted in with policy objectives:

- 1994 national wildlife and forest policy – list will help to implement
- Cocoa Research Institute – mandate to develop cocoa and other major tree crops in Ghana – species list will help them
- Develop human resources to help implement national policy
- Effective management planning
- Ensure food security
- Facilitate effective decision-making
- Facilitate good industrial practices
- Facilitate manufacturing decisions – herbal medicine
- Increase productivity in agriculture
- Legislative Instrument 1652 – Incorporating environmental issues into developmental goals
- Manage key pests and pathogens

- Parks and gardens – mandate to develop recreational and general landscape areas
- Promote environmental quality
- Promote tourism
- Protecting environment enshrined in the constitution – supports environmental protection/conservation
- Quicker decision-making
- Reduce poverty
- Help implement action plans
- Help halting desertification
- Help reduce/address climate change effects



**Fig. 1.** Relative importance of different species lists to questionnaire respondents, ranged from '1' (very important) to '5' (unimportant).

### *Sources of Species lists used (Annex 3, Table 9)*

#### *Lists of Scientific names*

Respondents indicated the highest source of list of scientific names to be (institutional) libraries (63%) followed by In-Country-Professionals (ICP) (22%). Surprisingly, only three of the respondents used the internet for their source of names, despite the very large number of names available there through single-taxon databases and aggregators such as Species 2000-ITIS Catalogue of Life and GBIF. While this may indicate inappropriate coverage of the database, lack of knowledge on the part of the respondents as to the availability of this resource, or access issues, it might also be related to the demography of the respondents, since observation suggests that use of the internet is more prevalent among younger workers. One respondent and a number of participants in the second workshop suggested that web-sites should be created. The GhanaBIF project with is currently under way may be able to provide such a Ghanaian web portal to names, as well as other information with a specifically Ghanaian focus.

The reliance on libraries for scientific names raises the question as to how up to date and complete the library coverage is, and whether different users are accessing the same literature sources to provide them with names. If not, there is a risk that different names for the same organism will be used by different workers in the country. This problem was addressed by participants in the second workshop, who felt that while individuals with sufficient skills might be able to check original literature there should be at least one certified source within the country responsible for providing the most correct names. At least one respondent noted that the local library did not have the information required, and a respondent from the education sector felt that schools needed to be supplied with lists. The sources of names used by the in-country professionals are not known.

Among the workshop participants there was an understanding that not all species found in Ghana will have been given scientific names. In such a case the need to contact an expert was clearly stated, in order to get a name given to a 'new' species. It was also pointed out that in some cases a generic name would suffice, and that the appropriate level of names should be selected. This is important in the context of identifications to ensure the most timely response, and to avoid paying for or spending too much time on a determination to a detail that is not required.

One respondent noted that "we usually rely on source seed or plant material for common and scientific names". This begs the question of where the suppliers obtain the names, and how accurate they are. Adequate quality control within Ghana might require a more 'approved' list. The sources used by government, including customs, were not clear.

While some respondents felt that the species lists were available to them others commented that the sources were limited and needed update. Others did not have adequate knowledge of where to seek such lists, and the need for training was identified. There was a belief in some parties that the sources are reliable, and the need to ensure such reliability and sustainability was recognised.

#### *List of common names*

The most-used sources of common names are libraries and in-country professionals with 47% and 30% respectively. Amateurs and local indigenous knowledge also provided appreciable sources which are available to them and believed to be reliable. Some of the respondents believed that common name lists were available in the universities, although no-one cited universities as the source they used. Other respondents noted that the common names were not all documented, that information was sometimes inaccurate and scanty, and that there is a need for updating the information held. There is a strong implication in the responses that action needs to be taken to compile lists of common names. This was underscored by the participants at the second workshop, who emphasised the need to collect these names, especially in the context of herbal medicines (while noting the need to protect traditional knowledge and Intellectual Property Rights).

### *Information on name changes*

As noted above, scientific names applied to species and higher taxonomic categories change according to novel taxonomic interpretations and application of nomenclatural rules. Only about half of the respondents thought this type of list to be important to their work, and it might be valuable to develop exemplar use cases to help users understand how such name changes might impact on their activities, and to what extent they would benefit by being aware of them, or at least alerted in the case of key taxa. Other respondents recognised the information as vital but recorded that to them the information was not available, whilst one respondent assumed that it was available through the country's universities.

Libraries and ICP were the main sources of information on name changes. Respondents also listed amateurs as very important source. Only one respondent used the internet which, as with scientific names, should be a very helpful resource. It is notable that at least some internet resources which would give this type of information are not freely available but require subscription.

While the majority of respondents felt that the information was not available, those who said otherwise thought that the sources are sustainable. This suggests a widespread misapprehension, and a problem to be solved.

### *List of invasive species*

Libraries and ICP constituted the main sources of information for lists of invasive species. The respondents, however, mentioned amateurs, government and experts as sources as well. Interestingly, none mentioned the internet, even though the Global Invasive Species Information System (GISIN) is freely available on the internet.

The majority of respondents thought that even though the information is very important to their work, it was not available to them. Related information is also unavailable; for example, the species of birds found at the airport is not available to the Airport Authority. One respondent noted that a list of invasive species requires constant update and revision of information. The issues concerning the names of Invasive species globally have been discussed in some detail in a Taxonomic Needs Assessment of IAS, and will not be repeated here<sup>2</sup>. In contrast to the majority of users, the sources listed are believed to be reliable by at least some respondents.

### *Lists of protected animals /plants*

Most of the respondents, as well as members of the workshops, believed such lists to be very important to their work, but a large minority believed the information was not available, however the sources they do use they believe to be reliable. A list of protected mammals is on the internet at <http://www.animalinfo.org/country/ghana.htm>

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<sup>2</sup> <http://www.gisp.org/publications/images/taxonomicreport.jpg>

### List of species in other countries

Libraries and internet formed the main sources of information for the respondents to the questionnaire, of whom only 26% thought it to be very important to their work. The rest think otherwise and also believed that the information was both unavailable and unreliable. Some thought that universities might have access to the information, although universities were not listed as a source by any respondent. It is notable that protection of benefits under Access and Benefit-sharing legislation might be impaired if it is not known whether any given species or strain is endemic to Ghana or also found in other countries. In addition, quarantine implementation against incoming pests rely in part on a knowledge of what is present in other countries, a list which is changing rapidly with spread of invasive species around the world.

### 3.2.1.2 Identification tools

Although the questionnaire respondents were asked about identification tools, this was based on the understanding gained from the participants of the first workshop, confirmed by the second workshop, that correct identifications are of great importance.

All the respondents indicated that identification tools are very important for their work (Fig. 2.). This also applied to the workshop participants, all of whom agreed that they needed to know the names of the organisms they studied or managed. It is notable from Fig. 2 that every type of identification tool is seen as very important by a majority of respondents to the questionnaire. An important point was made that “aid should never be far away from me”, underlining the issue that identifications are often needed very rapidly, and that the option of waiting for hours, days or weeks is not appropriate – one need think only of emerging pest infestations to see how delay in identification can lead to significant economic and livelihood loss.

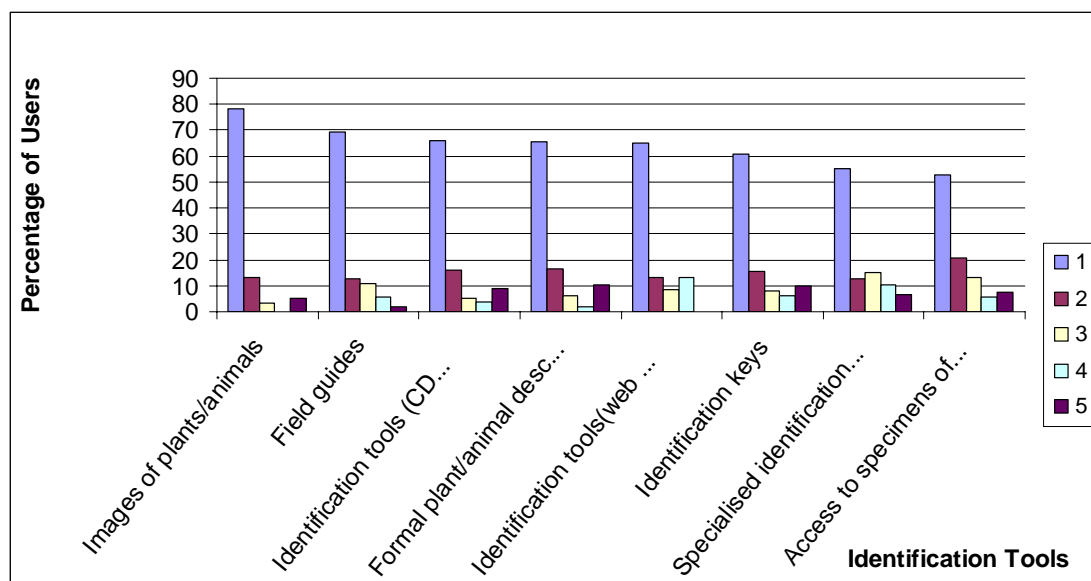


Fig. 2. Relative importance of different identification tools to questionnaire respondents, ranged from '1' (very important) to '5' (unimportant).

The workshop participants required the identification of a wide range of organisms, including mammals, insects, birds, microorganisms and pathogens. EPA, for example, is interested in bioremediation, so needs an institution to pick up work on microbes and provide identifications. They also noted the need for illustrated guides to invasive species. Participants also noted the use of identifications to assist village-level industry to prepare and sell boxes of identified specimens to tourists. Forestry would like a field guide with absolute key characters to priority species rather than covering all trees, since current identification guides are too large to use in the field; they would also like to work with local people. Forest managers had been complaining because names could not be provided for fungi, and hence measures could not be taken in a timely manner. Ghana's border control regularly detains biological material until identifications can be confirmed; the inability to obtain identifications from their labs or elsewhere might mean long-term detention of material, with consequent disruption to the owner.

A specialised need is in police forensics, where high-quality accurate identifications are required in some cases, and court appearances by the identifying expert may be required.

Participants used a variety of sources for identification, including:

- *Comparison with Type specimens*
- *Identification keys*
- *Examination of calls, footprints, or droppings*
- *Through in-country experts or experts/institutions in other countries, e.g. Royal Botanic Gardens Kew, IITA, WHO, Ghana Herbarium, ICIPE*
- *Extant personal knowledge*
- *comparison of DNA extracts with GenBank samples*

Of the various means of identification they noted the following tools as being of most use to them:

- *Expert advice*
- *Field guides – Paper based and CD-Rom*
- *Good infrastructure – Museums, herbaria, and Arboreta, both Central and Regional, to provide easier access. The herbaria should include carpological collections as well as dry and other collections.*
- *Identification keys*
- *List of all spp. associated with crops (pollinators)*
- *Literature*
- *Online identification guides (not preferred option by all)*
- *Published flora*
- *Sketches (Botanical)*
- *Specimen album (ID guide with images)*

Many of the participants took a graded approach, first using whatever field guides and keys were available to them, then consulting experts both in-country and internationally (including UK, Kenya, USA, Singapore, South Africa, China, Korea, Japan and Belgium). This overseas reliance takes time and money, and can cause economic losses. The principle of attempting to

identify specimens first then submitting elsewhere was noted by the second workshop as good practice.

The use of DNA sequences has developed during the preparation of this report, and several participants in the second workshop regularly use DNA sequences. Many others were unaware of the facility being available within Ghana, and there was considerable interest in its utility. One example of use given was the sequencing of a target plant specimen and the comparison of the sequence obtained with all those on GenBank<sup>3</sup>. This provided a likely match, which was then confirmed using images of the species on the web. Because of the currently high cost of the technology (although this is coming down) it may currently be most applicable for identifications of high commercial value such as in cocoa cultivation, or for cases where human life is at issue.

They mentioned the need for good optical equipment (from basic e.g. hand lens to complex) and GPS.

Workshop participants noted the problem of new (undescribed) species, which may be of particular significance in Ghana, as in other tropical highly biodiverse countries where a significant part of the fauna and flora may not yet be known to science. They also noted that in some cases the identification need only be to generic level to meet their needs, emphasising that the end use of the information was of paramount importance, especially noting that identification to genus level may also be cheaper than to species. However, they noted that the problem of getting identifications could delay publication of scientific papers produced within the country. At least one researcher in the second workshop noted that the publication of her work had been delayed because she could not provide a name for a species of micro-organism.

The workshop participants, when asked what they would like to do (or could do) if better access to identifications was made available, provided the following list:

- *Improve their teaching, using checklists, floras, faunas and descriptions;*
- *Bioremediation/restoration;*
- *Develop databases of species;*
- *Improve their research, increasing their research outputs;*
- *Provide more information on organisms;*
- *Produce much simpler field guides for students, and photo IDs;*
- *Provide training and awareness raising for public, policy makers, and students;*
- *Review names currently applied to specimens in collections;*
- *Study the biology of species and manage them more effectively;*
- *Use information to evaluate activities e.g. to assess results received from impact assessments;*
- *Use information to take decisions;*
- *Use information to understand status and trends.*

### **3.2.1.2.1 Sources of Identification tools used**

See Annex 3, Table 10 for summation of results.

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<sup>3</sup> <http://www.ncbi.nlm.nih.gov/>

### *Field guides*

The main source of field guides as an ID tool is the library as well as ICP. Respondents however listed amateurs, government and books as additional sources. 69% of the respondents identified field guides as very important to their work, and more than 80% as important or very important. Although an important resource, 64% of the respondents stated that field guides were unavailable to them. Only 59% think that the sources are sustainable. The workshop participants noted the importance of including many illustrations and making them sufficiently simple for local people to use (and also guides being written in an appropriate language). A similar need for many illustrations was a requirement for use with students. In most cases colour illustrations were required, although for some groups of organisms monochrome can be more effective. Extension workers could make use of pictorial guides to family level. Also highlighted was the use of non-traditional characters for identification, such as tracks and droppings, which might be included in guides. A further requirement was for focus of field guides on species of conservation priority. One of the questionnaire respondents noted that field guides for some insects were available but that more were needed for groups of all animals not yet covered. The requirement for species to be covered by such guides is very broad.

### *Keys*

Most respondents felt access to identification keys was very important but unavailable. One respondent stated that they were urgently needed, whilst another stated that they were necessary for his institution's work. One respondent needed keys to Invasive Alien Species. It was further noted that in some cases the only keys available were old and not fully correct for today's taxon concepts. The importance of good illustrations with the keys was highlighted. Some keys are available in electronic media (CD-ROM and on the internet); these are discussed below under those delivery systems. The main sources of keys used by the respondents are believed by some to be sustainable and include Libraries (75% of responses) as well as ICP.

### *CD-ROMs*

Most of the respondents who expressed an opinion thought CD-ROMs to very important but not available. There was little clarity on the content of the CD-ROMs they required, however. These media are sometimes used for keys and other interactive identification tools, as well as for publications, images, checklists etc. Overall the number of relevant products on CD-ROM is relatively much lower than those on the internet or on paper. In addition, many potential users may not be familiar with CD-ROMs as a medium, and utilisation of what is available may be lower than it could be. However, this medium for disseminating information may be important to examine further. Libraries and, to a much lesser extent, ICP formed the main source of information for those who used CD-ROMs, and these are believed to be reliable.

### *Web-based*

This is very important to respondents, who noted the wide range of identification tools available on the web. However, some of the participants in

the workshop felt that provision of such tools via the web was less valuable than having them on paper, because of the much greater ease of access to and flexibility of paper versions. Web-based tools are unavailable to many of the respondents, for reasons including limited access to computers and internet connectivity and, even where these are available, restrictions due to low bandwidth and consequently long hours in downloading documents. However the sources are considered reliable by respondents as long as connections and URLs are maintained (which is often not the case).

#### *Image/photo of animals and plants*

78% of respondents stated that such images are very important to their work; it was the most important form of identification tool for plants and animals to the questionnaire respondents who, among many other needs, noted the need for pictures of endangered species of Ghana and their habitats together with their distributions in map form. Images were also stressed by the participants in the workshop. One of the uses of images, in addition to identification, was in their use for environmental education. Libraries, ICP and the Internet formed the main sources of information for the participants and were believed to be sustainable. This may seem to contradict concerns about internet provision of information expressed elsewhere in the responses. However, respondents may have been distinguishing between communication with specialists and other peers through e-mail (which was deemed to be a reliable source of information) as opposed to web access, which suffered from problems of access already outlined. However, this apparent sustainability must be called into question because only 50% of the respondents felt the resource was available to them, and the comment was made that 'those available are not enough'. Of the three main sources Libraries were used far more than the Internet and ICP. A further comment is pertinent, based on usage of internet-based images. Although these are proliferating rapidly, they do not give an idea of all the variation of species, nor is there consistent quality-control on identifications of images, so that there are a significant number of images on the web with the wrong name attached. This was raised as a concern by members of the second workshop, some of whom noted that some tutors forbid their students to use this resource. The issue is compounded in cases where there is intraspecific variation within West Africa, which might not be shown on web images. This, however, does not detract from the usefulness of authoritatively-identified images for identifications. An example of a potentially valuable resource of this type is "West African Plants - A Photo Guide" which contains more than six thousand images of over a thousand species of West African plants taken in the field and is freely available on the web<sup>4</sup>. Ghana is now a member of this, and users can access the resource without payment.

#### *Specialized ID services*

More than half the respondents reported that this type of service was very important to them but, equally, felt it was not available to them. Participants at the workshop also used identification services, although sometimes as a last resort. In many cases these were through personal contact with known

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<sup>4</sup> <http://www.westafricanplants.senckenberg.de/root/index.php>

experts (often out of the country) rather than general enquiries to institutions. They noted that they rely on relatively few individuals, which clearly raises the issue of sustainability. In some cases identifications could not be undertaken even by external institutions (and sometimes submission of specimens did not elicit any response), and species new to science are still waiting to be described. Some participants noted that access to such outside expertise should be made simpler. Participants also had a concern over quality control of identifications. In many cases identification has been possible only to genus level and not species (sometimes this is sufficient, however). The questionnaire respondents listed in-country professionals and the UCC herbarium as the main sources; however, these sources were not believed to be sustainable. Libraries were also mentioned as a source of IDs, but since these institutions do not provide such services there seems to have been a misunderstanding; the respondents may have been conflating ID services and the provision of ID tools such as keys or images.

Various particular identification needs were mentioned. Agriculture has been having problems with snail pests of crops. In this instance the issue was complicated by (i) the national expert on Mollusca having passed away, and (ii) identifications had been carried out in the country but lack of communication between Legon and department of Agriculture had led to the latter not knowing the results. Assessing the impact of pesticide application on pollinators has been hampered by the un-met need to carry out more assessments; such assessments depend for success not only on the time and means to carry them out, but also on the availability of people to identify the specimens collected, which can run into quite large numbers. A similar point was made for surveys on fruit-flies, which include serious pests of mangoes; it is important to carry out surveys to determine which parties of the country are free of the pest and thus are accessible for export, but there are no resources to do this, or even catalogue which species are present in Ghana.

Workshop participants noted the need to train people such as farmers or fishermen to recognise specific organisms in certain localities. This might be effective to spot emergent pests or invasive species. The need might also be satisfied by delivery of simple identification aids, such as illustrated posters for highly important organisms.

Part of the rationale for setting up BioNET-WAFRINET was the cessation of freely-available identification services, and the prospect instead of carrying these out locally. Notably, in 2003-4 “[the] WAFRINET [Regional Coordinating Institute] collaborated with national partners in the sub-region conducted regular faunistic surveys in different ecological sites of Benin, Nigeria, Ghana and Togo to complement its reference collection of specimens in the biodiversity museum at IITA-Benin. The steady augmentation of the reference material improves the ability of [the] WAFRINET [Regional Coordinating Institute] to provide reliable identification service in the sub-region. Considerable material from numerous families is preserved in the collection, making this collection the second largest in West Africa, after the IFAN collection (Institut Fondamental D’Afrique Noire, Cheikh Anta Diop University) in Dakar.” In 2003 no identifications were provided to Ghana, however. (BioNET-WAFRINET report, 2003/4).

The respondents to the questionnaire noted the need to provide a reference consultancy centre, and one stated that they were training students at the postgraduate level for taxonomic services. However, another commented that there was a lack of further or in-service training. Some specimens are sent abroad for identification, but there is no clarity on how many are sent compared to those identified in-country. One respondent noted that there was a need to have information about competent taxonomists available in Ghana that one can easily rely on for identification of species or reliable data of a species.

There is an implication that identification services are not used because they are not known to potential users, and that cost may still be a drawback. This aspect required further investigation.

#### *Formal plant/animal description*

'Formal descriptions' are the scientific descriptions of organisms from the primary taxonomic literature. Within the Workshop there was a request for taxonomic descriptions of all animals and plants found in Ghana. Most questionnaire respondents (63%) misunderstood this to mean ordinary descriptions and this may have led them to consider the resource as important to them, whereas such usage is probably comparatively rare outside taxonomic institutions. However, even so, 51% reported that descriptions were not available, which points to the need for a greater availability of 'colloquial' descriptions. The necessity for the users to be skilled in the use of formal taxonomic descriptions was mentioned. Libraries, ICP and Internet constituted the main sources of descriptions (both formal and colloquial); most respondents considered these to be sustainable.

#### *Access to specimens of Animals/ plants*

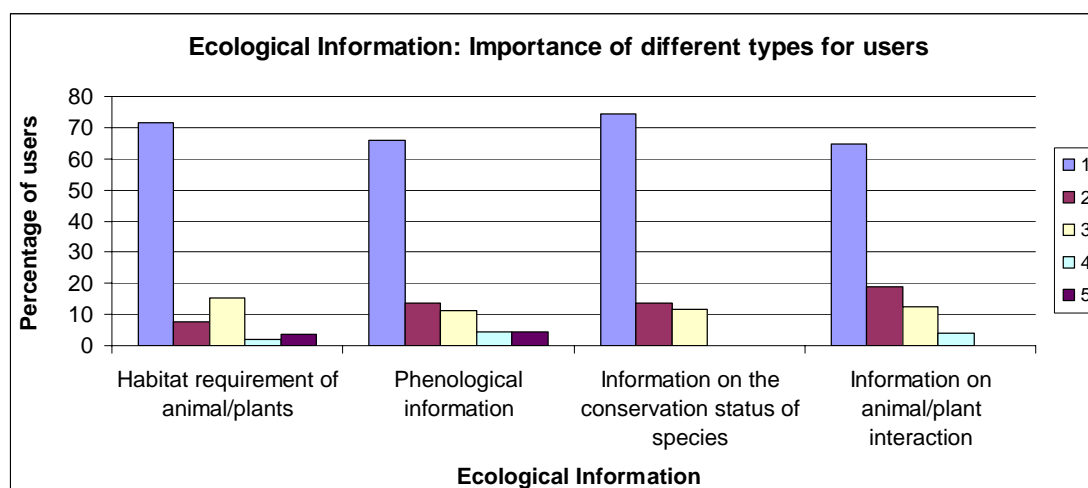
This resource refers to collections of reliably-identified specimens held in collections and available for comparison. Most of the respondents (73%) felt this resource was very important to them but is unavailable. Participants in the workshop also highlighted this need, suggesting that reference collections of authoritatively-named specimens should be available both centrally and regionally within the country. There was a concern in the workshop that the names attached to specimens in collections within the country may be out of date, and thus will lead to an incorrect identification and consequent problems to the end-user. The existence of many misidentifications in the past still present in collections was also identified as an issue that needs correction so that errors are not perpetuated. Workshop participants also noted the need for specialist collections such as carpological specimens (seeds). The importance of supervision by qualified personnel and the availability of appropriate tools were also highlighted by the respondents to the questionnaire. There was a suggestion that within educational institutions the biology laboratory should be equipped with specimens to enhance teaching and learning, although the responsibility for ensuring this was done was not felt to lie within the institutions. In the second workshop many participants felt strongly that a return to a largely abandoned practice of having students collect and identify specimens as part of their training would be of great value.

Such a system is used in University of Cape Coast and in developing the large insect collection at Ile-Ife, Nigeria.

The most reliable specimens, in a way, are the ‘type’ specimens, the ones designated as the ‘name carriers’ of the species and the ultimate reference. Most types of Ghanaian species are held in collections outside the country, and this can pose a problem for taxonomists seeking to make a fully authoritative identification. For plants, this problem is getting solved to an extent through participation in The African Plant Initiative<sup>5</sup> (Smith, 2004), which is seeking to take images of the types of African plant species in collections around the world and making them available on the web.

### 3.2.1.3 Ecological Information

A majority of the respondents agreed in their submissions that ecological information on habitat requirements of animals and plants, phenology, conservation status of species and animal and plant interactions are very important for their work (Fig. 3). Much of this is not the specific expertise of taxonomists or taxonomic institutions, but in many cases the information can be found there, or gleaned from the collections of specimens held.



**Fig. 3.** Relative importance of different types of ecological information to questionnaire respondents, ranged from ‘1’ (very important) to ‘5’ (unimportant).

The participants in the Workshop and the questionnaire respondents noted a number of uses of habitat and related ecological information, for example:

- to determine where to plant specific crops or trees;
- in the development of species as indicators of conservation trends;
- for Environmental Impact Assessments, and for educational purposes;
- to facilitate collection of plant species, particularly plant genetic materials;
- facilitates effective control and management of harmful species;
- easy access to species for protection purposes – knowledge of how to emplace protective measures;
- to understand and use ecological parameters for disease organisms and vectors.

<sup>5</sup> <http://apps.kew.org/herbcat/gotoApi.do>

A major concern was where to find the required information; they felt the current resources were scattered and they did not really know where to find the information they needed. One proposed solution to this was to enhance the CHM portal<sup>6</sup> to provide access to the information.

The workshop participants also identified information they felt was of high priority to them but which currently they cannot access. This included climate change information, including predictions of biotic changes under different models; environmental factors affecting the movement of tsetse flies; information on migratory birds; information on the population dynamics of crops and animals; information to help manage disease and pest outbreaks. One participant noted that there is a need to update maps on both distribution and conservation status, since in some cases ground-truthing had shown extant information to be incorrect.

### **3.2.1.3.1 Sources of Ecological and related information used**

See Annex 3, Table 11 for summation of results.

#### *Habitat Requirements*

The source of information on Habitat requirements of animals and plants most employed by correspondents was libraries and other sources of printer resources, followed by in-country professionals. Information on Habitat requirements of species was considered available by fewer than 50% of the respondents.

#### *Phenological Information*

Phenological information was considered as the least available by respondents, but again the most utilised sources of information were libraries and in-country professionals.

#### *Conservation status of species*

Information on Conservation status of species was considered available by fewer than 50% of the respondents. As with other sources of ecological information, the most utilised sources were libraries and in-country professionals.

#### *Animal/Plant interactions*

Information on Animal/Plant interactions was considered available by fewer than 50% of the respondents. As with other sources of ecological information, the most utilised sources were libraries and in-country professionals.

For all types of ecological information there was a general uncertainty as to where to find the information required. Many thought that Ghana's universities might hold the required data, and felt that the information should be made more available. In spite of this some 80% of correspondents felt the information provision to be sustainable. However, given the difficulty in locating and obtaining information the sustainability issue is currently relatively unimportant. Among the professionals who might be consulted there was

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<sup>6</sup> Ghana's Clearing-House Mechanism website is at <http://gh.chm-cbd.net/cooperation/cooperation.htm>

equal uncertainty of the expertise of others, and where information might be found.

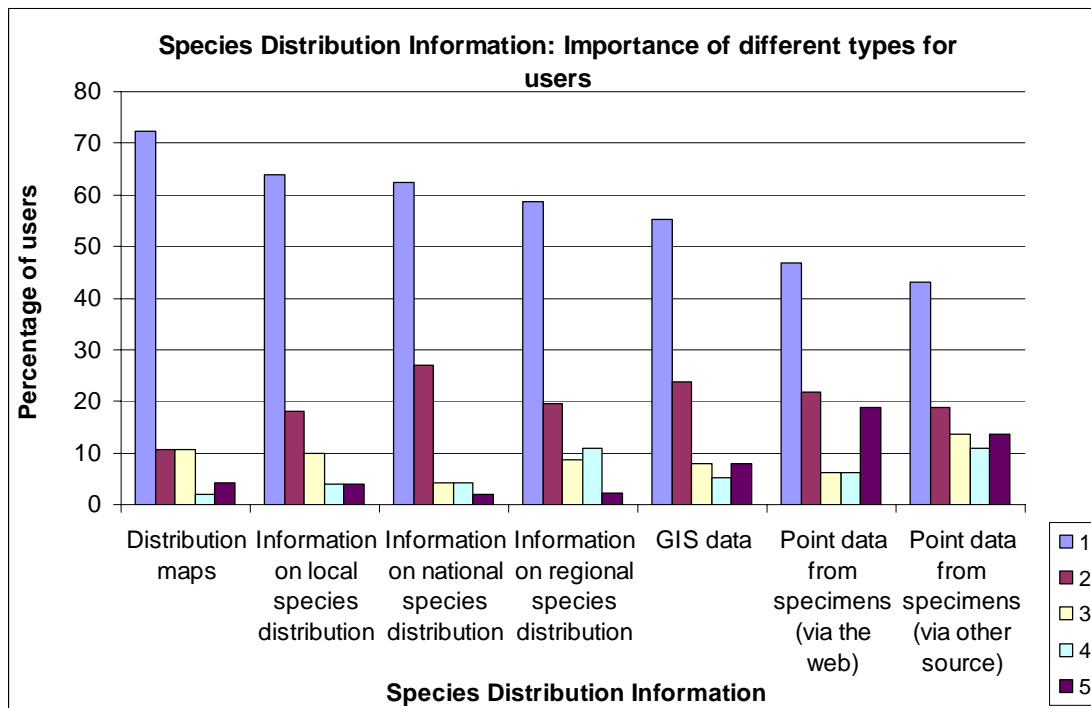
Interestingly, participants in both workshops noted that a valuable source of information for them was indigenous and local people, a source not mentioned by questionnaire respondents. Despite being very little used by questionnaire respondents, biological collections were seen by workshop participants as a major source of the types of information they wanted. However, the most effective means of accessing these data are if they are in digital form, as discussed below. Some digitisation efforts are under way, but there is a concern on the part of some collection and data holders on surrender of rights to those data, which need to be addressed.

#### **3.2.1.4 Species Distribution Information**

A majority of respondents reacting to the question of importance of species distribution indicated that this information was very important (Fig. 4). Participants in the workshops also give this type of information a high rating of importance, and wanted easy access to species distribution information to enhance conservation efforts, support trade and tourism, manage protected areas, for maximising the cost-effectiveness of surveys, collecting and research through pre-knowledge of where to work, and to facilitate the collection of genetic materials. Distribution maps were also recognised as being of value in education. In these cases some participants wanted maps of priority species, particularly those of conservation significance. Participants also wanted use of GIS to help map changing patterns of movements of species, and noted the need to be able to access fast and accurate predictions of species locations and distributions.

Of various sources of relevant information the questionnaire respondents preferred distribution maps to point data about specimen distribution (Fig. 4), suggesting that processed data were more useful to the respondents than raw data which were then analysed. However, GIS data were seen as important by a large number of respondents, suggesting that analysis is taking place. It is possible that the focus on pre-packaged information reflects a lack of knowledge or understanding of the raw data and how to analyse them, the latter point being made by some workshop participants. However, as the number of respondents providing a very high score ('1') declined, the numbers giving a rank '2' increased (Fig. 4), suggesting that while there is one group of users wanting pre-packaged information, there are others who can use or would prefer the raw data. Participants in the first workshop noted the benefits of being able to use GIS data, noting also the importance of being able to digitise data so that they can be displayed in ArcView and thus manipulated. They also noted the need of assistance (and computing power) to handle massive amounts of multi-variate data. In the second workshop presentations from the Department of Geography and Resource Development of the University of Ghana, Legon made it clear that the facilities to produce maps with GIS data are present and being used, in concert with the GhanaBIF project and others. However, the many data sets that are needed to make use of the facilities are either undigitised, scattered, or not being made available, and there is still a lack of adequate remote sensing and GIS within

Ghana. People are also not clear about the security of their data regarding ownership.



**Fig. 4.** Relative importance of different types of species distribution information to questionnaire respondents, ranged from ‘1’ (very important) to ‘5’ (unimportant).

That said, a number of technical points were raised as impediments by workshop participants. This included the issue of how to handle conflicting data, the need to have additional GPS units and locations to address the issue of poor locational information, how to turn distributional data into maps; how to manage scattered information; and access to standards.

The three classes of information on local, national and regional species distribution information are a little difficult to compare with the others as they refer to coverage rather than information type. However, there is an implication of pre-packaging of information for these classes. The key point is perhaps that there was no statistical difference between these three classes, indicating that all are equally important and preferences are likely to be in the context of the scope of responsibility of the organisation using the content.

**3.2.1.4.1 Sources of Distributional information used**

See Annex 3, Table 12 for summation of results.

Overall reactions to the source of information on species distributions were very low, with between 6 and 19 respondents. This is perhaps correlated with the large number of respondents who could not find such information (more than half of the 20-45 people responding to the availability question considered distribution data to be unavailable for all categories).

*Information on species distribution nationally, regionally and locally*

As noted above, these three types of information are related to content rather than delivery, and can be used in consideration of those delivery types. There was not great difference between them in results, although slightly more users were unable to find regional information than had difficulty finding national and local information (69% compared to 58.1% and 62.2% respectively) (in each case around half the questionnaire respondents commented). In all three cases respondents sought the information primarily in libraries and from in-country professionals. Respondents felt that perhaps the information should be maintained by Universities, although there was no further elaboration on this. They also felt that there was a need for more to be done to create a sustainable source of such information.

### *Distribution Maps*

Distribution maps, perhaps tailored to particular needs, ranked highest in the responses, although the differences between these and other means of acquiring such information were not great. However, more than half the respondents felt that such maps were unavailable or very difficult to obtain. The two most important sources for people were in-country professionals and libraries.

The stated requirements by workshop participants for both up-to-date distributions and maps detailing taxa of particular interest to them suggests that a solution might be found in making access to mapping software and data easier, so that users could create their own maps to best match their particular needs.

### *GIS data*

As with other types of distributional data, respondents sought information primarily in libraries and in-country professionals. However, this appeared to be the most difficult type of information to obtain, with 83% of the 35 respondents who had an interest in the data had been unable to obtain it. As with many types of information, the lack of availability had a compound effect, in that people who had not considered its value do not see it being employed by others and thus do not even look.

### *Point data from specimens, found on the web*

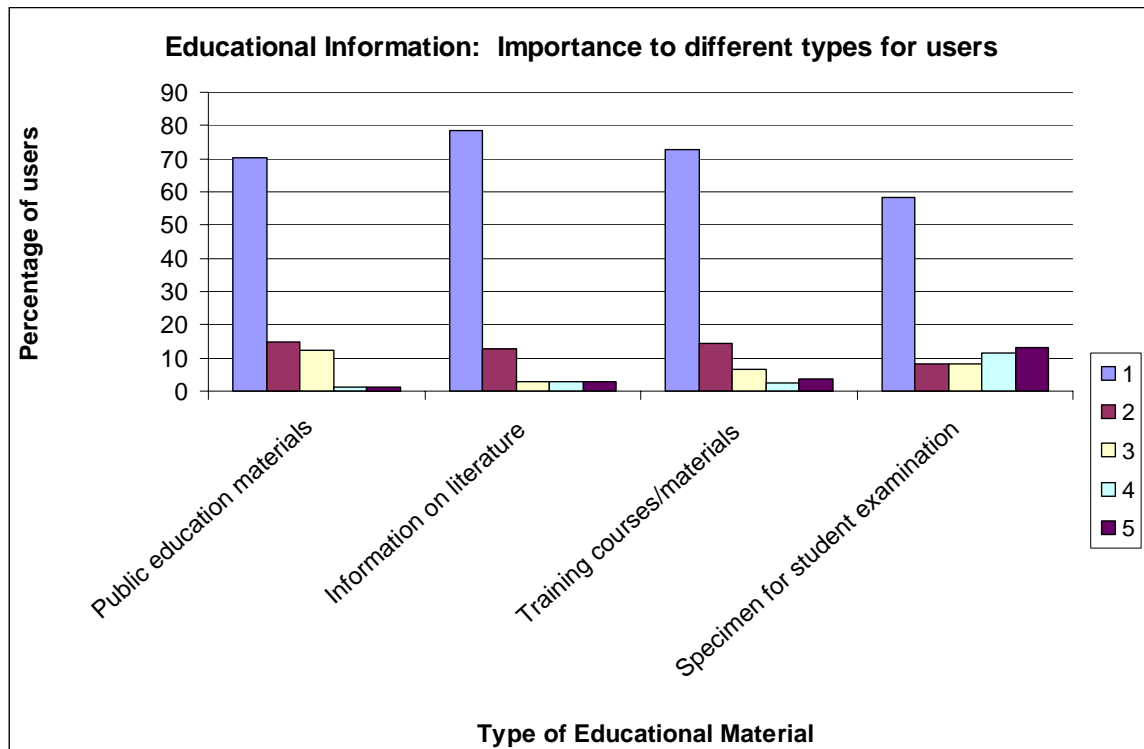
While the majority of respondents had sought these data on the web, others had sought it through intermediaries or in the library (perhaps to obtain internet connection?). More than half those who had sought such data had failed to find them, although there are no data to determine whether this is because they could not access the internet, did not know where to look, or found data in general but not on the species they were interested in. One respondent was concerned about data quality. Currently (December 2009) the Global Biodiversity information Facility (GBIF) mediates 87,001 specimen or observational records for Ghana, 66,708 of which are geo-referenced, representing 6,402 species (<http://data.gbif.org/countries/GH>).

### *Point data from specimens, found from other sources*

This was the least-used type of data, and of 33 respondents, 84.8% considered it as unavailable. There was no clarity on where people were

seeking the information because of small sample size, although in-country professionals were noted. None of the respondents mentioned biological collections (although one mentioned universities), which would seem the most likely source of such data, along with data found in taxonomic treatments.

### 3.2.1.5 Educational Information



**Fig. 5.** Relative importance of different types of educational information and resources to questionnaire respondents, ranged from '1' (very important) to '5' (unimportant).

All respondents rated educational information in its four suggested areas as very important, the least valued being specimens for student examinations. Notably, the difference between levels 1 and 2 on Fig. 5 is far greater than for other types of information; either the respondents need the information, or they don't. The responses include educational material at a variety of different levels, from secondary schools to universities to extension workers, and could probably be refined. However, the overall need is clear, and may be met with work focussed at different types of user.

This type of information is of course vital for the development of taxonomic capacity, and the difficulty which respondents had in obtaining them is disquieting.

#### 3.2.1.5.1 Sources of Educational information and materials used

See Annex 3, Table 13 for summation of results.

With the exception of Literature, for which more than half of those who responded indicated that was available, the rating for the types of materials in this section was poor. 37 and 34 respondents respectively responded on *Information on literature and Training Courses and Materials*; of these over

60% considered these forms of information as sustainable. However, for *Specimens for students*, with 27 responses, over 50% of these indicated that in the respondents perception this provision is not sustainable.

#### *Public Education materials*

The most-used sources for this type of resource are libraries and in-country professionals. However, the respondents commented that while these materials are very important they are generally not available or availability is limited, and that very few organizations have such materials. Where they are available they are not always supplied on regular basis. They also noted that such resources need to be designed and implemented to the level of the target group.

#### *Information on Literature*

Again, the most-cited sources were libraries, particularly local libraries. Also used are in-country professionals and the internet. Other sources are used, including donor agencies and embassies. The respondents commented that literature information is available but limited, and that very few organizations have such materials. They also noted that such information is not supplied on regular basis but felt that they should be provided and considered this as government responsibility.

#### *Information on Training /Courses materials*

Respondents sourced such material mainly from in-country professionals and libraries, although some used international donors, including embassies. The respondents felt that although there was some material available (not all agreed) it was limited, and not supplied on regular basis. There was agreement that more training course material needed to be prepared and supplied, as well as updated on a regular basis so that current text books and other materials were available. They also noted that teachers needed to be trained or have refresher courses to keep them up to date on developments. One commented that very few organizations have opportunities to access the materials, and there was a suggestion that the issue should be referred to the government for immediate attention.

#### *Specimens for student examinations*

Many individual sources were mentioned, but most of them could be grouped under the general heading of collection-holding institutions, such as research stations, universities and a museum. Two respondents identified collecting fresh material from the field. This theme was taken up very strongly by participants in the second workshop, many of whom emphasised the benefits of students collecting and then identifying specimens themselves, and felt strongly that this aspect of work should be re-introduced to curricula. The benefits of this extended beyond the immediate learning goals to the specimens being used subsequently in training and examinations, and also contributing to University or national collections. The many other sources listed suggested that specimens were sought from very different places, although it is notable that some, such as libraries, are unlikely sources, and indicate that the question may have been misunderstood. The respondents noted that specimens were available but limited, but in some cases not easily available because of lack of competent staff.

## 4 Taxonomic Capacity in Ghana

### 4.1 Collections and Infrastructure

Several major biological collections are maintained in the country. There are herbaria maintained in the Botany Departments of the Universities of Ghana, Legon, Cape Coast, KNUST Kumasi, Tamale; the research institutes on forestry (Kumasi) and herbal medicine (Mampong), the Forestry Commission in Kumasi; Botanical Gardens at Aburi, (the subject of a UK Darwin Initiative Project including inventorying the plants present and the construction of a database of the medicinal plant collection<sup>7</sup>), Legon, Cape Coast and Kumasi. In 2001 the Kumasi Forest Herbarium had 30,000 specimens, the Ghana Herbarium at the University of Ghana, Legon had around 90,000 and the Forestry Research Institute of Ghana, had only 1,200 specimens (Kabuye, 2001). There are Entomological and other Zoological collections at the Department of Animal Biology and Conservation Science ('DABCS') in the University of Ghana, Legon, and the Departments of Zoology in the Universities in Kumasi and Cape Coast. The Cocoa Research Institute of Ghana (CRIG) holds an entomological museum containing insect pests and beneficial insects collected from cocoa, coffee, cola and shea, both from Ghana and other Western African Countries. Of the 800+ species held in 2002, more than 400 had not been identified to species level. The CRIG also holds collections of virus isolates (CCSV), cocoa and coffee germplasm, and a herbarium (B. Padi, cited in Ayertey, 2002). The Animal Research Institute in 2002 held a seed bank and was setting up a herbarium with a focus on forage and pasture species (C. Domozoro, cited in Ayertey, 2002). There are also two zoos (Accra and Kumasi) although it is unclear if they have any taxonomic relevance.

These collections are maintained to prevent loss through pest attack or environmental decay, but are not actively curated, adequately staffed, or electronically data-based. Specimen housing (cabinets) are adequate, and developed to an internationally agreed level in some collections (noted in 2<sup>nd</sup> National Report to CBD), although it is worth noting that there are continual advances in collection housing standards, and the stresses on such housing posed by a tropical climate necessitate regular replacement. According to Ghana's 3<sup>rd</sup> National Report to the CBD, the country is not investing on a long-term basis in the development of an appropriate infrastructure for its national taxonomic collections.

There are no national institutional frameworks for herbaria. The herbarium at the Department of Botany at the University of Ghana is often referred to as the national herbarium but is without any national input for its operations. The meagre support provided to the department from the University's budget is used to run its operations. Consequently there is no room for staff development for it outside the main academic and/or technical requirements

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<sup>7</sup> <http://ictupdate.cta.int/en/Feature-Articles/Conserving-medicinal-plants-in-Ghana> and <http://www.unep-wcmc.org/species/plants/ghana/content.htm>

of the department. The situation is similar for Entomology and other collections in the Department of Animal Biology and Conservation Science at the University of Ghana. Nobody is specifically assigned to be solely responsible for the collections. It would help the situation to employ or train staff to be solely responsible for the day-to-day maintenance of the collection as well as replenishing stock from the field. This would involve planned and sponsored activities between Government and other stakeholders in collaboration with the University throughout the year. This would expand the use and functions of the facility. Separation of the facility to include a portion for academic and non-academic uses could be an added advantage or an option to be considered. The department also has a good collection of marine invertebrates preserved in formalin, some of which have deteriorated and need to be replaced. A good collection of vertebrate skeletons is also available in a separate museum for teaching.



**Fig. 6.** Collections housed in University of Ghana – (National Coordinating Institute, BioNET-Ghana)

Many specimens collected in Ghana are housed in collections outside the country, including many type specimens (Klopper *et al*, 2001); access to these by Ghanaian scientists is inevitably difficult because of travelling costs and knowing where the specimens are held. GBIF<sup>8</sup>, which makes specimen and observation data available from collections around the world, holds 85,953 records from Ghana, 66,325 of which are geo-referenced; none of these arise from collections held in Ghana. The formal establishment of the node of the GhanaBIF will enable easy access to and repatriation of information on Ghanaian specimens held outside the country. Digitisation efforts are under way at a number of collection centres including at the University of Ghana at Legon, Aburi Botanical Gardens, and the University of Cape Coast. To date at least 100,000 herbarium specimens have been digitized, 8,000 zoological specimens and 4,000 living plant specimens. In addition more than 10,000 records of Ghanaian specimens have been repatriated from institutions such as the Royal Botanic Gardens Kew (UK) and Wageningen University (Netherlands).

There is an inadequate supply of equipment necessary for carrying out research and other taxonomic activities, such as dissecting and compound microscopes, Scanning and Transmission Electron Microscopes (SEM and TEM), computers, incubators, PCR machines and laboratory facilities for molecular studies (Klopper *et al*, 2001; Ayertey, 2002). A major problem confronting the maintenance of the collections is the unavailability of transportation to the field for replenishment of specimens used or damaged in day-to-day teaching of students. If collection of specimens by students is re-introduced it could also solve this problem. Another danger to the collection in at least some institutions is the unreliability of the electricity supply to run the air conditioners in the museum; provision of generators would solve this very serious problem.

## **4.2 Molecular facilities and DNA Barcoding**

Molecular facilities are increasingly important to provide rapid identifications and assist in a wide range of activities with non-taxonomic deliverables, particularly using DNA Barcoding (see Case Studies in DNA Barcoding at <http://www.bolinfonet.org/casestudy/index.php/browse>). There have been two Regional Barcoding meetings, in South Africa and Kenya in 2006, and Nigeria in 2008 (report at <http://barcoding.si.edu/PDF/NigeriaDNAFinalReport.pdf>). The last-named meeting reported the greatest needs and opportunities for DNA Barcoding in the West and Central Africa to be:

- *“Identifying biological specimens and managing species diversity;*
- *Addressing environmental degradation, biodiversity loss, human poverty; public health concerns, policy issues, border inspection, air and land safety; and*
- *Forming a strong regional partnership because the region shares identical biological diversity and species evolution.”*

The main scientific challenges identified by the meeting where barcoding should be applied included:

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<sup>8</sup> Global Biodiversity Information Facility

- *“Biogeographic assessments and distributions (barcoding techniques can improve the definition of radiation centres for priority taxa);*
- *Intra-specific discrimination of species complexes;*
- *Molecular ecology and improved assessments of community structure of priority species/taxa;*
- *Environmental degradation and biodiversity loss assessments; and*
- *Misidentifications, quality control, quality assurance and problems created by agricultural pests.”*

The meeting also noted that Barcoding will provide non-specialists with tools and data for improved livelihoods in the region, and can:

- *help to boost the yields and quality of crops;*
- *facilitate sustainable use of natural resources;*
- *assist in an effective, sustainable control of diseases and public health concerns; and*
- *assist in poverty alleviation, policy issues, border inspection, air and land safety*

Participants in the workshop identified the training and capacity enhancement of resource persons as the main prerequisite for implementing barcoding in Western and Central Africa. Also the acquisition of relevant equipment and improving existing infrastructure within selected institutions was identified as relevant for the success of barcoding in the region.

Ghana would be well-placed for involvement in the global bee barcoding initiative, ‘Bee-Bol’, for example, because of its in-country expertise. The CSIR-Water Research Institute is involved in the Fish barcode of life initiative FISH-Bol, with two members on the Working Group. The Noguchi Memorial Institute for Medical Research, University of Ghana is the lead organisation for ‘Vector-BOL in West and Central Africa, and is involved in the barcoding of skin fungi. This centre is able to undertake barcoding work for other institutions. The University of Ghana is also engaged in the barcoding of stem borers of crops. The Animal Research Institute of the CSIR, is engaged in barcoding of poisonous plant materials in the digestive tract of cattle.

### **4.3 Education, training and staffing**

According to the 2001 assessment Ghanaian systematists numbered approximately 5, covering vascular plants fungi and bees. To this may be added the two entomologists participating in the current report and though the number has since increased we lack data to assess by how many. The 2001 figure itself may be an underestimate, although some personnel who carry out taxonomy as a part of their jobs are primarily employed to undertake other tasks. However, the 2001 report suggested that staff numbers were inadequate to address biodiversity issues. Taxonomy is taught at universities and colleges within the country to BSc level as a part of other subjects and to MPhil and PhD, but jobs in taxonomy may not be available for those trained. The 3<sup>rd</sup> National Report notes that “Universities and research institutes are providing opportunities for training in an effort to increase capacity of taxonomic research. However these efforts are hampered by infrastructural, human and financial limitations.”

In partnership with the African Pollinators Initiative (API), BioNET-Ghana has developed training curriculum on bee taxonomy. The course outline features

recognition of the bee Families Apidae, Megachilidae, Halictidae, Colletidae, Andrenidae and Mellitidae; understanding bee ecology; bee-plant relationships with special emphasis on pollination; bee sampling. The National Coordinating Institute of BioNET-Ghana has also initiated a training of trainers course in identification, detection and management of the alien invasive fruit fly pest, *Bactrocera invadens* which is of great quarantine concern in horticultural industry (especially mango) in West Africa.

#### **4.4 Networks and collaborations**

The CBD and other bodies have agreed that a means of combating individual countries' lack of sufficient trained taxonomists is to form regional or other networks and partnerships. This provides both a cost-effective solution to taxonomic capacity shortfall and delivers opportunities of scientific catalysis, partnerships and information sharing. Although both the 2<sup>nd</sup> and 3<sup>rd</sup> National Reports to the CBD from Ghana did not identify them, Ghanaian taxonomists are part of several international networks that are focussed on taxonomy or have a significant taxonomic component. These include the following:

##### **4.4.1 BioNET-WAFRINET**

Until the 1980s many biosystematic services were provided free of charge to West African countries by institutions in developed countries. Consequently there was little incentive locally to establish biosystematic resources and expertise. However, budgetary constraints and new financial policies imposed on these centres to become self supporting, coupled with increased demand for their services, led to imposition of charges for identifications. This in turn led to the realization that the lack of adequate biosystematic capabilities was a major constraint to agricultural development and sustainable use of environment and biodiversity resources. Most of West African countries lack taxonomic expertise, comprehensive reference collections of fauna and flora, and durable access to technical information. However, requests from donors for projects that were taxonomic in character received little attention.

The solution found to this need to achieve self sufficiency and self reliance in biosystematic capabilities was the establishment of a technical cooperation network for taxonomic capacity-building in West Africa – BioNET-WAFRINET, the West African Network for Taxonomy. This was endorsed in 1998 by West African governments to function as a Locally Organized and Operated Partnership (LOOP) of the global network for taxonomy BioNET-INTERNATIONAL, and with the International Institute of Tropical Agriculture (IITA) as the Regional Coordinating Institute.

BioNET-WAFRINET member countries are Benin, Burkina Faso, Cameroon, Cote D'Ivoire, Gambia, Ghana, Mali (membership pending), Niger, Nigeria, Senegal, Sierra Leone and Togo. Currently only five of these countries are notably active in the network. Stakeholder groups are research and training institutes/universities, Government departments, Convention of Biological Diversity (CBD) focal points, and development organizations LOOP membership is open to other West African countries.

BioNET-WAFRINET addresses the sub-regional taxonomic demand to support biodiversity identification, use and management. Its aims are:

- *To establish and sustain within W. African sub-region realistic self reliance in biosystematics with special reference to invertebrates and microorganisms for purposes of reference*
- *To support national and sub-regional programmes for sustainable agricultural development and the conservation and sustainable use of the environment and biodiversity*
- *To assist West African member governments to meet their obligations under CBD*
- *To provide W. African member governments and International organizations, NGOs, donors etc within the sub-region, with the best possible biosystematic services in support of biological programmes.*

There are 5 BioNET-WAFRINET work programmes which aim to identify, understand, use, monitor, manage and conserve biodiversity in agriculture, forestry, and aquatic ecosystems to improve livelihoods:

- *Rehabilitate and provide essential facilities to enhance biodiversity identification, use and management.*
- *Improve communications and information sharing between partners*
- *Enhance sub-regional capacity in taxonomy through training*
- *Identify, develop, adapt and apply taxonomic technologies*
- *Strengthen collaborative linkages within the sub-region and globe.*

These work programmes were defined by the first BioNET-WAFRINET planning and coordinating workshop and coordinating committee meeting from 27-30 November 2000 in Ghana. There were 31 participants representing 13 countries - Benin, Burkina Faso, Cameroon, Cote D'Ivoire, Congo Democratic Republic, The Gambia, Ghana, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo, and 3 organisations - UNDP-Ghana, International Plant Genetic Resources Institute (IPGRI) and BioNET INTERNATIONAL. Prior to this an orientation workshop took place in Ghana in September 2000, with 30 participants from some National Institutions, including KNUST, GAEC, CRI, WRI, ARI, PGRRI, Museums and Monuments Board & Ghana Herbarium, University of Ghana. The first BioNET-WAFRINET workshop also recommended the following, based on in-country reports and consultative meetings:

- 1) enhance national and location-specific expertise through training and better access to information at all levels;
- 2) identify and understand location-specific biodiversity;
- 3) provide identification services to support the development of agriculture, fisheries, forestry, germplasm conservation, health, aquatic resources and biodiversity conservation;
- 4) monitor selected ecosystems within biodiversity conservation programmes;
- 5) investigate species inter-relationships for development, testing and dissemination of sustainable options to manage targeted species and to promote wiser use of genetic resources.

The workshop also mapped out activities under respective output/results areas, indicated their milestones, time frames, responsibility and resources required for implementation. The tentative Plan of Operations was to be revised prior to implementation of funded work programmes.

The LCC structure, Steering committee, Technical workgroups and Fund raising task force were formalised. The Next Steps included:

- 1) Writing of Project proposals,
- 2) Publicity and Soliciting national commitment and support for implementing the action plans outlined
- 3) Annual LCC meetings to be held and venues rotated between Francophone and Anglophone countries.

Although projects have not always been taken forward under the BioNET-WAFRINET banner various participants have participated in a number of activities. For example, P. Kwapong (PK) and M. Cobblah (MC) were involved in the Bee Pollinator Summit in Tala South Africa in 2008. MC was also involved, with members of BioNET-WAFRINET from other countries, in the “DNA Barcoding Biodiversity in Central and West Africa” meeting in Abuja, Nigeria. PK was also involved in a follow up meeting of the Pollinator Summit in Nairobi to write proposals. The Pollinator Initiative is discussed further below.

The Ghanaian National Coordinator has been involved in monitoring and training programmes in Mango fruit fly identification and management for staff of the Plant Protection and Regulatory Services Directorate of the Ministry of Food and Agriculture. Staff can now identify the species of common fruit flies. When in doubt specimens are brought to the University of Ghana for identification or confirmation. The Coordinator is also a member of the National Fruit fly Management Committee.

Membership of the Ghanaian Network is given in Annex 3

Further information is at <http://www.iita.org/wafrinethome/index.htm>

Whilst there has been action within BioNET-GHANA, the network within the country is weak, as is BioNET-WAFRINET generally. The main problems hindering greater activity have been:

- Coordination of activities and difficulty in passing on information received from the Regional Coordinating Institute and BioNET Secretariat;
- Speed and reliability of internet varies, hindering communication and sharing of information
- Lack of database on taxonomic expertise within the country and region;
- Critically, there is no funding for coordination activities or any other aspect of the work of WAFINET as a capacity-building network. There is no administrative assistance to the National Coordinator, and neither the Network Coordinator nor the National Coordinator are resourced to implement decisions identified in the first LOOP meeting.
- Lack of clear regulatory policy on sharing of taxonomic information within the Country;
- No clear policy on loans of biological specimens to institutes in and out of Country
- Lack of clear relationship with the sector ministry (MEST) and National Focal Points within the Country

These issues are perhaps exacerbated by a lack of national focus and understanding of the linkage between taxonomic issues and biodiversity and development, support and commitment. This might be solved at least in part by clear policies and national awareness programmes. In turn this could assist in acquiring funding for increased activity in support of Ghana's NBSAP.

#### **4.4.2 Forest Invasive Species Network for Africa - FISNA**

The Network was created during a Task Force Meeting held in Zomba, Malawi in 2004. Seven African countries (Ghana, Kenya, Malawi, South Africa, United Republic of Tanzania, Uganda, Zambia) were represented and the 14 members successfully defined objectives and activities of the network.

This meeting was jointly organized by the Forest Research Institute of Malawi (FRIM) and FAO as the result of serious concerns by a team of African forest protection scientists to revitalize an existing network the "Tree Pest Management Network for Central, Eastern and Southern Africa" to ensure that it is updated to cater for the current needs of Africa.

In line with current forest health issues and increasing problems with invasive species, including insects, diseases and woody species, the existing network was renamed and the mandate and objectives updated.

The mandate of the network is to coordinate the collation and dissemination of information relating to forest invasive species in sub-Saharan Africa for sustainable forest management and conservation of biodiversity. All countries in sub-Saharan Africa that wish to participate in the network may do so; there is no distinction by language or forest type. The objectives of the network are:

- *To facilitate exchange of information and provide a link for communication about forest invasive species*
- *To alert and provide policy advice on trans-boundary movement, phytosanitary measures and other relevant information*
- *To raise regional awareness on forest invasive species issues*
- *To encourage the publication and sharing of research results, management and monitoring strategies*
- *To facilitate taxonomic support*
- *To act as a link between and among experts, institutions, networks and other stakeholders concerned with forest invasive species*
- *To facilitate the mobilization of resources for critical activities in management of invasive species*
- *To provide technical guides on research and control of invasives for sustainable forest protection and health issues in Africa*

The taxonomic support identified above included the following:

- *Prepare a directory of experts and institutes with areas of speciality in taxonomy e.g. FABI (tree diseases), National Museum of Kenya (insects)*
- *Establish agreements with taxonomic institutes to provide network members assistance with identifications*
- *Exchange information between countries of identification of new pests*
- *Make information available through electronic and paper format*

Further information can be found at <http://www.fao.org/forestry/25470/en/>

#### **4.4.3 International Centre for Tropical Agriculture (CIAT)**

CIAT is one of the CGIAR network of organisations, and in Africa. It pursues a programme of research on technology and processes important for development that helps rural communities build sustainable livelihoods, through competitive agriculture, healthy agro ecosystems, and rural innovation. In pursuit of these goals, it works closely with national institutions, NGOs, and the private sector, and uses participatory methods that offer rural people an active role in devising better ways to improve crops, build rural agro enterprises, and manage soil fertility, pests, and plant diseases. In the case of Ghana it has been involved in work on cassava, including at the germplasm level. While not a taxonomic organisation *per se* (and, indeed, it may be a user rather than supplier of taxonomic expertise), it is relevant at the molecular and strain level.

Further information can be found at <http://www.ciat.cgiar.org/africa/index.htm>

#### **4.4.4 African Pollinator Initiative (API)**

Pollinators provide the ecosystem service of ensuring fruit and seed production without any effort from man. Through their activities food is made available to both plants and animals leading to sustainable livelihood and food security. Pollinators also play a significant role in biodiversity by enabling the production of seeds of various plants on which all animals survive. It is estimated the over 75 percent of all plants depend on animal pollinators of which insects form 80%.

The African Pollinator initiative (API) is an African based initiative resulting from a group of scientists, biologists, conservationists and ecologists who recognized the important services pollinators provide to the ecosystem and are concerned about the threats to these pollinators (animals, mainly insects) due to activities of man: wrong methods of insecticide application in the environment, destruction of habitats through logging, forest fragmentation, wild fires, construction and urbanization etc. It is a part of the implementation of the CBD's International Pollinators Initiative.

The API was founded in January 1999, at the First Congress of the Systematics Society of South Africa (SSSA), in Stellenbosch, South Africa. It had two main purposes:

1. To facilitate African country participation in the International Pollinator Initiative's (IPI) global pollinator project (Conservation and management of Pollinators for Sustainable Agriculture, Through an Ecosystem Approach, IPI/GEF).
2. To improve pollinator biodiversity conservation, and the pollination of crops and wild plants through networking.

Three African countries agreed to participate in IPI/GEF: Ghana, Kenya, and South Africa. The responsible people in each country are: Peter Kwapong (Ghana), Wanja Kinuthia (Kenya), and John Donaldson and Ingrid Nanni (South Africa). The other IPI/GEF countries are Brazil, India, Nepal and Pakistan.

UN FAO adopted API as the African region IPI network, and it has become a model for implementation of IPI elsewhere. In February 2002 API held its First Meeting in Nairobi, Kenya (this was also the first IPI regional workshop), with assistance from the FAO. Its purpose was to enable API to create a more formal, co-ordinated approach to pollinator conservation and sustainable use, and to establish specific regional activities upon which FAO can react. The meeting developed an API Plan of Action (Anon, 2003), and established a Steering Committee. The committee's task was to develop the IPI/GEF project proposal. In 2004 the Global Environment Facility (GEF) provided funds for the preparatory phase of the global pollinator project proposal (PDF-B). This was for two years after which a final proposal was presented to GEF council for funding (March 2006). The pollinator project was approved by GEF and is now under way.

The API Action Plan seeks to implement several tasks that will develop and sustain pollination as an essential ecosystem service, including:

- *Collect and document baseline information on Pollination and pollinators*
- *Conduct both scientific research and survey traditional knowledge on pollinators*
- *Build capacity and create public awareness on the importance of pollinators to the ecosystem.*
- *Mainstreaming this information into policies of countries and sharing information among member countries.*

In 2003 twenty-one scientists from all the continents interested in pollinators and pollination met at Mabula, South Africa. Their aim was to develop a handbook to help people involved in land use/management to improve pollinator conservation and of pollination on their land. It gives some theory and many case examples. The book was published in February 2006 and was launched at the Eighth Conference of the Parties to the Convention on Biological Diversity (CBD-COP8), in Curitiba, Brazil, in March 2006 (Eardley *et al.*, 2006).

The National Museums of Kenya and BIOTA East Africa, together, hosted a course on the identification of Afro-tropical bee genera and pollination research techniques, in Nairobi, Kenya, during 27 September – 19 October 2006. There were 15 enthusiastic participants, many of whom are busy studying pollination or are interested in entering this field.

API has focused on the use of existing structures, such as BioNET-International's East, West and southern African networks, to achieve its objectives. Capacity building is being achieved through institutional strengthening and not through the creation of new organizations.

Part of the Action Plan is to discover which species pollinate which plants, and how to manage them sustainably. It should be possible to distinguish useful pollinators from insects which are simply flower visitors; for this and correct naming and identification is very important. We also need to find out the effects/ impact of human activities on pollinators and this demands that the pollinators are correctly identified – a taxonomic need.

#### **4.4.4.1 The API in Ghana**

In line with API's plan of Action, API Ghana has for the past eight years undertaken a number of initiatives and projects in country and continent-wide.

Since 2004 GEF through FAO has provided funds for the preparation of proposal for the global pollination project. This has involved workshops with project partners and stakeholders. A pilot project involving Mankessim Vegetable growers was carried out in 2007 in which some selected growers were trained in best practices for management of pollinators in their farms. Following the approval of the global pollination project, preparations are far advanced for the project take-off in Ghana. Several activities have been going on apart from the FAO and GEF global pollination project. The following are the highlights of some of the major activities:

#### *Capacity building and training:*

In 2003 the first bee taxonomy course was successfully held by Dr. Connal Eardley from South Africa. This course aroused interest in participants and as a result we now have the only Bee taxonomist in West Africa at the PhD level.

In addition, many students have been trained and carried out several pollination projects at both undergraduate and graduate level. Cape Coast University has trained and graduated 4 PhD students in Cashew, Cocoa, and Cowpea pollination and Bee taxonomy. In addition students have been trained at masters level in various aspects of pollination biology.

More than 150 local farmers and beekeepers have been trained in stingless beekeeping at the International Stingless Bee Centre, at Abrafo near the Kakum National Park. An international stingless bee training workshop was also held for beekeepers from 5 neighbouring West African countries and a timber firm (Samatex).

A training workshop has been carried out for over 100 vegetable farmers in 12 communities around the Mankessim area in pollinator friendly practices.

#### *Research*

Through rigorous research on stingless bees, and financial support from Marin Foundation and CS Fund of California, USA, the International Stingless Bee Centre (ISBC) has been established at Abrafo near the Kakum National Park. The research team under the leadership of Dr. Peter Kwapong, has carried out various aspects of research in order to domesticate stingless bees for their medicinal honey and hive products as well as for pollination. About 10 species of stingless bees have been collected and identified, 4 of which are being cultured and multiplied for their hive products and for pollination trials.

Experiments are being carried out on the medicinal properties of stingless bee honey to treat pathogens affecting the human eye and wounds or ulcers.

Plans are far advanced to establish satellite meliponaries in all the 10 regions of Ghana as well as other West African countries.

#### *Extension work*

Members of the API Ghana have been involved in various extension workshops throughout Ghana for beekeepers as well as in Sierra Leone.

#### *Collaborations*

API Ghana is involved in many collaborative research projects in Africa and globally.

### *Publication*

A new book on Stingless bees ('STINGLESS BEES: IMPORTANCE, MANAGEMENT AND UTILIZATION - A training manual for Stingless beekeeping') is in press.

Presentations and research findings are made available and shared among other collaborators and at various meetings around the world.

### Entomology museum

An entomological museum has been established in the department of Entomology and Wildlife, University of Cape Coast, primarily holding insect collections from flowers of various plants.

### **4.4.5 West African Regional Network (WARN)**

The primary objectives of the West African Regional Network<sup>9</sup> are to: foster research in environmental change that build on existing bilateral collaboration links; help develop research capacity among the partners involved through joint research activities on key aspects of environmental change; and train young scientists from African partner institutions in approaches and techniques for studying environmental change, such as the use of Earth Observation techniques and GIS.

The first WARN discussion meeting was held in 2005 to develop an Action Plan for West African Remote Sensing/GIS Network. WARN was officially initiated in 2007, at the 2nd West Africa Regional Network Meeting on Earth Observation and Environmental Change held at the University of Ghana.

The Department of Geography and Resource Development of the University of Ghana, Legon is a member of WARN. The work of digitizing and mapping biodiversity data is clearly an important component of developing the applicability of taxonomic information to biodiversity issues within Ghana and West Africa generally.

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<sup>9</sup> <http://www.fao.org/gtos/gofc-gold/net-WARN.html>

## 5 Discussion

### 5.1 Lists of names

There was much discussion of the need for species lists. Up to date scientific names were seen as very important, as were common names. The needs which such lists will meet are discussed above (section 3.2.1.1.) and summarised in Fig. 7. GhanaBIF will seek to manage names of species in Ghana, focussing on scientific names; but currently they have had no guidance from stakeholders about vernacular names. Many of the questionnaire respondents, as well as workshop participants, stressed the importance of common names, bearing in mind that these need to be collected with the language and place where they are used. Common names also do not necessarily have a one-to-one relationship with scientific names, nor does the same common name necessarily refer to the same biological species in different places. The issue of common name databasing is being discussed by GBIF, among others.

Much other data linked to names are required by different users as well. Rather than compile many different versions of the same list with different additional data (e.g. conservation status, pest status, distribution, host associations etc), a single list should be compiled (though the source may be distributed in different organisations) and used by all, with appropriate metadata or additional fields as required. The list could also be used by collection-holding institutions to manage their holdings. Ideally it should be dynamic and available on the web, to facilitate it being kept up to date, and used by the maximum number of sectors. Partnership with Species 2000-Catalogue of Life may be valuable in this endeavour. Use of GBIF-mediated data will assist in compiling a list.<sup>10</sup> Additional extra-national taxa could be added where important to do so (e.g. potential invasive species, quarantine-listed species, pests). Examples of such lists are the Species Dictionary of the UK's National Biodiversity Network<sup>11</sup> and Fauna Europaea<sup>12</sup>.

### 5.2 Identifications and identification tools

The NBSAP includes Required Actions to

- “inventorize existing forest reserves and their resources using modern technologies, such as, remote sensing, Geographical Information Systems and prepare a Red Data List”;
- “identify areas of biological diversity hot spots and promote their status” (including in the contexts of Permanent Protected Forests and Wildlife Reserves);
- “inventorize existing wildlife reserves using modern technologies, such as remote sensing, Geographical Information Systems”;
- “to build and manage databases on biodiversity and biological resources”

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<sup>10</sup> <http://data.gbif.org/species/browse/country/GH>

<sup>11</sup> <http://nbn.nhm.ac.uk/nhm/>

<sup>12</sup> <http://www.faunaeur.org/>

All of these need a suite of taxonomic expertise, including skills in monitoring and assessment, which rely on sampling and field skills developed in the course of taxonomic work. Critically, they also require implementation of a system of sorting and identification.

A similar need applies to the management of economic pests such as fruit flies, where a monitoring system needs to be put in place, including the capacity to identify the catches. Another priority example is the need for an assessment and monitoring system on pollinators, which will include the people trained to identify the specimens collected. Participants at both workshops, as well as questionnaire respondents, provided a long list of needs for identifications, and indicated the adverse economic, human and environmental consequences where these could not be provided.

Provision of identifications is a major issue within the country. While some people have made personal contact with trusted experts both inside and outside Ghana, others are struggling to find books, illustrations and scientific papers and then experts who might be able to deal with identifications they cannot. For some organisms, particularly insects, powerful microscopes or even DNA sequencing might be necessary as tools to carry out the identification, as well as a comprehensive reference collection for comparative purposes. A risk of identifications being too difficult to obtain is that individuals without the necessary expert knowledge and resources will have to attempt identifications themselves, introducing a higher risk of misidentifications and consequent economic and other loss. Workshop participants noted the need for in-country taxonomists to have to cover a much broader spectrum of taxonomic groups than was the case in countries with more taxonomic specialists available, and the consequent risk of misidentifications.

Identifications may sometimes not be possible because a species is not yet scientifically described and named. In these cases a specialist in the taxonomic group concerned will be needed to prepare and publish a description. Such people may also be key figures for authoritative identification of the group concerned. While there may be such a specialist within Ghana, it is equally or more likely that Ghanaian scientists will have to look for someone in another country. This might be in a regional centre such as IITA (where identifications of some groups can be provided without charge) but might equally be in an institution elsewhere in the World. A point made strongly is that approaches to experts should be made on an institutional rather than individual basis, to ensure clarity of responsibility. Often a charge is made by institutions for identification, necessary to cover their own costs, and means of absorbing these costs must be developed by the Ghanaian institutions needing the identifications. While participants in the second workshop agreed that the principle of user pays was a good one, they also recognised that in some cases there was no money available to make such payments or that (for example in the case of the general public) charging was inappropriate and may be counter-productive.

An important matter is to determine where the priorities are for taxonomic expertise. For example, the Cocoa Research Institute of Ghana in 2002 identified the need for a taxonomist to cover insects other than

Pseudococcae, and a fungal taxonomist (B. Padi, as reported in Ayertey, 2002). Such prioritisation will also govern the focus and scope of appropriate identification tools such as illustrated guides where these need to be developed. For example, a recognized need to help people identify forest trees led to the recent production of a photograph-rich field guide to trees using predominantly vegetative characters (Hawthorne & Gyakari, 2006).

An indication of needs, as well as the outline solutions, is presented in Fig. 8. Identifications can be delivered at various levels of detail (genus, species, strain) and it is important that the user requirements are taken into account when setting up an identification system. Some identifications need to be carried out by specialists while others can be handled at a more local level. Building up this local capacity integrated with regional and national centres will be valuable. In some cases expertise will be needed from outside the country, and collaborative systems need to be strengthened. This fits well with the NBSAP Required Action: “seek collaboration with both local and external institutions in information exchange, science and technology e.g., BioNET International”. The latter initiative, especially the local LOOP, BioNET-WAFRINET, is a key partner.

Overall, there is a need to have an easily-accessible and transparent system, including easy-to-use identification guides, tools for key groups or ecosystems, simple access to experts in Ghana and also in other countries where necessary. Development of such a system or protocol is a priority.

### ***5.3 Ecological and distributional information***

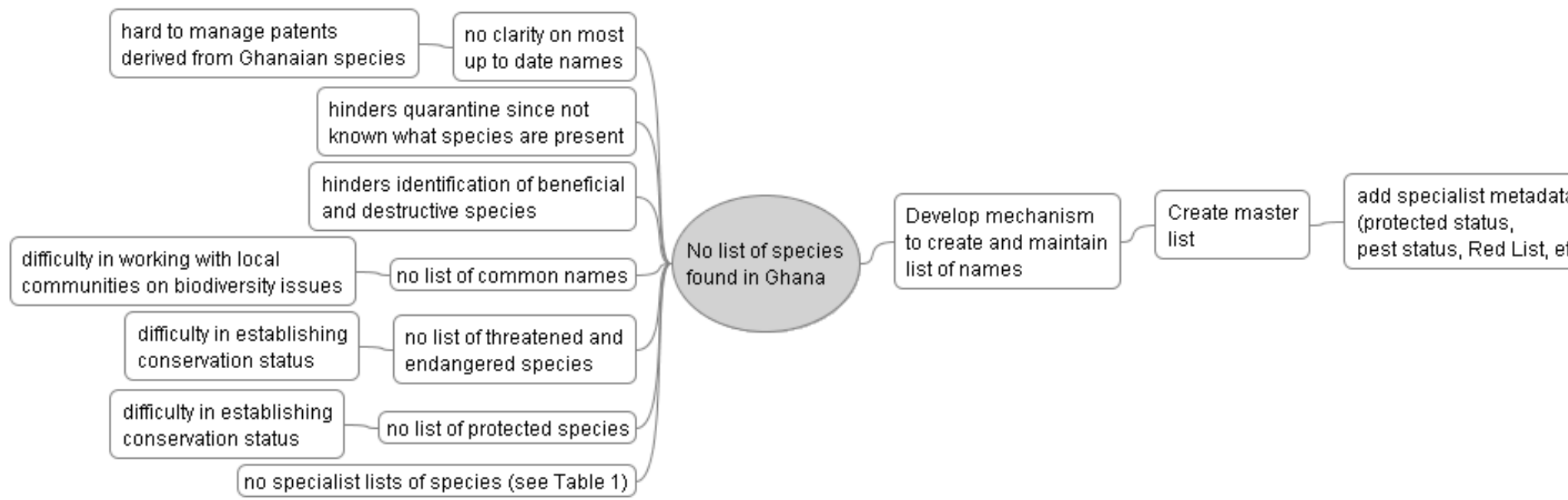
There is a demand for a variety of such information, needed to manage both natural and man-made systems such as agriculture (Figs 9, 10). Many people need pre-packaged information, including standard maps of, say, priority species for conservation, rather than engage in analysis themselves. This has partially been dealt with above, but there is a need to identify one or more sources of such information within the country which can then meet the needs of other institutions in a timely and accurate manner. How this should be created is unclear, but there are various models available in other countries, and it might be appropriate to work with GhanaBIF in this respect. Sources currently available should be listed on the CHM website as a first resort.

This topic is discussed further in Section 5.4.

Problems caused by the taxonomic impediment<sup>13</sup>

Major issue

Proposed solutions



**Fig. 7.** Taxonomic needs associated with the names of species, and proposed solutions.

<sup>13</sup> The problems caused to implementation of the CBD (among others) by difficulty in accessing necessary taxonomic information and expertise.

Problems caused by the taxonomic impediment

Major issue

Proposed solutions

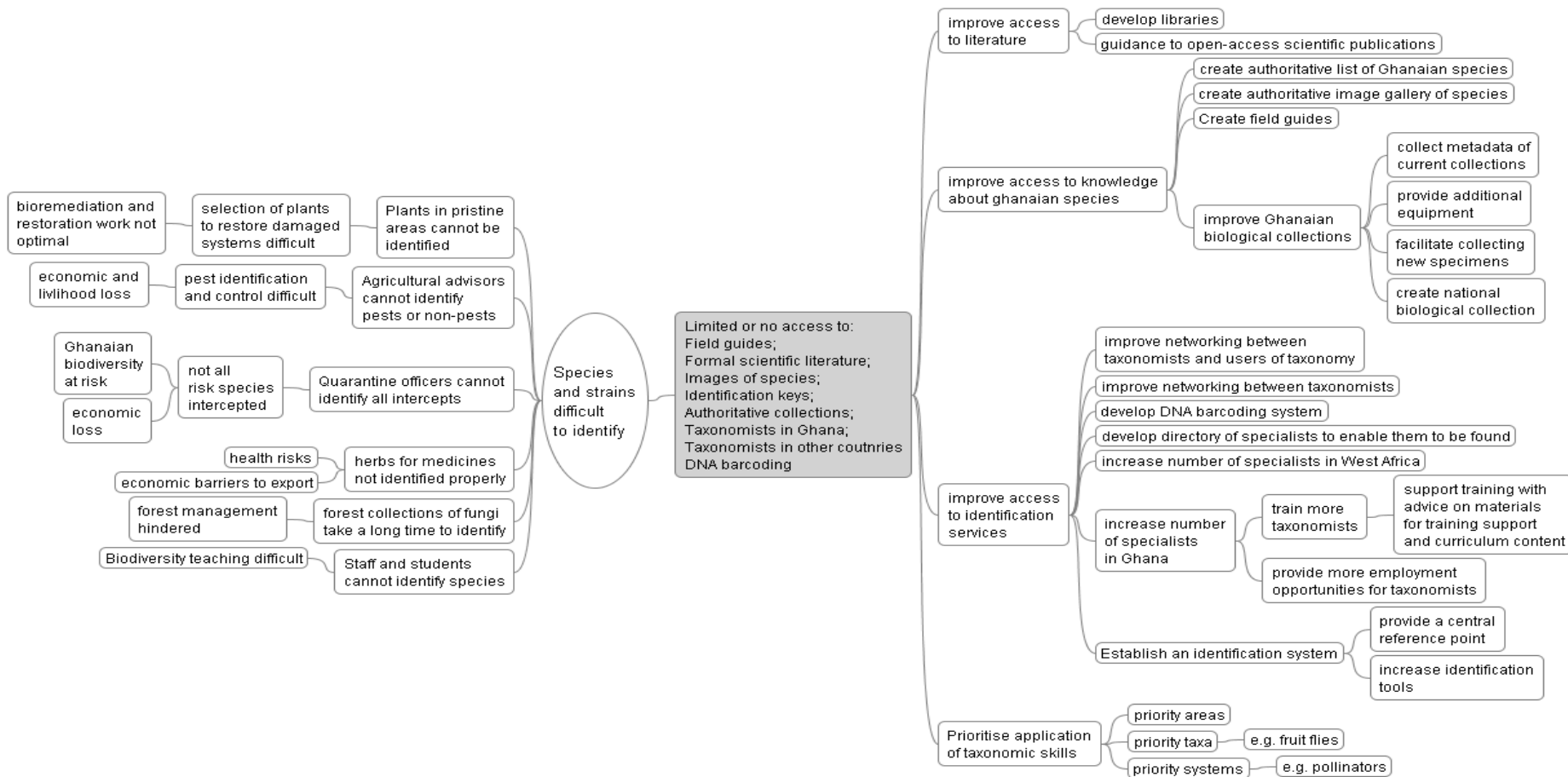
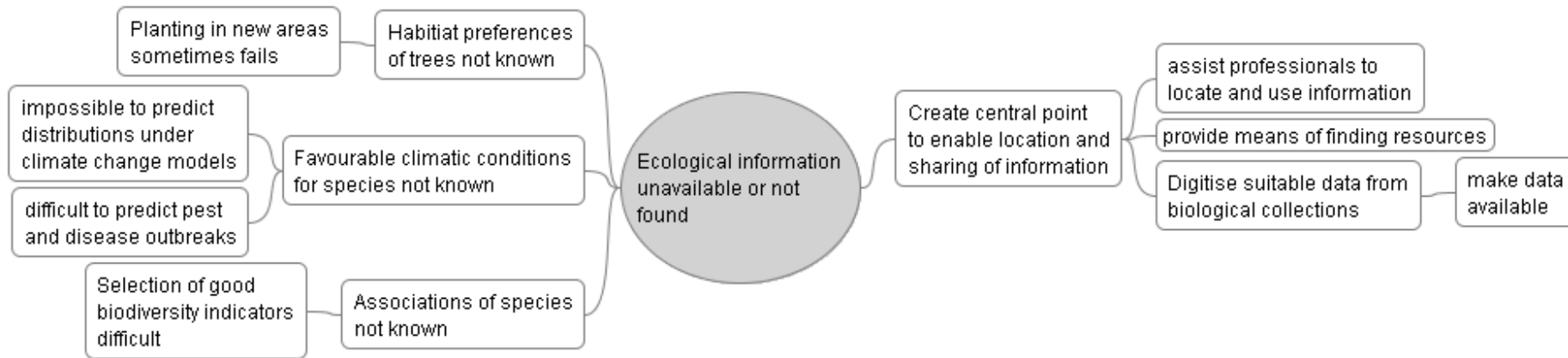


Fig. 8. Taxonomic needs associated with the identification of species and strains, and proposed solutions.

Problems caused by the taxonomic impediment

Major issue

Proposed solutions

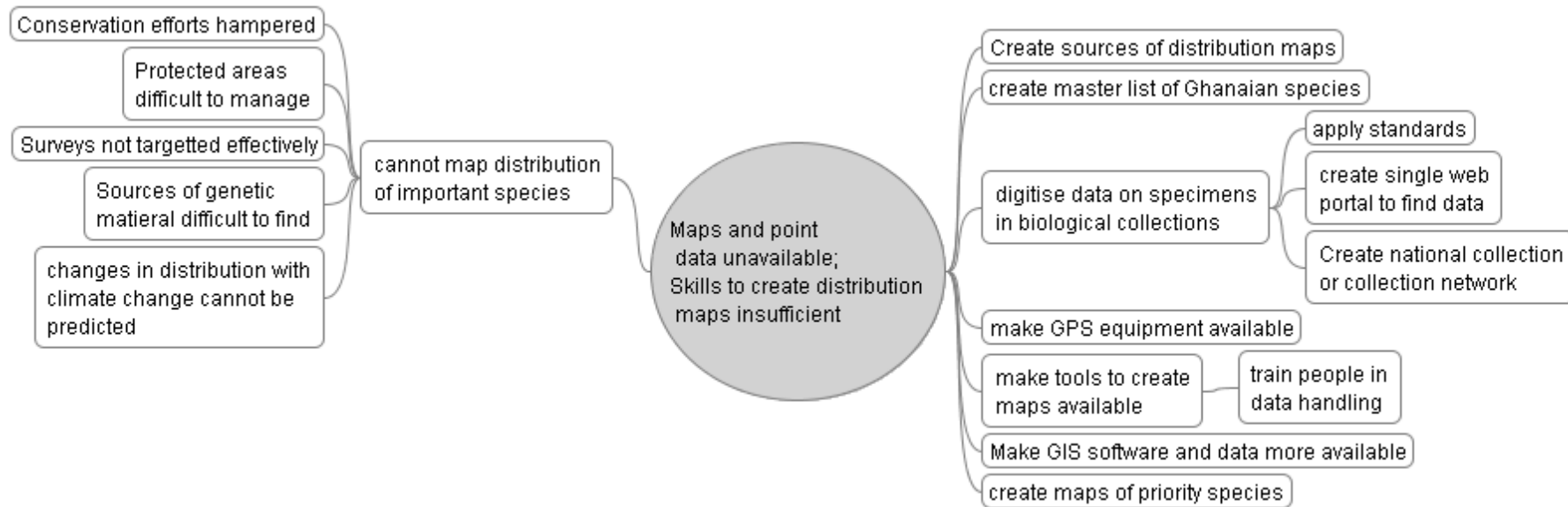


**Fig. 9.** Taxonomic needs associated with access to ecological information from taxonomic sources, and proposed solutions.

Problems caused by the taxonomic impediment

Major issue

Proposed solutions

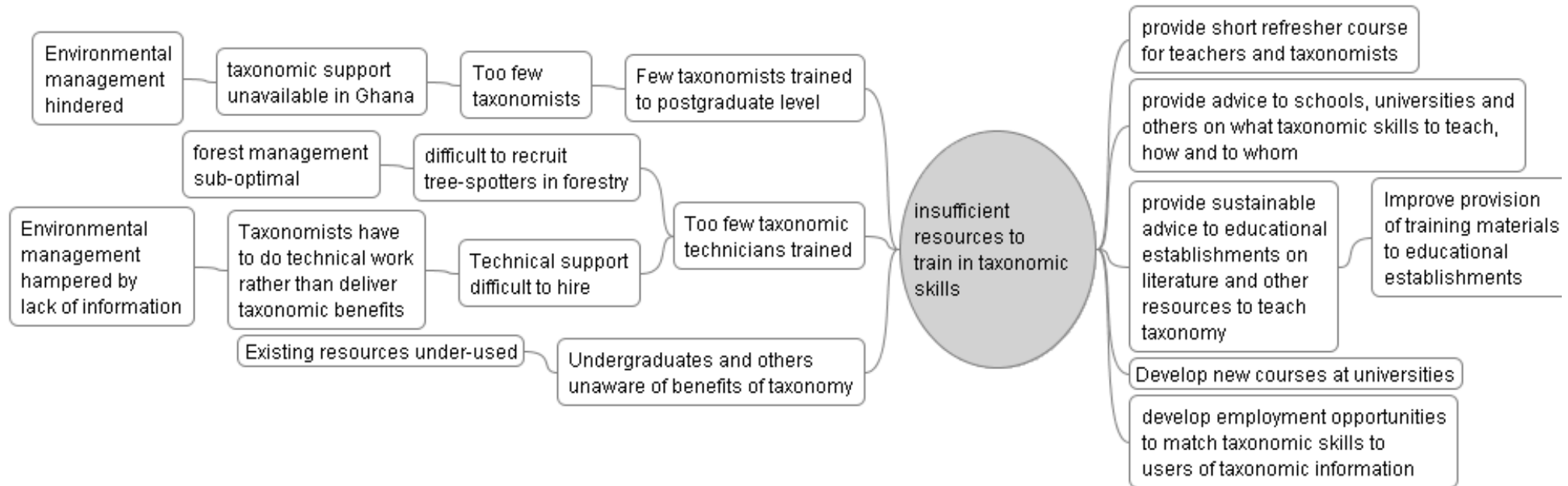


**Fig. 10.** Taxonomic needs associated with lack of species distribution information, and proposed solutions.

Problems caused by the taxonomic impediment

Major issue

Proposed solutions



**Fig. 11** Taxonomic needs associated with lack of trained taxonomic expertise, and proposed solutions.

## 5.4 Data management and analysis: Mapping, modelling and databasing



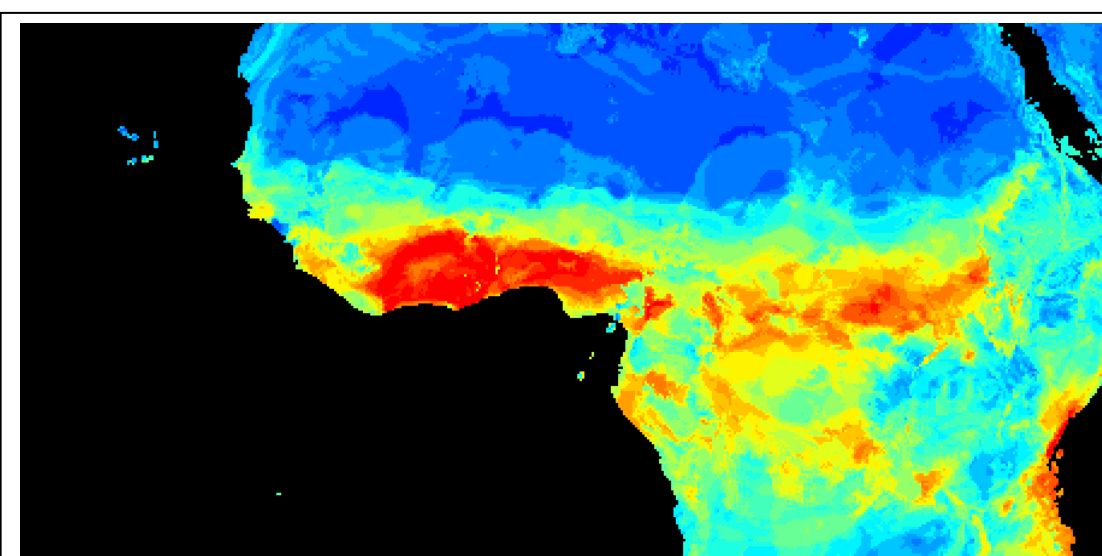
**Fig. 12.** Records of *Bufo* species in Ghana displayed on Google Earth generated on [www.GBIF.org](http://www.GBIF.org)

The participants in both workshops were very interested in the potential of data usage for mapping and prediction as outlined in section 5.3. A main source of data is those associated with specimens in biological collections both within and outside Ghana. Uses of these data included how to predict important biotic changes, such as outbreaks of pests and diseases, distribution of invasive species, and changes in distribution under different models of climate change. The impact of climate change on agricultural crops and pests was of particular interest, as was the ability to predict rapid pest outbreaks accurately. Representatives of fisheries departments were concerned whether baseline data on fish distributions and abundance were available, since without these it is very difficult to determine the effects of fisheries on stocks. Other participants simply wanted distribution maps, either for Ghana as a whole or across West Africa. More discussion of the uses of ecological and distributional information is given in the earlier sections.

In all these cases there is an important source of baseline data held in biological collections both within and outside Ghana. Each specimen in these collections (and the collections include pest and disease organisms, as well

as those of conservation interest) is accompanied with the data detailing when and where it was collected. The practice in the past has been for researchers to copy the labels and then plot or analyse the point sources. The need to train people in this methodology was raised during the Assessment, as well as how to handle conflicting data, how to refine poor point source data, and how to manage scattered information.

However, current best practice is to store the data once collected on a computer in a standard format (though workshop participants noted poor understanding of what these standards are and where to find them), so that they can if so wished be shared over the internet. Many such records are now made available through the Global Biodiversity Information facility (GBIF). The data made available through GBIF can be downloaded for analysis or even plotted by the GBIF site to provide a GOOGLE Earth view of the data



**Fig. 13.** Ecological Niche Model of *Bufo* species in Central Africa generated from Ghanaian data on GBIF. Red – high probability; blue – low probability.

(Fig. 12). Not only can these localities be plotted on a map, by adding climatic data covering those points a hypothesis of the ecological niche as controlled by climate can be derived (there are computer programmes such as GARP that are freely available to perform this analysis)<sup>14</sup>. Even easier, if the data are made available through GBIF<sup>15</sup> niche model software can be applied to the specimen data on the GBIF website as a web service (although only on a global basis at present – see Fig. 13). With this model the full distribution of each species can be predicted. This type of benefit would result from implementing the NBSAP action “promote international cooperation and information exchange”.

The capacity to collect manage and analyse the data from collections in Ghana is not currently sufficient, a problem not only identified by participants in the present study but also stated in Ghana’s NBSAP. The issue of data

<sup>14</sup> GARP can be downloaded from <http://nhm.ku.edu/desktopgarp/>

<sup>15</sup> The Global Biodiversity Information Facility, <http://www.gbif.org>

management is highlighted in several areas of the NBSAP and the contribution of data from collections is relevant to all. Within the Assessment a number of individuals felt that lack of skills and knowledge in this area was hindering their work.

In addition to skills issues, there were also problems with equipment and infrastructure in this area. Some individuals noted difficulties in handling massive amounts of data and carrying out multivariate analysis; both necessary not only for taxonomy *per se* but also to deliver some classes of taxonomic information to users. GIS support was called for, to facilitate analysis of distributions and predictive models. The needs for equipment, including and computing hardware and software, were noted. Because of the rapid growth of information on the internet, in order to make best use of this and to develop Ghana's own contributions, the limitations of bandwidth must be addressed. Ghana Telecom does now offer broadband, and access to this needs to be increased.

The distribution records are only as good as the data they are based on. Those data must come from specimens or observations. Currently the specimens on which the above maps are based are all held outside Ghana, but doubtless represent only a fraction of what is actually in those collections. Within Ghana no specimen data have been placed on the web in such a way that they can be retrieved and analysed in the manner shown. There are examples (e.g. e.g. CONABIO in Mexico, INBIO in Costa Rica, NBN in UK) where digitised specimen and observational data of this type are being used regularly and often by Government and business to inform their decision-making and activities.

The NBSAP notes a required action to build and manage databases on biodiversity and biological resources, particularly in the context of Off-reserve Areas. Such databases will also be required to support inventories of forest reserves, biodiversity hot spots and wildlife reserves, as well as developing a Ghanaian Red List of threatened and extinct species, all of which are also listed as required actions. Construction of databases will need to be a coordinated activity across a number of sectors, but will ultimately depend on the provision of taxonomic names and specimen data. Thus they will require action to support this necessary taxonomic component.

As a response to this matter Ghana is setting up a GBIF Node, the Ghana Biodiversity Information Facility (GhanaBIF)<sup>16</sup>, although currently it is not serving data to GBIF. The goals of GhanaBIF are to develop biodiversity informatics tools in order to support the conservation and sustainable use of biodiversity in Ghana, to establish a functional node for GBIF in Ghana and to promote, coordinate and share information in Ghana including existing initiatives thereby facilitating integration of data and information. GhanaBIF is particularly concerned with information relevant to key issues such as climate change and the management of biodiversity. It is developing a Ghana Biodiversity Portal which, in addition to making simple data available it plans to give access to additional materials such images and sound recordings, These should be attractive to the general public as well as to scientists. It also plans to provide additional information such as where to find herbaria in

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<sup>16</sup> Currently managed by Mr. George Owusu-Afriye of Aburi Botanical Garden

Ghana, links to what is going on, research, sources of identification and information about international initiatives.

In some of its aspirations GhanaBif parallels initiatives such as the North American Integrated Taxonomic Information System ITIS and the UK's National Biodiversity Network, NBN. ITIS arose from the USA's White House Subcommittee on Biodiversity and Ecosystem Dynamics. It identified systematics as a research priority that is fundamental to ecosystem management and biodiversity conservation. This primary need identified by the Subcommittee requires improvements in the organization of, and access to, standardized nomenclature. ITIS was designed to fulfil these requirements<sup>17</sup>. NBN has a much wider content area than ITIS, but like ITIS was set up by the Government (of the UK) to provide standardised information<sup>18</sup>. The NBN is the UK's GBIF Node.

In addition to the digitisation work being carried out independently and in concert with developing the GhanaBIF, there is a metadata initiative being undertaken by the University of Ghana, Legon. The group have been active for some years, including using the system in biodiversity areas such as with a small village herbarium, under a GEF small grant. They are interested in extending their work to some of the matters discussed in the report. Metadata (literally 'data about data' will allow access to information that particular data sets exist without providing access to the data themselves. This is important in cases where the data have not been digitised but need to be findable. It also deals with concerns of data owners who do not want their data to be freely available because of concerns over possible IPR infringement. Notably, GBIF is developing recommendations on the use of metadata of biological collections<sup>19</sup>, linked to the standards being developed by the Biodiversity information Standards group TDWG<sup>20</sup>.

In the second workshop in particular some participants expressed concerns over making data and information freely available over the internet. There was a feeling that data could be 'stolen' and the work of the data compiler not acknowledged. Such concerns are very widespread across the World. Countering these concerns were the possibility of making only some data, or just metadata, available, and the distinction between the raw data and the processed information (which unlike data has intellectual content). Some workshop participants noted the problems of working with overseas partners who despite agreements signed had not made data from joint research or collecting available. There was a general agreement that as part of granting research permits there should be a requirement for making data available within a predetermined time. A suggestion was made that Ghana should develop a national policy on the sharing of information and modify the existing collecting permit, with the intent of protecting information from within Ghana.

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<sup>17</sup> <http://www.itis.gov/>

<sup>18</sup> <http://www.nbn.org.uk/About.aspx>

<sup>19</sup> Information on the developing recommendations at <http://www.gbif.org/informatics/discoverymetadata/>

<sup>20</sup> Natural Collections Descriptions (NCD): A data standard for exchanging data describing natural history collections. <http://www.tdwg.org/standards/312/>

## **5.5 Taxonomic Expertise and Training**

Many of the individuals contributing to the assessment are in the education sector, from Secondary to University. Training in taxonomy to some level is key to development of taxonomic capacity and to the understanding of the benefits of taxonomy. Some of the needs and associated outline solutions are given in Fig. 11. Awareness of taxonomy and taxonomic tools should form part of the background of trainers and teachers. Participants in the second workshop noted that even in institutions that might be expected to teach taxonomy there were shortfalls in taxonomic expertise. A useful first step in developing the capacity base to teach the next generation would be to hold a short training course or workshop to bring people up to date on taxonomy and the tools now available. Such a course could be of value to both teachers / lecturers and to professional taxonomists; the proposal was supported by the participants in the second workshop.

Taxonomy training is being offered at Certificate level (a 3-year course at Aburi School of Horticulture) and BSc, MPhil and PhD levels in the universities within the country, although some students are going abroad to be trained.

Overall people are being trained in taxonomic skills not only in formal educational settings but also either self-taught or *ad hoc* as a part of their job in a different sector, to enable them to do their work better. This might include ecologists who need to identify species within their study area, be it one or two families or across the taxonomic spectrum, and extension workers who need to be conversant with the important pest species. FORIG has addressed this in the past by training technicians as 'parataxonomists' to identify species in the forest (although not to recognise new species or describe taxa). However, this course has in recent years been translated into a degree-level study at KNUST.

The second workshop noted with concern the diminution of training at the technical support level, for areas such as fieldwork, extension services and laboratory support. Many of the current staff in these areas are aging and there is a risk of losing this vital component.

It was recognised by participants in the second workshop that students were not electing to do taxonomy in tertiary education, and solutions to this state of affairs are needed. One is to increase understanding of taxonomy from primary level and maintain it as a curriculum element until tertiary. It should also be included as a component in biological and environmental degree studies where it is not being done, at least to ensure that students are aware of the taxonomic needs they might face and of the methods that taxonomy applies, as well as a basic understanding of the fauna and flora of the Country.

A suggestion made by many of the participants at the second workshop was that students should be required to collect and identify specimens as part of their courses. This would have the dual benefit of developing a resource for the training establishments and improving the students' knowledge.

A component of the training that was raised as an issue was the difficulty people had in finding the correct course materials, including the most appropriate literature. It was suggested as a valuable next step to bring

together a consortium of experts within the country or region tasked to identify necessary elements of taxonomy to be taught at Secondary and degree level, as well as for *ad hoc* training requirements, and provide an outline syllabus for each of these different targets. They might also recommend a list of resources and where to obtain them. This could then be used by teachers and trainers to prioritise budgets and requests for their courses. Such recommendations should be regularly revised.

There may also be scope for short training courses, perhaps at regional level, on particular skills or taxa. This might be extended to introduce new Vocational Qualifications on identification skills, for example, suitable for practitioners of Environmental Impact Assessments. Such qualifications would ensure that the requisite skills were employed in such assessments, and could give the users of such assessments an indication of quality.

## **5.6 Biological Collections**

In several aspects of the assessment the need for reliably-identified specimens in collections was highlighted. This part of the solution is also seen in several of the above figures of needs and solutions (Figs 8, 9, 10). Improving the collections and collection infrastructure would not only provide a source of data for mapping and modelling studies such as discussed above, but also act as a local reference for named specimens with which to compare specimens submitted for identification. Thus in carrying out inventories, for example (noted as important activities in the Ghanaian NBSAP), identification of some taxa, particularly plants and invertebrates, can only be done reliably through comparison with named examples. Of course, collections made during an inventory or monitoring project should ideally have voucher material archived to provide a permanent record and be resource to facilitate identification of specimens collected subsequently. In order to develop such a resource institutions need to have both good housing for their collections and trained staff to manage them. This in turn will demand adequate training and funds to ensure employment of those staff. Currently there is a severe gap in this area.

Even though there are several collections within Ghana, non-specialists are not fully aware of where they are or what they contain. Although the Assessment did not obtain detailed information about the collections that do exist, experience in other countries suggests that the same species may be held in different collections under different names, either because of identification problems or the lack of resources enabling collection managers to keep all their specimens named in line with changing names and taxonomic concepts. This would pose real problems in comparing any monitoring and assessment work within the country that used different collections as a resource rather than a core National Resource.

This issue might be addressed through developing a collections network within the country, including both living and dead collections, building on the BioNET-WAFRINET partnership and the developing metadata initiative. This would enable location of relevant collections, synergy between collection managers, an understanding of the range of biological collections available within Ghana, development of an overall strategy for growth and maintenance of those collections.

A complimentary approach would be to designate a National Biological Collection (on one or more sites, to capitalise on the work already done within the country), ensuring that there is adequate national support and recognition. It may be appropriate to create a statutory responsibility for such collections to ensure their maintenance. As National Collection(s) it/they should be a core repository for Ghanaian and other regional specimens, and could become a regional resource as well as a national one. CBD COP Decision IV/1.D states, in the Suggestions for Action: "Parties and authorities responsible for museums and herbaria should invest, on a long-term basis, in the development of appropriate infrastructure for their national collections. As part of that investment, donors, both bilateral and multilateral, in their commitment to the conservation and sustainable use of biological diversity in countries where they provide investment support, should support infrastructural needs of collection-holding institutions. "The CBD identifies such museums and herbaria as key players in delivering taxonomic information to support CBD implementation by Parties.

### ***5.7 Libraries and Journals***

Many of the Questionnaire respondents cited libraries, books and journals as an important source of almost all types of information they were asked about. In some cases it was difficult to see from a taxonomic point of view that this was the most effective source, but clearly it is extremely important and, along with in-country professionals, is an area that may need to be strengthened in order to meet needs of non-taxonomists either directly or by strengthening the capacity of taxonomists within the country. The second workshop discussed some issues of literature-based information. There appears to be no abstracting service that is either relevant to or accessed by all Ghanaian researchers. This was apparent from the 'discovery' of some extant literature resources during the workshop. There was concern that checking changes in nomenclature was made difficult because of uncertainty of accessing the most up to date literature. Some literature, both older works now out of copyright and modern open-access journals are freely available on the internet, and a selection of these will be included in the proceedings of the workshop. However, there is a need for a centralised resource of some type to facilitate discovery of and access to the most important literature.

### ***5.8 Increasing awareness and building communication***

The purpose of a taxonomic needs assessment is to establish what requirements the users of taxonomic information have, and as a result of that identify priorities for taxonomic capacity building or other action that must be put in place to meet those needs. Such a process is hampered by the lack of knowledge that users may have of the possibilities of taxonomy and taxonomic information to assist in their work. In general, there is perhaps a lack of national focus and understanding of the linkage between taxonomic issues, biodiversity and development. In the current assessment much of the work was done by questionnaire and the lack of awareness by many of the respondents was very clear in their answers. It was clear from both the inaugural workshop and the questionnaire that as individuals became more aware of the possibilities of taxonomic information and other benefits the more they could see how their sector could benefit and become more effective. In

this respect the Assessment itself fell under the Ghanaian NBSAP Priority Action “institution of a national biodiversity education, training and awareness programme for all sectors of the economy and all levels of the political structure”.

Another point that came up in workshop discussions and through the questionnaires was the lack of understanding and awareness of the policy framework in which the Assessment was taking place. Despite the considerable detail in the CBD’s Global Taxonomy Initiative documentation, and commitments that Ghana’s government had entered into, the majority of participants and respondents had not been involved and had not seen ways in which they could participate in the national efforts. Most workshop participants were not really aware of the CBD or the Global Taxonomy Initiative. Equally, they did not know of the CBD COP Decisions, nor their means of decision making through recommendations from the Subsidiary Body on Scientific, Technological and Technical Advice (SBSTTA), where they might be expected to be able to put in useful comment. It was felt that clear policies and involvement were needed within Ghana. There was also a need for a national awareness programme to ensure that taxonomists and non-taxonomists understood their roles and the linkage and the coordination necessary between their sectors.

The further development of Ghana’s Clearing House Mechanism may help this situation, as well as other means of communication between the Government and those who can implement policies. The National GTI Focal Point might also be assisted through a strengthened BioNET-WAFRINET-Ghana as both a network to distribute information and to gather information towards national reporting and other needs. Currently the GTI Focal Point is a particularly well-informed individual but there is no infrastructural system in place to ensure that any successor can acquire the same degree of knowledge on what is happening both within the Country and internationally or even contribute to the issues.

BioNET-Ghana could have a pivotal role to play in communication and building awareness. Not only could it interact more with institutions across the country, but also with the national GTI Focal Point. Already the National Coordinator receives information from the BioNET global Secretariat, but also from the BioNET-WAFRINET Regional Coordinator. However, the National Coordinator role is not supported and is essentially done in free time and without resources for postage etc, so information received cannot always be passed on. A small amount of targeted support here could have a major catalytic effect, as seen in other BioNET regions.

In addition to location of collections some participants noted the difficulty in finding taxonomic experts, and were unaware of the range of taxonomic expertise within the country. A directory of taxonomic expertise, as a component of the global directory called for under CBD COP Decision IV/1.D, would help solve this problem, as well as make that expertise more easily available to Government and overseas partner-search.

Not only was there a need for location of taxonomic experts, but both workshops demonstrated the benefits of bringing workers from different disciplines together. There were a number of instances where workshop

participants were able to help others with problems because of work done in their own institution but which others were unaware of. There would clearly be benefits of improving communications between Ghanaian institutions in different areas, perhaps by holding cross-disciplinary workshops and conferences, under such umbrella issues as meeting challenges of climate change, or invasive species as they impact on different ecosystems.

BioNET-WAFRINET currently operates through institutions, with the contact point usually being the Director or Head of department. However, many of the benefits are potentially enjoyed by individuals within those institutions. Strengthening communication between individuals, whilst maintaining (and enhancing) the institutional membership, could potentially bring major benefits to the network.

## 6 Priorities and Recommendations

The recommendations given below are derived from the solutions identified above, particularly in section 5 (see Figs 7-11). They deal primarily with capacity development and guidance to policy and practices. The recommendations, while expected to be taken up by the biodiversity sector, cut across different areas of Ghana's work with the environment, including conservation, agriculture, fisheries, forestry, herbal medicines, customs and quarantine. Consequently solutions have to extend across these and other sectors, which will necessitate integration not only within Government departments but across departments in government and institutions.

The more detailed recommendations of the Assessment (4-27) can be integrated with the first three overarching goals. For ease of use the recommendations are grouped according to areas of work.

The recommendations are given as a table, with suggested actors and timeline.

Overarching vision	Actors	Timescale
The second workshop believed that, by the end of 2010 and beginning of 2011:		
1. A special coordination mechanism for biodiversity should be created at the national level.	Government	By beginning of 2011
2. Biodiversity should be fully integrated into all the sectors of Ghanaian economy, with MEST promoting inter-ministerial co-ordination.	Government	By beginning of 2011
3. The majority of Ghanaians should be adequately informed about biodiversity and ecosystem services for human well-being.	Government / IYB committee	By beginning of 2011

<p><b>Increasing awareness and building communication</b></p> <p>Implement the NBSAP Priority Action “institution of a national biodiversity education, training and awareness programme for all sectors of the economy and all levels of the political structure” for this sector.</p>		
<p>4. Develop an Action Plan to take forward the recommendations in this Assessment, including developing and working with provider and user groups to discover how best the benefits of taxonomy can be generated and delivered.</p>	<p>Government, with CSIR, Universities</p> <p>Support will be required.</p>	<p>By end 2010</p>
<p>5. Create and maintain a directory of taxonomists and their expertise as a means to facilitate contacts between non-taxonomists and taxonomists, in the context of delivering taxonomic information and identifications. It should include taxonomists within the country and taxonomists in other countries with appropriate knowledge and interest in the region.</p>	<p>It could be created by BioNET-WAFRINET and maintained in conjunction with the Clearing-House Mechanism (CHM) of Ghana.</p> <p>Support will be required.</p>	<p>By end 2010</p>
<p>6. Strengthen the means of communication between the Ghanaian Government and the taxonomic community and others on the policy needs identified in CBD COP Decisions on GTI and other relevant thematic areas and cross-cutting initiatives, and of the efforts made to implement these policies.</p>	<p>Government (National Focal Points), with BioNET - WAFRINET network within Ghana,.</p> <p>Some support will be required.</p>	<p>By end 2010</p>
<p>7. Improve communication between different sectors with responsibility for or interest in biodiversity such as plant and animal health, to maximise sharing of benefits and potential improvement of mission delivery.</p>	<p>Government, BioNET-Ghana, Departments</p>	<p>Ongoing; improvement by end of IYB</p>
<p>8. Encourage taxonomists and</p>	<p>Government, IYB</p>	<p>Ongoing;</p>

others to engage more with the public and other stakeholders, and build better understanding of the subject.	Committee, Institutions employing taxonomists.	improvement by end of IYB
9. Hold cross-disciplinary workshop on themes such as climate change or invasive species to improve interactions between different sectors, including taxonomy.	Science Association of Ghana?; IYB Committee.	During IYB
<b>Improving the creation and delivery of taxonomic information through human capacity-building and experiential training</b>		
10. Increase provision of training resources to educational establishments.	Government, Universities, Education Authorities Resources will be required	Ongoing; requires clarity from training establishments on requirements
11. Establish a Consortium of Experts within the Country or Region, with the responsibility to: (i) identify necessary elements of taxonomy to be taught at Primary, Secondary and Degree level; (ii) to provide a recommended list of resources and where to obtain them.	Government; Educational bodies	By end of 2010
12. Create and deliver a short refresher course on taxonomy and taxonomic tools. It should be aimed at practicing taxonomists and those that teach or lecture on taxonomy.	Training and educational establishments; institutions employing taxonomists	Courses in place by beginning of academic year 2011
<b>Developing Biological Collections</b>		
13. Create a National Biological Collection on one or more sites. It should have a statutory duty to maintain the collection for the benefit of research, Ghanaian people and as a Regional resource.	Government; Collection-holding Institutions	By end 2015
14. Improve the ability of collection-holding institutions to employ sufficient staff to manage collections and provide an expert resource,	Government; Collection-holding Institutions	By end 2015

as part of a broadened biodiversity strategy.		
15. Develop and give visibility to a network of biological collections within Ghana, with the aims of building synergy between the institutions, facilitating capacity building, facilitating use, and developing an overall strategy for their development.	Collection-holding Institutions; BioNET-WAFRINET	Ongoing; progress by mid 2011
16. Create an inventory of the holdings of biological collections within Ghana at collection level (e.g. "Ghanaian bees"), so an overview of contents can be obtained. This should build on the metadata work that has begun in the University of Ghana and also contribute to Ghana's participation in GBIF;	Collection-holding Institutions; University of Ghana, Legon (Metadata Group); GhanaBIF; BioNET-WAFRINET	Ongoing; progress by mid 2011
17. Build capacity to capture data from Ghanaian specimens held within Ghanaian collections, and making these data available. This will build on the digitisation work already under way, and will contribute to Ghana's membership of GBIF.	Collection-holding Institutions; GhanaBIF Will require resources to accelerate progress.	Ongoing; targets could be set.
<b>Data management and analysis</b>		
18. Build and enhance capacity within collection-holding and other relevant organisations in data and information management, including exchange mechanisms, particularly regarding specimen and observational-level data.  This is recommended within actions in the NBSAP for Protected Area management (including Permanent Protected Forests and Wildlife Reserves);	Collection-holding Institutions; GhanaBIF Will require resources to accelerate progress.	Ongoing; targets could be set.
19. Ensure delivery of training in bioinformatics to increase the number of people interested in using point data to create	Collection-holding Institutions; GhanaBIF; BioNET-WAFRINET	By end 2011

distribution models. This should be preceded by a survey to establish how many people might attend such as course.	Will require resources to accelerate progress.	
<b>Provision of taxonomic information through institutional capacity-building</b>		
20. Build Identification System within Ghana, strengthening existing resources, integrating local level services such as extension workers with regional and national centres, and creating capacity where gaps exist. This will include building on the BioNET-WAFRINET network to develop reliable partnerships nationally and internationally to provide timely identifications. This will need the development of an economic model to enable it to be maintained.	Government; Universities and other institutions employing taxonomists; BioNET-Ghana; BioNET-WAFRINET; Sectors requiring identifications.  Will require resources.	Target to be set
21. Develop a range of cheap and user-friendly picture based identification / field guides to priority groups and ecosystems, including agricultural systems. This might include pictures and posters of endangered species.	Government / New Biodiversity Coordination Mechanism / NBSAP to identify priorities.  Will require resources.	Priorities agreed by end of 2010; targets to be set.
22. Improve contents of and access to specialists libraries within Ghanaian taxonomic centres.	Universities, other institutions employing taxonomists.  Will require resources.	Target to be set.
23. Create authoritative and accessible set of images of key Ghanaian species.	Universities, other institutions employing taxonomists, GhanaBIF, general public.  Will require resources.	Target to be set.
24. Ensure taxonomic, identification and assessment capacity is available to carry out inventory work in priority areas, and to identify	Institutions with taxonomic capacity, in concert with environmental sectors. New	Target to be set.

biodiversity hot spots.	Biodiversity Coordination Mechanism to initiate. Will require resources.	
25. Develop capacity to protect fruit production by monitoring fruit fly across Ghana, including sampling capacity, identification capacity, and voucher collections;	Will require resources.	Target to be set
26. Develop capacity to protect pollination of crops by monitoring and assessing pollinators across Ghana, including sampling capacity, identification capacity, and voucher collections;	Will require resources.	Target to be set
27. Seek collaboration with local and external institutions in information exchange, science and technology e.g., This is as required in the NBSAP;	Institutions in various sectors; Universities; BioNET-WAFRINET; BioNET-Ghana.	Progress to be made by end of 2010
28. Develop a list of all Ghanaian species, and putting in place a means to maintain it. This might use sources such as Catalogue of Life to ensure up to date nomenclature. It should include vernacular / local names as well as scientific names. It should have the property of linking to relevant data and metadata to suit individual user needs.	Ghana-BIF, taxonomists inside and outside Ghana. Will require resources.	Targets to be agreed in 2010
29. Engage taxonomic support for the building of a Red Data List of threatened and extinct species. (Action required in NBSAP)	Will require resources.	Target to be set.
<b>Ecological and distributional information</b>		
30. Develop a sustainable web-based resource in Ghana for sharing distributional and ecological information.	Universities, GhanaBIF and others as appropriate. Will require resources.	Targets to be set.
31. Create distribution maps for priority species in	Universities, GhanaBIF and others	Targets to be set.

conservation.	as appropriate. Will require resources.	
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## 7 Lessons Learned

Many of the results of the Assessment, while important for Ghana, are likely to be generic across many other African countries. The Assessment can therefore be taken as information to be tested and used in other countries in the absence of one carried out locally. In such a case it can be supplemented with information taken from documents specific to the country and tested with small groups. This will provide very valuable information without having to apply for a large grant to carry out a full Assessment. As and when such assessments are carried out, they should be considered together to build a regional picture and perhaps find regional solutions to meet needs. In the second workshop of the assessment, representatives from BioNET-WAFRINET in three other West African Countries indicated that they would be seeking means of carrying out Assessments based on the model used in Ghana.

A number of areas of the original project plan were changed during the development of the project. The Ghanaian team felt that the most effective means to pursue the assessment was to take on the work themselves rather than through an employee. Such a decision is likely to depend on in-country staff time availability, but needs to be considered carefully in case it limits flexibility. The requirements of time from the UK partners were greater than had been expected, leading to some slippage of time against the project schedule; future projects of this type should build in additional flexibility on time allocation between the different partners. The UK Taxonomic Needs Assessment included a Steering Committee drawn from the sector being assessed. In contrast, the Ghanaian Assessment did not have such a Committee. This may have led to a less penetrating assessment than might have otherwise been possible. The value of documentary evidence became increasingly apparent during the preparation of the report, and an early assessment of such documentation as is available would have been helpful.

The Assessment benefited from a very wide range of individuals and institutions providing information. In this we discovered that significant expertise is available within the country, but lines of communication between them negate this benefit. This was particularly apparent within the workshops, and for future assessments we note that Workshops can have a catalytic property outside their main purpose.

Of some 500 questionnaires issued 96 were returned. Dissemination was sometimes to individuals and sometimes to offices; the latter method did not always assure that it reached the right individuals. In some cases managers were asked directly to hand it to the appropriate officer(s) within their organisation. The questionnaire design is critical, and for future Assessments we recommend consideration of ways in which questions can be modified in the light of responses that indicate that terminology (e.g. libraries, species formal descriptions, etc) or question format is causing confusion. Such

modification should, however, enable the answers to modified and unmodified questionnaires to be considered together. The questionnaire used in this assessment included language and terms that not all respondents were familiar with, including the names of the various CBD Thematic Areas and Cross-Cutting Issues.

Workshops and interviews were vitally important elements of the methodology. They allowed the project leaders to explore with the users the potential for taxonomic information and input to their work, uncover and clarify misperceptions and misunderstandings, and better understand what user needs really are. In this study interviews were used to help respondents understand and complete the questionnaire, and were effective at this. However, notes of discussions during the interviews were not kept, so information was potentially lost. In future we recommend that notes be kept.

A benefit of the Assessment has been its value in helping participants understand the uses of taxonomic products and how they can benefit from them. The prior differences in understanding of this, and the value of close communication between the Assessment project team and other scientists and managers was considerable.

The chief lesson learned is that the potential contribution of taxonomic expertise and information to Ghana is very great, and that Ghanaian scientists are willing and eager to build on this.

## Conclusion

The Assessment Report includes many Recommendations that should, if implemented, lead to benefits to non-taxonomists and taxonomists alike, and greatly increase the efficiency and effectiveness of Ghana's environmental, biodiversity and productivity management. One key element of responding to the recommendations will be integrating biodiversity work across government and all areas of Ghanaian economy. A means of catalysing this will be the creation of a Biodiversity Coordination Mechanism at inter-departmental level. Such a body will be able to identify targets and work with relevant bodies across Ghana.

There is a strong requirement to increase awareness of the benefits of taxonomy and the requirements for them to be delivered to other biodiversity sectors. Taxonomy can provide the Ghanaian public to a large body of information and, through this, become aware of the significant issues of biodiversity, including developing an understanding of the status and trends of Ghanaian biodiversity heritage. Awareness-raising is also vital among non-taxonomists of the ways in which taxonomy can be used to progress their work, and among taxonomists of the benefits to which their work can be directed, and of the ways in which they should become more integrated with other sectors. Greater understanding of CBD and other international policies as they affect Ghana, and of Ghanaian implementation, will greatly help Ghana's scientists to operate effectively within a policy framework.

Training in all its forms including field collection of specimens of species, data collection, their management and analysis are essential in making information

about biodiversity in Ghana easily available. This information can then be used in a wide variety of areas across Ghana. A priority is to improve access to identifications and identification tools. A solution is to build a system within the country which, even if it uses personnel outside Ghana, is easy to access and will deal with identification needs in a far more effective manner than at present. Such a system will include the provision of simple to use tools such as field guides and identification keys, as well as professional taxonomists.

Tools to make use of data from biological collections are being developed, and an increase in access to these digital resources, coupled with both training and increase of data digitization, will provide powerful tools.

It is believed that the necessary steps will be taken to address all the priorities and recommendations identified so that the lessons learned become the driving force in raising the profile of taxonomy in Ghana for the benefit of Ghanaian biodiversity heritage on one hand and of future generations of Ghanaians on the other.

## 8 Acknowledgments

The work was carried out under a grant from the UK Department of Food, the Environment and Rural Affairs (Defra), to whom we are very grateful. Additional support was also given by the BioNET-INTERNATIONAL Secretariat, the Natural History Museum, London, and CSIR Ghana. Considerable effort was put into the development of the original methodology, as well as planning and assistance at the first workshop, by Mr Alistair Taylor, then UK GTI Focal Point and currently at the RSPB, UK. We would also like to thank Ms Jennifer Lyal for her voluntary work as rapporteur for the second workshop.

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## 10 Annexes

### ***Annex 1 Ghana Taxonomic Needs Assessment Resource Pack***



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## **Assessing Taxonomic Needs in Ghana**

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### *Annex 1. 1. Resource Pack Contents*

The Resource pack included the following contents:

1. Project Summary and Outline
2. Project timeline (not included in this Report)
3. Draft Terms of Reference for Project Partners and MoU
4. Taxonomic Needs Assessments: Introduction and Guidance
5. Draft form/questionnaire
6. Draft GTI Guide (not included in this Report; superseded by a published version – see References)
7. UK Taxonomic Needs Assessment (not included in this Report – available on the internet at <http://www.cbd.int/doc/programmes/cro-cut/qti/qti-needs-uk.pdf> )
8. Presentation launching Ghanaian Taxonomic Needs Assessment at CBD COP 8
9. Presentation on the CBD (not included in this Report, since now superseded)
10. presentation on the GTI (not included in this Report, since now superseded)
11. presentation on Taxonomic Needs Assessments
12. Poster for project outreach – template (not included in this report, since never used)
13. Logos for project use (not included in this Report)
14. Acronyms and glossary (not included in this Report)
15. Contacts (not included in this Report)

16. Bibliography (not included in this Report)
17. template for case studies (not included in report; available on the internet at <http://www.bionet-intl.org/opencms/opencms/caseStudies/contribute/contribute.jsp>)

## *Annex 1.2. Project Summary and Outline*

This document outlines a collaborative project between the UK Natural History Museum (NHM), BioNET-INTERNATIONAL (BioNET), the Ghanaian Council for Scientific and Industrial Research (CSIR), BioNET-WAFRINET and the UK Department of the Environment and Rural Affairs (Defra).

### **Project Summary**

#### *Introduction*

The UK Natural History Museum (NHM), BioNET-INTERNATIONAL (BioNET), the Ghanaian Council for Scientific and Industrial Research (CSIR) and BioNET-WAFRINET supported by the WSSD Implementation Fund (WIF) of the UK Department for Environment Food and Rural Affairs (Defra), are working together to carry out a taxonomic needs assessment in Ghana, in support of biodiversity conservation and sustainable development.

The Programme of Work of the Global Taxonomy Initiative (GTI) calls for national, regional and global taxonomic needs assessments (TNAs). Ghana's third national report to the Convention on Biological Diversity (CBD) (submitted October 2005) highlighted the need for a TNA at the national level.

The Global Taxonomy Initiative of the Convention on Biological Diversity was created to combat the 'taxonomic impediment' - the lack of taxonomic skills, expertise and facilities that makes carrying out effective assessment of diversity and an understanding of what animals, plants and micro-organisms live in any environment very difficult. However, before the appropriate taxonomic resources can be made available, it is necessary to identify just what problems and gaps they are needed to meet. To do this a Taxonomic Needs Assessment is necessary. So far the majority of taxonomic 'needs assessments' that have been carried out around the world have focussed on taxonomic capacity and not on taxonomic needs that arise in meeting commitments under the Convention on Biological Diversity. In contrast, the methodology for a needs assessment as outlined in CBD's (unpublished) 'Guide to the GTI', calls for a focus on the taxonomic problems faced by those managing conservation, sustainable use or access-related work, and on the capacity-building and information requirements that would be necessary to enable these problems to be met. The UK has carried out an assessment of this type, and the support provided by Defra allows the experience gained in the UK to be shared with Ghana, and applied for the first time to a developing country.

### *Purpose and Project Outline*

The Ghana assessment is intended to provide the Government of Ghana and key stakeholders with a clear analysis of the taxonomic needs of priority biodiversity-related sectors in the country. This information can then be used to integrate taxonomic priorities into government policies, and will enable help in-country taxonomic institutes to target the work of on identified needs.

The assessment will be carried out by a Ghanaian national team assisted by the UK partners, who will draw on experience gained during the recent UK taxonomic needs assessment. Information will be gathered through analysis of explicit and implicit needs in published sources, interviews and through questionnaires circulated to in-country stakeholders.

The information gathered will be used to produce a report that will serve as a basis for Government, taxonomists, end-users of taxonomy and funding bodies to prioritise decisions on taxonomic information development and provision.

This report, a report on lessons learned from the assessment, and a best practice manual, will be circulated nationally, regionally and globally to;

- The Government of Ghana
- Contributing stakeholders
- Regional and National Coordinators of BIONET-WAFRINET – the West African Network of BioNET-INTERNATIONAL
- BioNET-INTERNATIONAL Technical Secretariat, for distribution globally
- The CBD's Global Taxonomic Initiative Programme Officer
- The CBD's Clearing House Mechanism
- The Global Taxonomy Initiative Coordination Mechanism;
- Defra
- GEF implementing agencies and secretariat

The project was inaugurated at a side event at the Conference of Parties to the CBD (COP8) in March 2006 in Curitiba, Brazil.

### *The Project Partners*

Both BioNET and the Natural History Museum have a strong reputation in the scientific (taxonomic) and biodiversity conservation fields, not only at a practical level, across the globe but also in engaging in relevant intergovernmental processes such as the CBD. Both partners are represented on the Coordination Mechanism of the CBD's Global Taxonomy Initiative.

The Natural History Museum is the UK's National Focal Point for the Global Taxonomy Initiative. BioNET-INTERNATIONAL has been responsible for the development of sub-regional technical cooperation networks and has experience of assessing taxonomic needs regionally and internationally.

## **Project Outline**

The Project will have the following elements.

1. Development of MOUs between relevant institutions.

These will include Terms of Reference for each participant.  
Actors: BioNET, Natural History Museum, CSIR, BioNET-WAFRINET.  
Starts: March 2006. End: May 2006.

2. Production of Assessment Information Pack by UK team.

This will be based on the recent Taxonomic Needs Assessment carried out in the UK, and information from the unpublished 'Guide to the GTI', together with other documentation, particularly in electronic form. If further information resources are required the Project Partners will attempt to provide them.

Actors: BioNET-INTERNATIONAL, Natural History Museum, CSIR, BioNET-WAFRINET.

Starts: April 2006. End: May 2006.

3. Building in-country project team.

The team is likely to comprise:

- One person in overall control as Project Leader, who can ensure the work is done and the budget managed (although not necessarily undertake the assessment work themselves).
- An in-country Steering Committee with expertise in the needs for taxonomic information and services in support of implementation of the Convention on Biological Diversity (CBD), agriculture, plant health, trade and other environmental and economic priorities in Ghana. The project team will be identified in consultation with the in-country Project Leader, the Council for Scientific and Industrial Research (CSIR), BioNET-WAFRINET National Coordinator (Ms Millicent Cobblah, University of Ghana) the Africa Pollinator Initiative National Coordinator (Dr Peter Kofi Kwapong, University of Cape Coast) and others as identified in-country.
- One person as Principal Investigator (PI) assessment leader, who would be responsible for the work being carried out, and undertake most of it themselves. This person would report to the Project Leader. The post is likely to be part-time.
- Additional staff to assist the PI on short-term contracts, as required.
- Project Secretary / Research Assistant

Actors: This will be managed by the project participants in Ghana.

Starts: April 2006. End: June 2006?

4. Preparation for Assessment, carried out by Ghanaian project team, with Helpdesk assistance from UK team, including:

- a. Organisation of planning meeting for the in-country Project Team, Natural History Museum and BioNET International Secretariat. Objectives: May 2006.
- b. Familiarisation with the taxonomic needs assessment framework and process proposed by the Natural History Museum and BioNET.
- c. Identification and review of all available key documents relevant to taxonomic support for CBD implementation in Ghana, including National Reports and Thematic Reports to the CBD.
- d. Identification and review all available key documents relevant to taxonomic support for agriculture, plant health and trade.

- e. Identification of key sectors relevant to implementation of the CBD in Ghana and prioritisation of these in terms of their significance for biodiversity conservation, sustainable use and benefit sharing in Ghana.
- f. Identification of the main stakeholders within each key sector and prioritisation according to their importance within each sector.
- g. History Museum and the BioNET Secretariat in order to gather information on the needs of biodiversity conservation stakeholders in Ghana for taxonomic information and services.
- h. Development of prioritised list of stakeholders based on tasks (e) and (f) and identification of those key stakeholders that must be interviewed, and those stakeholders that should be sent a questionnaire. Preparation of draft questionnaire in consultation with the Natural

Actors: All project partners

Starts: April / May 2006. Ends: June 2006?

5. Assessment, carried out by local team, with helpdesk assistance from UK partners, including:
  - a. In-country workshop for stakeholders from key sectors in order to launch the project, secure stakeholder buy-in to the aims of the project, and to finalise the process and questionnaire for the assessment. Suggested timing: July 2006.
  - b. Circulate the finalised questionnaire to relevant stakeholders with a deadline for response that allows adequate time to analyse responses received.
  - c. Arrange and carry out a series of interviews with key stakeholders, focussing on highest priority stakeholders/sectors first.

Actors: All project partners

Starts: June / July 2006. Ends: February/March 2007

6. Analysis of results, carried out by local team, assisted by UK partners. Compile and analyse data gathered through activities 4c, 4d and 5.
7. Design and preparation of final outputs by local team, Natural History Museum and the BioNET Secretariat. Products will be tailored to meet needs of Government, CBD, Clearing-House Mechanism, other in-country stakeholders and publication.

Actors: All project partners

Starts: Reports in final draft end of May 2007.

8. Final in-country workshop, with regional observers from the BioNET-WAFRINET Coordinating Committee and interested international biodiversity organisations.

Actors: All project partners

Project ends June 2007

### *Annex 1.3. Terms of reference for Project Partners*

#### **Terms of Reference for in-country Project Leader**

1. Non-salaried post, although it might be combined with the PI and thus receive salary.
2. Act as primary in-country contact for UK project team.
3. Take responsibility for delivery on Ghanaian component of project.
4. Agree a Memorandum of Understanding with the Natural History Museum (UK), the lead UK institution in the project. The MOU will cover project delivery, financial reporting and remuneration of Principal Investigator (Ghana) and other in-country staff.
5. Appoint a project PI within Ghana.
6. Manage PI (Ghana).

#### **Terms of reference for the in-country Principal Investigator (PI)**

1. Work under the guidance of the Project Leader and with the assistance of the Steering Committee, reporting to the Project Leader.
2. Identify individuals to form an in-country Steering Committee with expertise in the needs for taxonomic information and services in support of implementation of the Convention on Biological Diversity (CBD), agriculture, plant health, trade and other environmental and economic priorities in Ghana. The project team will be identified in consultation with the in-country Project Leader, Professor Alfred Oteng-Yeboah (Council for Scientific and Industrial Research), BioNET-WAFRINET National Coordinator (Ms Millicent Cobblah, University of Ghana) the Africa Pollinator Initiative National Coordinator (Dr Peter Kofi Kwapong, University of Cape Coast) and others as identified in-country.
3. Contract secretarial and project officer / researcher support in consultation with the Steering Committee.
4. Organise a planning meeting for the in-country Project Team (Project Leader, Principal Investigator, contracted staff and Steering Committee), Natural History Museum and BioNET Secretariat. [possibly May 2006]
5. Organise an in-country workshop for stakeholders from key sectors in order to launch the project, secure stakeholder buy-in to the aims of the project, and to finalise the process and questionnaire for the assessment. [possibly July 2006]
6. Organise a final in-country workshop, with regional observers from the BioNET-WAFRINET Coordinating Committee and interested international biodiversity organisations. [May-June 2007]
7. Lead and coordinate the activities of the in-country Project Team. See Annex X for a description of project activities.

8. Prepare a report on needs for taxonomic information and services by [May 2007].

### **Terms of reference for the UK Project Team**

The Natural History Museum and BioNET Secretariat will:

1. Agree an MoU with the Ghanaian Project Leader and others as appropriate.
2. Produce an Assessment Information Pack and provide copies of this pack in both electronic form and hard copy to the Project Team.
3. Provide training and other experience on use of the Information Pack.
4. Provide a 'helpdesk' to:
  - a. Assist the Project Team with the organisation of in-country meetings to the extent that this is feasible within the constraints of time and language
  - b. Assist the Project Team with drafting a questionnaire to gather information on the needs of biodiversity conservation stakeholders in Ghana for taxonomic information and services.
  - c. Assist the Project Team with the production, editing and circulation of final reports on the assessment.
  - d. Provide whatever other support might reasonably be required in implementing the project, on demand.
5. Participate in discussions at the CBD Conference of Parties in Brazil in 2006.

### *Annex 1.4. Taxonomic Needs Assessments: Introductions and Guidance*

#### **Introduction**

One hundred and eighty-seven nations around the world that have signed and ratified the Convention on Biological Diversity. All have made commitments on conservation, sustainable use, and fair and equitable access to the genetic benefits of biological diversity – the three aims of the Convention. In order to meet these commitments, and manage their biodiversity, they need to be able to identify what that biodiversity is made up of. This process needs taxonomy – the identification, naming and classification of organisms.

For most countries in the world, there is simply too little taxonomic expertise, information and infrastructure available to enable them to work with their biota in the way they need. This deficiency is known as the 'Taxonomic Impediment' to implementing the Convention on Biological Diversity. The Taxonomic Impediment is therefore specifically about the taxonomic needs of non-taxonomists: conservationists, environmental managers, quarantine officers, foresters and so on. It is distinct from the Taxonomic Capacity of a country, which refers to what taxonomy can be done, and the levels of expertise, information and infrastructure, without considering needs.

Understanding the Taxonomic Impediment in a country or region so that it can be removed can only be done by working with the users of taxonomy in these other fields, and identifying their taxonomic needs and the way they use taxonomy. This process is known as a Taxonomic Needs Assessment.

The Parties to the Convention on Biological Diversity (CBD) have repeatedly identified the importance of National Taxonomic Needs Assessments. The GTI Programme of Work suggests that National Governments, with the support of national and international organizations and institutions as needed, should play a leading role in carrying out assessments. Some countries have used national biodiversity strategies and action plans (NBSAPs) as well as national reports under the Convention to indicate their need for taxonomic capacity, but few details have been provided. So far, national needs assessments have been or are being carried out by a few countries, for example UK and South Africa. In each case the assessment does not cover all possible stakeholders with an interest in taxonomic information, since resources have been too few to allow such a comprehensive process.

Understanding what taxonomic information is required in order to meet CBD-related needs is vital for good management and of great importance in building National Biodiversity Strategies and Action Plans. Once the needs are known the available resources can be assessed and the results used to set goals and priorities for building necessary capacity. If countries are involved in regional taxonomic networks, needs can also be assessed within the context of meeting obligations to those collaborations, especially when participation may include complementarities and sharing of research effort. For Ghana, the partnership with other countries of the WAFRINET LOOP of BioNET-INTERNATIONAL is of potential importance in this regard.

As with so many Convention-related activities, a taxonomic needs assessment has both policy and implementation outputs. For policy, assessments should state clearly if and how lack of taxonomic capacity and / or information impedes implementation of NBSAPs. The needs assessment is also a working document which can be used to inform taxonomists and funding bodies of the taxonomic input required. The process of conducting a needs assessment itself can be used to raise awareness of the CBD and of taxonomic needs.

Some valuable suggestions on how to carry out a national needs assessment were provided by the report of the DIVERSITAS/Systematics Agenda 2000 Workshop (Anon, 1998c<sup>21</sup>). These suggestions are summarized below, with additional ideas and protocols developed through the UK assessment and discussions with the Ghanaian Needs Assessment team.

The process can be seen as a seven-step operation:

- a) Selection of Assessment focus;
- b) Assessment of national user needs and priorities for taxonomic information;

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<sup>21</sup>UNEP/CBD/SBSTTA/4/INF/7 - <http://www.biodiv.org/doc/meetings/sbstta/sbstta-04/information/sbstta-04-inf-07-en.pdf>

- c) Assessment of existing taxonomic knowledge about national biodiversity, its availability to and employment by users, and the sustainability of these sources;
- d) Assessment of current national taxonomic infrastructure;
- e) Assessment of current national human resources in taxonomy;
- f) Analysis of results; and
- g) Recommendations for action.

### **Selection of Assessment Focus**

The focus of the assessment is likely to be one or more of the focal areas of the CBD ('Thematic Areas' and 'Cross-cutting Issues'). Alternatively, it might be a sector such as 'Conservation' (the focus of the recent UK Assessment). Such targeting will assist mapping to CBD COP Decisions, which will be useful in formulating questions, subsequent analysis and targeting and prioritisation of resources as a response to the Assessment. It will also assist the National CBD Focal Point in reporting on activities, since these are organised by CBD Thematic Areas and Cross-Cutting Initiatives. The methodologies described below can also be applied to areas outside the direct focus of CBD, such as health or farming, although both of these have CBD implications.

Within these focal areas there are many non-taxonomist users of taxonomic information. Some of the most significant of these from the point of view of CBD implementation are:

- Conservation managers, environmental managers, resource managers, protected area managers;
- Environmental protection agencies;
- Agencies involved in intercepting and managing invasive alien species and pests;
- Agencies responsible for biosafety, including those dealing with genetically modified organisms;
- Departments involved in implementing Access and Benefit-sharing legislation;
- Agriculture, horticulture, forestry, and fishery agencies;
- Forest product industries;
- Biotechnology industries;
- Ecotourism industries;
- Agencies and organizations involved in applied health and medical research; and
- The research community (biological science, global change, environmental science).

This list is not exclusive, and other areas of focus might be appropriate for Ghana.

These users may be government departments, NGOs, research institutions, amateur societies, educational bodies, private companies etc. Each might have different needs, and different sources for the information they use.

Ultimately, taxonomic information is used by individuals, and it is those who determine what is useful and desirable. Consequently, a taxonomic needs

assessment may include gathering information from people such as quarantine officers, extension workers, village communities etc.

In addition to the Users, there are likely to be national policy documents or reports that deal with the focal area. These might contain information on taxonomic needs, either explicitly or by inference (any call for 'monitoring and assessment', for example, implies a need for a taxonomic resource to identify the organisms being monitored). Since one of the benefits of carrying out a taxonomic needs assessment is to inform policy, and allow policies to be put in place to meet the needs identified, particular attention needs to be paid to extant policy documents.

Finally, having identified the sector or sectors that will be the focus for the assessment, a steering group representing different sectors including the focal sectors may be valuable. This group can inform the team carrying out the assessment of priority areas, suggest lines of questioning,

*The first steps in the Assessment project will be to:*

- a) decide which sector or sectors to focus on,*
- b) identify the stakeholders that should be included,*
- c) decide the paper and policy documents that should be examined*
- d) set up multi-sector steering group.*

## **Assessing national user needs and priorities for taxonomic information**

There are two tools that will be of value in assessment of user needs. These are a questionnaire and interviews. Ideally, they should be used in conjunction, so that the subject can think about the questionnaire and enter data that, being of a standard format, is more simply analysed, and then interviewed to discover aspects that either do not fit on the questionnaire, or can be prompted by the questions. As the assessment continues, the interviewer will become increasingly aware of issues and needs that were not recognised initially, and can use the interviews to explore these. Although such issues may be discovered, the questionnaire should not be changed, since this will make subsequent analysis more difficult.

### *Questionnaire*

A draft questionnaire is included in the pack. This is based on the one used for the UK Taxonomic Needs Assessment of conservation bodies, and may not be fully appropriate for Ghana. However, it does give some ideas which could be incorporated.

Before sending out the questionnaire the recipient should have been contacted to give them warning, and an explanatory letter accompanying the questionnaire will need to be drafted.

In the UK and Europe, legislation gives people certain rights over data about them held electronically. For this reason the questionnaire includes a form on which the person filling it in can signify their agreement to the use of the data. Ghana may or may not have similar legislation, but it might be useful to include on the form a statement of the use of the information collected, and its distribution.

The first part of the form collects information about the organisation being questioned, including their status. Different types of organisations may use taxonomic information in different ways, so this classification will assist analysis. A classification not included on the draft of the questionnaire is the nature of the 'customers' of the organisation. For example, an organisation may need taxonomic information because its staff manage the environment directly, because they advise those who do, because they advise government, or because they create analyses that are used by other researchers.

A potentially useful figure not included in the draft questionnaire is the number of people in the organisation that are working on the focal area. For example, the questionnaire may be completed by someone working in a one-man ecotourism business, or a government body with several hundred staff who might be using the resources. Such a figure, appropriately scaled, will assist in providing levels of need.

Although the focus has been determined by this stage, the users selected might be asked to identify the areas of CBD implementation they are focussed on. It may be that their interpretation differs from that of the Assessment Team, or that their interests (and resources) extend more widely than anticipated.

The Thematic Areas of the CBD are referred to in the draft questionnaire as Ecosystems. However, this breakdown is quite possibly insufficiently detailed to account for sectoral interests in Ghana, and a more detailed term for the ecosystem or environment may be useful (e.g. 'mangroves', 'savannah', 'desert' etc.).

In addition to the ecosystem the draft questionnaire has a table investigating the higher groups of organisms the users may be interested in. This table is grouped by broad ecosystem, and it might be useful to change this grouping. In addition, not all users may be interested in groups as set out; 'forest pests', or 'grassland herbivores' are equally valid groups from a non-taxonomist user point of view, and the questionnaire may need to be modified to accommodate such assemblages.

The draft questionnaire also seeks to establish to what extent the activities of the user involve different taxonomic activities and tools. There is some overlap with earlier questions as the draft is written, and we may wish to change this. This table is essentially about what the organisation does rather than what it needs; needs, however, may be inferred from the responses, and investigated during an interview.

The next part of the form is focussed on what taxonomic products the organisation uses or needs. Before finalising the questionnaire the various categories and items should be considered carefully to see if any should be omitted or more added. For example, currently the form includes a set of ecological information elements which, although they fall under the heading of the GTI (taxonomy operating at ecosystem, species and genetic levels) may be outside the remit of most taxonomic organisations. For each item the organisation is asked:

1. to rank the importance of the item on a scale of 1-5, 1 being 'very important' and 5 'unimportant';

2. state whether the resources are available or unavailable;
3. identify the source of the resources (e.g. in-country professionals, amateurs, local library);
4. indicate whether the source is in their view sustainable;
5. Make additional comments.

Finally, the questionnaire includes a blank page where the user is invited to add more detail to their taxonomic needs.

### *Interviews*

Following the questionnaire it may be valuable to carry out an interview with the correspondent. In this points made in the answers can be followed up, and more detailed questions asked to clarify or explore problems and needs.

For example:

- The interviewee should be encouraged to think of both current and expected future needs for taxonomic information.
- Where do they currently obtain taxonomic information, and are these sources adequate and sustainable?
- What kinds of taxonomic knowledge (e.g. species lists, identification tools, authoritative images, data from specimens in collections) about those groups are most essential?
- What format (e.g. field guides, formal taxonomic publications, dedicated reports, dynamic web-based) do they prefer the information to be in?
- What gaps in knowledge need to be filled?

It is difficult, and probably counter-productive, to set a prescriptive list of questions.

## **Assessing existing taxonomic knowledge about national biodiversity and its availability to users**

At least some taxonomic information about national biota exists for all countries, but this is scattered over a myriad of different sources, is of uneven quality, and may not be easily available electronically. Moreover, where it exists it may not be in a format or language that makes its employment simple for non-taxonomic users or even many taxonomists, especially in the country of origin. Consequently an assessment of availability must include its main formats and the possibilities of distributing it to the appropriate personnel (Lyal, 2004). The types of knowledge that might be considered arise from the needs assessment, but are likely to include: (i) species lists for the country and areas within it, particularly protected areas; (ii) detailed data associated with specimens; (iii) taxonomic literature (including field guides and electronically-mediated information) pertaining to the biota of the country.

Two key data sources for species lists are existing literature and specimens held in collections. An important consideration is that taxonomic names do change through time, and consequently any list must be checked and corrected if it is to be of value.

Some information from the literature may be relatively easy to retrieve. This is most likely to be so for well-known groups, such as many vertebrates, some groups of vascular plants, and some of the more spectacular or economically important invertebrates. Such information can often be found in field guides, extant national or regional checklists and reports, and electronic databases.

On the other hand some faunal or floristic lists, reports, and databases may be unavailable within the country, and will need to be sought elsewhere. More difficult to collect are species data discussed in detailed and specialist sources, such as monographs and primary taxonomic literature, both because of the distributed nature of the information within the publications, and the likelihood that they will not be available within the country.

Natural history collections potentially provide the most reliable records of species distribution, whether at national or other geographic scales, and thus have a role in compilation of species lists. A benefit of data from this source is that records can be associated with voucher specimens, the identity of which can be checked. For the purposes of a national assessment, key national and extra-national collections could be identified and information of the holdings requested from the institution concerned. Routes to identifying these key collections are (a) asking institutions within the country about contacts and long-term scientific involvement with extra-national institutions; (b) searching the internet for relevant collections information; (c) checking the major web portals to such information (see section 622); (d) checking available taxonomic literature for references to specimen repositories (e) asking the major world collection-holding institutions, which can generally be named by any competent taxonomist. Provision of the information by collection-holding institutions may, however, require a considerable amount of work, not least because many institutions do not keep records of their holdings associated with geographic origin. Information delivery might therefore involve a cost, which should be factored into the budget of the needs assessment. A valuable exercise that might arise from this part of the assessment could be networking relevant institutions to pool collections data.

For many taxonomic groups, information retrieval will be extremely time consuming and may not be possible with available resources. In such cases, estimates of species richness of such groups would be valuable so that plans can be made to acquire or develop additional information subsequently. Moreover, the information that is gathered may highlight gaps in data availability, and provide the basis for subsequent data- or specimen-collection projects. Plans for subsequent projects could be included within the NBSAP.

The creation of a list of species found within a country is not an academic exercise. Apart from supporting implementation of Article 7 of the Convention, it underpins many other aspects of Convention implementation. One key aspect is that of Access and benefit-sharing, where knowledge of the species, subspecies, varieties and strains within a country's borders is a vital prerequisite to protecting genetic resources and their benefits (see below).

Detailed data associated with specimens can be of value for a number of reasons, including ecological modelling of species distributions. This system has been used to great effect in Mexico, where databases of specimen-level information have informed policy on a number of issues including invasive alien species, living modified organisms, and protected areas. The assessment will determine what collections are readily available and what can

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<sup>22</sup> Many specimen records from numerous institutions are accessible through the Global Biodiversity Information Facility: <http://www.gbif.org>

be found outside the country. Plans and priorities can then be developed for data repatriation. Issues regarding location of collections apply here also.

Taxonomic literature is a necessary tool for the majority of users. In order to maintain any functional taxonomic activity there must be access to the appropriate specialist literature. This is covered under 'libraries' below. Literature of a more generalist type including field guides and electronically-mediated information pertaining to the biota of the country is also of considerable value, particularly to non-taxonomists charged with implementation work. A review of field guides that deal with biota of the country would be comparatively simple, and stem perhaps from responses to questions by the users targeted in the assessment.

### **Assessing available taxonomic infrastructure**

A survey of scientific infrastructure supporting taxonomic research is a key element of any taxonomic assessment. Three broad categories of taxonomic infrastructure include: i) collection facilities, ii) libraries, and iii) associated technical, management and other institutional support for taxonomists.

#### *i) Collections facilities*

These include museums, herbaria, arboreta, zoos, botanical gardens, culture collections and seed banks. The facilities might be housed in stand-alone institutions, universities, private institutions or governmental agencies such as agricultural research stations. As part of any assessment, the following information should be gathered for each collection:

- taxonomic coverage and the kind(s) of specimens housed;
- curation of collection (the proportion of specimens which are identified and / or sorted, those which are available for research, and whether specimen tracking systems are in place);
- capacity for growth, in terms of space and infrastructural support;
- quality of the facilities (e.g. adequacy of collection housing such as cabinets, supplies, maintenance, specimen preparation areas, curatorial and staff office and research space);
- security (whether the collection is adequately protected from fire, pests, and other adverse conditions);
- information availability and communications infrastructure (e.g. printed catalogues, electronic database(s) and electronic links to other databases);
- institutional structure (e.g. relevant policies, quality of business management, budgetary support, sustainability, whether loans of specimens can be received from other institutions); and
- institutional long-term planning, particularly in terms of GTI goals.

#### *ii) Libraries*

Taxonomic research requires access to libraries with reference collections. Thus the libraries in natural history institutions, universities, agricultural or medical research centres, and other agencies should be surveyed for their capacity to support taxonomic research. General information to be gathered will include:

- numbers and kinds of libraries;

- extent of holdings (e.g. books, monographs, journals, electronic databases etc relevant to the particular area of the world and group(s) being studied);
- financial support to enable continued purchase of relevant journals and books;
- communication capabilities (e.g. electronic access to holdings; electronic linkages to other libraries, ability to receive books on interlibrary loan).

iii) *Associated scientific support (policies, infrastructure)*

All scientific research, including taxonomy, requires a broad range of general supporting infrastructure. An assessment might include the following broad categories:

- universities with appropriate expertise, relevant governmental and nongovernmental institutions, field stations, etc.;
- computing capacity and quality;
- molecular, biochemical, morphological, cytological and other laboratory facilities;
- research equipment available (microscopes, field vehicles, etc.);
- ocean-going ships, other research vessels, and sorting gear; and
- existing strategies and frameworks to develop and promote in-country research (including funding procedures, agencies, project evaluation, legislation, permit access policies, and multilateral institutional agreements).

### **Assessing available human resources supporting taxonomy**

For the GTI to contribute adequately to the implementation of NBSAPs, action may be needed to strengthen the human resources supporting taxonomic work. No country has all the taxonomists it needs, nor taxonomic expertise in all groups. Therefore, countries will want to assess current human resources in the light of national goals and needs, taking into account accessibility of expertise at regional levels. The following information will be useful in evaluating capacity:

i) *Professional research staff in each taxonomic institution (curators, research scientists):*

- Numbers;
- Demography (age structure of experts in the various areas of work);
- Taxonomic coverage (expertise); and
- Status: (e.g. qualifications, participation in professional activities within the country and internationally).

ii) *Support staff:*

- Professional collection managers;
- Technicians or research assistants;
- Students (undergraduate, graduate, and postdoctoral);
- Parataxonomists (non-professionals having some curatorial or research responsibilities);
- Collectors;
- Interns and trainees;
- Volunteers (retired scientists, trained lay persons, amateurs etc.);

- Financial support staff (with expertise in funding agencies, financial administration, etc.); and
- Managers.

iii) *Capacity for education and training in taxonomy:*

- Education or training available (taxonomic coverage, content, course titles);
- Level of education available (B.Sc, M.Sc., Ph.D., other qualification, parataxonomy training, collections management, etc.);
- Numbers and kinds of trainees;
- Facilities for training; and
- Prospects for productive employment in relevant taxonomic work (institutions, number and kind of posts available, sustainability).

The results of such a survey could be used to inform prospective students and trainees through publication either as hard copy or on the internet.

While national human resources in taxonomy are being evaluated, countries could assess human resources at the international level that may have a relevant role in building in-country capacity. Critical areas of needed information include:

- a list of in-country specialists working in foreign countries;
- a list of foreign taxonomists working in-country;
- a list of foreign taxonomists experienced in relevant groups; and
- the availability of training opportunities in foreign countries.

### *Annex 1.5. Draft Questionnaire for Taxonomic Needs Assessment*

The text below is as was originally produced for Ghana, and is based on the UK Assessment, and complies to UK data protection legislation.

The purpose of this assessment is to identify the taxonomic information that is required for *[focus to be identified]* in Ghana. The assessment is focussed on the needs of Ghanaian organisations involved in *[focus to be identified]*. The results of this assessment will help to inform the priorities of interested taxonomic organisations in Ghana and elsewhere, and of the wider biodiversity conservation community. Results will be made available to the Government of Ghana so that national policy may be informed.

It is hoped that the methodology developed for the Ghanaian needs assessment will provide a useful model for other countries in the region, and in particular for partners in the taxonomic cooperation network BioNET-WAFRINET.

## IMPORTANT

**The personal details you provide are protected by the provisions of the Data Protection Act. Under the terms of this legislation the Board of Trustees of the NHM, our data controller, is responsible for processing this information fairly and lawfully.**

### **How will my information be used?**

Some of the information on taxonomic needs that is collected will be made available publicly in the form of a report that may be published on the World Wide Web. This will include the names of the organisations consulted and key needs identified by particular groups of organisations.

This information will only be made available with your explicit permission, all other information will be kept private and only used for statistical purposes.

Please tick this box if you are happy for the information outlined above to be made available

You may withhold permission for *any* of your details to be published via the internet at any time.

By submitting the form enclosed you consent to the Museum collecting and processing the data you provide within the terms of the Data Protection Act and using that data only for the purposes outlined above.

You have a right to access or amend these data at any time by contacting the GTI focal point at the Natural History Museum;

***N.B. This component was incorporated into the UK Needs Assessment in order to comply with UK and EU law. We should discuss whether similar legal constraints apply to Ghana.***

## Part 1 – About your organisation

Details of Organisation	
Name and Address of organisation	
Homepage (URL)	

Name of person who has filled in questionnaire	
Name	
Position in organisation	
Phone/Fax	
Email	

Is your organisation (please tick one or several)	
<input type="checkbox"/> A statutory agency	<input type="checkbox"/> A private company
<input type="checkbox"/> A government department	<input type="checkbox"/> A research institution
<input type="checkbox"/> A national non-governmental organisation	<input type="checkbox"/> An amateur society
<input type="checkbox"/> A regional non-governmental organisation	<input type="checkbox"/> A University or other Educational body
<input type="checkbox"/> An environmental management body	<input type="checkbox"/> A small business
Other (please specify);	

Please Provide a brief statement of the role and interests of your organisation

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Please indicate the Ecosystem(s) to which your activities relate. Write '1' for most and '2' for some.

<input type="checkbox"/> Agricultural Biodiversity	<input type="checkbox"/> Forest Biodiversity
<input type="checkbox"/> Dry And Sub-Humid Lands Biodiversity	<input type="checkbox"/> Inland Waters Biodiversity
<input type="checkbox"/> Marine and Coastal Biodiversity	<input type="checkbox"/> Island Biodiversity
<input type="checkbox"/> Mountain Biodiversity	
More detailed term (one-4 words only)	

Please indicate the CBD Cross-Cutting Issue to which your activities relate. Write '1' for most and '2' for some.	
<input type="checkbox"/> Access to genetic resources and benefit-sharing	<input type="checkbox"/> Invasive Alien Species
<input type="checkbox"/> traditional knowledge, innovations, and practices	<input type="checkbox"/> Biodiversity and tourism
<input type="checkbox"/> Climate change and biodiversity	<input type="checkbox"/> Economics, trade and incentive measures
<input type="checkbox"/> 2010 Biodiversity target	<input type="checkbox"/> Global Taxonomy initiative
<input type="checkbox"/> Ecosystem approach	<input type="checkbox"/> Global Strategy for Plant Conservation
<input type="checkbox"/> Impact Assessment	<input type="checkbox"/> Indicators
<input type="checkbox"/> Liability and redress	<input type="checkbox"/> Protected areas
<input type="checkbox"/> Public education and awareness	<input type="checkbox"/> Sustainable use of biodiversity
<input type="checkbox"/> Technology transfer and cooperation	

With which of the following groups of species is the work of your organisation most concerned (please tick one or several and if appropriate specify species)

**Terrestrial Species**

<input type="checkbox"/> Birds	
<input type="checkbox"/> Insects and Spiders	
<input type="checkbox"/> Mammals	
<input type="checkbox"/> Microorganisms	
<input type="checkbox"/> Plants (Cryptogamic)	
<input type="checkbox"/> Plants (Vascular)	
<input type="checkbox"/> Reptiles and amphibians	
<input type="checkbox"/> Invasive alien species	

**Marine Species**

<input type="checkbox"/> Birds	
<input type="checkbox"/> Fish	
<input type="checkbox"/> Invertebrates	
<input type="checkbox"/> Mammals	
<input type="checkbox"/> Microorganisms	
<input type="checkbox"/> Plants	
<input type="checkbox"/> Invasive alien species	

**Freshwater**

<input type="checkbox"/> Fish	
<input type="checkbox"/> Invertebrates	
<input type="checkbox"/> Micro-organisms	
<input type="checkbox"/> Plants	
<input type="checkbox"/> Invasive alien species	

Other (please specify);

Which of the following activities is your organisation involved in: (please tick one or several)

<input type="checkbox"/> Identification, assessment and monitoring	<input type="checkbox"/> Conservation
<input type="checkbox"/> Legal and Policy	<input type="checkbox"/> Capacity building
<input type="checkbox"/> Developing reference collections	<input type="checkbox"/> Assessment of phylogenetic diversity
<input type="checkbox"/> Molecular assessment methods	<input type="checkbox"/> Producing identification aids/tools
<input type="checkbox"/> Developing ecological indicators	<input type="checkbox"/> Indicator species taxonomy
<input type="checkbox"/> Compiling Biodiversity Inventories	<input type="checkbox"/> Environmental impact assessment
<input type="checkbox"/> Climate change monitoring	<input type="checkbox"/> Developing rapid assessment techniques
<input type="checkbox"/> Environmental monitoring	<input type="checkbox"/> Environmental research
<input type="checkbox"/> Environmental consulting	<input type="checkbox"/> Analysing species distribution
<input type="checkbox"/> Managing protected areas	<input type="checkbox"/> Selecting/designating protected areas
<input type="checkbox"/> Habitat restoration	<input type="checkbox"/> Species reintroductions
<input type="checkbox"/> Identifying wild relatives	<input type="checkbox"/> Natural resources exploitation
<input type="checkbox"/> Disease control	<input type="checkbox"/> Ecotourism
<input type="checkbox"/> Basic taxonomic training	<input type="checkbox"/> Professional/accredited training
<input type="checkbox"/> Publishing educational materials	<input type="checkbox"/> Providing information to inform Government
<input type="checkbox"/> Enforcing Government policy	<input type="checkbox"/> CITES
<input type="checkbox"/> Legislation and species protection	
<input type="checkbox"/> Other (please specify)	

## Part 2 – About your organisation’s use of taxonomic information

Please read through the following list of information and services. Please identify which of these services are most important for the work of your organisation and in column 2 rank them according to importance from 1 (very important) to 5 (unimportant). In column 3 state whether the resources are available or unavailable. In column 4 please identify the source of the resources (e.g. in-country professionals, amateurs, local library), and in column 5 indicate whether the source is in your view sustainable. Column 6 is for your comments.

1. Taxonomic information and services you use, or would use if they were available	2. Importance	3. Available (y/n)	4. Source	5. Sustainable (y/n/?)	6. Additional Comments
<b>Species Lists</b>					
<ul style="list-style-type: none"> <li>• Lists of scientific names of animals/plants</li> </ul>					
<ul style="list-style-type: none"> <li>• Lists of common names of animals/plants</li> </ul>					
<ul style="list-style-type: none"> <li>• Information on name changes</li> </ul>					
<ul style="list-style-type: none"> <li>• Lists of invasive alien species</li> </ul>					
<ul style="list-style-type: none"> <li>• Lists of protected animals/plants</li> </ul>					
<ul style="list-style-type: none"> <li>• Lists of species in other countries (e.g. neighbours, sources of pests)</li> </ul>					
<ul style="list-style-type: none"> <li>• Other (please specify)</li> </ul>					

<b>Identification Tools</b>					
• Field Guides (paper)					
• Identification keys (paper)					
• Identification tools (CD-ROM)					
• Identification tools (web based)					
• Images/Photographs of animals/plants					
• Specialised Identification services (taxonomic)					
• Formal (taxonomic) Plant/Animal Descriptions					
• Access to specimens of animals/plants					
• Other (please specify)					



<b>Ecological Information</b> (relevant data can sometimes be obtained from taxonomic institutions, although this is generally not the primary source of information)					
• Habitat requirements of animals/plants					
• Phenological information					
• Information on the conservation status of species					
• Information on Animal/Plant interactions					
• Other (please specify)					
<b>Species Distributional Information</b>					
• Point data from specimens (via the web)					
• Point data from specimens (other source)					
• Information on local species distributions					
• Information on national species distributions					
• Information on regional species distributions					
• Distribution maps					

• Other (please specify)					
<b>Educational Information</b>					
• Public education materials					
• Information on literature					
• Training courses/materials					
• Specimens for student examination					
• Other (please specify)					

Please use the following page to provide more detailed information on the taxonomic information or services you require for biodiversity conservation which are currently unavailable (e.g. specific species/areas, or other types of information not included in the above list)



Many thanks for your time

*Annex 1.6. Presentation on Taxonomic Needs Assessment*



# Assessing Taxonomic Needs Why? and How?

Presentation for the Ghanaian  
Taxonomic Needs Assessment  
First Workshop



## Why Assess Needs?

To identify needs and priorities  
for taxonomists

- Needs of users e.g. conservationists
- Needs for particular tools e.g. species lists
- Priorities of users e.g. 'quick and dirty'

## Why Assess Needs?

To identify needs and priorities  
for policymakers

- Needs relating to specific policies/actions
- Needs for tools for use in delivering government objectives
- Needs for tools to deliver international objectives

TO SHOW THERE IS NO MAGIC WAND!

## How to Assess Needs?

Why use the UK approach?

- Focused on the needs of end users
  - Targets end users
  - Asks about conservation tools
- Raised awareness about the T word
- Delivered needs that taxonomists can respond to and informed policymakers

## How to Assess Needs?

How will we gather information?

### Workshop

- Facilitated by whole project team – USE US!
- Attended by important stakeholders

### Interviews

- Face to face contact – more friendly
- Responses – more complete/honest

### Questionnaires

- Questionnaire design
- Handling feedback

## How to Assess Needs?

What kinds of needs?

- Not just 'taxonomic information'

Also

- Tools that rely on taxonomic information
  - Maps, reports, surveys
- Processes that use taxonomic expertise
  - Laws, quarantine services

## ***Annex 2 Individuals and institutions providing input***

<b>NAME</b>	<b>ORGANISATION</b>
Alfred Oteng-Yeboah	Council for Scientific and Industrial Research (CSIR)
Alistair Tailor	Natural History Museum, London, UK
Chris Lyal	Natural History Museum, London, UK
Richard Smith	BioNET- INTERNATIONAL Technical Secretariat, Egham, UK
Peter Kwapong	University of Cape Coast - Entomology/W.L
Millicent Cobblah	University of Ghana, Legon -Dept of Zoology
Jack Vesper	Ministry of Food and Agriculture - Plant Protection and Regulatory Services Directorate (MoFA: PPRSD).
Francis Addo	Ministry of Trade, Industry and President's Special Initiatives (MOTI & PSI)
Edward Decker	CSIR
Eric A. Okoree	Ministry of Local Government, Rural Development, and Environment (MLGRDE) –Environment Section.
Akpabey Felix	CSIR – Water Research Institute
Grace Andah	Department of Agricultural Extension Services (MOFA–DAES)
Kingsley E Gurah-Sey	Environmental Protection Agency
Eunice Hodasi	Customs, Excise and Preventive Service (CEPS)
Seymour Coke	Faculty of Renewable Natural Resources (FRNR), KNUST, Kumasi
Esther M.-Ahenkora	CSIR-Animal Research Institute.
Lucy Amissah	CSIR –Forestry Research Institute of Ghana
G.K.S Aflakpui	CSIR –Crops Research Institute
Moses Ndebugri	Ghana Trust Bank
Milly Kyofa-Boamah	Ministry of Food and Agriculture - Plant Protection and Regulatory Services Directorate (MoFA: PPRSD).
Yaw Kwakye	Forest Services Division, Forestry Commission
Gabriel Ameka	University of Ghana, Legon -Dept of Botany
Rev. A.Q.Donkor	Cocoa Research Institute of Ghana, New Tafo
Chris M. Asare	CSIR – Plant Genetic Resources Research Institute
Joseph Yaw Opong	Wildlife Division, Forestry Commission
Daniel Adams	Development Partners Group, Accra
Edwin Ofori Lartey	Centre for Scientific Research into Plant Medicine (CSRPM)
Essandoh Paul K.	University of Cape Coast, Microbiology Department

**Table 2.** Participants in inaugural workshop for taxonomic needs assessment in Ghana

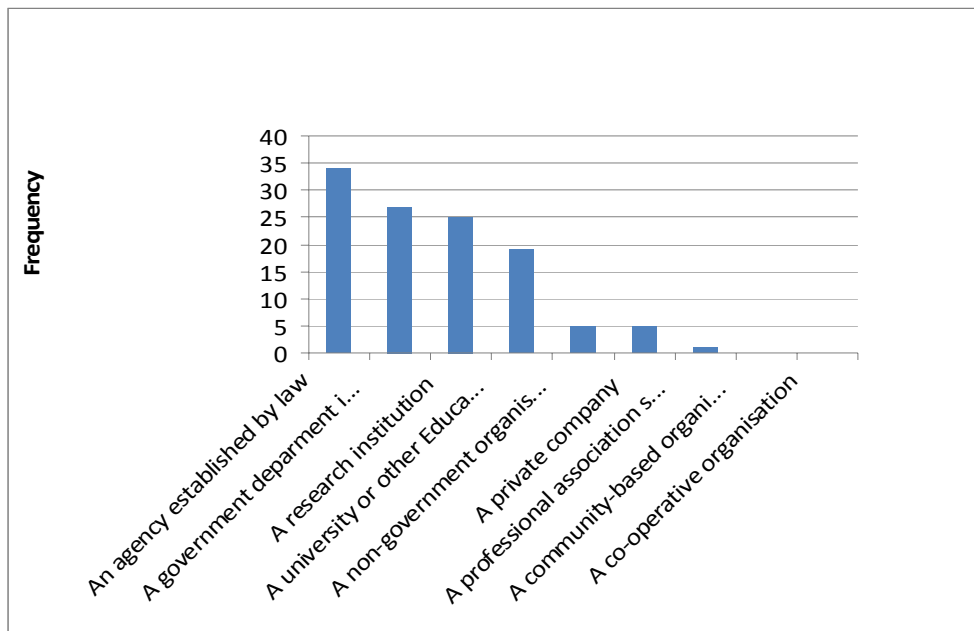
ORGANISATION	LOCATION	NUMBER OF RESPONSES
Action Secondary Technical School	Accra	1
Animal Production directorate	Accra	1
Births and Deaths Registry	Accra	1
Conservation International-Ghana	Accra	1
Department of Biochemistry, Legon University	Accra	1
Department of Biology	Accra	1
Department of Community Development	Accra	1
Department of Oceanography and fisheries, University of Ghana	Accra	1
Directorate Of Crop Service, Ministry of Food and Agriculture	Accra	1
Ebenezer Secondary School	Accra	1
Environmental Health and Sanitation Directorate, Ministry of Local Government Rural Development and Environment	Accra	1
Environmental Protection Agency	Accra	2
Friends of the Earth	Accra	1
Ghana Civil Aviation Authority	Accra	1
Ghana Customs Excise and Preventive Service	Accra	2
Ghana Wildlife Society	Accra	1
Labone Secondary School	Accra	1
Ministry of Education Science and Sports	Accra	1
Ministry of local Government Rural Development and Environment	Accra	2
Odorgonno Secondary School	Accra	1
Plant Protection and Regulatory Agency	Accra	1
Presby Boys Secondary School	Accra	1
St Thomas Aquinas Secondary School	Accra	1
Town and Country Planning Department	Accra	1
University botanical garden	Accra	1
University of Ghana	Accra	2
Wesley Grammar School	Accra	1
West Africa Secondary School	Accra	1
CSIR - Plant Genetic Resources Research Institute	Bunsu	7
Births and Deaths Department	Cape Coast	1
Commission on Human Rights and Administrative Justice	Cape Coast	1
Community Based Rural Development Project of the Ministry of Local Government	Cape Coast	1
Department of Animal Science Department, University of Cape Coast	Cape Coast	1
Department of Children	Cape Coast	1
Department of Entomology and wildlife and Human Biology, University of Cape Coast	Cape Coast	1
Department of Molecular Biology and Biotechnology	Cape Coast	1
Dept. of Parks and Gardens	Cape Coast	1
Environmental Protection Agency	Cape Coast	1

Ghana Heritage Conservation trust	Cape Coast	1
Ghana Immigration Service	Cape Coast	1
Ghana News Agency	Cape Coast	1
Ghana Police	Cape Coast	2
Ministry of Fisheries	Cape Coast	1
Ministry of Food and Agriculture	Cape Coast	3
National Board for Small-scale Business Industries (NBSSI)	Cape Coast	1
National Commission for Civic Education	Cape Coast	2
National Population Council	Cape Coast	1
Polytechnic	Cape Coast	1
Cocoboard Quality Control Division	Cape Coast	1
Regional Education Office	Cape Coast	1
Rozytechnic	Cape Coast	1
Forest Research Institute of Ghana	Kumasi	12
Ghana Customs Excise and Preventive Service	Kumasi	1
CSIR, Coconut Research Programme	Sekondi/Takoradi	1
CSIR-OPRI, Coconut Research Programme	Sekondi/Takoradi	2
Customs, Excise and Preventive service	Sekondi/Takoradi	2
Essikado Hospital	Sekondi/Takoradi	2
Essiwadu Hospital	Sekondi/Takoradi	1
Fijai Secondary School	Sekondi/Takoradi	2
Ghana Primewood Product Ltd	Sekondi/Takoradi	2
Ghana Secondary Technical School (GSTS)	Sekondi/Takoradi	1
Jaisem Co. LTD	Sekondi/Takoradi	1
Plant Protection and Regulatory Services	Sekondi/Takoradi	2
Ricerca the cooperazione	Sekondi/Takoradi	1
Sekondi College	Sekondi/Takoradi	1
Western Veneer company ltd	Sekondi/Takoradi	1

**Table 3: List of Institutions responding to questionnaire**

Organization Type	Number of responses
Statutory Agency	34
Government departments	27
Research Institution	25
University and other Educational Body	19
Non Governmental organizations	5
Private Company	5
Professional Association	1

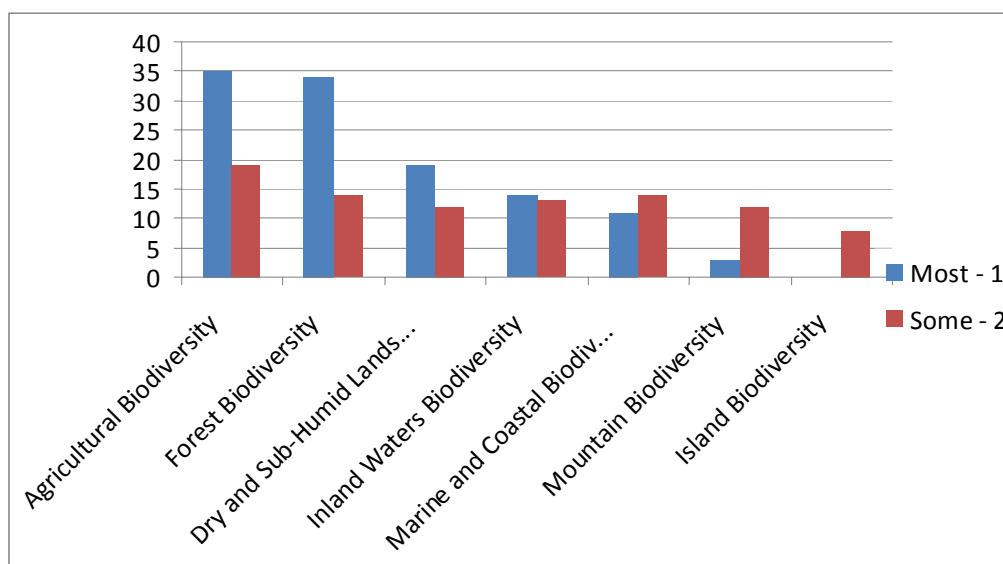
**Table 4:** Categories of organisations responding to Questionnaire (note that some of the 98 responding organisations fell into more than one category)



**Fig. 14:** Categories of organisations responding to Questionnaire (note that some of the 98 responding organisations fell into more than one category)

Ecosystem type (CBD Thematic Area) covered by respondents	No. of responses	'most'	'some'
Agricultural Biodiversity	54	35	19
Forest Biodiversity	48	34	14
Dry and Sub-humid lands Biodiversity	31	19	12
Inland Biodiversity	27	14	13
Marine and Coastal Biodiversity	25	11	14
Mountain Biodiversity	15	3	12
Island Biodiversity	8	0	8

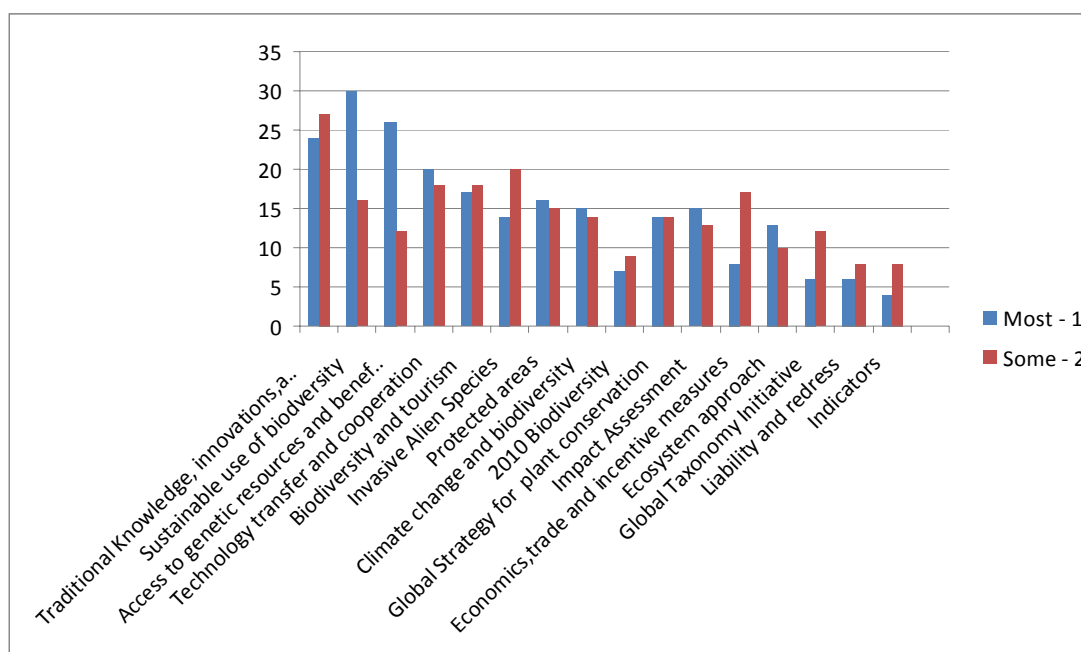
**Table 5:** Ecosystems forming the focus of work by questionnaire respondents. Ecosystem to which activities of organisations responding to questionnaire relate and whether they underpin 'most' or 'some' of the organisations' activities.



**Fig. 15:** Ecosystems forming the focus of work by questionnaire respondents. Ecosystem to which activities of organisations responding to questionnaire relate and whether they underpin 'most' or 'some' of the organisations' activities.

<b>CBD cross-cutting issue covered by respondents</b>	<b>No of organisations</b>	<b>'Most'</b>	<b>'some'</b>
Public education and awareness	52	35	17
Traditional Knowledge, innovations & practice	51	24	27
Sustainable use of biodiversity	46	30	16
Access to genetic resources	38	26	12
Technology transfer and cooperation	38	20	18
Biodiversity and tourism	35	17	18
Invasive alien species	34	14	20
Protected areas	31	16	15
Climate change and biodiversity	29	15	14
Impact assessment	28	15	13
Global Strategy for Plant Conservation	28	14	14
Economics, Trade and Incentives	25	8	17
Ecosystem approach	23	13	10
Global Taxonomy Initiative	18	6	12
2010 Biodiversity	16	7	9
Liability and redress	14	6	8
Indicators	12	4	8

**Table 6:** CBD Cross-cutting issues to which activities of organisations responding to questionnaire relate and whether they underpin 'most' or 'some' of their activities.



**Fig. 16:** CBD Cross-cutting issues to which activities of organisations responding to questionnaire relate and whether they underpin 'most' or 'some' of their activities.

<b>Group</b>	<b>number of responses</b>
<b>TERRESTRIAL SPECIES</b>	
Vascular plants	57
Mammals	51
Insects and spiders	43
Microorganisms	38
Birds	33
Cryptogamic plants	29
Invasive alien species	23
Reptiles	20
<b>MARINE SPECIES</b>	
Fish	27
Plants	16
Birds	15
Mammals	15
Invertebrates	14
Invasive alien species	12
Microorganisms	9
<b>FRESH WATER SPECIES</b>	
Fish	29
Invertebrates	15
Plants	15
Invasive alien species	12
Microorganisms	12

**Table 7:** Taxonomic or other 'group' of importance to organizations responding to questionnaire.

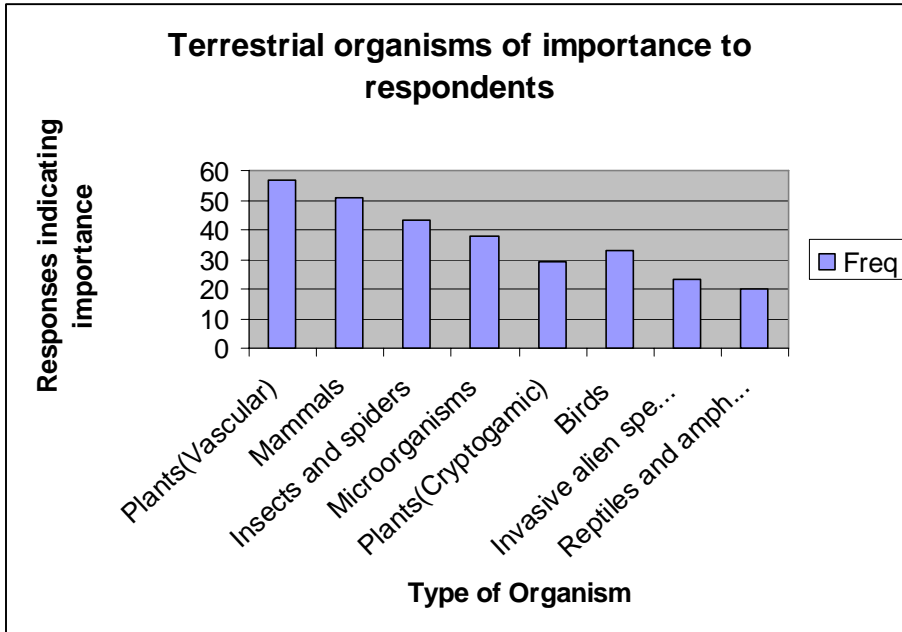


Fig. 17. Terrestrial organisms of importance to respondents

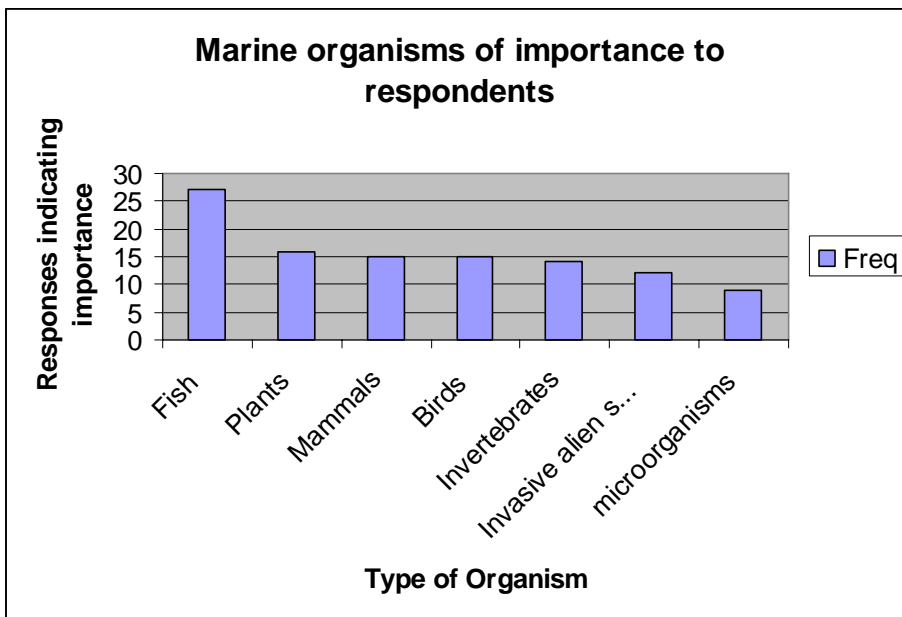


Fig. 18. Marine organisms of importance to respondents

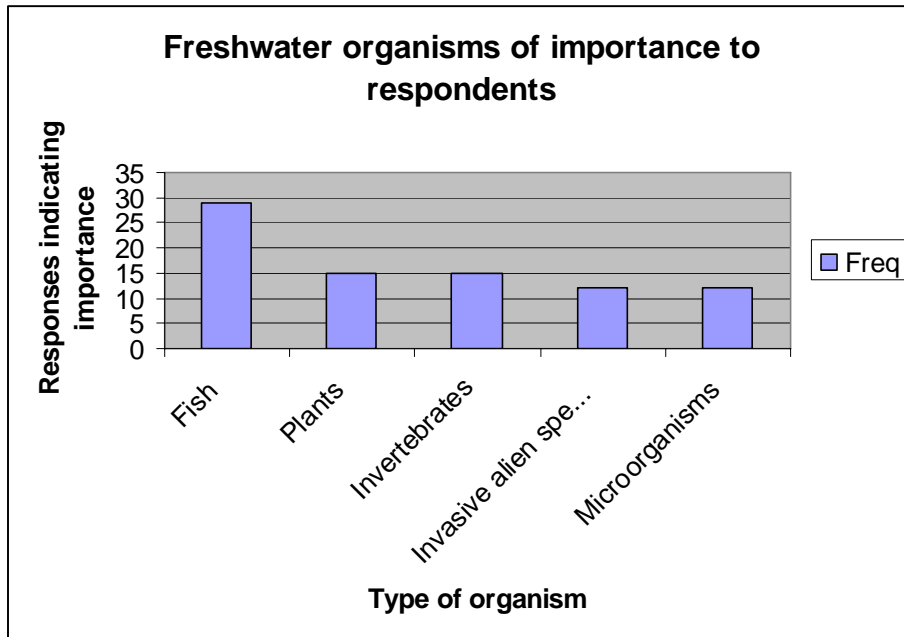


Fig. 19. Freshwater organisms of importance to respondents

<b>Activity</b>	<b>Number of organizations</b>
Providing information to inform government	49
Identification, assessment and monitoring	47
Capacity building	43
Conservation	41
Disease control	39
Publishing educational materials	37
Enforcing government policy	33
Ecotourism	30
Legal and policy	28
Environmental monitoring	25
Environmental research	23
Professional/accredited training	22
Managing protected areas	20
Habitat restoration	20
Compiling biodiversity inventories	20
Environmental impact assessment	19
Natural resources exploitation	18
Legislation and species protection	17
Environmental consulting	16
Analysing species distribution	15
Basic taxonomic training	13
Developing reference collections	12
Developing ecological indicators	12
Molecular assessment methods	11
Climate change monitoring	11
Producing identification aids/tools	10
Species reintroductions	10
Assessment of phylogenetic diversity	9
Convention on International Trade in Endangered Species	9
Developing rapid assessment techniques	9
Identifying wild relatives	7
Selecting/designating protected areas	5
Convention on migratory species (CMS)	5

**Table 8:** Activities in which organizations responding to questionnaire are involved

### **Annex 3. Sources of information used by Questionnaire respondents**

Source  Users	Scientific names		Common names		Synonyms		IAS		Protected spp.	
	Respondent numbers	Respondent percentage	numbers	percentage	numbers	percentage	numbers	percentage	numbers	percentage
<b>Amateurs</b>	1	2%	4	9%	2	11%	1	5%	1	3%
<b>Customs (local, global)</b>	1	2%	1	2%	1	5%	-	-	-	-
<b>Forest reserve</b>	1	2%	-	-	-	-	-	-	-	-
<b>Forestry Commission</b>	1	2%	-	-	-	-	-	-	-	-
<b>Garden curator</b>	1	2%	1	2%	-	-	-	-	1	3%
<b>'Game &amp; wildlife'</b>	-	-	-	-	-	-	-	-	1	3%
<b>In-country professionals</b>	11	22%	12	30%	6		7	37%	12	33%
<b>Indigenous knowledge</b>	-	-	2	5%	-	-	-	-	-	-
<b>Internet</b>	3	6%	1	2%	1	5%	-		3	8%
<b>Library (all references to books)</b>	32	63%	20	47%	6	32%	8	42%	13	36%
<b>Government (including statute books etc)</b>	1	2%	1	2%	-	-	2	11%	2	6%
<b>Timber Industry Development Division</b>	1	2%	1	2%	-	-	-	-	1	3%
<b>Training School</b>	1	2%	1	2%	-	-	-	-	1	3%
<b>Workshop</b>	-	-	-	-	-	-	1	5%	-	-
<b>Other</b>	1	2%	2	5%	3	16%	1	5%	1	3%
<b>Total</b>	<b>51/98</b>		<b>43/98</b>		<b>19/98</b>		<b>19/98</b>		<b>362/98</b>	

**Table 1.** Sources of lists of names from questionnaire respondents. The figures in the 'total' row are the number of responses to this question against the number of questionnaires returned (98). The percentages are against the number of responses not the total number of questionnaires, and are rounded to the nearest whole number.

Source	Field Guides		Keys		CD-ROM		Internet		Images		ID service		descriptions		specimens	
	Respondent numbers	Respondent percentage	nos	%	nos	%	nos	%	nos	%	nos	%	nos	%	nos	%
<b>Library (includes all references to books)</b>	13	65%	12	75%	7	44%	4		13	54%	5	38%	11	58%	6	
<b>Bookshops / personal copies</b>	2	10%	-	-	-	-	-	-	1	4%	-	-	-	-	-	-
<b>In-country professionals</b>	1	5%	2	13%	1	5%	1		3	12%	6	46%	5	26%	7	
<b>Internet</b>	-	-	1	6%	-	-	4		5	21%	-	-	2	10%	-	-
<b>Amateurs</b>	1	5%	1	6%	1	5%	1		1	4%	1	8%	1	5%	1	
<b>COGENT</b>	-	-	-	-	1	5%	-	-	1	4%	-	-	-	-	-	-
<b>CABI</b>	-	-	-	-	1	5%	-	-	-	-	-	-	-	-	-	-
<b>Government</b>	1	5%	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Training School</b>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<b>Other</b>	4	20%	5	31%	5	31%	3		5	21%	1	8%	1	5%	2	
<b>Total</b>	<b>20 / 98</b>		<b>16/98</b>		<b>16/98</b>				<b>24/98</b>		<b>13/98</b>		<b>19/98</b>			

**Table 2.** Sources of identification aids from questionnaire respondents. The figures in the 'total' row are the number of responses to this question against the number of questionnaires returned (98). The percentages are against the number of responses not the total number of questionnaires, and are rounded to the nearest whole number.

Source	Habitat Requirements		Phenological Information		Conservation Status (species)		Animal/plant interactions	
	Respondent numbers	Respondent percentage	numbers	percentage	numbers	percentage	numbers	percentage
Library (includes all references to books)	14	54%	8	53%	9	36%	10	42%
In-country professionals	8	31%	5	33%	8	32%	6	25%
Internet	1	4%	1	7%	3	12%	2	8%
Overseas sources	1	4%	1	7%	1	4%	1	4%
Media, TV	1	4%	-	-	1	4%	1	4%
Nursery	1	4%	-	-	-	-	-	-
Plant Protection and Regulatory Service ( <i>PPRS</i> ), Wildlife, Fisheries	1	4%	1	7%	1	4%	1	4%
Conservation Institution	-	-	-	-	1	4%	1	4%
Workshop	-	-	-	-	1	4%	-	-
Government	-	-	-	-	-	-	1	4%
Regional Directorate	-	-	-	-	-	-	1	4%
Other	1	4%	1	7%	1	4%	1	4%
<b>Total</b>	26/98		15/98		25/98		24/98	

**Table 3.** Sources of ecological information from questionnaire respondents. The figures in the ‘total’ row are the number of responses to this question against the number of questionnaires returned (98). The percentages are against the number of responses not the total number of questionnaires, and are rounded to the nearest whole number.

Source	Distribution Maps		Local Species Distribution		National Species Distribution		Regional Species Distribution		GIS Data		Point Data from Specimens (web)		Point Data from Specimens (other)	
	Respondent numbers	Respondent percentage	nos	%	nos	%	nos	%	nos	%	nos	%	nos	%
Library (includes all references to books)	6	38	8	100	11	58	9	90	2	22	2	33	1	17
In-country professionals	6	38	8	100	5	26	5	50	4	44	1	17	2	33
Internet	1	6	1	13	1	5	2	20	-	-	5	83	1	17
Overseas sources	-	-	-	-	1	5	1	10	-	-	-	-	-	-
Media, TV	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nursery	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant Protection and Regulatory Service ( <i>PPRS</i> ), Wildlife, Fisheries	1	6	1	13	1	5	1	10	1	11	1	17	1	17
Conservation Institution	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Workshop	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Government	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Regional Directorate	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Within own institution	1	6	-	-	-	-	-	-	-	-	-	-	-	-
Other	1	6	1	13	1	5	1	10	2	22	1	17	1	17
<b>Total</b>	16/98		8/98		19/98		10/98		9/98		6/98		6/98	

**Table 4.** Sources of distributional information from questionnaire respondents. The figures in the 'total' row are the number of responses to this question against the number of questionnaires returned (98). The percentages are against the number of responses not the total number of questionnaires, and are rounded to the nearest whole number.

Source	Public education materials		Literature		Training courses / materials		Speci
	Respondent numbers	Respondent percentage	numbers	percentage	numbers	percentage	numbers
Library (includes all references to books)	8	28	24	65	5	18	4
In-country professionals	8	28	6	16	7	25	3
Internet	1	3	5	14	1	4	-
Amateurs	2	7	1	3	1	4	-
International Donors (including embassies)	2	7	2	5	3	11	-
Archives	1	3	-	-	-	-	-
CI-Ghana	1	3	-	-	-	-	-
Own resources	1	3	-	-	-	-	-
Own institution	1	3	1	3	2	7	-
Overseas sources	-	-	-	-	1	4	1
Field Collecting	-	-	-	-	-	-	2
West Africa Examinations Council	-	-	-	-	-	-	1
Government Departments	3	10	1	3	1	4	1
Training school	1	3	-	-	1	4	2
Ghanaian research institutions, including universities, Museum and 'collections'	-	-	-	-	-	-	10
Other	3	10	2	5	2	7	1
<b>Total</b>		29/98		37/98		28/98	25/98

**Table 5.** Sources of Educational information and material from questionnaire respondents. The figures in the 'total' row are the number of responses to this question against the number of questionnaires returned (98). The percentages are against the number of responses not the total number of questionnaires, and are rounded to the nearest whole number.

#### **Annex 4. Membership of Ghanaian network within BioNET-WAFRINET**

**National Coordinating Institute:** Department of Zoology, University of Ghana, Legon

**National Coordinator:** Ms. Millicent Asaaba Cobblah, Systematic Entomologist, Email: macobb@ug.edu.gh

#### **National Institutes**

Institution	Contact/ resource persons
Cocoa Research Institute of Ghana, (CRIG) Tafo	The Executive Director
Department of Biological Sciences, Kwame Nkrumah University of Science and Technology, Kumasi	Professor Yeboah Gyan
Department of Zoology, University of Cape Coast Dr.	Professor M. Botchey
Department of Botany, (Ghana Herbarium) University of Ghana	Professor I.K. Asante and Mr Patrick Ekpe
Department of Fisheries and Oceanography, University of Ghana	Dr F.K. Nunoo
Department of Crop Science, University of Ghana	Professor Owusu Ofori
Biotechnology and Nuclear Agricultural Research Institute, (BINARI), Ghana Atomic Energy Commission	Mr Egyir Yawson
Plant Genetic Resources Research Institute, Bunso	Mr E. A. Osekre
Animal Research Institute, Achimota	Dr Charles Domozoro
Noguchi Memorial Institute for Medical Research, University of Ghana	Professor D. Boakye
Environmental Protection Agency, Accra	Mr Carl Fiati
Water Research Institute, Accra	The Director
Crops Research Institute, CSIR. Kumasi	The Director
Savannah Agricultural Research Institute, Tamale	The Director
Oil palm Research Institute, CSIR, Kusi	The Director
CBD Focal Point, Ministry of Environment Science and Technology	The Chief Director, MEST, represented by Prof. A Oteng Yeboah, Department of Botany, University of Ghana, Legon (GTI National Focal Point)

## **Annex 5. Glossary of Acronyms and Terms**

<b>Acronym used in text</b>	<b>Full Name</b>	<b>URL and description</b>
ABS	Access and Benefit-Sharing (Cross-cutting issue of the CBD)	<a href="http://www.cbd.int/abs/">http://www.cbd.int/abs/</a>
API	African Pollinators Initiative	<a href="http://www.arc.agric.za/home.asp?pid=3493">http://www.arc.agric.za/home.asp?pid=3493</a>
ARI	Animal Research Institute, Ghana	
Biodiversity		The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. (CBD definition)
BIOTA	Biodiversity Monitoring Transect Analysis in Africa – a German-funded research network.	
CBD	Convention on Biological Diversity	<a href="http://www.cbd.int/">http://www.cbd.int/</a>
CEPA	UN's Global Initiative on Communication, Education and Public Awareness	<a href="http://www.cbd.int/cepa/toolkit/2008/cepa/index.htm">http://www.cbd.int/cepa/toolkit/2008/cepa/index.htm</a>
CEPS	Customs, Excise and Preventive Services of Ghana	
CGIAR	Consultative Group on International Agricultural Research	<a href="http://www.cgiar.org/">http://www.cgiar.org/</a>
CHM	Clearing House Mechanism of the CBD	<a href="http://www.chm-cbd.net/">http://www.chm-cbd.net/</a> and CHM-Ghana at: <a href="http://gh.chm-cbd.net/cooperation/cooperation.htm">http://gh.chm-cbd.net/cooperation/cooperation.htm</a>
CIAT	International Centre for Tropical	<a href="http://www.ciat.cgiar.org/Paginas/index.aspx">http://www.ciat.cgiar.org/Paginas/index.aspx</a>

	Agriculture	
CITES	Convention on Trade in Endangered Species of Wild Fauna and Flora	<a href="http://www.cites.org/">http://www.cites.org/</a>
CMS	Convention on Migratory Species	<a href="http://www.cms.int/">http://www.cms.int/</a>
CONABIO	Comisión nacional para el conocimiento y uso de la biodiversidad, Costa Rica	<a href="http://www.conabio.gob.mx/">http://www.conabio.gob.mx/</a>
COP	Conference of the Parties (to the CBD, although other Conventions also have a COP)	The COP takes 'Decisions' at each of its meetings, relating to the detailed operation and implementation of the CBD. These are often referred to by numerals, so that COP V/9 is the Decision 9 of the fifth meeting of the Conference of the Parties to the Convention on Biological Diversity.
COP Decisions (CBD)		The Conference of the Parties to the CBD meets approximately every two years to debate and decide on the means required to advance and implement the Convention. At each meeting the COP takes Decisions, which as non legally-binding agreements.
CRIG	Cocoa Research Institute of Ghana	
CSIR	Ghanaian Council for Scientific and Industrial Research	
CSRPM	Centre for Scientific Research into Plant Medicine	
Defra	UK Department of the Environment, Food and Rural Affairs	<a href="http://www.defra.gov.uk/">http://www.defra.gov.uk/</a>
EPA	Environmental Protection Agency	
FABI	Forestry and Agricultural Biotechnology Institute	<a href="http://www.fabinet.up.ac.za/">http://www.fabinet.up.ac.za/</a>

FAO	Food and Agriculture Organisation of the United Nations	<a href="http://www.fao.org/">http://www.fao.org/</a>
FISNA	Forest Invasive Species Network for Africa	<a href="http://www.fao.org/forestry/fisna/en/">http://www.fao.org/forestry/fisna/en/</a>
FORIG	Forestry Research Institute of Ghana	<a href="http://www.csir-forig.org.gh/">http://www.csir-forig.org.gh/</a>
FRIM	Forest research Institute of Mali	
FRNR	Faculty of Renewable Natural Resources (KNUST)	
GAEC	Ghana Atomic Energy Commission	<a href="http://www.gaecgh.org/">http://www.gaecgh.org/</a>
GARP	Genetic Algorithm for Rule Set Production. GARP is an algorithm primarily designed for predicting the potential distribution of biological entities from raster based environmental and biological data. This post describes examples of the interpretation of different sets of rules developed by GARP.	
GBIF	Global Biodiversity Information Facility	<a href="http://www.gbif.org/">http://www.gbif.org/</a>
GEF	Global Environment Facility	<a href="http://www.gefweb.com">http://www.gefweb.com</a>
GhanaBIF	The Ghanaian Node of GBIF	<a href="http://www2.ug.edu.gh/ghanabif/about.php">http://www2.ug.edu.gh/ghanabif/about.php</a>
GIS	Geographical Information System	
GISIN	Global Invasive Species Information System	<a href="http://www.gisnetwork.org/">http://www.gisnetwork.org/</a>
GPS	Global Positioning System	
GSPC	Global Strategy for Plant Conservation	<a href="http://www.cbd.int/programmes/cross-cutting/plant/">http://www.cbd.int/programmes/cross-cutting/plant/</a>

	(CBD)	
GTI	Global Taxonomy Initiative	<a href="http://www.cbd.int/gti/">http://www.cbd.int/gti/</a>
IAS	Invasive Alien Species	<a href="http://www.cbd.int/invasive/">http://www.cbd.int/invasive/</a>
ICIPE	African Insect Science for Food and Health	<a href="http://www.icipe.org/">http://www.icipe.org/</a>
ICP	In-Country Professional	
ID	Identification	
IFAN	Institut Fondamental D'Afrique Noire	<a href="http://ifan.ucad.sn/">http://ifan.ucad.sn/</a>
IITA	International Institute of Tropical Agriculture	<a href="http://www.iita.org/">http://www.iita.org/</a>
INBIO	National Biodiversity Institute of Costa Rica	<a href="http://www.inbio.ac.cr/en/default.html">http://www.inbio.ac.cr/en/default.html</a>
IPGRI	International Plant Genetic Resources Institute	<a href="http://www.bioversityinternational.org/">http://www.bioversityinternational.org/</a>
IPI	International Pollinator Initiative	<a href="http://www.cbd.int/agro/pollinator.shtml">http://www.cbd.int/agro/pollinator.shtml</a> and <a href="http://www.internationalpollinatorsinitiative.org/">http://www.internationalpollinatorsinitiative.org/</a>
ISBC	International Stingless Bee Centre	
ITIS	Integrated Taxonomic Information System	<a href="http://www.itis.gov/">http://www.itis.gov/</a>
KNUST	Kwame Nkrumah University of Science and Technology	<a href="http://www.knust.edu.gh/pages/">http://www.knust.edu.gh/pages/</a>
LCC	Loop Coordinating Committee of a BioNET LOOP	
LOOP	Locally Owned and Operated Partnership of BioNET-	

	INTERNATIONAL	
MC	Ms Millicent Cobblah	
MEST	Ministry of Environment Science and Technology	
MLGRDE	Ministry of Local Government, Rural Development, and Environment	
MoFA	Ministry of Food and Agriculture	
MOTI	Ministry of Trade and Industry	
NBN	National Biodiversity Network (UK)	<a href="http://www.nbn.org.uk/">http://www.nbn.org.uk/</a>
NBSAP	National Biodiversity Strategy and Action Plan	
NGO	Non-Governmental Organisation	
NHM	Natural History Museum, UK	<a href="http://www.nhm.ac.uk">http://www.nhm.ac.uk</a>
PCR	Polymerase chain reaction (amplification of DNA)	
PGRRI	Plant Genetic Resources Research Institute of Ghana	
PK	Dr Peter Kwapong	
PPRSD	Plant Protection and Regulatory Services Directorate	
PSI	President's Special Initiatives	
SBSTTA	Subsidiary Body for Scientific, Technical and Technological Advice (to the Conference of the parties of the CBD)	

SCBD	Secretariat of the Convention on Biological Diversity	
SEM	Scanning Electron Microscope	
Taxonomic Impediment		The problems caused to implementation of the CBD (among others) by difficulty in accessing necessary taxonomic information and expertise.
Taxonomic needs		The needs of non-taxonomists for taxonomic information and expertise.
Taxonomy		The science of identification, naming and classification of organisms.
TCN	Technical Cooperation Network	
TEM	Transmission Electron Microscope	
TNA	Taxonomic Needs Assessment	
UCC	University of Cape Coast	
UNDP	United Nations Development Programme	
WHO	World Health Organisation	
WIF	WSSD Implementation Fund of Defra (UK)	
WRI	Water Research Institute	
WSSD	World Summit on Sustainable Development	