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C3.1.1 First design report of integrated physical infrastructures

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Aim and status of this document

In this report, the final version of which is due 31 July 2008, we intend to prepare the ground for decisions by the EDIT Board of Directors on necessary steps in the design of the EDIT physical infrastructure (see section "outline of procedure followed"). The report also aims to help streamlining the general process of and specific thinking on the integration of European taxonomic institutions.

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PREFACE

This is the second, revised, updated and extended version of the first design report of integrated physical infrastructures as part of the preliminary analysis of possible designs for EDIT as a supranational entity. The preliminary version was distributed in April 2008, in line with the deliverable date of D4.

The focus on the current report lies on physical infrastructures. Hence, important infrastructure components such as the Distributed European School of Taxonomy have been omitted. This and other components will be considered in a later report (D17, Second analysis of possible designs for European Distributed Institute of Taxonomy as a supranational entity; due in month 42).

Any infrastructure report is a snapshot in the process of designing and realizing the infrastructure. Conditions change all the time during the development of a project through new agreements, meetings and workshops on different levels. While reading parts of this report, it might therefore already be out-of-date in some aspects. However, it is intended to provide ideas and improve interest and involvement in this process by the decision-makers, e.g. directors or heads of departments of EDIT member institutions.

This report reflects the state-of-the-art of July 2008, including the results of the Directors of Collections workshop in Leiden, 12 & 13th June 2008. It will form the basis for discussions during the next EDIT BoD meeting or for an intermediate BoD working group.

With respect to the original DoW, there have been new insights in how to build an infrastructure:

- When starting our work, it was planned to design one common EDIT infrastructure. However, during the process it became more and more obvious that it may be more fruitful to think in terms of various partial infrastructures, related to different infrastructure components such as collections, laboratories, and libraries. By analogy with the notion of mosaic (or partial) MoUs in lieu of encompassing MoUs, we envisage the coagulation of mosaic components (or partial infrastructures) into the sustainable EDIT infrastructure.
- Each of these partial infrastructures might be a network in itself with integrated components and shared facilities, with coordinating structures such as a Board of Directors of Collections or committees
- All these networks will be linked with each other in many ways within EDIT and each might have a light secretariat for outside communication, possibly sharing the task with other projects and network activities
- The process is likely not to be the same for each component/ partial infrastructure, e.g., the speed may vary significantly, as may background and conditions.
- Discussions on this approach fall within the scope of a BoD working group meeting and require the highest decision-making level of each component/partial infrastructure

The last part of the report contains one more fully developed example devoted to collections and recent developments in European DNA barcoding facilities.

INTRODUCTION

Considerations

The key objective of the NoE EDIT is “to integrate European taxonomic effort within the ERA and to build a world leading capacity” and highlights two main approaches strategies of this project. The first is at the practical level, through several work packages (WP) dealing with concrete joint action, enabling scientists to cooperate and create an international collaborative atmosphere, and leading to well-defined products. The second strategy is a more abstract approach through WP3 (Integrating and Reshaping the Infrastructure Basis). This work package deals with the infrastructure basis: the organisation of, e.g., taxonomic collection institutes and lab facilities. The central objective is to come to a unified vision for the preferred infrastructure basis at European level, and to prepare the design of a new integrated infrastructure for implementation.

The WP3 description of work (EDIT, DoW, 2005) states that adaptation and collaboration of the European taxonomic infrastructures are necessary to be able to undertake large-scale challenges in established institutional and digital networks. There are some considerations for this statement. Most important is that the taxonomic practice and the collection institutes have to change to meet a number of challenges. New digital and molecular technologies open up a new area of scientific opportunities, but also require working together in larger networks. The outside world forces us to give more attention to the various applications of taxonomic knowledge, which also implies more emphasis on multidisciplinary cooperation. This goes together with changes in financial mechanisms, requiring working in larger and multidisciplinary consortia. Taxonomy has to develop into a pro-active community with joint activities (e.g., DNA-barcoding) and common work processes (e.g., web-based taxonomy).

In order to decide about the way European taxonomic infrastructures need to adapt, it is necessary to start with categorising the infrastructure operations and to analyse to which extent and how these ideally should be integrated, where pooled resources and common management and where a harmonised approach is needed or/and recommended. By describing the requirements to enter a process of change, it will become clear which obstacles are present and to which extent these can be removed. This may end up in (alternative) approaches to start implementing a realistic process of change already in the lifetime of EDIT.

The question of which operations need to be integrated and in what way leads to a list of issues to consider for various levels of European integration (Kriegsman & Rijkers, 2007; annex 1). The list resulted from discussions within the Dutch WP3 team.

Corporate operations (internal organisational functioning)

- Conservation (storage systems and specimens), safety measures
- Job stratification and staffing plans
- Task division
- Inter-institutional departments
- Management at various levels
- Performance assessment

Common work processes

- Project priority setting, development, execution and management
- Collection priorities
- Web-based taxonomy; digitisation efforts (already promoted by GBIF)
- Selection of and logistics in collecting and research sites

- (Super)labs and equipment
- Publication mechanisms & IPR

Product development

- Project proposal development
- Taxonomic services (i.e. identification services; admission of visiting researchers)
- Business plans
- Education / training

Communication

- Relation management, PR, lobbying

Infrastructure design report in relation to EDIT roadmap

The current report aims to provide first ideas and steps towards a design of the EDIT infrastructure, by which we mean the sustainable infrastructure starting to operate by the end of the EDIT NoE, i.e. early 2011. The emphasis lies on the physical infrastructure and supportive digital infrastructure, but the report does have a bearing on other elements of the infrastructure, such as research, personnel, finances, and management structure (decision procedures).

The report may be seen as a small step within the EDIT roadmap. Figure 1 (below) shows a simplified version of the roadmap from the perspective of physical infrastructures: a series of practical design steps and decisions by the BoD.

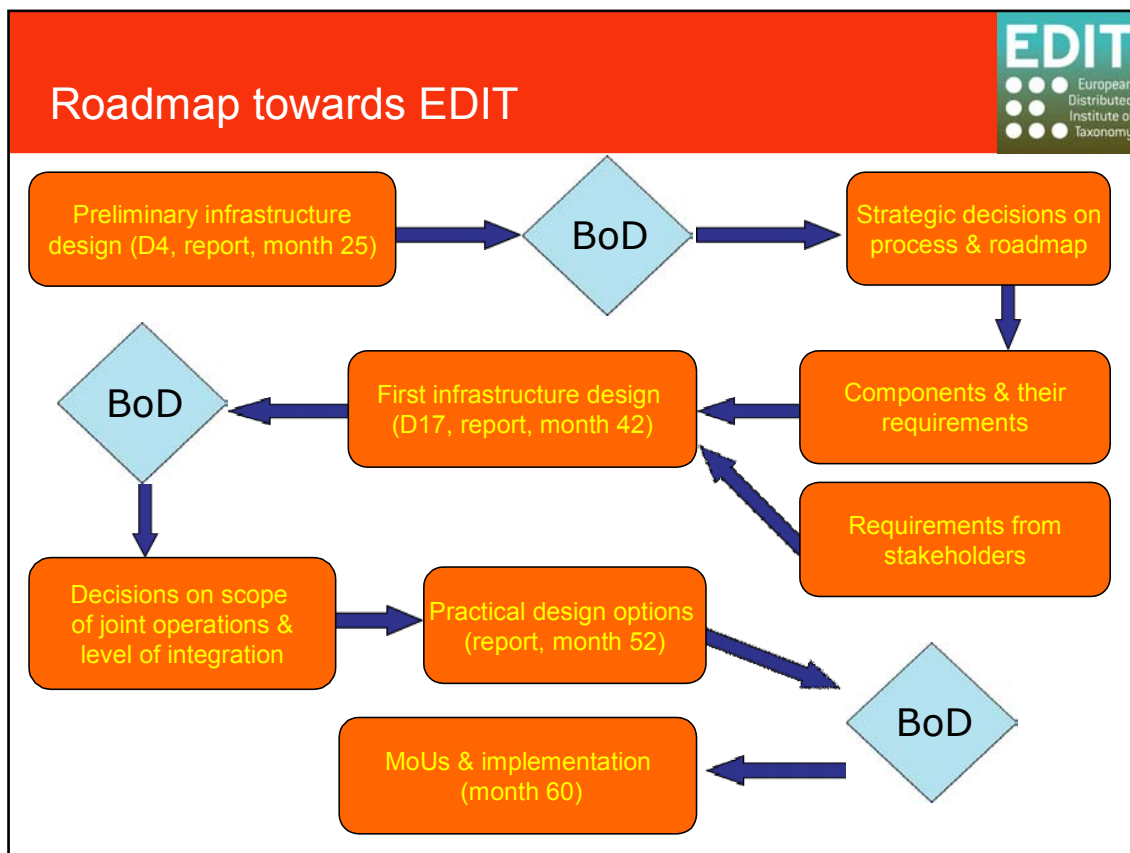


Fig. 1. Schematic roadmap of the process towards a sustainable European Distributed Institute of Taxonomy. Blue squares: key decision moments for Board of Directors.

Scope and outline of procedure followed

Fundamental steps in the design of an EDIT infrastructure are:

- (1) Formulation of widely accepted visions
- (2) Expectations from visions, i.e. requirements of the infrastructure as a whole
- (3) Strategic decisions including demarcation, timing and roadmap
- (4) Defining infrastructure components (building blocks) and their requirements
- (5) Options for building the components and linking them into the desired infrastructure including legal status and organisational models
- (6) Multi-criteria analysis leading to the selection of a concept
- (7) Design of components and creating prototypes
- (8) MoU's on separate prototypes; integrating components into a sustainable infrastructure

This preliminary analysis focuses on steps 1 to 4 and will give some perspectives on step 5. Finally a case study is given for one infrastructure component: collections. It presents discussions on details concerning requirements, obstacles, possible solutions and concrete next steps. Step 6 to 8 are still beyond scope.

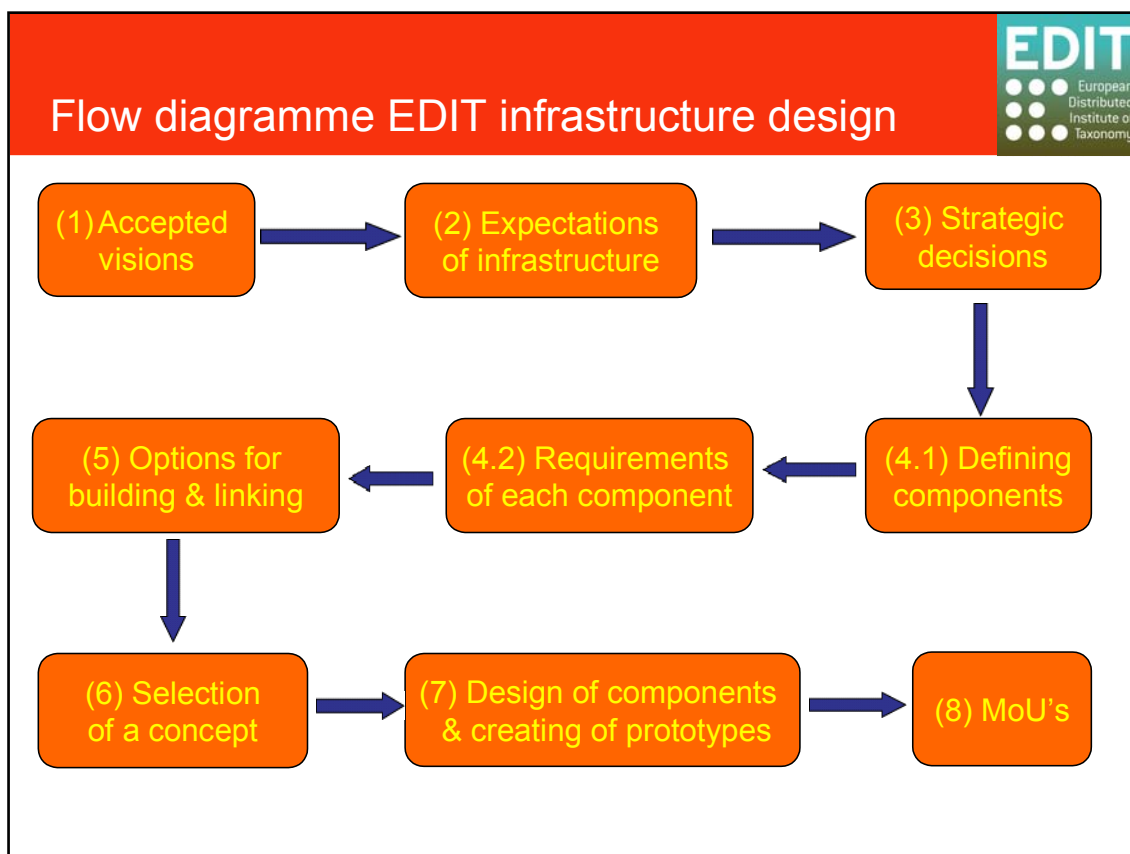


Fig. 2. Flow diagramme for an EDIT infrastructure design.

Step 1

Formulation of a widely accepted vision on the EDIT infrastructure before and beyond 2011

Defining an organisational structure for EDIT needs clear decisions on strategic objectives and priorities. This strategic positioning is based on expectations of the infrastructure, which in this first design report will be extracted from vision statements of groups on different decision-making levels. Several documents on visions about the EDIT infrastructure have been expressed over the last three years. The basic documents are:

- Vision section of the Description of Work, the EDIT starting document (EDIT, DoW, 2005)
- Talk given by Martin Sharman (European Commission) at the EDIT kick-off meeting in Paris (July 2006)
- Views expressed in SAC reports and EC reviewers' comments (2007)
- Vision document by the NSC, visions given by each WP and compilation and summarized by Simon Tillier (NSC, 2007)
- Vision document of the BoD working group chaired by Bertrand-Pierre Galey (BoD, 2007)
- Report of the Future Scoping Group (FSG) chaired by Richard Lane (FSG, 2008).
- Summary of the EDIT Science Symposium 'Future Trends of Taxonomy', Carvoeiro, 2008 (Eekhout, 2008)
- Powerpoint presentations given by Bertrand-Pierre Galey and Leo Kriegsman at the directors' workshop in Carvoeiro, 2008 (Kriegsman, 2008; summary: Galey & Kriegsman, 2008)

Step 2

Expectations from the vision, i.e. requirements of the infrastructure as a whole

From the existing vision documents we extracted the most important ideas/constraints on physical and general infrastructure. We classified the statements according to: threats, opportunities & challenges, predictions, choices and action points. In addition, we considered thematic aspects covered by the vision documents such as future trends in taxonomy; facilities & expertise needed; stakeholders; and management. Grouping the statements per theme gives first ideas on the requirements of the infrastructure as a whole, under the assumption that BoD members agreed with every single statement in the Future Scoping Group vision document. At the next BoD we intend to check with the directors if this assumption is valid.

Step 3

Strategic decisions including demarcation, timing and roadmap

Based on step 2, we started making an extensive list of strategic decisions needed in order to make significant progress and define probable components of a possible EDIT infrastructure. This list was sent to the BoD and NSC members for comments (early May); responses were compiled to finalize the list and add it to the preliminary report on the EDIT infrastructure (due May 31). Some decisions mentioned below will hopefully be formalised at the next BoD meeting.

Answering questions like "What is in and what is out" and "Which products for whom", demarcation is a specific type of strategic decision.. The answer to the second question seemed to be that we aim for both academic and societal relevance. An answer to the first question would be premature. Some directors proposed to investigate two options: (i) integration of taxonomic components only (= original scope of EDIT); (ii) integration of entire natural history museums,

including mineralogy and anthropology (possibly needing extra budget). The discussion on demarcation clearly needs further refinement and must lead to strategic decisions soon (starting at the next BoD meeting), with considerable emphasis on research strategy.

Another aspect to consider is the design process itself (see Fig. 2), both the steps we envisage and their timing. At various moments in the process, key decisions need to be taken by the BoD (see Fig. 1). The EDIT roadmap (see EDIT website) gives an outline of the EDIT project with all its deliverables and milestones, but here we emphasize the general design and decision-making process to reach a sustainable infrastructure. Again, we intend to ask the Board of Directors to agree with or amend the steps in this process.

Step 4

Defining infrastructure components (building blocks) and their requirements

There is a strong need for prior strategic decisions here, but in their absence a minimum set of components and their requirements has been compiled, comprising physical and digital components, and personnel. Again, we used the vision document by the Future Scoping Group and the presentations and discussions at the directors' workshop in Portugal (Carvoeiro, Jan 2008, see Galey & Kriegsman, 2008) and we will seek formal approval later.

In general it seems logic that a certain amount of compatibility in structure and function of all parts of the network is necessary to enable EDIT to work as a supranational entity.

Step 5

Options for building the components and linking them into the desired infrastructure including legal status and organisational models

Step 5 is beyond the current report, but it is obvious that there are many ways to link components into an infrastructure and that it is closely related to the preferred organisational model. Some examples of questions that need to be addressed are:

Is flexibility the main criterion for the legal structure?

What are the main executive bodies? BoD, SAC (or a more general Advisory Council), an "Executive Committee" of Directors, Subcommittees, and a Reference Group with stakeholders and users of taxonomy

Will EDIT be a dedicated structure or a collaborative network?

Will we delegate responsibilities to one member or share a common facility?

Will we use extensive subcontracting?

Are institutions prepared to devolve some power for some operations to a centralised body?

Will we allow an open phase for institutions stepping out of or joining the EDIT successor?

The Board of Directors, chaired by Bertrand-Pierre Galey (MNHN Paris), will itself organise the discussions and decision-making process pertinent to these issues. It is anticipated that BoD working groups, comprising a limited number of EDIT directors, may meet from time to time to work out details to be decided/voted on by all directors.

In a next report, we will add examples of potential organisational role models. One example already studied, Biological Resource Centres, has been published as deliverable D.3.1.2 (Rijkers & Kriegsman, 2007, see annex 2).

Steps 6-8 are beyond the current report.

DEVELOPMENT OF AN INFRASTRUCTURE DESIGN

Step 1 & 2: Visions and expectations

I. Expectations from the EC (based on Martin Sharman's talk, July 2006)

Following statements are copied from the ppt-presentation given by Martin Sharman, as a representative of the European Commission (EC), at the EDIT kick-off meeting in Paris, July 2006. They reflect visions and expectations the EC associated with the EDIT project as a whole.

Greater capacity for **better research**:

- Long-term taxonomic research network
- Shared protocols including metadata
- Shared data and data structures

Integration is the key aim:

- Functional and effective inter-institutional agreements and decision-making process
- No un-necessary overlap, no avoidable gaps
- Strategy for continued collaboration

Examples of **results** to be achieved:

1. Common management of infrastructure

- Shared installations and equipment
- Agreements for use of infrastructure
- Access conditions more favourable to members than others outside network

2. Common knowledge management

- Participants share pre-existing knowledge
- Intellectual property rights over results generated by network fairly distributed
- Common patents

3. Common management of human resources

- Mobility programmes among participants
- Common training programmes for personnel
- Training programmes for students and researchers outside partnership
- Harmonised working conditions, e.g. salaries, social protection, etc.

4. Assured continuation after the end of EC funding

- All participants work on a shared portfolio of projects
- Search for external funding sources
- Decreasing dependence on EC funding

II. Expectations extracted from EDIT vision documents

The following list of statements is extracted from EDIT vision documents (FSG, 2008; NSC, 2007) and the summary of the Science Symposium in Carvoeiro, January 2008 (Eekhout, 2008). A strong focus lied on the document mentioned first (FSG, 2008). To keep track of these statements, they have been marked with (*).

Visions given in these documents reflect in different ways predictions, threats, challenges, choices and decisions expected to become reality from short- to long-term future of EDIT and beyond. They can be used as criteria to facilitate strategic decisions to be taken by the BoD on their way developing a sustainable integrated taxonomic infrastructure in Europe.

The statements cover many facets of taxonomic research. A classification according to their main focus (strategy, integration, technologies and web facilities) facilitates an overview and reveals overlap and likewise entries in different documents.

Predictions

1. Strategy

- More political, i.e. user driven, selection of research priorities will become increasingly necessary (*).
- Customisation of taxonomic information will be essential. However, the way in which information is provided may well change, using a just-in-time approach, on demand from users, rather than the current just-in-case approach, determined by suppliers. (*).
- Technology problems can be solved (relatively) easily; sociological problems are more difficult and should receive serious attention (*).

2. Integration:

- The taxonomic contribution to research may increasingly focus on natural history, that is, taxon-based integrative knowledge (*).
- To measure the impact of taxonomy, new evaluation metrics will be developed that more effectively recognise taxonomic contributions to knowledge and world science. It will be essential that the intellectual content of synthetic taxonomic publications, especially floras, faunas and revisions, is recognised and hence are more valued (*).
- Harmonise disparate efforts for digital taxonomic information infrastructure: the priority will turn to standardisation over development. An open-source approach will enhance this development (*).
- Internationally, taxonomic efforts will be increasingly organised through globally relevant bodies such as GBIF, CBoL, ToL, EoL, and similar large infrastructures (*).
- Within Europe, a broadly based and forward looking coordinating mechanism will be important, perhaps centred around a revised CETAF (Consortium of European Taxonomic Facilities) incorporating national taxonomical societies and associated users (*).
- The relative importance of amateurs or citizen scientists will increase and the challenge for the professional community is to provide opportunities for their effective contribution (*).
- The training of new taxonomists within Europe could benefit from a distributed model but again will have to be integrated (*).

3. Technologies:

- Much previously unknown biodiversity will be found in the micro-world of invisible and barely-visible organisms (*).
- Specimens, or vouchers, will remain a critical part of taxonomic science as hypotheses are based on them, but our concept of 'specimens' will include surrogates such as digital images, bioacoustic data and molecular sequences (and 3D models like casts and scans) (*).

4. Web facilities:

- New tools enable integrating, analysing and verifying vast quantities of morphological data (automated analyses of digital images), sequence data (automated assignment of specimens to taxa via sequence) and other modes (e.g. chemistry, bioacoustics).
- Virtual research environments and collections will increasingly serve as the primary contact of urbanised human populations with nature (*).

- Maintenance of up-to-date information, and therefore rapid response to new information and mediated taxonomic judgment, will be vital (*).
- While internet based tools will correlate and organise information, human editorial control will be necessary and this is likely to be a key role for tomorrow's taxonomists (*).

Threats

- "Business as usual", even if scaled up, is not an option (*).
- Full-time taxonomists are declining, as universities and other organisations continue to reduce positions, ageing of experts (*).
- The training of taxonomists is likely to be undertaken by specialised institutions, but with this comes the risk of a narrow perspective (*).
- Groups under risk of become "orphans".

Challenges/opportunities

1. Strategy

- Underpin efforts to produce a credible tree of life (*).
- There is a general lack of data as what is the real status of the funding and training of taxonomy in Europe.

2. Integration

- The role of Universities in both teaching and research cannot be underestimated for introducing new blood as well as integrating taxonomy into other subjects. These roles cannot be left to specialised institutions alone (*).
- Integrate taxonomists into different disciplines (genomics, conservation, ecology, etc.), in order to realise their potential, involvement of most EDIT researchers in joint projects (*).
- Information on taxonomic researchers and their ongoing research readily available
- Integrate to provide critical mass and delivery of ambitious projects (*).
- Europe has a rich amateur sector that needs encouragement and further integration to existing and developing infrastructures. Integrate research done by amateurs (*).
- Mobility of personnel between partner institutions.
- There is also a need to increase the involvement of ADCs local taxonomists and Institutions in the process of discovering and inventorying the biosphere, as most of the unknown diversity is found in tropical areas.

3. Technologies

- Incorporate rapidly expanding fields of high-throughput DNA sequencing, automated digital data-gathering and biodiversity informatics in the science of taxonomy (*).
- The need of large-scale exploration programmes to discover the "unknown world" was widely acknowledged - Urgent need to develop technologies for discovering and inventorying the "small world" (prokaryotes, single-cell eukaryotes and micro-metazoans), such as environmental sequencing or DNA taxonomy, use emerging molecular tools that allow discoveries at larger scale and higher speed (*, partly).
- Make possible fast access of leading taxonomists to breakthrough technologies as well as of citizen scientists and taxonomists in ADCs to well-established technologies.
- Develop open access sources of geographical data, with an agreed structure, so that collection data from diverse sources can be viewed as a whole (*).

4. Web facilities

- A problem to be considered is that of the long-term maintenance and updating of the databases.
- Explore the possibility to make taxonomic information (e.g. Zoological Records, primary literature) truly freely available to the wide taxonomic community.
- The final goal should be granting free access to the biodiversity for taxonomic purposes (i.e. non-commercial).

Choices

1. Strategy

- Radically review current approaches to taxon description **(*)**.
- Promote taxonomic research as a EU scientific priority, with policies being directly designed by scientists under scientific criteria (bottom-up approach like US NSF).
- Change the systems for the assignment and evaluation of scientific products, establish specific criteria for the scientific evaluation of taxonomic excellence **(*)**.
- Articulate clearly defined “big science” projects, which can be achieved with specified new resources, prioritise projects **(*)**.
- Clearly articulate how to integrate collections, biodiversity informatics provision and research capability **(*)**.
- Rationalise collections to provide critical mass for addressing large-scale programmes **(*)**.
- Develop criteria for continued collection development and management, based on gap analysis, risk assessment and future scoping of usage **(*)**.
- Support and promote large-scale sampling expeditions.

2. Integration

- Constitute the European focal point for species information and for taxonomic contributions to societal relevant issues e.g. CBD, climate change and invasive species, concentrate resources for data extraction, storage and analysis in a few regional centres.
- Work in integrated teams rather than individually **(*)**.
- Purpose of training of taxonomists, with the need of separating the training of taxonomy as a tool for identification, or the training (and employment) of taxonomic scientist for studies in an evolutionary framework.
- Establish a career design, support the possibility that large museums award PhDs in taxonomy.
- The important role of citizen scientists and of local taxonomists in ADCs should be recognised, knowledge transfer to biodiversity-rich countries.
- Promote interdisciplinary training.
- Inside promotion of new developments both technological and conceptual both as a science, among the scientific community and funding agencies, and as a supporting service, among stakeholders and the general public.

3. Technologies

- Use formal description only in taxa or instances where a formal name is essential + use emerging biodiversity informatics techniques to associate different kinds of information with unique identifiers that do not require a formal name (or provisional automatic naming?) **(* partly)**.
- Move parts of taxonomy from ‘artisanal’ to ‘industrial’ scale: massive sequencing and other data capture to create massive output and analysis, high throughput identifications (expert systems, and through barcoding) **(*, partly)**.

- Use emerging technologies (e.g. digital imaging, bioacoustics) to automate collection of 'specimens' and make field trips more productive (*).

4. Web facilities

- Endorse the open access principle (*).
- Taxonomic information must be in the public domain and machine-readable to remain productive and relevant (*).
- Stimulate broadening of the community of users and collaborators by making taxonomic information and new tools more readily available (*).
- Standardised ontologies will be necessary for linking information. This is a necessity not only for the management of vast amounts of data, but also for the meaningful and objective treatment of scientific judgments. (*).

Decisions

1. Strategy

- Substantially / radically change how taxonomy is done and how supporting infrastructure is operated (*).
- Ensure training of excellence in taxonomy.
- Ensure research of excellence in taxonomy.
- Ensure access and integration of taxonomic information.
- Create awareness of biodiversity-related issues in the general public.
- Continue collecting as an essential component of taxonomy, agreement on privileged repositories by taxa, mobility of collections through long term loans (*).

2. Integration

- Build consortia embracing taxonomists and other biologists, efficient and sustainable mechanisms to integrate core business operations and assist the decision-making process (means = multilateral MoUs, possibly an overarching legal status, sharing information); establish lasting partnerships with non-EU taxonomic infrastructures and with key sectors of users of taxonomy (*).
- Common strategy for equipments/labs and agreement for their shared use, implement a common collection management strategy through common management standards, best practice, common indicators.
- Build new storage facilities that relate more to tissues and microbial diversity than whole organisms (*).
- Common database standards, common platforms, integration of IT policies, coordinated contribution to very large e-facilities; general adoption and promotion of common data structure platforms such as EoL.
- Invest in taxonomists, train students in taxonomy, focusing on exploring and understanding biodiversity. (*).
- Implement a joint employment strategy for taxonomists.
- Organize efficient and, if necessary, fast deployment of personnel and amateur societies through task forces.
- Implement new ways of working and interacting with taxonomists to accommodate interdisciplinarity (collaboration with universities and other users of taxonomy) and integrate taxonomists into interdisciplinary teams (note: partly via scratchpads) (*).
- Constitution of taxonomic expert-groups both taxon- and location- focused, including both amateurs and professional inside and outside EDIT members institutions.

3. Technologies

- Implement new working methods and new work evaluation methods (*).
- Industrialise data production through cheap and fast, high-throughput DNA sequencing (Costs are falling as capacity is increasing) (*).
- Make rapid identification means available to users (means: coordinating barcoding and other identification means; e-tools), accommodate the need for 'pocket identifiers' (digital, molecular, bioacoustic) for use in the field, increase specimen value and use by georeferencing (*, last part).
- The wide access for routine taxonomic work of well-established technologies (DNA sequencing, image analysis) to citizen scientists (amateurs) and taxonomists in advanced developing countries (ADCs) should be equally promoted.

4. Web facilities

- Move taxonomies to the web (distinct from just digitising data), make large publications interactive on the web, in real time. (*).
- Scale up and strengthen biodiversity informatics capability, expand computer storage and computation capacity to cope with exponential data increase (*).
- The considerable volume of heritage data must be transformed into digital form using emerging technologies, use a unique identifier system to underpin different types of data (*).
- Sustain and develop the elements of the Internet platform for cybertaxonomy (data access, IT tools for field work, data analysis and assembly of treatments, scratchpads) .
- Use Information Technology to track source and use of samples (*).
- Free and general access of the taxonomic data and primary literature, with a specific mention to the Zoological Records.
- Implement information management systems to drive the management and evaluation of taxonomy within Europe (*).

Summary

A summary of all statements regardless any classification or focus revealed seven keynotes stressed in all or most of all documents. These are:

- Harmonisation and standardisation over change/development (all tasks: management, performance assessment, collections, labs, technologies, IT);
- Technological up-scaling (especially for DNA-barcoding);
- Human integration on all levels: professional taxonomists, amateurs, citizen scientists;
- Project cooperation;
- Access to new technologies and web facilities, also for ADCs;
- Promotion (in all facets: taxonomy, training, new technologies to stakeholders, public, scientific community, decision-makers, ADCs);
- New evaluation metrics.

Interestingly, this goes further than the questionnaire on the design of a realistic working model for EDIT executed two years ago (Kriegsman & Rijkers, 2007; see annex 1). In this survey the top-4 of most required/most desired integration/cooperation issues were:

1. Taxonomic database infrastructure & standards
2. Transnational service (= access)
3. Common external communication
4. Taxonomic training with EU institutions

Another two themes scored partly above average with ‘transnational species registers’ seen as more desired but less required issue and ‘European collection policy’ as more required but less desired issue.

Although vision documents and consequently keynotes extracted from them are based on a broader and more diverse audience than the questionnaire done on the director’s level between CETAF and EDIT institutions, there is an obvious increase of awareness of challenges and opportunities taxonomists and taxonomic institutions will face in the future. This can be seen by the broadening of issues addressed, e.g. from integration/cooperation of taxonomic database infrastructures and standards in the questionnaire to harmonisation and standardisation of all techniques as summarized from the vision documents. This can also be seen by addition of new aspects, e.g. the necessity of new evaluation metrics.

Step 3: Strategic decisions – condensed from vision documents

Based on the expectations extracted from vision documents, a list of possible strategic decisions can be extrapolated. As clear, short statements they will help to make a significant progress in the development of an infrastructure design and will facilitate the decision-making process. In a next step they will be sent for comments to the BoD.

Three statements lead to more general decisions:

- Radically **change** how taxonomy is done and how supporting infrastructure is operated.
- Clearly articulate how to **integrate** collections, biodiversity informatics provision and research capability.
- Implement information **management** systems to drive the management and evaluation of taxonomy within Europe.

Going into detail, decision statements can be classified in one of the aspects covered by EDIT:

- Collections
- Databases & web tools
- DNA and other new technologies
- Training
- Promotion
- Human resources
- Taxonomic research

Collections

1. **Maintain** collections
2. **Continue** collecting
3. Develop **common** collection management **strategy**
4. Develop **criteria** for continued collection development and management, based on gap analysis, risk assessment and future scoping of usage
5. **Rationalise** collections to provide critical mass for addressing large-scale programmes
6. Promote **mobility** of collections through long term loans

Databases & web tools

1. Long-term **maintenance** and **updating** of databases
2. **Standardisation** over development, common database standards, common platforms, integration of IT policies
3. Human editorial **control**

4. **Free** and general **access** of the taxonomic data and primary literature, with a specific mention to the Zoological Records
5. Usage of unique **identifiers**
6. Promote and support **Zoobank**

DNA and other new technologies

1. **Common** strategy for equipments/labs and agreement for their shared use
2. **Up-scaling**: massive sequencing and other data capture to create massive output and analysis, high throughput identifications
3. Large-scale **exploration programmes** to discover the “unknown world”: Urgent need to develop technologies for discovering and inventorying the “small world” (prokaryotes, single-cell eukaryotes and micro-metazoans).

Training

1. Provide integrated training on **all levels**
2. Role of **Universities** in both teaching and research
3. **Interdisciplinary** training
4. **Distributed** model

Promotion

1. Taxonomic research as a EU **scientific priority**
2. **European focal point** for species information and for taxonomic contributions to societal relevant issues, climate change and invasive species

Human resources

1. Integrate **taxonomists** = integrated teams
2. Integrate **amateurs** and citizen scientists
3. Increase the involvement of **ADCs local taxonomists and institutions**, establish lasting partnerships with **non-EU taxonomic infrastructures**
4. Joint **employment strategy** for taxonomists
5. **Career design**, PhD awards in taxonomy in larger museums

Taxonomic research

1. Political, i.e. user driven, selection of **research priorities**
2. Establish specific **criteria** for the scientific **evaluation** of taxonomic excellence, contributions to knowledge and world science
3. **Knowledge transfer** to biodiversity-rich countries
4. Support and promote large-scale **sampling expeditions**

Step 4: Defining infrastructure components and their requirements

Strategic positioning determines the infrastructure model. Without clear decisions on strategic objectives and priorities it is not possible to define organisational structures. However, in absence of prior strategic decisions made by the BoD, again the vision documents and all conclusions drawn concerning expectations and strategic decisions will be used to develop a first proposal of possible infrastructure components and their requirements. This can be seen as a White Paper for an infrastructure design for EDIT as a supranational entity. Providing well-founded proposals and options, it might be an excellent basis to facilitate and speed up the decision-making process by the BoD.

Where possible solutions and answers have been taken from vision documents, references to original sources are given. In many other cases new ideas resulting from the work of the EDIT WP3.1 team in Leiden have been added.

As shown by all steps given above the statements from the various EDIT documents reflect the interest in at least two infrastructure components:

- Component 1: Natural history collections as one basis of taxonomic research
- Component 2: Lab facilities, with emphasis on equipment needed to extract information from collection material (thus also enhancing the depth and quality of the collections) and on technologies to discover and inventory biodiversity of small organisms.

As for the access to primary literature the Future Scoping Group focussed their thoughts on online publications as the unique medium, which will be able to manage the vast amount of new data and information and making them available on the web in real time. Additionally, at the Science Symposium in Carvoeiro, Portugal the EDIT scientists' community stressed a general and free access to primary literature (Eekhout, 2008). However, not all publications will be online available in the mid-term future and most parts of archives linked to the collections and collection material may never become digitized. Physical libraries related to taxonomic research and archives containing useful documents on collection backgrounds will therefore remain an important source of primary data. Facilitating their smooth operation, they need to be included as a component in an infrastructure design model.

Since a majority of archives belong to libraries and many management standards and problems affect both, libraries and archives can be considered and discussed as one unit.

In our view, libraries and archives need to be included as another component to facilitate smooth operations of the infrastructure:

- Component 3: Libraries related to taxonomic research and archives containing useful document on the collections

Component 1: Collections

Current situation

On European level institutions holding very substantial collections are organised under the roof of the Consortium of European Taxonomic Facilities (CETAF). CETAF aims to promote research in systematic biology and palaeobiology as well as access to the information and expertise of its member institutions, by improving the efficiency of their taxonomic facilities through co-operation. In support of its aims, CETAF will act as a forum for the exchange of information and policies, working towards co-ordinated activities. The objectives for co-operation cover the following areas:

- Digitisation of collections and associated information, in line with agreed priorities.
- Development of information services for scientific, commercial and public use.
- Promotion of training for systematists, both at the academic and at the technical levels.
- Improvement of curation and conservation of collections.
- Improvement of access to collections for visiting researchers and other workers through common procedures and assistance routines at each of the members' facilities.
- Co-ordination of those scientific policies and other initiatives that will benefit from a common approach.
- Submission of joint funding proposals that will contribute to the previous objectives.

CETAF initiatives towards these objectives are Synthesys and EDIT. Synthesys comprised travel grants to enable access to natural history collections and carried out network activities, such as the development of a collection survey, collections assessment and training.

Apart from these overarching programmes, bi- and multilateral agreements aim at realising clearly defined projects and activities, e.g. between taxonomic institutions in Europe (Quaiser & Kriegsman, 2008). Several national consortia, e.g. DNFS or NL-TAF, are providing steps towards integration of national history museums and herbaria on a national level.

Due to the work of Synthesys and collaborations with outside organisations, e.g. SPNHC, overviews on collection management standards and best practises are already available. However, there is no infrastructure yet to implement these results, nor structures to develop a joint collection strategy within the community of European natural history collections.

Visions on future infrastructure: natural history collections

Responsibility in EDIT: BoD, Directors of Collections, WP3

Implementation & coordination beyond 2011: task force or/and committee of collection heads (see B.-P. Galey, “EDIT in 2011 and beyond: from scope to structures” – unpublished table discussed during a BoD working group meeting, Jan. 2008), Collections Management Working Group

Links: Synthesys NA, NHML, SPNHC (standards), BRC report (TCR design model, Rijkers & Kriegsman, 2007, see annex 2)

Main goals: highly accessible, integrated European collections & research infrastructure, transparent decision-making process, strategic positioning decides on structure model

Strategic decisions condensed from the vision documents for this component have been:

1. **Maintain** collections
2. **Continue** collecting
3. Develop **common** collection management **strategy**
4. Develop **criteria** for continued collection development and management, based on gap analysis, risk assessment and future scoping of usage
5. **Rationalise** collections to provide critical mass for addressing large-scale programmes
6. Promote **mobility** of collections through long term loans

Due to their origin these statements are still containing some overlap on one and missing at least one essential element (access) on the other hand. In a following step we tried to reduce overlap and reorganize statements in relation to current business models of natural history collections and according to the main goal of this component. This procedure resulted in five aspects, which will now be discussed in detail with focus on main decision, goal, and a set of possible requirements, obstacles, and solutions:

1. Maintenance of collections and improvement (decision statement 1)
2. Access to collections (new)
3. Common collection management strategy (decision statement 3)
4. Rationalisation and reorganization of collections (decision statements 4-7)
5. Common collecting and acquisition strategy (decision statement 2)

1. Maintenance of collections and improvement

Decision: in general yes, specimens or vouchers will remain critical part of taxonomic science (FSG, 2008), but see below, improvement and reorganisation necessary

Goal: ensure long-term preservation and availability of taxonomic collections (NSC, 2008) as the backbone of research, but see below

Requirements: physical maintenance of collections, buildings, minimum set of physical requirements, well-skilled staff

Obstacles: funding, financial limitations, shortage of staff, short- and long-term degradation, loss of skills in maintaining collections

Solutions: savings through common collection management and reorganization of collections (see below), exchange of experiences, staff training

2. Access to collections

Decisions: facilitate loans and access for scientists and other users, digitization of collections

Goal: highly physically and digitally accessible collections for researcher and other user groups – link to WP 4 (stakeholder liaison office)

Requirements: within EDIT community common simplified loan policy, programmes to enable access, digitization projects, cooperation with GBIF and other international initiatives – link to Synthesys Access, WP 5 & 6, GBIF

Obstacles: funding, financial limitations, legal regulations and restrictions

Solutions: joint travel budget, intelligent joint implementation of loans, interoperable on-line collection databases, ideally with one common portal

Performance indicators: number of visitors, loans, objects on-line available

3. Common collection management strategy (see also BoD, 2007)

Decisions: yes, implement common collection management standards, common indicators, best practice (NSC, 2007), develop a common certificate on a set of collection standards (like ISO norm)

Goal: common management standards and strategy between EDIT institutions, certification of collections fulfilling a defined set of collection standards

Requirements:

- Agreements (on higher decision-making level) on *standards in preservation* and management of natural history collections (MoU's), covering museum-wide issues (loans, destructive sampling, acquisition) – link to Synthesys, NHML, available standards, e.g. SPECTRUM, other relevant organizations and societies, e.g. SPNHC
- Development of a common *certificate* on a certain set of collection standards – link to ISO norm, certification as a sign to the outside
- Agreements on *standards in databasing* – link TDWG/ABCDEFG
- Agreements on *shared facilities and resources*: databases & server facilities, human resources (collection managers, taxidermists), preparation facilities (MoU's) – link to WP5 & 6, Synthesys, Leonardo programme
- Agreements on *common work process*: collective acquisition and management of expendable collection goods, e.g. label paper, glass jars etc. mechanisms for the exchange of freshly collected, unregistered material (MoU's)
- Joint projects on concrete integrated structure details, e.g. receive a certain standard in all European collections – link to Synthesys; see report on Taxonomic Collection Repositories (Rijkers & Kriegsman, 2007, see annex 2)
- Initiate a Collections Management Working Group for technical implementation, incl. regular meetings
- Training and exchange of collections managers – link to Synthesys NA C, WP 2, 8
- Performance assessment (see also BoD, 2007), internal (self-audit) and external (second-party) assessment and advice on the basis of the procedure development Synthesys NA C: status quo, possibilities for improvements

Obstacles: financial limitations

Solutions: additional funding through joint projects, savings through more efficient working processes and shared resources

Performance indicators: accessibility of collection and data, certain parameters achieved, procedure documents realized – see Synthesys NA C website and report

4. Rationalisation and reorganization of collections (see also BoD, 2007)

Decision: yes, reorganize and strengthen collections

Goal: Reducing fragmentation through exchange of objects/collections under taxonomic, geographical, historical aspects, highly integrated collections

Requirements:

- Criteria for continued collection development and management, based on gap analysis, risk assessment and future scoping of usage (NSC, 2007)
- Evaluation: identification of strengths (taxonomic, geographical, historical focuses) and weaknesses of collections (lack of curators or other experts for certain collections, orphaned collections, poor conservation status) – link to Synthesys NA B, NA C
- Reorganization: mechanisms for the exchange of collection material, e.g. through long-term loans, merging collections
- Rescue plan for orphaned or endangered collections (national to European level)
- Task force of BoD or/and heads of collections

Obstacles: incompatible legal statuses of institutions, financial limitations

Solutions: exchange of material through long-term loans, savings through reorganisations and mergers of collections on a national level

5. Common collecting and acquisition strategy

Decision: yes, collecting will remain an essential component of taxonomy (FSG, 2007), the need for large-scaled exploration programmes to discover the “unknown world” was widely acknowledged (Eekhout, 2008)

Goal: Common future collecting strategy

Requirements:

- Joint sampling and research focus – link to WP4, 7
- Coordination of the constitution of new collections (see B.-P. Galey, “EDIT in 2011 and beyond: from scope to structures” – unpublished table discussed during a BoD working group meeting, Jan. 2008)
- New storage facilities that relate to tissues and microbial samples (FSG, 2007) - link to Synthesys NA E
- Facilitation of non-commercial biodiversity collecting and the movement of specimens (Eekhout, 2008)

Challenges:

- Automate collecting through emerging technologies (digital imaging, bioacoustics) and usage of ‘pocket identifiers’ (digital, molecular, bioacoustic) (FSG, 2007)

Obstacles: legal restrictions, management of increasing amount of data, financial limitations

Solutions:

- Promotion of the facilitation of non-commercial collecting and movement of specimens
- Attract and include amateurs in collecting & expeditions
- Development of new databasing tools, common budget for bioinformatics specialists
- Combine EDIT activities, e.g. ATBI+M and DNA-barcoding
- Networking with external research institutions & companies (e.g. for molecular analyses, databasing)
- Start mechanisms for joint identification of funding opportunities

Component 2: High-tech labs

Current situation: role models

In contrast to the other infrastructure elements discussed here, molecular labs already present role models of integration and cooperation of their physical infrastructure. Three examples, within and outside EDIT will be given here:

Inside EDIT: JEMU (Joint Experimental Molecular Unit)

Concept: Integrated research infrastructure between RBINS and RMCA Brussels, financed by Belgian Science Policy (= governmental money)

Focus: a) DNA barcoding and phylogeny and b) exploring, testing and optimizing techniques for DNA extraction from a wide array of different sorts of museum samples

Pros: JEMU provides scientific, technical and financial support to (non-molecular) taxonomists of both institutions to start up DNA-research that complements (or integrates with) their other taxonomic activities, hence JEMU strives at collaboration, not merely technical execution. Moreover, JEMU encourages researchers of both institutions to join forces and to involve external partners.

Outside EDIT: EMBL (European Molecular Biology Laboratory)

Concept:

- Europe's flagship laboratory for basic research in molecular biology and financed by public research foundations/funds from 20 member states and the one associate member.
- Research at EMBL is conducted by approximately 85 independent groups covering the entire spectrum of molecular biology.
- Facility dedicated to basic molecular biology research, technology development, service provision and advanced training
- Main lab in Heidelberg, outstations in Hamburg, Monterotondo, Hinxton (=EBI) and Grenoble
- Led by a Council in which each member state is represented by one or two members
- Scientific Advisory Council advises Council
- Council appoints Director General
- EMBL has established a Bioinformatics Advisory Committee for EMBL-EBI: Open access bioinformatics service centre with data on sequences, genomes, expression, structures, interactions, pathways, etc and provides analytical tools, maintains comprehensive range of molecular databases

Outside EDIT: NORDSIMS (Nordic Secondary Ion Mass Spectrometry)

Concept

- NORDSIMS is a high-resolution ion-microprobe facility for measuring radioactive and stable isotopes on small volumes of a mineral to obtain key information on ages and processes that affected the rock containing that mineral. It is a bottom-up initiative stemming from the research community in the Nordic countries, formalised by an agreement in 1993. Partner countries are Sweden, Denmark, Norway and Finland. After an initial capital investment, the countries' contributions to operating costs are matched by their annual usage of the facility; with the exception of Sweden who fund three dedicated staff members. 70% of analytical time is distributed to the Nordic user base, complemented with limited EU access. Applications are evaluated annually by a steering committee. Approved applications are admitted with nominal user fee. NORDSIMS also organises SIMS course supported by Nordic Research Council (NorFA), aimed at disseminating knowledge of SIMS techniques and improving the quality and diversity of applications.

What can EDIT learn from this: The NORDSIMS initiative could serve as a model for infrastructure sharing and co-financing. Examples are massive scanners, experimental growth facilities, and digital infrastructure.

Visions on future infrastructure: lab facilities

Responsibility in EDIT: BoD, Directors of Research, Heads of labs, WP3

Implementation & coordination beyond 2011: management board or consortium, Lab Management Working Group

Link: Synthesys NA F, WP4

Main goals: integrated network of high-tech lab facilities, facilitated access to new technologies, transparent decision-making process, long term-vision on labs in the EU and strategic positioning decides on structure model

Strategic decisions condensed from the vision documents for this component have been:

1. **Common strategy** for equipments/labs and agreement for their shared use
2. **Up-scaling:** massive sequencing and other data capture to create massive output and analysis, high throughput identifications
3. Large-scale **exploration programmes** to discover the “unknown world”: Urgent need to develop technologies for discovering and inventorying the “small world” (prokaryotes, single-cell eukaryotes and micro-metazoans).

Again decision statements have been applied on a physical infrastructure. Statement 2 and 3 are seen in a broader sense as a part of the network development. Enabling and organizing access to lab facilities is added as another aspect of this component.

1. Common strategy for labs – compatibility and calibration (decision statement 1)
2. Complementarity of (super)lab facilities – network development (including decision statement 2 & 3)
3. Access to labs and equipment – access to the network (new)

The scope of EDIT comprises lab facilities and equipment related to taxonomic research. These are mainly molecular labs and microscopy facilities. Geological labs, e.g. electron microprobe, ion probe, or spectroscopy do not yet belong to that scope. It is a question of demarcation of EDIT beyond 2011 whether geological and anthropological collections, research and lab facilities will become involved. This is the same for exploration programmes to discover and inventory the “world of small organisms”. However, the latter has already been mentioned in the vision document of the FSG (FSG, 2008) and will therefore be included here.

1. Common strategy for labs – compatibility and calibration

Decision: yes, implement common standards and best practice in lab facilities

Goal: common management standards and strategy between EDIT lab facilities

Requirements:

- Agreements on *common standards* in protocols and best practice, calibration & accreditation, safety measures (MoU's) - possible liaison has still to be defined
- Agreements on *standards in databasing* – link to EBI & Genbank
- Initiate a *Lab Management Working Group* for technical implementation, participation from ‘outside’ institutions, exchange and transfer of technical expertise, training
- Performance *assessment*, internal (self-audit) and external (second-party) assessment and advices for improvements; calibration of lab facilities, serving as second opinion labs for partner institutions (e.g., ancient DNA) – liaison has still to be defined

Obstacles: quality control, financial limitation

Solutions: calibration & accreditation of labs, identification of extra national funding and co-funding opportunities, cooperation and knowledge exchange with institutions outside EDIT, defining labs for natural history museums as key components in ESFRI roadmap

Performance indicators: quality and quantity of analysis, service, certain standards and procedure documents realized, certification (ISO standard)

2. Complementarity of (super)lab facilities – network development

Decision: shared lab facilities and resources, common future development strategy, realising joint projects, up-scaling

Goals: physical and digital integrated and optimised (super)labs on national - EDIT - European level, development of large-scaled lab facilities, purchasing expensive equipment through co-financing, implementation of joint exploration programmes, complementarity of (super)lab facilities; streamlining common access to facilities in other communities

Requirements:

- Agreements on *shared facilities and resources*: lab facilities and equipment (molecular labs facilities: PCR, sequencing, facilities of non-destructive methods: CT; NMR / MRI; microscopy: light, SEM, TEM; photography: 2D- & 3D-images and other facilities for analysing), databases & servers, storage facilities, human resources (technical staff) (MoU's) – link to WP5 & 6, example JEMU, Belgium
- Agreements on common *work process*: collective acquisition and management of expendable goods (MoU's)
- Agreements (on higher political level) on *co-financing* major lab facilities (common policy, see above, MoU's):
 1. *DNA-barcoding factory* or another high throughput, fast turnaround DNA-lab for massive sequencing and other data capture to create massive output and analysis, high throughput identifications
 2. Possibility of *other* cost-extensive *lab facilities*, e.g. microscopes, and other facilities, e.g. scanner, cameras
 3. *Optimisation* of networking: pros and cons of remote microscopy and analysis
- Large-scale *exploration programmes* to discover the “unknown world”: Urgent need to develop technologies for discovering and inventorying the “small world” (prokaryotes, single-cell eukaryotes and micro-metazoans), FSG (2008).

Obstacles: financial limitations also due to competition between institutions, management problems, e.g. concerning utilisation

Solutions: budget optimisation and co-financing through cooperation and sharing of resources, also with research institutions and organisations outside EDIT (e.g. EMBL = European Molecular Biology Laboratory) and with industry

3. Access to labs and equipment – access to the network

Decision: facilitate access to labs, identification methods and databases for scientists and other user groups, e.g. nature conservation, CITES

Goal: user-friendly, accessible lab facilities

Requirements: common management, development of an expertise centre, agreements on costs and sharing

Obstacles: financial limitations, management problems, data rights, measuring data use

Solutions: cooperation and co-financing through nature conservation organisations, other user groups, streamlining of access and output, safeguarding data rights, can also be used as a performance indicator for the network

Component 3: Natural history libraries and archives

Current situation

On **European level** libraries are organised under the roof of the Conference of European National Librarians (CENL), a non-governmental organisation and network of all European national libraries. On this level all points mentioned below are covered: policymaking, working groups, standards on preservation, best practice, guidelines, knowledge exchange, training, access, research & development, digitizing, e-depots, cooperation with international organisations. Preservation standards and best practice are the work of the European Commission on Preservation and Access (ECPA). Access and online services is in the focus of The European Library (TEL), which is funded by the CENL and comprises on different levels all 47 members of the CENL. In the future, The European Library will be the organisational ground for the "European digital library". This European Commission initiative will encompass not only libraries but also museums, archives and other holders of cultural heritage material.

On **national level** the KB Den Haag is the policy maker, for university libraries also the UKB. They are part of all these European networks, involved in their developments and fulfilling their requirements.

On the **level of a single self-standing library of natural history** the Naturalis library gives an example (based on an interview with Tom Gilissen, librarian at Naturalis). Many standards concerning databases and data structures are available, however, implementation is a more matter of practicability and feasibility. Certification: ISO standards are available. However certification is not of main interest. There is therefore no assessment, no quality control. Main focus of cooperation lies on information exchange and compatibility of databases and data structure between libraries. There are no formal agreements, but informal cooperation, e.g. between libraries from regional (Leiden) to national level on acquisition of expensive literature, to avoiding overlap through specialisation etc.

The Naturalis library and archives are involved in several national, European and international projects, e.g. Metamorfoze and MITCH. Membership of national professional organisations, e.g. NVB, section Special Libraries, and contributions to international associations are a matter of funding and therefore not yet realised. However there are private memberships of staff members, e.g. to exchange knowledge. Training on this level is offered by national organisations, e.g. STGO.

Summary: The situation in Naturalis can probably also be applied to other libraries of natural history museums, e.g. of the MNK, NHML and MNHN. These libraries are linked to their hosting institution, the museum or university. The connection to other libraries is given by joint activities such as projects. There is no permanent common platform or consortium yet, nor common strategies.

Visions on future infrastructure: natural history libraries & archives

Responsibility in EDIT: BoD, Directors/Heads of Information Services/Archives/Libraries, WP3
Implementation & coordination beyond 2011: task force or/and committee of heads, Librarians/Information Management Working Group

Links: CENL (Conference of European National Librarians, standards on European level, TEL – digital library), CDNL (Conference of Directors of National Libraries), IFLA (international standards, working group PAC – Preservation and conservation), NPO (National Preservation Office, British Library, UK), Synthesys NA, Biodiversity Heritage Library (BHL), WP6

Main goals: highly accessible, integrated (optimised) European libraries and archives of natural history embedded in international initiatives and projects of national libraries, free and comprehensive online access to information relevant for taxonomic research and collections

Since there are no strategic decisions from vision documents focussing on libraries and archives related to taxonomic collections, main aspects of the component collection will be adopted here:

1. Common management strategy of libraries and archives
2. Access to information
3. Development and reorganization of libraries and archives

1. Common management strategy of libraries and archives

Decisions: implementation of common standards in libraries and archives, common indicators, development of a quality control and common certificate on a set of collection standards (like ISO standard)

Goal: common management standards and strategy between EDIT institutions, certification of libraries fulfilling a defined set of standards

Requirements:

- Agreements on standards in preservation and management of libraries of natural history museums – link to European and international organisations (see above)
- Development of a quality control system and common certificate on a set of collection standards (like ISO standard), certification as a sign to the outside
- Agreements on standards in databasing – link to TEL (The European Library)
- Agreements on shared facilities and resources: databases & server facilities, human resources (e.g. restoration specialists), restoration facilities
- Agreements on common work process: collective acquisition and management of expendable archival material, e.g. special kind of acid free paper, archival boxes, maps etc.
- Joint projects on concrete integrated structure details, e.g. reach a standard on certain details in all European archives and libraries of natural history
- Joint projects with libraries and archives outside natural history
- Initiate Information Managers Working Group for technical implementation, knowledge exchange, incl. regular meetings, workshops or training courses
- Training and exchange of librarians and keepers of the archives – link national organisations, libraries
- Performance assessment, internal (self-audit) and external (second-party) assessment on status quo, possibilities for improvements and advice

Obstacles: financial limitations

Solutions: additional funding for joint projects, e.g. restoration of special documents; savings through more efficient working processes and shared resources

Performance indicators: certain storage and preservation parameters and procedure documents realized

2. Access to information

Decision: physical access: facilitate loans, access for all users; digital access: digitize publications and archival material linked to collection material, delivering important background information, enable and guarantee long-term – permanent digital access; developments coordinated with and embedded in European and international initiatives

Goal: physically and digitally highly accessible libraries of natural history for all user groups

Requirements:

Physical Access

- Within EDIT community common simplified loan policy, information exchange

- Facilitate physical access to libraries and archives
 - Joint projects to dig out information buried in archives etc and making it available
- Digital Permanent Access – link to the Netherlands Royal Library (KB) for experiences with legal issues and techniques
- Facilitate national – international online library catalogues to provide a comprehensive overview and details of library holdings - link NCC, Worldcat, financial support
 - Cooperation with international initiatives: digitizing and online access to published literature and archival material of biodiversity held in the respective collections under one roof / in cooperation with existing projects / programmes, e.g. BHL, GDZ etc. (joint forces) – Virtual European biodiversity library & archive digitization projects – link WP 5
 - Clarify legal rights and all problems linked to online publications and digitizing publications
 - Implementation of technical developments to enable long-term access, e.g. Persistent Identifiers for online available publications, e-Depot
 - Manage problems of long-term storage of digital information – link TEL
 - Initiate a Task Force Permanent Access
- Obstacles:* funding, financial limitations, technical limitations (e.g. server storage space, long-term preservation of digital objects)
- Solutions:* joint travel budget, intelligent joint implementation of loans, interoperable on-line library and archival databases, ideally with one common portal, support of research and development of new techniques concerning storage facilities and preservation, sharing costs for acquisition of publications and maintenance of server
- Performance indicators: number of visitors, loans, publications or pages on-line available

3. Development and reorganizing of libraries and archives

Decision: yes, rationalise, reorganize and strengthen natural history libraries and archives

Goal: maintenance of libraries and archives of natural history, long-term preservation under reorganisation, reducing fragmentation, highly integrated (optimized) libraries and archives

Requirements:

- Criteria for continued development and management, based on gap analysis, risk assessment and future scoping of usage

Mid-term scope: maintenance of physical libraries

- Evaluation: identification of strengths and weaknesses of libraries/archives (storage parameters, number of titles, completeness, focal points, lack of skilled librarians with background knowledge), risk analysis – survey? link to Synthesys NA B, NA C
- Reorganization: reducing fragmentation and risk through streamlining, conflation and exchange of publications and archival material with respect to material held in related collections and availability for users! – link to collections
- Rescue plan for orphan or endangered archives and libraries (national – EDIT - European level)
- Task force Heads of Information Services/Libraries

Long-term scope: e- Depot and central reference library including digital access

- Participation in the development of a centralised/distributed-integrated e-Depot of biodiversity (and related) publications and archival information from the side of natural history libraries and archives – For example, in The Netherlands a link is envisaged with the Royal Library (KB).
- Establishment of a central reference library on national level as a hard copy repository, incl. digital access

Obstacles: incompatible legal statuses of institutions, financial limitations

Solutions: savings through reorganisations and streamlining on national level, additional funds through international initiatives and projects

Case study: Collections

Fine-tuning of requirements and infrastructure solutions

A Directors of Collections Workshop at the NNM Leiden, on 12 - 13 June 2008 gave the chance to take another step towards defining requirements, identifying obstacles and finding solutions matching the specific demands and visions of this component (for agenda and participants see annex 3 and Quaisser, 2008). This workshop provided the opportunity to advance the collections component as a case study to test next steps towards an integrated infrastructure.

Overview of requirements identified in step 4 of this report:

- **Maintenance:** physical maintenance of collections, buildings, minimum set of physical requirements, well-skilled staff;
- **Access:** simplified loan policy within EDIT, programmes to facilitate physical access, digitization project to facilitate digital access (collaboration with international organisation and initiatives);
- **Collection management:** agreed standards in collection management and data basing, certification on collection standards, incl. methods for self-assessment and peer-review, agreements on shared facilities and resources, integration of present work flow, joint projects, knowledge exchange;
- **Rationalisation** of collections: collections development and reorganisation according to collections strengths, Collections Rescue Task Force and rescue plan for orphaned or endangered collections;
- **Collecting** strategy: joint sampling and research focus, coordination of the constitution of new storage facilities, facilitation of collecting and movement of vouchers.

Apart from different WP's of EDIT (strategic management), parts of these requirements are covered by Synthesys (standards and assessment). Synthesys itself is - as EDIT - a network project within the EU Framework Programme FP VI. It is aiming at facilitating physical access to collections, facilities and expertise and at setting standards for collection management and databases, and raising scientists' awareness of best practice by offering improved training and workshop opportunities, and guidelines for the care, storage and conservation of collections. Synthesys is also supposed to provide new policies on emerging technologies for storing collections, such as DNA samples or tissue banks.

In many cases Synthesys provides therefore the basis by collecting data and developing standards and best practises to be implemented by EDIT in order to build up a sustainable infrastructure.

It is important to clarify which parts of the work are done by Synthesys and which parts will be done by EDIT:

- **Maintenance:** physical maintenance of collections, buildings, minimum set of physical requirements, well-skilled staff – **Synthesys incl. risk management;**
- **Access:** simplified loan policy within EDIT – **data Synthesys, implementation EDIT WP3.1**, programmes to facilitate physical access - **Synthesys**, digitization project to facilitate digital access (collaboration with international organisation and initiatives) – **EDIT WP3.2 & 5;**
- **Collection management:** agreed standards in collection management and data basing, certification on collection standards, incl. methods for self-assessment and peer-review – **Synthesys**, agreements on shared facilities and resources, integration of present work flow, joint projects – **EDIT WP3.1**, knowledge exchange – **training of technical staff Synthesys, coordination Leonardo EDIT Directors of Collections & EDIT WP3.1;**

- **Rationalisation** of collections: collections development and reorganisation according to collections strengths, Collections Rescue Task Force and rescue plan for orphaned or endangered collections – **EDIT WP3.1**;
- **Collecting** strategy: joint sampling and research focus, coordination of the constitution of new storage facilities, facilitation of collecting and movement of vouchers – **EDIT WP3.1 with input from EDIT WP4**.

In the scope of EDIT central goals of the first **workshop of EDIT Directors of Collections (DoC)** in Leiden, June 2008 were (see also annex 3):

- Decisions on and timeline towards unified collection standards, protocols and policies;
- First steps towards a common European collection strategy;
- Decisions towards an efficient workflow and mechanisms for knowledge exchange;
- Initiation of a Collections Rescue Task Force.

An important part of the meeting was dedicated to the exchange of experiences with workflows and staff structures in each institution and the comparison of different institutional working models. Discussions led to the definition of requirements, identification of obstacles and ideas of how to overcome them (Quaisser, 2008).

As the result a list of action points has been compiled. The focus of these points lies on the compilation of data and the comparison of different management structures, strategies, standards and policies and the development of joint structures such as working groups.

Most relevant for the future work of WP3.1 are:

- Comparison of staff structures in museums and definitions of responsibilities
- Comparison of collections management working models (pros and cons) to draw up an EDIT model of collection management
- Initiate a Collections Policy Group to collect information on policies available in EDIT member institutions, analyse them and develop a proposal of joint standards to implement by directors
- Initiate a Collections Rescue Task Force and define structure and protocol
- Initiate exchange programmes for staff members

One of the most important results of this workshop in the light of EDIT was that decisions and first steps have been taken to improve integration and build up new sustainable infrastructures. The participants agreed on the maintenance of the DoC as a working group on a decision-making level. Furthermore opportunities were discussed to form a core group and set up a secretariat to support small task groups in organising workshops or meetings on particular issues. Meetings (or workshops) might then be dedicated to topics such as loan policy or collection donations as it was proposed in the first place. They might also address staff members on different hierarchical levels.

As another strategic decision the EDIT DoC did not initiate a Collection Management Working Group (CMWG) as originally planned and decided at the EDIT directors' workshop in Carvoeiro (Galey & Kriegsman, 2008). Discussions revealed incompatibilities between the staff structures of EDIT institutions and a lacking middle management level in the collection department of many museums. However, this lacking management level was precisely the one supposed to populate the CMWG.

Proposed decisions to be taken by the EDIT Board of Directors

As in the case of the CMWG, the decision-making process by the DoC needs to be facilitated and accompanied by strategic decisions taken by the Board of Directors. Discussions on this management level started at the EDIT directors' workshop in Carvoeiro (Galey & Kriegsman, 2008). However, to enable the development of an integrated and sustainable EDIT infrastructure this decision-making process asks for more attention and efforts. As for the case study collections examples of strategic decisions to be taken by the BoD can be concluded from statements based on vision documents (see above), underpinned by the report on collection management standard in the NHM by Paul Davis (Davis, 2004). These are for example:

1. The BoD will demonstrate stewardship of EDIT taxonomic collections by ensuring a long-term preservation and availability of objects within them.
2. The BoD will strive to ensure minimum standards for security and housing of all EDIT collections.
3. The BoD will strive for a high digital accessibility of EDIT collections to all user groups.
4. The BoD will facilitate appropriate physical access to EDIT collections.
5. The BoD will strive for harmonised (agreed) collections management standards and policies.
6. The BoD will strive to reach a certain standard of collection management in all EDIT collections (e.g. according to Synthesys NA assessment standard 'B').
7. The BoD will facilitate the DoC in their work on structural details, e.g. the development of agreed policy documents, the set up of exchange programmes.
8. The BoD will identify chances for rationalizing and reorganizing EDIT collections.

This is without doubt a non-exhausting list of strategic decisions. Details need to be discussed and specified by the BoD and will therefore be an important topic on the next BoD meeting.

Perspectives for component collections

It became obvious that even within a single infrastructure component certain parts are developing faster than others. Steps towards an exchange programme for staff members or an agreed collection loan policy for example might be more concrete than the development of a working model of collection management. With the first workshop of EDIT directors of collections a first step towards a sustainable new infrastructure has been taken. In the upcoming time within EDIT further meetings will be organised to underpin and vitalize this process and to give a few examples on how integration of collections might look like in detail.

Following-up workshops are in planning, one will be held as a side event during the SPNHC conference in Leiden in July 2009.

Case study: High-tech labs

Recent developments in European DNA-barcoding: shared large facilities and leading labs *(leaning on texts written by Pedro Crous, CBS Utrecht)*

DNA barcoding (www.barcoding.si.edu), a concept, which was proposed in 2003, is now widely seen as “the renaissance of taxonomy”. Taxonomists working on a wide variety of organisms are now using or testing DNA barcoding as a research tool. The rapidly growing barcode database is offering biologists a unique system for comparative analysis across a broad spectrum of taxa. High-throughput labs began to develop at the University of Guelph (www.biodiversity.uoguelph.ca) and the Smithsonian, and BOLD (www.barcodinglife.org) was constructed as the barcoder’s workbench. CBOL (consortium for the barcode of life; www.barcoding.si.edu) held the First International Barcode of Life Conference in London in February 2005 (<http://www.barcoding.si.edu/London.html>). The conference made barcoding highly visible and publications critical to barcoding continued to appear, based largely on misconceptions about barcoding and resistance to new approaches.

Major DNA-barcoding facilities have been established in Canada and the US, but as yet there are none in Europe. In Europe, the DNA barcoding efforts of the major taxonomic facilities and museums are being coordinated via the Netherlands (www.ecbol.org), as part of EDIT WP3. Recently, the members of CETAF (Consortium of European Taxonomic Facilities, www.cetaf.org) expressed a need to establish a DNA Barcoding Centre in Europe to facilitate high throughput DNA sequencing, labeling and data capturing of specimens. Several lines of activity are being undertaken to speed up DNA-barcoding in Europe:

1. Establishing a Network of Leading Labs (NELL)

As part of a funding proposal to the EuroBioFund, involving commercial sponsors, the participating institutions are establishing a Network of Leading Labs (NELL) that will jointly carry out DNA barcode initiatives. This strategy is built on the premise that strengthening existing labs and stimulating them to divide tasks is more efficient than focusing solely on one or two superlabs.

2. Attracting large-scale facilities

Currently, The Museum and Institute of Zoology, of the Polish Academy of Sciences (MIZPAN (Partner 16) is actively engaged in attracting a large-scale DNA-barcoding facility to Poland through EU structural funds. The taxonomic facilities of the Netherlands (NL-TAF) are also preparing a funding proposal for a central facility for this activity through national funds. Such centres would also manage the DNA barcode data, and link these data to associated metadata of the specimens and DNA, which will all be preserved. The action points are:

- Establish a core European facility for DNA barcoding in the Netherlands, equipped with high-throughput robotics for DNA extraction and sequencing, and a well-trained technical staff;
- Establish a permanent infrastructure for DNA biobanking which will provide Europe and the global scientific community with access to reference material;
- Conduct coordinated, systematic surveys of biological monitoring sites in critical ecosystems throughout Europe. These ‘sentinel sites’ will be part of a monitoring system for studying the long-term impact of global climate change and other human-induced impacts on the environment; and
- Build on the networks of databases, experts and research projects already underway, e.g. LifeWatch, with support of national research councils and the European Commission

to create a seamless data-sharing environment that connects the new “barcode factory” with users such as border inspectors, public health officials, agriculture specialists and the general public.

The strategy for doing so is:

- Convene a high-level Barcoding Council from EDIT and CETAF (www.ecbol.org)
- This Netherlands Core Facility will handle DNA extraction, sequencing, archiving and databasing on an industrial scale. Depending on the project, time constraints or legal issues, some or all steps of certain projects will be conducted in regional European Biobanks, with only the data and a subsample of the DNA being deposited in the Core facility
- Establish a network of European Biobanks, with facilities for DNA extraction, DNA banks, specimen archiving and databasing
- Create companion bioinformatics nodes at the Core Facility and regional nodes
- Convene a Users Council with representatives of different sectors (agriculture, environment, health, etc.) divided into interest-based subcouncils
- Design five-year barcoding initiatives within each subcouncil, drawing on existing collections in museums and herbaria supplemented by new collections
- Select sentinel monitoring sites and conduct ATBIs to establish biodiversity baselines

After initial investments, sustainable financing may be stimulated as follows:

- Regional (national) European and other international barcoding projects
- A portion of the structural budgets from the European partner institutions to be reserved for DNA barcoding activities via the European Core Facility situated in the Netherlands
- Industrial support linked to the products generated from the barcodes generated in phase one
- Selling barcoding products to industry, conservation agencies, agriculture, health organisations, etc.

SUMMARY AND CONCLUSIONS

1. This report is mainly based on three EDIT vision documents the EDIT BoD agreed on during the BoD workshop in Carvoeiro, January 2008 (Galey & Kriegsman, 2008). Additionally visions from the EDIT DoW, EC reviewers and the Science Symposium in Carvoeiro, January 2008 (Eekhout, 2008) have been taken into account.
2. Two infrastructure components could directly be extracted from EDIT vision documents: collections and lab facilities. Although not mentioned as physical institutions in these documents, libraries and archives linked to taxonomic collections have been included as a third infrastructure component.
3. The component 'collections' has been chosen to create a case study. For this component first decisions on its requirements and ways of realisation have been taken. However, this example revealed that there is not a single EDIT infrastructure with several components. Each component will act in its own as a network with its own structures and components and interacting with other networks in many different ways.
4. For each of the three infrastructure components strategic decisions and related requirements have been extracted from vision documents, possible obstacles and solutions have been concluded. The case study 'collections' showed that there are no clearly defined building blocks and options (yet) to agree on in order to develop an integrated infrastructure. Instead there is a set of individual decisions and steps to be taken on different strategic levels and with different outreach. The clearer, the more defined these decisions and steps are formulated, the easier and quicker implementation is supposed to be.
5. Upcoming steps in the process of designing an EDIT infrastructure - selection of a concept, designing components, creating prototypes to agree on and to sign MoU's on - still need to be worked out in detail. However, it becomes more and more obvious that MoU's will not be signed on complex infrastructure prototypes, but on well-defined details (structure elements) within each component (collections, lab facilities, libraries and archives). This might comprise agreed standards as well as shared facilities.
6. As mentioned by Galey & Kriegsman (2008), the discussion on demarcations needs further refinement and must lead to common strategic decisions on the level of the BoD soon. In this process emphasis has to be put on a common EDIT research strategy and stakeholders needs. Draft proposals of decisions to be taken might help to speed up the decision-making process of the BoD. In addition, BoD working groups, comprising a limited number of EDIT directors, may meet from time to time to work out details to be decided/voted on by all directors.

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ABBREVIATIONS

ATBI+M	All Taxa Biodiversity Inventories + Monitoring
BHL	British Heritage Library
BoD	EDIT Board of Directors
BRC	Biological Resource Centre
CDNL	Conference of Directors of National Libraries
CENL	Conference of European National Librarians
CETAF	Consortium of European Taxonomic Facilities
DoC	EDIT Directors of Collections
DoW	Description of Work
EC	European Commission
ECPA	European Commission on Preservation and Access
ERA	European Research Area
FSG	Future Scoping Group
GDZ	Göttinger Digitalisierungszentrum (Centre for Retrospective Digitization, Göttingen)
KB	Koninklijke Bibliotheek (National Library of The Netherlands), The Hague
MNHN	Muséum National d'Histoire Naturelle (Museum of Natural History), Paris
MNK	Museum für Naturkunde (Museum of Natural History), Berlin
MoU	Memorandum of Understanding
NHML	Natural History Museum, London
NL-TAF	Netherlands Taxonomic Facilities, including National Herbarium of The Netherlands, NHN, ZMA and CBS
NNM	Nationaal Natuurhistorisch Museum, Naturalis, Leiden
NoE	Network of Excellence
NPO	National Preservation Office, British Library, UK
NSC	Network Steering Committee
NVB	Nederlandse Vereniging voor Beroepsbeoefenaren in de Bibliotheek-, Informatie- en Kennissector (Dutch Association for Library, Information and Knowledge Professionals)
PAC	Preservation and conservation
SPECTRUM	Standard Procedures for Collections Recording Used in Museums
SPNHC	Society for the Preservation of Natural History Collections
STGO	Stichting Gemeenschappelijke Opleiding voor archief, bibliotheek, documentatie en informatiebewerking (Dutch company for training and education in the ICT sector)
TCR	Taxonomic Collection Repositories
TDWG	Taxonomic Database Working Group (now Biodiversity Information Standards)
TEL	The European Library
UKB	Universiteitsbibliotheken en Koninklijke Bibliotheek, Nederland (network of Dutch university libraries and the National Library of The Netherlands)
UvA-ZMA	Universiteit van Amsterdam, Zoologisch Museum Amsterdam
WP	Workpackage