CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

Twenty-first meeting of the Plants Committee
Veracruz (Mexico), 2-8 May 2014

Interpretation and implementation of the Convention

Trade control and marking

DEVELOPMENT OF A TIMBER IDENTIFICATION DIRECTORY FOR CITES-LISTED SPECIES

1. This document has been submitted by the European representatives (Mr Sajeva and Ms Clemente) on behalf of the European Union (EU) [*] in relation to agenda item 14 on "Review of identification and guidance material (Decision 16.59)".

2. It provides a summary of ongoing work by TRAFFIC to create a "Timber Identification Directory for CITES-listed Species" supported by the European Union (EU) and its Member States, with more detail on identification techniques and expertise, in addition to examples from the directory, provided in the Annex.

Background

3. In May 2013 the European Commission initiated a consultation amongst EU Member States, in keeping with Decision 16.60 c), to establish their main concerns and needs in relation to ensuring the successful implementation of the new timber species Appendix II listings agreed at CoP16. One principal issue highlighted by several EU Member States in their feedback related to the need for further support in identifying timber specimens in trade, in particular for enforcement purposes. It was suggested that the amalgamation of sources of information on institutes and experts able to identify CITES listed timber products could be particularly useful for this purpose.

4. The Commission consequently asked TRAFFIC to initiate the process and to start collecting available information on institutions with morphological or molecular timber identification expertise, details of experts in timber identification and tools/manuals available to help authorities with identification (Phase 1). It is intended that this information be brought together in the form of a directory/ directories, with the aim of providing this to all CITES Parties in the future (Phase 2).

Progress

5. TRAFFIC is currently working on Phase 1 of directory development and to date has contacted over 30 plant and timber specialists with wood anatomy (macroscopic and microscopic), chemistry, DNA and isotope expertise, across Europe, the US, Canada, Central America, Singapore and Australia. Phase 1 consists of the following four main Steps:

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[*] *The geographical designations employed in this document do not imply the expression of any opinion whatsoever on the part of the CITES Secretariat or the United Nations Environment Programme concerning the legal status of any country, territory, or area, or concerning the delimitation of its frontiers or boundaries. The responsibility for the contents of the document rests exclusively with its author.*

a) Consulting several experts in order to better understand the processes and any limitations associated with testing, in order to develop the best possible templates for information collection

b) Making initial contact with specialists to ascertain whether they have expertise in identifying the CITES-listed timber species, and if not who else to contact for further information

c) Asking experts to complete a simple table describing which CITES-listed timber species they are able to identify/have experience in identifying and the technique(s) they use to do so

d) Following up with experts (primarily over the telephone) to collect more detailed information on their testing capabilities, sample availability and institution information.

6. As this work was initiated in response to requests by EU Member States, to date the focus has been on collecting information on expertise held within Europe, with the exception of a few acclaimed experts and institutes based elsewhere. In addition to contacting specialists directly, a request for contact details of experts was sent out as part of the update to the 2013 CITES Experts Directory of the European Region for Plants.

7. With regard to the above Steps (a) to (d): Step (a.) has been completed and, depending on feedback received from those experts contacted; Steps (b.) to (d.) are underway or have been (near-)completed. The template for data collection is currently in Excel format. Table 1 in the Annex shows all institutes which provided at least some feedback (or in some cases where a third party provided information on their experience) and their respective timber identification expertise: wood anatomy, chemical, DNA or isotope analysis. Tables 2 and 3 show the type of more detailed information collected as part of Step (d), in addition to a completed example for one of the European institutes with wood anatomy and DNA expertise – Naturalis Biodiversity Center in the Netherlands.

8. Phase 1 progress was presented to participants of the EU Expert Meeting on CITES-listed tree species held in Brussels on 5th December 2013, where positive feedback concerning this first stage and the usefulness of such a directory was received. Participants recommended a summary of this work be presented to the CITES Plants Committee, for its consideration.

Considerations/Recommendations

9. In the context of Decisions 16.59 and 16.60, the Plants Committee is invited to note the information contained in this document and the Annex, including the need expressed by a number of EU Member States for a directory amalgamating sources of information on institutes and experts able to identify CITES listed timber products.

10. The Plants Committee is also invited to consider whether this document, its Annex and the directory presented are/will be of assistance in determining the current availability of timber identification material and increasing its accessibility to Parties.

11. In support of Decision 16.59 b and c), the Plants Committee is invited to make recommendations regarding the continued development of a comprehensive Timber Identification Directory for CITES-listed timber species.

Overview of timber identification techniques applicable to CITES-listed tree species

The four main techniques available for identifying the taxon involved and/or the geographical origin or source of CITES timber specimens in trade are wood anatomy (macroscopic and microscopic), chemical, DNA and isotope analysis. These approaches are being increasingly used to support timber traceability, certification, chain-of-custody and timber tracking systems and technology (RAFT, 2012; Seidl *et al.,* 2012). This Annex focuses on those most applicable to verification of specimens in trade for CITES enforcement purposes. It provides an overview of information on CITES-relevant timber identification expertise, research and progress collated as part of Phase 1 of the timber identification directory development. It aims to provide a basis for ongoing and future discussions, and not to provide an exhaustive list of references and projects, in this field.

A summary of each of the four techniques is provided, including information on how they work, their capabilities and limitations, and how they are/can be applied to timber identification and CITES species in particular. A selection of relevant publications, tools and/or information on research projects are also presented. The Annex concludes with an overview of timber identification directory development, format and content. It includes a list of institutes contacted during Phase 1 and their relevant expertise, and an example of more detailed information contained in the directory for one institute – the Naturalis Biodiversity Center in the Netherlands.

In addition to the information and references covering specific techniques/expertise outlined below, there are a number of publications and workshops that have discussed and reviewed the variety of knowledge and research in this area in recent years. They provide essential background information on how techniques can complement each other and their respective advantages and disadvantages, despite considerable progress in the use of chemical, DNA and isotopic techniques, and the number of species for which they have been tested and applied, since their publication. The content of three such publications are summarised below:

Degen (2008) ***Proceedings of the international workshop "Fingerprinting methods for the identification of timber origins" October 8-9 2007, Bonn/Germany***

Contains eight papers on the use of DNA analysis for tracing illegal timber and identifying the geographic origin of tropical timber; the history and potential application of stable isotope analysis to determine wood origin; and the first version of CITES*woodID* (computer-aided wood identification programme for CITES species).

Baas and Wiedenhoeft (2011) ***Wood Science for Promoting Legal Timber Harvest***

Special issue of the IAWA (International Association of Wood Anatomists) Journal containing proceedings of the June 2010 symposium on "Practical and Scientific Efforts to Combat Illegal Logging' held in Madison, United States (US) and additional contributions on CITES listed timbers (papers also published individually in IAWA Journal 32 (2)). It discusses advantages and disadvantages of using macroscopic and microscopic wood anatomy for identification and includes an atlas of wood anatomy of all then CITES-listed tree taxa. It covers the use of databases and programmes for wood identification, including 'InsideWood', the second version of CITES*woodID* and PL@NTWOOD (graphical identification tool for 110 Amazon tree species). It also presents the early work on "Machine Vision" (a tool for automating the timber identification process), the application and problems of DNA methods, and infrared spectroscopy to identify *Swietenia macrophylla*.

Von Scheliha and Zahnen (2011) ***Genetic and isotopic fingerprinting methods – documentation of the international conference, 3-4 November 2010 Eschborn, Germany***

Provides an overview of genetic and isotopic fingerprinting methods and project results testing their applicability for teak and mahogany species and at forest concession level in Cameroon. It includes reflections on these techniques from a variety of experts and discusses future plans and research.

Finally, this Annex focuses on identification expertise and capabilities and does not discuss sample collection protocols, "forensic-level" testing or the suitability of techniques depending on the product types to be tested (such as when non-destructive techniques are required for high value products). These are all very important issues to be considered, however. Ogden *et al.* (2009) highlight the need for method validation at each stage of the analytical process, from sample collection to data analysis and the requirement for wildlife DNA forensic analysis to be performed under equivalent quality assurance standards to those of human forensic genetics. The Society for Wildlife Forensic Science (SWGWILD), formed in 2011, brings together wildlife forensic science experts to standardize and promote best practices across diverse species and evidence types. SWGWILD has developed a set of Standards and Guidelines for wildlife forensic analysts of DNA and morphology. This document covers good laboratory practices, evidence handling and training, and critical considerations of phylogeny, taxonomy, and reference collections that are specific to wildlife forensic science (SWGWILD, 2012). Establishment of standards is also a principal consideration for the timber database and facility being developed by Bioversity International (see section on DNA below).

Wood anatomy

Identification of wood samples using anatomy is based on observations of three planes of the wood – transverse (face), radial (section) and tangential (surface), which provide a three-dimensional picture of the gross wood structure. Observed differences in structure between the various timbers can be described, attributed to certain characters, and used for wood identification with the help of reference material for comparison.

Wood anatomy can be analysed at microscopic and macroscopic levels. Traditional wood identification techniques using light microscopy are usually sufficient to identify a wood sample to the genus level, and in some cases also to the species level, however the precision with which a wood sample can be identified depends on how much and how accurate the supporting information is. Microscopic analysis is time-consuming and requires specialised equipment and reference material, in addition to considerable expertise, experience and practice (Gasson, 2011; A. Huitema, Customs Port of Rotterdam, pers. comm., 2013). Macroscopic analysis (relying on characters that can be observed or perceived with the unaided eye or a hand lens of approximately 10-fold magnification) can be quicker, require less specific expertise and be very useful for providing at least an indication of the taxon involved. However, final or definitive identification typically requires microscopic analysis, which offers a range of additional structural features for species recognition (Koch *et al,* 2011).

There are many public and private scientific institutes and experts around the world with the necessary equipment and knowledge to carry out microscopic wood anatomy analysis – those contacted during Phase 1 of the timber identification directory development are listed in Table 1. Many of these boast extensive wood collections - Index Xylariorum is an online directory of institutional wood collections from around the world, last updated in 2009 by the Royal Botanic Gardens (RBG) Kew, UK (Lynch and Gasson, 2010). In many cases individual samples are now being digitised and imaged, with information becoming increasingly available online on databases such as InsideWood (Wheeler, 2011) and institution-specific portals such as the Tervuren Xylarium Wood Database (H. Beekman, Royal Museum for Central Africa, pers. comm., 2014). Furthermore, the ongoing development of "Machine Vision" (see below) is resulting in the imaging of large numbers of wood samples held across the globe, initially focusing on Central America and Brazil (Gardener (2013).

Despite these developments, an overarching limitation to accurate wood identification through anatomy continues to be the lack of authenticated reference material currently held and shared amongst the world's xylaria (P. Gasson, RBG Kew, pers comm., 2013). Concerns over the lack of reference samples for newly CITES-listed Malagasy species in particular, has resulted in the development of several collaborative projects working on the taxonomy of *Diospyros* species in Madagascar and the collection of samples of around 300 species of *Dalbergia* spp. and *Diospyros* spp. (Sosa Schmidt, 2013a).

A number of identification tools, guides and other materials to aid identification of wood species through anatomical features have been developed for CITES-listed species, including Mahogany (White and Gasson, 2008) and Ramin (Garrett *et al.* 2010). Toolkits and training courses on identification of Mahogany and Cedar species, specifically aimed at enforcement officers have been developed by Brazil and Peru (Sosa Schmidt, 2013b) and Customs guidelines and posters on Mahogany, Afrormosia and Ramin have been developed by RBG Kew (Groves, M., RBG Kew, pers. comm., 2013). Broader publications on this topic include the CITES Identification Guide for Tropical Woods available in English, French and Spanish (Environment Canada, 2002) and translated into Chinese by TRAFFIC, and the "CITES I-II-III timber species manual", which deals not only with identification, but also with procedures for enforcement (USDA, 2006). More recent contributions include an update to the CITESWoodID CD-ROM (Richter *et al*., 2014) and the development of a prototype "Machine Vision" (Gardener, 2013) – more details on these two and other useful resources on CITES wood anatomy are provided below.

Gasson (2011) ***How precise can wood identification be?***

Covers identification challenges related to CITES-listed species, including Ramin (*Gonystylus* spp.), Brazilian Rosewood (*Dalbergia nigra*) and Agarwood (*Aquilaria* and *Gyrinops* species). Also discusses all other timbers listed in CITES Appendices in 2011 and some other taxa that are traded or confused with listed species and/or might in the future be protected by legislation.

Gasson et al. *(2011)* ***Wood anatomy of CITES-listed tree species***

Includes low- to high-power magnification light micrographs, illustrations and lists of diagnostic wood characters and features of all CITES-listed angiosperm and conifer tree taxa listed in CITES Appendices in 2011.

Wheeler (2011) ***InsideWood Database*** *(http://insidewood.lib.ncsu.edu/welcome)*

Internet-accessible wood anatomy (IAWA) reference, research and teaching tool developed by North Carolina State University, US, that contains anatomical descriptions of more than 5800 woods and 36 000 images of modern woods. Multiple entry key allows searching by presence or absence of IAWA features and serves as a virtual reference collection.

Richter et al. *(2014); Koch* et al. *(2008, 2011)* ***CITESwoodID CD-ROM***

Tool facilitating wood identification based on macroscopic features, developed at the Institute for Wood Technology and Wood Biology, Johann Heinrich von Thünen Institute, Germany, in the DELTA-INTKEY-System. Recently updated to incorporate all newly listed CITES species from CoP16, the database now contains descriptions and an interactive identification system for 22 CITES-listed wood species and 34 similar species which can be mistaken for CITES-listed timbers. Intended for use by inspectors and officials, but also useful wood anatomy teaching tool. Available on CD-ROM in four languages: English, German, French and Spanish.

Hermanson and Wiedenhoeft (2011); Gardener (2013) ***Machine Vision Automated Wood ID System***

Prototype Machine Vision (MV) Version 1.0 produced by the US Forest Service (FS) Forest Products Laboratory is a self-contained, portable unit that currently identifies wood samples of the commercial woods of Central America at a level equal to or greater than that of a typical person with one week of wood identification training. Uses advanced combinations of sensors and software to mimic and improve upon human perception of wood. Reference database being tested with additional wood samples located with partners across the globe and expanded to include Brazilian species.

Chemical analysis

Chemical identification of wood species is based on the presence or absence of specific compounds and/or variations in levels of certain compounds analysed through different mass spectrometry (MS) techniques, such as liquid chromatography-MS and "DART-TOF-MS" (direct analysis in real time time-of-flight), which can analyse solid samples. Chemical analysis has been used successfully to identify a number of CITES listed species such as *Dalbergia*, *Swietenia*, *Cedrela* and Agarwood species (Kite *et al.*, 2010; Lancaster and Espinoza 2012a, 2012b), and to differentiate between cultivated and wild-sourced specimens (Espinoza, 2014). The US Fish and Wildlife Service (FWS) Forensic Laboratory has reported significant progress with DART-TOF MS, with it currently being tested for several *Diospyros* species. DART-TOF MS allows analysis of solid wood samples, meaning that preparation time and cost is minimal. Once tests have been developed, DART-TOMS can test one sample every 10 minutes and can process 400 samples a day (E. Espinoza, USFWS, pers. comm., 2013).

Kite et al. *(2010)* ***Dalnigrin, a marker for the identification of Brazilian rosewood***

Liquid chromatography–MS used to identify a chemical marker for *D. nigra* heartwood – Dalnigrin, not detected in extracts of >50 other heartwood samples representing 15 species of *Dalbergia*.

Lancaster and Espinoza (2012a, 2012b); Espinoza (2014) ***DART-TOF-MS* – Dalbergia *and* Aquilaria**

DART-TOF-MS results found to be reproducible and provide good classifications useful for identifying unknown wood samples of *Dalbergia* and *Aquilaria*. Able to authenticate Agarwood species from samples of wood chips, sawdust, incense and liquids, and to differentiate wild from cultivated Agarwood and provide strong inference of origin.

DNA analysis

There are three main scientific approaches applicable to timber identification and tracking involving DNA analysis: DNA barcoding (developing genetic markers for species identification), population genetics/genographic mapping (country/area of origin) and DNA fingerprinting (identification of individuals) (Lowe and Cross, 2011; Geach *et al*., 2011). There has been rapid progress in this field over recent years, with pilot projects carried out in 2012-2013 resulting in tested methods being available for mainstream trade and enforcement services in 2014. Past concerns over DNA extraction from dried wood, older samples and processed products such as veneer, chipboards, plywood, cardboard and paper have been overcome in many cases (Degen, 2013; J. Geach, DoubleHelix, pers, comm., 2014).

DNA barcoding is relatively fast and cheap to develop for new species, however genographic mapping is a slower and more costly process (J. Geach, DoubleHelix, pers, comm., 2014). With international co-operation, it is estimated that genetic markers for an additional 20-50 tree species could be developed every year, together with genetic reference maps for two to five species (Degen, 2013). As for all techniques, however, progress is reliant on the availability of samples and developing comprehensive reference databases. Bioversity International is currently establishing a database managed from a regional centre in Kuala Lumpur with the aim of becoming a global repository for genetic datasets for numerous timber species (Geach *et al.*, 2011). Species to be included in the database are being prioritised according to criteria such as conservation status, trade and use levels, identification problems and existing sample collections (Ekue, 2013).

Following on from research into molecular identification of three select species, including *Fitzroya cupressoides* (Hanssen *et al.* 2011), the Centre of Wood Science of the University of Hamburg, Germany, has been working on developing DNA-markers for rapid identification of nearly 20 CITES-listed timber species and 40-50 similar taxa. Primer combinations have been developed for 35 taxa, including for *Gonystylus* and *Swietenia* species, which were validated in 2013 (Hajo Schmitz-Kretschmer, BfN, pers. comm. 2014). An ITTO-CITES pilot project to develop a DNA traceability system for *Pericopsis elata* in forest concessions and sawmills in Cameroon and Republic of Congo is also currently underway. It will include development of genetic markers for *Pericopsis elata* suitable for DNA fingerprinting and capacity building and training of local teams in DNA sample collection and storage (Sosa Schmidt, 2013b). Further examples of how DNA techniques can be applied to the identification of CITES-listed species and/or their populations, and other relevant projects, are provided in the publications below.

Nielsen and Kjæ (2008) ***Tracing timber from forest to consumer with DNA markers***

Describes different DNA markers and their suitability for tracing timber, challenges to extracting DNA from wood samples and the process and estimated costs for practical examples such as detecting the origin of and identifying *Swietenia macrophylla* logs. Based on a literature survey and the fingerprinting methods workshop held in Bonn (see above).

Odgen et al. *(2008)* ***Genetic identification of Ramin*** **Gonystylus** ***spp. timber and products***

Feasibility study, describing the development of a genetic assay resulting in a robust, cost-effective, transferable method for identifying processed Ramin. Addresses all steps required to develop a genetic identification assay for enforcement use; but notes that further work is required to produce a fully validated forensic identification tool.

Geach et al. (2011) ***The state of DNA technology for trees & wood products***

Describes progress in this area, the three main approaches involving DNA analysis applicable to timber identification and examples of projects and species to which these have been/are being applied, including large scale genographic mapping of *Swietenia macrophylla* and *Cedrela odorata* and genetic barcoding of 20 species in the African Congo Basin. It discusses the International Barcode of Life (iBOL) and Tree Barcode of Life (TreeBOL) initiatives, relevant DNA databases such as GenBank and the work of the Consortium for the Barcode of Life (CBOL) in relation to the development of international standards and protocols.

Degen et al. *(2013)* ***Verifying the geographic origin of mahogany with DNA-fingerprints***

Creation of a genetic reference database to determine the country of origin of *Swietenia macrophylla* wood samples, which includes genotypes from nearly 2000 trees sampled across the species range.

Isotopes

Isotope analysis is the identification of an isotopic signature or profile using mass spectrometry. For example, stable hydrogen, oxygen, nitrogen, carbon and sulphur isotopes found in water and soil can be analysed to identify an isotope profile for a geographic area. Samples taken from timber from trees previously growing in this area can then be traced back to the location by analysing the isotope profile. A precondition for using this method is that the isotopes of the respective region are already known, defined and registered (Boner, 2013).

Isotope analysis is already extensively used in the agricultural sector, for example to differentiate products grown in different fields, and has been increasingly tested for timber species in recent years.

For example, between 2008 and 2010, as part of a WWF funded project, Agroisolab in Germany looked into differentiating the origin of tropical timber such as teak and mahogany growing in Southeast Asia and Central America using isotopes (Förstel *et al.,* 2011, Boner, 2013). The Reston Stable Isotope Laboratory (RSIL) in the US has been carrying out isotope research on various rosewood species (T. Coplen, RSIL, pers. comm., 2013) and the UK Food and Environment Research Agency (FERA) on Malagasy species in particular (Cable and McGough, 2014).

Boner, M. (2013) ***Applications of stable isotopes for timber tracking***

Presents Agroisolab (Germany) isotope research in the agricultural sector and more recently for timber, including the development of reference databases for spruce, teak and Siberian oak, and combined isotope and DNA analysis in a Cameroon concession.

Cable and McGough (2014) ***Isotope analysis of* Dalbergia *and* Disopyros *species of Madagascar***

A collaborative proof of concept project involving Royal Botanic Gardens Kew, FERA and Madagascar National Parks, focusing on verification of the declared origin of Malagasy *Dalbergia* and *Diospyros* timber using Stable Isotope and Trace Element (SITE) fingerprinting.

Timber identification directory development, format and example

Over 40 institutes and experts were contacted as part of Phase One of the timber identification directory development. Table 1 shows all institutes which provided at least some feedback (or in some cases where a third party provided information on their experience) and their respective timber identification expertise: wood anatomy, chemical, DNA or isotope analysis.

As described under paragraph 5 of PC21 Doc 15, after an initial response was received, experts were contacted for more detailed information. This is currently being collated in an Excel template. For each institution/expert, further information on the following general subjects was requested: institution type and standards, identification expertise (techniques, test limitations, species, geographical scope), number and type of samples held, staff availability and skills, test turnaround times and costs, training experience, other relevant work/research or identification tools, contact persons and details, and additional experts to consult. Table 2 summarises the type of information collected under each of these subjects (excluding additional experts), in addition to a completed example for one of the European institutes with wood anatomy and DNA expertise – Naturalis Biodiversity Center in the Netherlands.

More specific sample and testing information was also collected for all CITES-listed taxa, and Table 3 provides an example of this sample and testing information, again for the Naturalis Biodiversity Center. The Excel template contains additional information on annotations and populations covered by the CITES listings in the equivalent sample and testing tables, however this information has not been repeated in Table 3 to enable better visualisation of the example provided.

(Tables in English only / Cuadros únicamente en inglés / tableaux seulement en anglais)

Table 1: Institutes with expertise in CITES-listed timber identification (contacted/having provided feedback to TRAFFIC prior to February 2014)

Country	Institute	Expertise			
		Anatomy	Chemical	DNA	Isotope
Australia	University of Adelaide			•	
Belgium	Laboratory for Wood Biology and Xylarium, Royal Museum for Central Africa	•			
Costa Rica	Forest Products Laboratory, University of Costa Rica	•	•		
Finland	Finnish Museum of Natural History, Wood Laboratory	(•)			
Germany	TÜV Rheinland Agroislab				•
Germany	Thünen Institute for Wood Technology and Wood Biology	•		•	
Germany	Centre of Wood Science, University of Hamburg	•		•	
Italy	National Research Council	•			
Poland	University of Warsaw Botanic Garden	•			
Mexico	Biology Institute, National Autonomous University of Mexico	•			
Netherlands	Customs Port of Rotterdam and Customs Laboratory	•	•	•	
Netherlands	Naturalis Biodiversity Center	•		•	
Singapore	Double Helix Tracking Technologies			•*	
Sweden	Swedish Museum of Natural History, Centre for Genetic Identification			(•)	
United Kingdom	Royal Botanic Gardens Kew	•	•		
United Kingdom	European Plant Science Laboratory	•			
United Kingdom	Food and Environment Research Agency				•
United Kingdom	TRACE Wildlife Forensics Network			•	
United States	National Fish and Wildlife Service Forensic Lab		•		
United States	Reston Stable Isotope Laboratory, US Geological Survey				•
United States	US Forest Service	•			

Notes: (•) Have expertise in this technique, however no direct experience with CITES-listed timber species
* Do not carry out actual testing, but work with partners to develop traceability systems

Table 2: Detailed information being collected on institutes and testing capabilities, including a completed example from the directory

Subject	Type of information being collected	Example - Naturalis Biodiversity Center, Netherlands
Institution type	*Government, Commercial, Research?*	Independent institute, partly government funded
Institution standards	*ISO Compliance, forensics, experience being expert witness?*	Internationally accepted methods are used when testing. Dr. P. Baas has carried out identifications for police and Customs officials. Can be expert witness, but not been called to court as yet, more likely for DNA barcoding work.
Expertise - techniques/ test limitations	*General description - morphological (anatomy, macroscopic, microscopic); molecular (chemistry, DNA, isotopes), any general test requirements/limitations*	Microscopic wood anatomy, using light microscopes and DNA testing. Anatomy - identification is harder than "confirmation", in the former case additional information such as geographic origin useful; need blocks of at least 1-5 cm ^{3}, where possible wood near the bark (sapwood), quality of wood sample not as important for anatomy as for DNA testing, but harder if damp and has been attacked by fungus. DNA testing - if very dried out, hard to extract DNA, better if fresh, project based on leaves.
Expertise - species/ geography	*General description - specific timber taxa/geographical expertise, CITES-listed species*	Historically wood/timber expertise in South-east Asia, but as three Dutch institutes have recently combined their collections in Naturalis, now also have timber samples from Africa and Latin America.
General sample information	*Have own collection? Number and types of samples held, happy to exchange?*	Now estimated to hold the largest wood collection in the world (110,000 wood samples), including all specimens from Leiden, Wageningen and Utrecht. Information currently being digitised will be available online in 2014. Most samples are wood blocks (plus 3 section slides when samples have been checked/ identified). Most are duplicated and are linked to voucher/herbarium specimens (not all in same institute). Happy to exchange samples, already do so, especially with duplicate slides.
Staff availability and skills	*How many staff, their availability and skills?*	2 staff with wood anatomy expertise, plus a PhD student, have technicians to section wood to help with preparations, and several technicians working in the DNA barcoding laboratory.
Test turnaround times	*Minimum/average/maximum time needed to carry our tests, under urgent and normal conditions*	Approx 3-6 weeks, depending on how many samples; urgent request 2 weeks minimum due to other staff commitments; basic anatomical wood identification is possible in 1 hr if it an emergency - resulting in yes / no / possibly answer.
Cost per test/sample	*Basic /range of costs - per sample, verification versus identification, reduced prices for non-commercial purposes/ for many samples?*	Wood anatomical identification ~EUR150 per sample, DNA analysis ~EUR240. For larger numbers, for instance in case of government research, prices may be adjusted.
Training	*Identification training experience/potential, for enforcement/other audiences?*	Not carried out regularly in the past, but able to for CITES-listed species. Have held hands-on workshops for Customs officials and Inspection teams of the Netherlands Food and Consumer Product Safety Authority (NVWA).
Other relevant work/ research, identification tools	*Publications, tools/guides developed, new/planned research, e.g. sample collecting trips, new tests for CITES-listed species?*	No plans for specific CITES-related work, expeditions to collect more samples are based on personal research goals (e.g. Malaysian Borneo). Inside Wood contains many photos of light microscope slides for comparison.
Contact persons and details		Frederic Lens (frederic.lens@naturalis.nl), Pieter Baas (pieter.baas@naturalis.nl), Barbara Gravendeel (barbara.gravendeel@naturalis.nl); Expertcentum front desk - expertcentrum@naturalis.nl; +31 (0)71 5687687 ,+31 (0)6 44193182

Table 3: Example of testing and samples information taken from the directory - Naturalis Biodiversity Center, Netherlands

Species/Taxon[1]	Common name	App.	Ann.	Samples held	Types and numbers of samples[2]	Anatomy expertise[3]	DNA expertise[4]
Abies guatemalensis	Guatemalan fir	I	A	NO		NO	NO
Aniba rosaeodora	Brazilian rosewood	II	B	YES	ca. 10 herbarium specimens	YES	NO
Aquilaria spp.	Agarwood	II	B	YES	224 specimens of 19 species, including herbarium specimens and wood samples	YES	YES
Araucaria araucana	Monkey-puzzle tree	I	A	YES	ca. 5 herbarium specimens, 1 fruit specimen, 3 wood samples	YES	NO
Bulnesia sarmientoi	Holy wood	II	B	YES	1 wood sample	YES	NO
Caesalpinia echinata	Brazil wood	II	B	YES	2 herbarium specimens	YES	NO
Caryocar costaricense	Ajillo	II	B	NO		NO	NO
Cedrela fissilis	Mahogany	III	C	YES	ca. 5 herbarium specimens, 14 wood specimens (1 wood slide), 1 fruit specimen	YES	NO
Cedrela lilloi	Mahogany	III	C	YES	2 herbarium specimens	NO	NO
Cedrela montana			D	YES	5 herbarium specimens, 2 wood samples	NO	NO
Cedrela oaxacensis			D	NO		NO	NO
Cedrela odorata	Spanish cedar	III	C	YES	ca. 100, including herbarium specimens and wood samples	YES	NO
Cedrela salvadorensis			D	NO		NO	NO
Cedrela tonduzii			D	YES	1 herbarium specimen, 2 wood samples	NO	NO
Dalbergia cochinchinensis	Thailand rosewood	II	B	YES	ca. 20 herbarium specimens, no wood samples	NO	NO
Dalbergia dariensis		III	C	NO		NO	NO
Dalbergia granadillo	Granadillo rosewood	II	B	NO		NO	NO
Dalbergia nigra	Brazilian rosewood	I	A	YES	no herbarium specimens, 4 wood samples	YES	NO
Dalbergia retusa	Black rosewood	II	B	YES	3 wood samples	YES	NO
Dalbergia spp.	Malagasy rosewoods	II	B	YES	ca. 60, including herbarium specimens and wood samples	YES	NO
Dalbergia stevensonii	Honduras rosewood	II	B	NO		NO	NO
Diospyros spp.	Malagasy ebony woods	II	B	YES	ca. 54, including herbarium specimens and wood samples	YES	NO
Dipteryx panamensis	Almendro	III	C	YES	1 wood sample	YES	NO
Fitzroya cupressoides	Alerce	I	A	YES	2 wood samples	YES	NO
Gonostylus spp.	Ramin	II	B	YES	We have samples, but not in the computer files at this moment**	YES	NO
Guaiacum spp.	Lignum-vitae	II	B	YES	ca. 54, including herbarium specimens and wood samples	YES	NO
Gyrinops spp.	Agarwood	II	B	YES	26, including herbarium specimens and wood samples	YES	NO
Oreomunnea pterocarpa	Gavilan	II	B	NO		NO	NO
Osyris lanceolata	East African sandalwood	II	B	YES	ca. 45 specimens, including herbarium and wood samples	NO	NO
Pericopsis elata	Afrormosia	II	B	YES	ca. 23 specimens, including herbarium and wood samples	YES	NO
Pilgerodendron uviferum	Pilgerodendron	I	A	YES	1 herbarium specimen, 1 wood specimen	YES	NO

Species/Taxon[1]	Common name	App.	Ann.	Samples held	Types and numbers of samples[2]	Anatomy expertise[3]	DNA expertise[4]
Pinus koraiensis	Korean pine	III	C	YES	7 cones, 2 wood specimen, no herbarium specimen	YES	NO
Platymiscium pleiostachyum	Quira macawood	II	B	NO		YES	NO
Podocarpus neriifolius	Yellow wood	III	C	YES	ca. 170, including herbarium specimens, wood samples and cones	NO	NO
Podocarpus parlatorei	Parlatore's podocarp	I	A	YES	3 herbarium specimens, 3 wood samples	NO	NO
Prunus africana	African cherry	II	B	YES	ca. 23 specimens, including herbarium specimens and wood samples	YES	NO
Pterocarpus santalinus	Red sandalwood	II	B	YES	4 herbarium specimens	YES	NO
Swietenia humilis	Honduras mahogany	II	B	YES	1 herbarium specimen, 1 wood sample	YES	NO
Swietenia macrophylla	Big-leaf mahogany	II	B	YES	ca. 40, including herbarium specimens, wood samples and fruits	YES	NO
Swietenia mahagoni	Caribbean mahogany	II	B	YES	ca. 30, including herbarium specimens and wood samples	YES	NO
Taxus chinensis	Chinese yew	II	B	YES	1 wood sample	NO	NO
Taxus cuspidata	Japanese yew	II	B	YES	ca. 20, including herbarium specimens and wood specimens	NO	NO
Taxus fuana	Tibetan yew	II	B	NO		NO	NO
Taxus sumatrana	Sumatran yew	II	B	YES	10 samples, including herbarium specimens and wood samples	NO	NO
Taxus wallichiana	Himalayan yew	II	B	YES	1 herbarium specimen and 1 wood sample	NO	NO

Notes:

1 - Current tree taxa used for timber (but not necessarily as their primary purpose) listed in CITES Appendices (App.) and/or EU Wildlife Regulation Annexes (Ann.), valid 02/10/2013

2 - The database used to check samples is not entirely complete; possibly have more specimens in-house, which will become clear when digitization is completed.

3 - All species marked 'YES' have been tested in the past within Naturalis using wood anatomy, all species marked 'NO' have not been tested in the past within Naturalis using wood anatomy, but if wood anatomy identification is possible to the species level, Naturalis has the expertise to do this.

4 - Naturalis has the expertise to develop genetic markers for specific species, however have only worked on *Aquilaria* until now (as suitable markers have been identified).

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