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Best Practice Guide for Forensic Timber Identification

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INTERNATIONAL CONSORTIUM ON COMBATING WILDLIFE CRIME

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Note

Operating and experimental conditions are reproduced from the original reference materials, including unpublished methods, validated and used as per the list of references. A number of alternative conditions and substitution of named commercial products may provide comparable results in many cases, but any modification has to be validated before it is integrated into laboratory routines. Mention of names of firms and commercial products does not imply the endorsement of the United Nations.

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Abbreviations

ASEAN	Association of Southeast Asian Nations
CBM	Coordinated Border Management programme
CCP	UNODC-WCO Container Control Programme
CCPCJ	United Nations Commission on Crime Prevention and Criminal Justice
CEN	Customs Enforcement Network
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CITES MA	CITES Management Authority
CoP	Conference of the Parties
DART TOFMS	Direct Analysis in Real Time, Time of Flight Mass Spectrometry
DNA	Deoxyribonucleic acid
EGM	Expert Group Meeting
GTTN	Global Timber Trafficking Network
IAWA	International Association of Wood Anatomists
ICCWC	International Consortium on Combating Wildlife Crime
IFSA	International Forensic Strategic Alliance
INTERPOL	International Criminal Police Organization
IRT	Incident Response Team
ITTO	International Tropical Timber Organization
LSS	Laboratory and Scientific Section
MLA	Mutual Legal Assistance
MLAT	Mutual Legal Assistance Treaty
NCB	National Central Bureau (INTERPOL)
NEST	National Environmental Security Taskforce
NIRS	Near Infrared Spectroscopy
PCU	Port Control Unit
QA	Quality assurance
QMS	Quality management system
SAWEN	South Asian Wildlife Enforcement Network
SHERLOC	Sharing Electronic Resources and Laws against Organized Crime portal
SLU	Sustainable Livelihoods Unit
SNP	Single nucleotide polymorphisms
SOP	Standard Operating Procedures
STR/SSR	Short tandem repeats/simple sequence repeats
SWFS	Society for Wildlife Forensic Science

SWGWILD	Scientific Working Group for Wildlife Forensic Sciences
TRACE	TRACE Wildlife Forensics Network
UNODC	United Nations Office on Drugs and Crime
WCO	World Customs Organization
WEN	Wildlife Enforcement Network
WEN-SA	Wildlife Enforcement Network–Southern Africa
WIST	Wildlife Incident Support Team

Contents

1. Introduction

Background

Illegal logging and the illegal timber trade are major problems domestically and internationally, threatening not just individual species, but entire ecosystems. The negative impacts are diverse, causing untold environmental, social and economic damage. Illegal timber trade fuels forest degradation and deforestation, causes harm to local communities, and deprives producer countries of billions of dollars in revenue.

The illegal timber trade is a complex issue, often involving multiple actors in multiple countries around the world. Illegal activities can occur at all stages in the timber supply chain and range in complexity from local illegal harvesting through to international and highly organized criminal syndicates with established commercial supply chains. Timber crime has all the hallmarks of organized and sophisticated crime, sharing many characteristics with other transnational criminal activities, frequently involving fraud, money-laundering, corruption, and counterfeiting.

There are very few mechanisms at the international level to combat illegal timber trading. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international treaty aiming to ensure that international trade in specimens of wild animals and plants does not threaten their survival. CITES regulates the trade in more than 35,000 species of plants and animals to safeguard certain species from over-exploitation by listing them in one of three appendices (I, II and III). From the initial 18 tree species listed in the CITES appendices in 1975, today more than 600 tree species are listed with over 400 used for their timber. One of the most challenging issues in the implementation of CITES is the definitive identification of specimens found in trade, which is required to demonstrate whether the activity is legal or illegal. For law enforcement authorities, identification is a necessary action that proves to be at the front-line of the global legal and illegal trade in timber.

The International Community has recognized the severity of the problem of global biodiversity loss and degradation of ecosystems and this is reflected in a number of recent conferences, resolutions and decisions. During the twenty-second Session of the United Nations Commission on Crime Prevention and Criminal Justice (CCPCJ) in April 2013, Member States strengthened the mandate of the United Nations Office on Drugs and Crime (UNODC) in the field of wildlife and forest crime by adopting a resolution on "Crime prevention and criminal justice responses to illicit trafficking in protected species of wild fauna and flora", which was subsequently adopted by the Economic and Social Council (ECOSOC Resolution 2013/40). The resolution encourages UNODC, in coordination with other members of the International Consortium on Combating Wildlife Crime (ICCWC),[1] "to continue its efforts to provide technical assistance to combat illicit trafficking in wild fauna and flora". During the twenty-third Session of the CCPCJ in May 2014, Member States specifically addressed the issue of timber crime by adopting the resolution "Strengthening a targeted crime prevention and criminal justice response to combat illicit trafficking in timber and forest products" (Resolution 23/1), which invites UNODC to strengthen "the development of tools and technologies for addressing illicit trafficking in forest products, including timber" and to "promote enforcement related to illicit trafficking in forest products, including timber".

At the sixteenth meeting of the CITES Conference of the Parties (CoP16, 2013), 177 governments voted unanimously to bring 293 new timber species under CITES control in order to ensure legal, sustainable and traceable trade in timber and non-timber forest products. A number of Decisions adopted at CoP16 encourage the increased use of forensic analysis to support the implementation and enforcement of CITES.

Building upon this political momentum, UNODC was given the lead, on behalf of ICCWC, for the development of a Guide to address the challenges posed by timber crime and provide support to law enforcement operations through the use of forensic technology and laboratory data.

The identification of evidence in criminal investigations can be achieved through the application of forensic science. Forensic analysis can significantly contribute to legal, sustainable and traceable trade in timber and non-timber forest products. Forensic analysis of timber can provide robust results, including the identification of the species and geographical provenance of the timber sample, when based on comprehensively validated methods. These methods can be applied to verify or refute species and/or origin declarations made by timber-traders, and as such, it is expected that the availability of this Guide will provide support to tackle the problem of illegal logging, mislabelling of timber species shipments, and smuggling of timber products. This information is also vital for the design of targeted law enforcement responses. It will help to ensure that resources are directed to those areas where illegal logging occurs and will support countries to combat the illegal trade in products of protected timber species more effectively. In addition, identifying where logging activities prove to be illegal assists countries in taking responsibility for the illegal activities within their borders, helping to promote international cooperation to address the problem.

[1]The International Consortium on Combating Wildlife Crime (ICCWC) is a partnership between CITES Secretariat, INTERPOL, UNODC, World Bank and World Customs Organization. ICCWC was formally launched in November 2010 at the International Tiger Summit in Saint Petersburg, Russian Federation. ICCWC partners united to deliver a coordinated and comprehensive approach to wildlife and forest crime.

Purpose and scope

In order to ensure that forensic data are credible and admissible in court, appropriate methods and procedures must be used throughout the entire investigative process, from the first inspection of a timber load, to timber sample collection and transport, analysis in the laboratory, and interpretation and presentation of results for prosecution.

This Guide is intended for worldwide use, with the aim of facilitating the employment of forensic science to the fullest extent possible to combat timber crime. This Guide covers the whole chain of events, providing information on best practices and procedures from the crime scene to the court room. The target audience ranges from front-line officers, crime scene investigators, law enforcement officials, scientists, prosecutors and the judiciary. The Guide, as a whole, represents a starting point for a uniform approach to the collection and forensic analysis of timber for identification purposes. It is hoped that the use of the Guide will lead to more timely, thorough and effective investigations, resulting in an increased number of successful prosecution and a reduction in the illegal timber trade.

Due to the varied, complex and highly technical nature of timber identification methodologies, this Guide does not provide step-by-step scientific processes for their application in the field or laboratory. Instead, this Guide focuses on the procedural aspects for obtaining robust identification outcomes suitable for presentation in court to support illegal timber trading prosecutions. A glossary of terms can be found in annex 1. Example resources detailing the required scientific methodologies are referred to throughout the Guide; however, as forensic timber identification is a growing discipline, resources cited here should be considered only as examples. To obtain a current picture of the available resources, a forensic timber identification expert should be consulted.

Wood can be processed in a myriad of different ways; it can be turned into pulp to make paper, powdered for traditional medicine, planed into extremely thin veneers, fixed together to make plywood or worked into high value objects such as musical instruments. The applicability of the various available timber identification methodologies can vary according to the wood material in question. To avoid confusion, this Guide focuses on the identification of solid timber only. An explanation of the various other wood products that may be encountered and considerations for obtaining forensic identification for these materials can be found in annex 2. Specific information about non-solid-timber wood products of CITES-listed tree species can be found in annex 3.

The provision of forensic services is affected by the legal framework in place and includes issues related to entering the crime scene, conducting the investigation, handling evidence, laboratory analysis and others.

The Guide is divided into four parts containing information specific to different audiences. They are collectively intended to provide integrated tools for gathering and processing evidence on timber crime and performing laboratory analysis in support of prosecution and for intelligence purposes. A full reading of the Guide will provide valuable insight and advance understanding of the forensic challenges facing each actor along the crime chain.

Part I provides information for law enforcement. It describes initial risk analysis and search guidelines for front-line officers. It advises on options for rapid-field identification and formulation of forensic questions. Guidance is provided on the collection and preservation of evidence, maintaining the chain of custody, including through transport of samples to the laboratory. It also advises on communication with the timber identification service provider.

Part II is aimed at scientists undertaking forensic identification tests or those who seek to do so in the future. Some information is also relevant to research scientists involved in the development of identification methodologies but who may not necessarily undertake forensic case work. The various methods of timber identification are summarized as an introduction to the associated disciplines. Resources for acquiring reference material and data are presented, and guidance is provided regarding laboratory procedural requirements for undertaking forensic work. It also advises on communication with law enforcement and communication of scientific results by an expert witness in court.

Part III is aimed at law enforcement, prosecutors and the judiciary. It is focused on appropriate considerations when preparing an illegal timber case for court. To facilitate understanding of identification methods and results by the prosecution and judiciary, simple descriptions of the relevant methods are provided. Key forensic requirements and specific legal considerations regarding the use of forensic timber identification services are discussed, and a final checklist is presented.

Part IV discusses the importance of international cooperation to tackle timber crime. It covers relevant international legal frameworks, which form the basis for cooperation between countries, and at the global level, the basis for regulation, communication, exchange of information and mutual assistance to tackle transnational organized crime. Information is provided on networks, mechanisms and tools available for countries and individuals seeking to obtain legal or scientific assistance from another country. It outlines some of the benefits, challenges and opportunities to improve cooperation, communication and collaboration internationally among and between legal and scientific communities.

Accompanying the Guide, a best practice flow diagram (as shown in figure 1) has been developed to lead front-line officers through the steps that should be completed when dealing with a load or shipment containing timber that is passing through a checkpoint such as an international border crossing. An online version of this flow diagram that includes dynamic links to additional resources can be accessed at: www.unodc.org/documents/Wildlife/Timber_Flow_Diagram.pdf

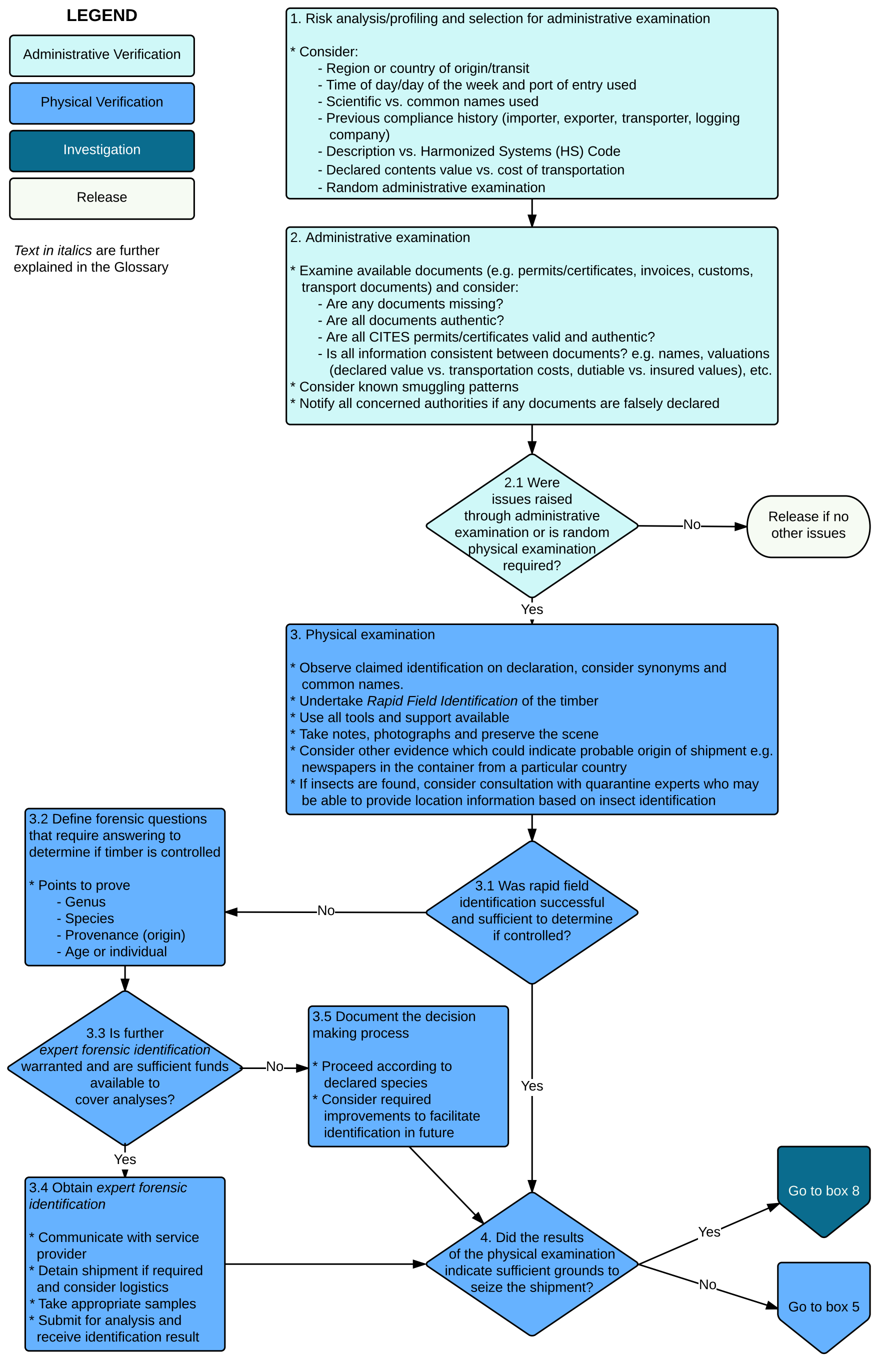
Part I. From search decisions to forensic timber identification: Information for law enforcement

Part I of the Guide is aimed at law enforcement practitioners to provide information on current and emerging technologies available for the forensic identification of timber, including how to decide whether to utilize a particular technology and the methods and approaches most suitable for obtaining robust evidentiary outcomes. This information is not necessarily exhaustive, and given the intended global audience cannot address every country's specific issue. The Guide as a whole represents a starting point for a uniform approach to the collection and forensic analysis of timber for identification purposes.

Law enforcement can include police, customs officers, detectives, and a range of authorities tasked with enforcing timber laws. In practice, customs organizations tend to most often encounter illegal timber as part of their routine work at border crossings. The guidance presented here includes information that may only be relevant in a customs context, such as risk assessments for incoming shipments. However, other information, such as the processes involved in taking samples and maintaining chain of custody, will be relevant in all law enforcement contexts. The information contained in part I may also be of interest to scientists, prosecutors and members of the judiciary, to provide insight and advance understanding of the challenges facing front-line officers who encounter a suspect timber load.

Part I of the Guide first presents a flow diagram designed to demonstrate best practice for law enforcement with respect to timber, and then covers in more detail: initial risk analysis; search guidance; rapid-field identification; formulation of forensic questions, collecting and preserving evidence, chain of custody, transport of samples to the laboratory, and communication with the timber identification service provider.

Figure 1. Law enforcement best practice flow diagram for timber



Glossary

Expert forensic identification: Scientific identification undertaken by experts according to strict standards; required for court proceedings; often a lengthy process; not always required to establish grounds for further investigation (see *rapid field identification*).

Rapid field identification: Tools and identification techniques available to non-experts; used to quickly establish a legal basis for intervention (e.g. seizure, provision of charging documents etc.); less accurate than *expert forensic identification* but adequate to establish grounds for further investigation.

2. Law enforcement best practice flow diagram for timber

The best practice flow diagram (see figure 1) indicates the steps law enforcement agents should follow when dealing with cross-border shipments of timber. The flow diagram represents the ideal case, and reality may dictate that actual processes need to differ to fit local conditions. The particular law enforcement personnel involved in undertaking each step may change depending on jurisdiction. If the inspection takes place at an international border crossing, these personnel will likely all form part of a coordinated border management programme (CBM). For example, customs may inspect shipments with police taking over cases that become criminal investigations; in other circumstances customs may only deal with document checking and other agencies undertake physical inspections. The flow diagram is designed to cover the general principles of dealing with timber at checkpoints and users should consider how each recommended step fits into their own organizational structure and division of responsibilities. In cases where there is any contradiction between the recommendations presented here and any local or national requirements, law enforcement officers must comply with the requirements of their jurisdiction.

Layout of the diagram

The flow diagram with all associated documents and links can be can be accessed at: www.unodc.org/documents/Wildlife/Timber_Flow_Diagram.pdf Where electronic smart devices are available for use by law enforcement, the flow diagram can be accessed in full as a pdf with dynamic links, removing the necessity for paper versions. The flow diagram itself, without dynamic links and associated documents (figure 1), covers two pages and is designed to enable printing on a single double-sided sheet of A4 paper that can be easily taken into the field by officers. It can also be printed on larger poster sized paper and mounted on office walls to provide a frequent reminder to staff but one which is not necessarily carried out of the office.

The flow diagram is separated into three distinct sections:

Administrative verification

Administrative verification refers to the document checking that must be completed prior to any physical examination or sampling of a timber load.

Physical verification

Physical verification refers to the process of checking whether the physical materials present in the shipment are consistent with the documentation and that all required documentation has been provided given the physical nature of the shipment.

Investigation

An investigation will begin if and when any inconsistencies or concerns are raised as part of the physical verification.

3. Initial risk analysis

Illegal timber can only be identified through appropriate intervention at some point in the timber supply chain. Customs, and other organizations that form part of a CBM programme are well placed to intervene as imported products are subject to verification processes, such as document checking and physical examination. To aid front-line decision making with respect to illegal timber, a best practice flow diagram has been developed (see section 2, figure 1, and: www.unodc.org/documents/Wildlife/Timber_Flow_Diagram.pdf).

Given the large amount of trade and the wide remit of most customs agencies, enforcement capacity is a critical limitation. Strategic risk assessments and trend analyses to determine which consignment should be subject to further scrutiny are therefore fundamentally important, along with random routine checks. In order to develop awareness with respect to the potential for illegal trade in wood products through certain checkpoints, the following should be considered:

1. Volumes of timber shipments passing through specific checkpoints (import, export and transit)
2. Areas from which and to where timber movements are made
3. Identification of the importers, carriers, brokers and/or exporters involved in timber shipments
4. History of companies and particular personnel involved, including data from previous audits and/or visits
5. The activities of relevant companies and personnel, what types of timber are thereby required or could be required
6. Listings of the timber species, along with the descriptions and product Harmonized System (HS) codes of material expected in shipments, considering the identified source countries (see point 2 above) and the type of timber required by relevant companies (see point 5 above)
7. The validity of CITES documents, which can be checked with the appropriate CITES Management Authority

CBM organizations should assess these sorts of information, along with other relevant intelligence to develop hypotheses regarding potential risks of illegal timber in shipments. These hypotheses should be tested by carrying out inspections (during import, transit, export, and storage, and/or stock) and risk profiles developed. Ongoing physical inspections should be used to refine the risk profiles over time. Some common risk indicators are described in annex 4. Specific details relating to timbers covered by CITES can be found in annexes 5 and 6. Since species may be added or removed over time under CITES, please also check on the CITES website for updates to the list, www.cites.org.

4. Undertaking a search

Once a shipment, load, premises or other area has been identified as warranting further scrutiny, a search needs to be undertaken.

Searches must be undertaken in strict compliance with all applicable laws, policies and procedures. Failure to adhere to correct protocols can lead to inadmissible evidence and jeopardize the entire case.

Personnel undertaking searches must be aware of the nature and purpose of the search and the evidence sought. Search officers are responsible for complying with the law and ensuring that they do not search beyond the statutory limitations imposed. They must remember that the power to search is limited to the extent that is reasonably required for the purposes of discovering and securing evidence [1]. Search officers must also fully understand their powers of seizure and powers to take samples.

Searches can include the search of containers and their cargo, vehicles or premises. The search method can vary according to the reason for the examination. Regardless, searches should be carried out methodically and thoroughly. Set procedures should always be followed when searches are conducted.

Some countries and organizations might already have comprehensive search guidance procedures in place that law enforcement officials could draw upon. Access to such search guidelines is often restricted to the law enforcement community. Broad considerations for law enforcement authorities engaged in different types of searches are included in annex 7 [1].

The inspection search must stop at the first indication of a crime, for example, when the first timber item is uncovered in a container, vehicle, etc. that should otherwise not contain wood, or when a rapid-field-identification result (see section 5) suggests potential criminal activity. Any further search activities should be conducted according to the appropriate protocols for criminal evidentiary searches, which may (depending on jurisdiction) require different personnel and approaches. Officers are encouraged to use the information contained in annex 7 to complement search guidance procedures that might be available to them through their respective organizations.

5. Rapid-field identification

As expert forensic identification of timber can be costly and time consuming (annex 8), to decide whether a particular timber load warrants expert forensic identification, front-line law enforcement officers need to be able to undertake an initial rapid-field identification. The results of this identification will be necessarily preliminary, and further definitive forensic identification will eventually be required to support a prosecution case. Initial rapid-field-identification needs to provide officers with enough information to indicate whether there is due cause to further investigate.

Pre-identification process

Timber loads selected for examination require rapid-field identification of a representative portion to determine if further forensic testing is necessary.

Once a load has been selected for further examination, it will be necessary to undertake some form of rapid-field identification to determine whether there is cause to warrant further expert forensic testing of the material. Timber loads can range from a single item to hundreds of whole logs and/or thousands of pieces of manufactured products. It is not always practical or necessary to undertake rapid-field identification of every item. Instead, the aim is to undertake rapid-field identification on a portion that is representative of the load or to target examination efforts to the most probable illegal subset of the load.

Only authorized personnel should be present; gloves should be worn; all activities should be documented.

Access of personnel should be limited at this stage so that materials are not unnecessarily disturbed, and care should be taken to ensure that every person handling the timber or wood pieces wears examination gloves to prevent introduction of trace contamination. All observations and steps should be carefully documented, including the time, date and personnel involved in any verbal approval processes required to instigate rapid-field identification.

All applicable laws and protocols for inspection, search and seizure must be followed.

Not every inspection of a timber load or container will warrant compliance with criminal evidence-collection procedures. In fact, the majority will not. However, all inspections should adhere to applicable national laws and organizational protocols for inspection, search and seizure. Failure to adhere to these requirements may render any evidence gathered inadmissible in court.

Video or photograph the load before moving anything, using only approved equipment, file storage and transfer methods.

As there is no way of predicting in which direction a case will turn at this stage, it is essential to ensure that the contents of the timber load or container are preserved as close to the state they were initially found as possible. Videoing the scene prior to search, such as with a camera or smartphone, is a good way of preventing allegations of items being moved or placed prior to any subsequent photographing. If videoing is not possible, still photographs of the intact shipment are recommended. Organizations may have their own policies procedures and protocols regarding how recording equipment and subsequent data can be used. Officers should always comply with these requirements.

Do not move anything unless it is necessary to reach parts of the load.

In cases where materials are packed or stored in such a way that access does not require unpacking the content, rapid-field identification (and any subsequent sampling for forensic analyses) should be completed without undue disturbance to the load.

If movement of the load contents is necessary, create a map linking back to the original arrangement.

When dealing with a truck carrying logs or planks, or a tightly packed container, unpacking is generally necessary to access all of the material. In these cases it is important to note how the load was packed so that specimens' original locations within the load can be identified, usually through a combination of video or photography (complying with local policies on the use of recording equipment and the storage and transfer of derived data), labelling, and the creation of a map of the unpacked contents linking back to the original arrangement of the load. Ensure that any labelling at this stage does not create permanent markings on the material, for example use tags or removable labels instead of permanent markers.

Undertake rapid-field identification of the material according to the method(s) available at the time.

There are a variety of methodologies available for rapid-field identification, and the most appropriate one in any given circumstance will depend on the resources available and the nature of the potential violation. The various options for rapid-field identification are described in the next subsection.

Where screening suggests possible criminal violation, inform relevant supervisor and/or investigators.

If rapid-field identification of a suspect timber load indicates that a possible criminal violation has occurred, the relevant supervisor should be notified and if appropriate, criminal investigators should be notified. If control of the investigation delegated to another staff member, any subsequent decisions in relation to the load should be made with the approval or at the direction of that staff member.

Methods currently in use for rapid-field identification of timber

Macroscopic wood anatomical identification by law enforcement

Timber identification through sectioning of the wood with a sharp blade and examination of the internal structure using a magnifying lens.

A variety of aids have been developed that describe the macroscopic anatomical features of a selection of timbers to assist law enforcement in the rapid-field identification of timber loads. These resources include manuals, interactive reference databases and posters, and they should be accompanied, where possible, by training programmes on their effective use conducted by professional wood anatomists. A list of these available resources can be found in annex 9. Examples of timbers from known species that may be frequently encountered at a particular checkpoint are another option for supporting front-line macroscopic wood identification. Officers can examine these real timber examples and compare them directly to the evidence. However, great care must be taken when obtaining such examples for reference, as an incorrect example can obviously lead to incorrect rapid-field-identification results. Example timbers should be checked by an expert wood anatomist before use to ensure correct identification. Choice of appropriate resources to aid macroscopic wood anatomical identification by law enforcement personnel should be made based on the regions of origin of loads that are encountered and/or the specific species or legislation that are of interest. More specific information on CITES-listed timbers and a range of lookalike species, which can be distinguished using macroscopic wood anatomy, can be found in annex 10. Information about the 100 most important timbers in trade, which can be distinguished using macroscopic wood anatomy, can be found in annex 11.

Given appropriate training and ongoing proficiency testing, wood anatomical identification by law enforcement can be a successful rapid-field-identification method. However, its feasibility as a complete solution in any one circumstance is inversely proportional to the scale of identification requirements that are likely to be encountered. For example, law enforcement agents trained to identify a small suite of species (approximately fewer than 10) that are the most commonly transported illegally through their checkpoint are likely to master these skills effectively and be able to meet most, if not all, of the rapid-field-identification needs encountered at their post. However, their ability to identify novel illegal timbers will be low. For international ports receiving global shipments, the accuracy achieved through the use of these tools alone is likely to be relatively poor, given the highly technical nature of wood anatomical identification and the extended training required to achieve proficiency. Some larger ports, such as Rotterdam, have dedicated CITES officers on call who are well trained in macroscopic wood identification of CITES species and their lookalikes. However, this solution is only likely to be cost effective for large international ports and only covers identification of CITES-listed species.

Macroscopic wood anatomical identification by an off-site expert

Timber identification through close-up photography of the structure of the wood, sent electronically (e-mail/SMS) to a professional wood anatomist who returns the identification result to law enforcement.

Front-line law enforcement personnel can be trained in image capture suitable for macroscopic wood anatomical identification. Photographs of suspect timber products are then transmitted electronically to a laboratory where rapid-field identification of these images is then undertaken by expert wood anatomists who can identify the timbers macroscopically and indicate which need to be sampled for further forensic identification. Rapid-field-identification decisions can be made as quickly as possible by trained experts and transmitted in real time to the front-line staff that can enforce the decision. Additional information observed by the front-line officers can also be of value for rapid-field identification and can be provided to the off-site expert along with the photographs, such as the smell and/or overall colour of the timber, as well as information on any other foliage or insects that may also be in the load.

The equipment required at the point of rapid-field identification is minimal: just an appropriate camera set-up able to capture macroscopic anatomical images and the means to transmit these images securely to experts and receive decisions in return. Some skill is required to capture the images correctly, but this can be acquired relatively easily and inexpensively when compared to the skills required to make anatomical identifications. Without the need for experts to be on-site, a relatively small pool of experts can service a relatively large area. Options for development of this approach should be discussed with local and/or regional wood anatomical experts. An example of this approach is provided in the references [2].

Detector dogs

Timber identification through the use of trained detector dogs who recognize the scent of certain timbers.

The use of detector dogs for rapid-field identification of timber can be very useful for particular species of concern, specifically those under CITES regulation. However, a dog can only confirm if it detects the odour of a substance to which it has been trained to respond; it cannot determine the identity of other substances. As such, the use of detector dogs can augment the tool kit of law enforcement personnel, but cannot fulfil all timber rapid-field-identification needs. There is no set limit to the number of targets a dog can be trained to detect, but 12-15 is considered a reasonable suite of odours for any one particular dog given the time required for ongoing training to preserve efficacy. Additionally, the intensity of odours and frequency of their presentation can impact on a dog's willingness to seek them out. Rare and faint odours can be ignored by the dog in favour of stronger more common ones. Guidelines for the training of dogs to detect wildlife in trade have been developed and a pilot project was undertaken to assess the feasibility of using detector dogs to identify specific timbers. Information is provided in the references [3].

Methods currently under development for rapid-field identification of timber

There are currently two automated methods under development to assist in the rapid-field identification of timber. At the time of publication, these methods were not widely available for use by front-line law enforcement officers, but it is hoped that in the coming years they will be. The methods are automated macroscopic wood anatomical identification (otherwise known as "machine vision") and near infrared spectroscopy (NIRS). Further information on these methods can be found in annex 12. Although not yet rolled out for use by law enforcement for rapid-field identification, these methods are appropriate for use by experts as forensic identification tests in some circumstances (see annex 8).

Results of the rapid-field identification

If the results of the rapid-field identification are inconclusive, law enforcement will need to make a decision regarding whether there is due cause to pursue expert forensic timber identification in the absence of field identification. This decision is completely at the discretion of the law enforcement agency and may be influenced by circumstances such as:

- The strength of the non-timber evidence that indicates potential illegality
- The resources and time required to utilize an appropriate forensic timber identification service

- The availability of a suitable forensic identification service
- The suitability of available forensic identification services for the specific question(s) at hand

If a rapid-field-identification result is consistent with the declared items and all other aspects of the load and its transport are in order, there is usually no reason to pursue further forensic identification. In certain circumstances, however, there may be sufficient reason to move to expert forensic identification even where the declaration and rapid-field identification are consistent. For example, rapid-field identification confirming a genus that is consistent with the declaration (e.g. declared *Dalbergia spruceana* returns a positive rapid-field identification of timber from the genus *Dalbergia*), but that genus also contains restricted lookalike species (e.g. *Dalbergia nigra*) or there is other evidence to suggest that the shipment may have originated in an area of high risk for illegal timber (e.g. Madagascar, where all *Dalbergia* species are CITES restricted from export). Again, these decisions are at the sole discretion of law enforcement.

Where rapid-field identification does indicate a CITES restricted species or genus containing one, officers should check whether the part or derivative of timber they are dealing with is covered by an annotation, in which case there may be no CITES violation. See CITES Resolution Conf. 10.13 (Rev. CoP15) for further information, available at cites.org/eng/res/10/10-13R15.php.

Violations may be CITES related or could be associated with other local or national laws. Officers should familiarize themselves with the specific laws applicable in their jurisdiction.

6. Formation of the forensic questions

Where the results of rapid-field identification of timber indicate that further investigation is warranted, officers must spend some time considering exactly what information they require to proceed with their investigation.

Before requesting forensic testing, confirm the suspected offence and information required to determine if a crime has been committed.

Before expert forensic timber identification information can be obtained, it is first necessary for law enforcement to determine the exact nature of the forensic questions they need to answer. In order to do this, the following information is required:

- The outcome of any rapid-field-identification procedures
- Whether the species and product are listed under CITES (considering any relevant annotations) or protected nationally

- The suspected offence including the relevant Act and Section
- The level of identification required

Case study A is a simple example of this information in a fictional situation.

Case Study A

- Detector dogs indicated a positive result for ramin in a timber load.
- Ramin (*Gonystylus* spp.) is listed in appendix II of CITES and no annotations exclude timber material.
- Importing or exporting CITES species without a permit is an offence under national law.
- The entire genus *Gonystylus* is listed in appendix II so genus level identification is sufficient to prove the point of law.

This information facilitates the determination of the following forensic question:

> "Is the wood material sampled from shipment X from the genus *Gonystylus*?"

Case study B is a more complex example of this information in a fictional situation.

Case Study B

- Rapid-field identification using macroscopic wood anatomy by front-line law enforcement suggests that a timber load of sawn wood contains *Dalbergia*.
- Risk profiling of the trader suggests that they have a history of trading in Madagascar.
- The shipment is claimed to be *Millettia laurentii* originating from Cameroon.
- All *Dalbergia* from Madagascar are listed in appendix II of CITES (and have a zero export quota).
- *Dalbergia nigra* is listed in appendix I of CITES.
- Several other *Dalbergia* species are listed on appendix III of CITES.
- Importing or exporting CITES species without a permit is an offence under national law.
- National legislation requires correct species declaration on all imported timber.

This information facilitates the determination of the following forensic questions:

> "Is the wood material sampled from shipment X from the genus *Millettia*?"
>
> "If the wood is not from the genus *Millettia*, is it from the genus *Dalbergia*?"
>
> "If the wood material is of the genus *Dalbergia*, does it originate from Madagascar?"
>
> "If the wood material is of the genus *Dalbergia* but does not originate from Madagascar, is it a protected species?"

Develop a set of forensic timber identification questions and discuss how these can be answered with timber identification service providers.

Discrete sequential questions that each focus on one aspect of an identification requirement are more useful than a single complex question. All forensic timber identification requirements can be broken down into the need for information in one or more of the following areas:

- Genus (or higher level taxonomic identification) of the evidence
- Species of the evidence
- Geographic provenance of the evidence
- Age of the evidence
- Individual from which the evidence originates

It is unlikely that all questions will need to be answered in any one case. The specifics that apply to the case at hand will need to be determined by the investigating personnel. Timber identification service providers will be able to advise which levels of identification are possible with current scientific knowledge (see annex 8 for details of which forensic identification methods may be able to answer specific identification questions). Investigators can then assess whether the available information is of use to the investigation. For example, in Case Study B, wood anatomists could identify the genus of the shipment. Chemical analysis could be used to determine whether any *Dalbergia* originated in Madagascar and may also be able to determine species if non-Madagascan origin was determined. Even when the capacity to answer the full suite of questions is limited, pursuing expert forensic identification to the level available can still be of use. For example, if a genus other than *Millettia* was identified through wood anatomy, the trader would have been proven to have broken the law requiring correct species declaration for imports.

Consider other evidence that may prove specific points such as geographic origin determined through paperwork, or other materials in shipment.

If a positive genus or species level identification is obtained for a protected species, but there are no tests available to identify provenance, investigators may deem their case sufficiently strong as to proceed anyway with other evidence to prove the geographic origin of the shipment. For example, in Case Study B, other documentation or evidence associated with the shipment may have been sufficient to prove a Madagascan origin, in which case forensic geographic region of origin identification would be unnecessary. Additional biological material evidence, such as insects, can also assist in determining the geographic region of origin in some instances (see section 7 on collecting and preserving evidence).

7. Collecting and preserving evidence

After rapid-field identification has indicated that an investigation should be opened (see section 5) and appropriate forensic questions have been formulated (see section 6), law enforcement must decide whether to seize the load and await the results of expert forensic timber identification. If the decision is made to go ahead with the seizure and seek forensic testing, officers need to collect evidence samples that can be sent to service providers.

The collection of timber samples as evidence that will later be subject to expert forensic testing must adhere to the relevant organization's evidence-collection procedures.

Any staff members tasked with collecting samples should be appropriately trained, equipped and operating under the direction of the person in charge of the investigation or a crime scene officer. Chain of custody is vital in demonstrating the integrity of the exhibit (see section 8). Where feasible, consideration should be given to appointing a dedicated staff member to be responsible for all samples that have been collected. That staff member should be responsible for sealing any sampling transportation container(s) and providing the documentation and/or chain-of-custody forms (see annex 13) that accompany the samples to the laboratory.

Aim to collect samples from a portion of the shipment that is representative of the timber seized, following the procedures outlined.

The following procedure is a suggestion. Each investigation team may determine which procedure it should follow based upon the circumstances, such as the level of training of staff, weather conditions, stability of the load, safety of staff and other considerations. The following procedure assumes there is a large load of timber that requires unpacking and addresses common issues that occur when sampling.

As with rapid-field identification, it is not always practical or necessary to sample every item for laboratory analysis. Instead, the aim is to collect a portion that is representative of the timber seized, maximizing the chances of including samples representative of all locations in the consignment. Specifically, for expert forensic testing, the sampling must be conducted in a way that does not give the appearance that it was subjectively designed to mischaracterize the load. This Guide focuses on the procedure for choosing sampling locations, the physical sampling requirements for large-scale timber seizures and the challenges posed. However, the same techniques can be applied, as appropriate, to small-scale seizures and consignments of timber—although these may not require unpacking of the load.

Preparing the work area

Prepare a secure, dedicated work area of adequate size with required facilities to sample timber.

Prior to sorting and sampling the timber or wood pieces, a dedicated work area must first be set up. This work area should be:

- Cordoned and secure; no unauthorized persons should be in this area
- Sufficiently large to lay out all the wood to be sampled
- Protected (e.g. from rain, sun and wind)
- Connected to an electricity supply for electric drills, lighting, etc. (optional)

Recording information

Throughout sampling maintain accurate field notes.

Throughout the entire process of timber seizure and analysis, documentation and recording of information is crucial. For the sampling procedure, detailed recording of information is essential and should be organized at the outset. When possible, one officer should be assigned exclusively to take notes and assign/record sampling numbers.

Information can be recorded in officers' notebooks or on dedicated forms as stipulated in the relevant organizations' policies, procedures and protocols. If in doubt as to the correct format, officers should consult their supervisor. Note-taking, record-keeping and crime scene documentation are thoroughly discussed in basic evidence gathering and forensic literature.

An officer should record the following information:

- Date, time and location of data recording
- Title of the case
- Name of person recording the data, their agency and contact details
- Date, time and location of seizure
- Name of person who carried out the seizure, their agency and contact details
- Additional information on circumstances of seizure

Video or photograph the load before moving any items, using only approved equipment, file storage and transfer methods.

Videoing the scene prior to sampling, such as with a camera or smartphone, is a good way of preventing allegations of items being moved or placed prior to any subsequent photographing. If videoing is not possible, still photographs of the intact shipment are recommended. Organizations may have their own policies, procedures and protocols regarding how recording equipment and subsequent data can be used. Officers should always comply with these requirements.

Conducting a timber inventory and selecting products for sampling

Conduct and record a thorough timber inventory following all required national and local procedures; ensure all officers coming into contact with the load wear gloves.

A timber inventory allows the investigating officers to record a full picture of the shipment seized, which can be extremely important later in the investigation. A timber inventory facilitates estimations of timber weight and volume, which are critical for correctly characteriszing the offence and recording accurate information for reporting purposes (e.g. to CITES). The timber inventory also allows the results from any expert forensic timber identification tests undertaken on samples to be referenced back accurately to the load in its entirety, and it provides a framework to help ensure that all steps are conducted in the proper order.

Every person handling the timber or wood pieces, even at the inventory stage, should wear examination gloves. As the load is unpacked (if this is required), a load map should be created that links back to the original arrangement of the load.

Examine all the timber and wood pieces found in the load. Determine if all the timber or wood appears to be the same colour, grain and texture (in cases where there is a large number of wood pieces, this step might not be feasible). When examining a container shipment, quite often contraband is found toward the back of the container with legal products closer to the entrance. A change in the type of wood or appearance within a container is an indication of possible illegality.

Complete an inventory of the timber, details of which can be found in annex 14, along with an example form.

Select for sampling at least one item from each group.

Once a timber inventory has been completed, the various different types of timber or other products within the load will have been organized into groups of like-items, e.g. group 1 (G001) may contain unprocessed logs, group 2 (G002) may contain planks, and group 3 (G003) may contain picture frames. The officer should now select which items from the load should be sampled for expert forensic timber identification.

At least one item from each group should be chosen for sampling. If the wood is all the same in appearance and shape, consider taking one piece from each defined shipping pallet or box and from different locations in the shipment.

Assign and record a unique item number for each item to be sampled.

Give each item to be sampled a unique number; this may have already occurred when the load was unpacked and items were selected for rapid-field identification. If a unique number has already been assigned to an item, be consistent with its usage and do not assign additional numbers to items.

Writing, scratching or painting on samples by the officers can reduce and jeopardize their evidential value so should be avoided where possible. However, when cataloguing large timber seizures, marking logs is generally required. The marks should be consistent and easily identifiable. If working with valuable finished products, avoid the use of permanent markers, which can severely diminish a product's value. Instead, use removable tags or labels (but ensure that they are securely attached so as not to be accidentally removed).

Photograph and record the details of each item to be sampled, using only approved equipment, file storage and transfer methods. Add details of sampled items to the load map.

Record all information related to the item and subsequent sample either in the officer's notebook, on an appropriate form (see example in annex 14, part C) or other dedicated method as prescribed by the relevant organization.

Photograph each item after it has been numbered according to the policies, procedures and protocols of the relevant organization. At each point on the load map from where an item was taken, mark the corresponding unique item number. Reference to the original load map is important as it allows officers to:

- Accurately document the precise location where each evidence item was collected and the relationship of these to one another
- Illustrate sampling was representative of the wood material being identified
- Prevent data loss in instances of camera or camera card failures

Preventing cross-contamination of samples

Take appropriate measures to prevent cross-contamination, such as wearing examination gloves, separating samples and cleaning equipment.

Protective measures are necessary to prevent cross-contamination of samples. Failing to implement these measures can lead to irrevocable contamination of the samples, which could misdirect investigators or laboratory technicians and adversely influence the final result of analysis. Cross-contamination may even prevent the solution of the case or result in misidentification of the wood. Whist the possibility of cross-contamination of a plank of wood from an ungloved hand may seem remote, the potential difficulty in explaining a failure to follow recognized sampling procedures may create doubt about how careful investigators were in other aspects of the investigation. To prevent contamination the following should be considered before sampling begins:

- Immediate segregation and packaging of samples (e.g. in separate containers or bags)
- Wearing and changing examination gloves for each activity
- Cleaning sampling equipment between samples or using different sampling equipment for each sampling event
- Storing bulk goods and trace exhibits separately at all times (including transfer to and from the forensic science service)

Cutting the sample

Follow the guidance below to cut standard samples or consult with the laboratory and the prosecutor to consider alternative non-destructive sampling

methods for very high value items.

If dealing with a finished product or a very valuable piece of timber, seek the least intrusive method of sampling. In some cases, the sampling process may disfigure, destroy or otherwise decrease the value of the item. In such cases, consult with the laboratory and the prosecutor to consider alternative methods of sampling before proceeding. Depending upon the country, if it is determined after the investigation that there was no violation of law, the owner of the item may seek compensation. In such cases, the issue of how reasonably the sampler acted and whether other authorities were consulted could become important.

For most forensic analyses, a simple physical cutting procedure is sufficient, but care should be taken to ensure that the sample is taken from the correct area of the timber depending on the type of analysis sought (see table 1). If there is any uncertainly about the required sample size and type, an appropriate expert should be consulted to determine the exact requirements.

Table 1. Details of how many samples and area of timber to sample for each queried item for forensic timber identification, depending on methodology.

Identification method	Number of samples required from each item	Area of timber to be sampled
Wood anatomy	1	Heartwood preferable, sapwood acceptable, avoid first 5 cm under bark where possible.
Dendrochronology	1 stem disk; or 2-3 increment cores	A stem disk preferred, or increment cores (in the direction of bark to pith). If boards are encountered, a piece of wood on which you can see the maximum number of tree rings is recommended.
Mass spectrometry	1	Heartwood
Near infrared spectroscopy	1	Anywhere
Stable isotopes	1	Anywhere
Radiocarbon	1 increment core; or 2 small blocks	Increment core preferred (from bark to pith) covering 5-20 rings (ideally >10); two small blocks should include one from outermost surface and one from 5-20 rings in (ideally <10). If collecting two samples, photograph and/or count the number of unsampled rings between samples. You must indicate which sample comes from where in the original item.
DNA analyses	1	Anywhere

When choosing an area of timber to sample, the following should be considered:

- Any specific requirements for the particular identification method to be employed (see table 1)
- Selection of an area that is representative of the timber type being sampled, i.e. avoid discoloured or structurally compromised areas as they may result from a wood treatment or pathogen infection that could complicate identification and/or pose a biosecurity risk for transport of samples to externally located laboratories

Sampling can be quickly achieved by cutting off the end of a plank of wood with a small saw, producing a sample somewhere between the size of a "sugar cube" and a "cigarette packet".

Cutting a sample using a hack-saw, hand-saw or other kind of saw can be appropriate when you have planks of wood or timber products that are otherwise relatively easy to sample by cutting off a small piece somewhere between the size of a "sugar cube" and a "cigarette packet" (see figure 2a). Before sampling begins using this approach, it is important to check when the forensic identification method you intend to employ requires a sample (or samples) from a particular plane (such as dendrochronology and radiocarbon, see table 1). In such cases, it will generally be more appropriate to use a coring method (see below). Sawing manually also requires no electricity, which can be an important consideration in some circumstances.

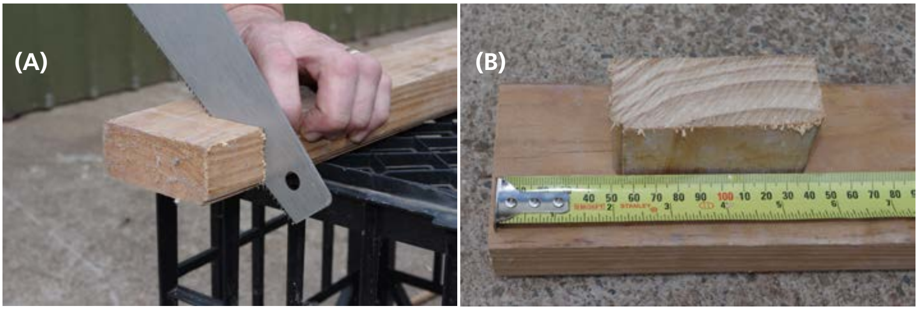


Figure 2. Demonstration of basic sample cutting with a hand saw (A) and resulting sample size (B).

Photo: Eleanor Dormontt.

Samples can also be acquired easily and quickly through use of a drill attachment capable of taking cores. This method works particularly well with dry timber, but results are more variable in wood with a higher moisture content.

Samples can be obtained relatively easily through use of a hand drill and attachment capable of taking cores. This method is more universally appropriate as it can be used on all items that are suitable for sampling with a saw (see above) but it is also capable of taking small samples from large logs and taking increment cores suitable for dendrochronological and radiocarbon analyses (see table 1). Sampling in this manner requires electricity, which can be a limiting factor in some circumstances; however, a cordless drill can be used, which can be charged off-site. A high moisture content in the wood (as found in many "raw" logs prior to processing) can have a negative impact on drill performance and prevent straightforward sample collection with this method.

When using a drill and core attachment to take samples:

- Sampling along the grain is easier and therefore generally the preferred option.
- Sampling from the end grain is technically more problematic but may be the preferred option when access for sampling along the grain is difficult.
- Where possible, efforts should be made to minimize the damage caused by sampling to the overall product, such as by sampling logs or planks near the end or base, or by sampling finished products from an area that is out of sight.

For taking samples along the grain, hole-saw attachments (figure 3a) and dowel-and-plug cutters (figure 3b) both work well. For taking samples from the end grain, a dowel-and-plug cutter is required (figure 3b). Where a sample has been cut, but remains attached to the body of the item once the drill has been removed, a simple tool can be hammered into the cut groove and used to lever the sample free (figure 4). For dowel-and-plug cutters no pilot drill is used, and hence, use of a plastic guide affixed to the wood prior to sampling is recommended to make a safe start and prevent skidding (figure 5).

Considerations for choosing an appropriate drill and bit for taking timber samples:

- Drill bit design should allow for ease of sample separation from the drill.
- Where possible, drill bits should be suitable for keyless chuck use for ease of use and safety.
- Where possible, the drill should be cordless for ease of use.
- The power of the drill should be at least 800 W where possible.
- The cutting surface of the drill bit should be durable.

Figure 3. Example drill bits suitable for taking timber samples: hole saw (A); dowel-and-plug cutter (B).

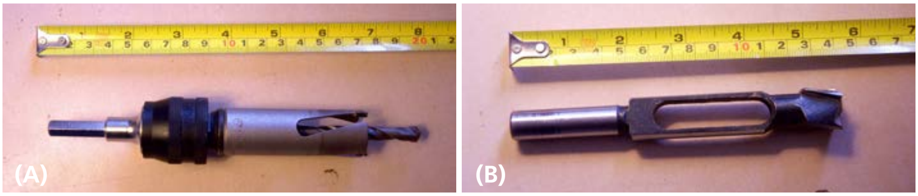


Photo: Samplexx, Kingsley Barraclough.

Figure 4. Example tool suitable for levering cut sample away from body of timber. The short, flat edge of the tool can be hammered into the cut groove once the drill bit has been removed and then used to lever sample away from the item.

Photo: Eleanor Dormontt.

Figure 5. Example plastic guide affixed to timber sampled with the dowel-and-plug cutter to make a safe start and prevent skidding.

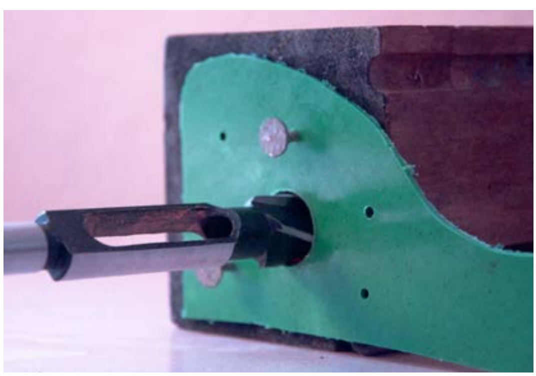


Photo: Samplexx, Stephen Kenny.

- For hole saws, a pilot drill is required, and 120 mm is the recommended size.

Stem disks can be obtained using a hand saw for small diameter logs and an electric saw can be used for larger diameter logs.

Sampling to produce a stem disk can be an option for dendrochronological and radiocarbon analyses (see table 1). A stem disk is a cross section of a log (see figure 6). Sampling a cross section can be relatively easily achieved for small diameter logs by using a hand saw. For larger logs, larger electric saws may be required (e.g. band saw, circular saw or chain saw). Large samples can present logistical and financial difficulties with respect to transport. It is recommended that officers liaise directly with their forensic identification service provider in cases where a stem disk

may be required.

Figure 6. Stem disk of *Pericopsis elata* from the Democratic Republic of the Congo.

Photo: Royal Museum for Central Africa.

Sampling non-wood biological evidence

When sampling timber items in a container, any other organic material, such as vegetation, mould, dirt/soil or insects, should also be documented, photographed (using only approved equipment, file storage and transfer methods) and when possible, collected as evidence. If these materials trigger a phytosani-

tary violation, follow appropriate local protocols.

Additional biological materials can assist in the taxonomic identification of timber, as well as in determining its geographical origins. Sampled leaves and other dry vegetative material can be stored in the same manner as wood evidence without additional preservation. Any wet or moist vegetative materials and all dirt/soils samples must be preserved with an appropriate desiccant (e.g. silica gel) before shipment to the forensic identification facility. Potentially invasive or pathogenic materials, such as insects or moulds, should be preserved individually in sealed containers with a 70 per cent ethanol solution. Collection of live insects for evidence should not be made without checking with the appropriate authorities regarding health, safety and invasive species issues.

In many instances, the existence of such materials in a load will trigger a phytosanitary violation, providing additional justification to seize a shipment regardless of timber identification. In such cases, officers must follow appropriate local protocols for dealing with phytosanitary violations.

Discuss any additional biological evidence with the laboratory service provider to establish whether the material should be sent along with the wood evidence or should instead be sent elsewhere to a separate facility with expertise in identification of that specific evidence type.

When collecting non-timber biological evidence:

- Photograph (using only approved equipment, file storage and transfer methods) each item in its original place in load.
- Assign and record a unique item number for each item sampled.
- Place item (or subsample of item) in appropriate container with preservative (if required) and label container with unique sample number.
- Record the details in the officer's notebook or other recording device as appropriate:
  - unique number of the sample taken as recorded on the sample evidence bag
  - date, time and place (refer to load map) where the sample was collected
  - name of the person who took the sample
  - short description of the sample, e.g. leaf material.

When describing the evidence, record only the facts, rather than opinions or hypotheses. For example, the description of leaves recovered from a container of logs should not suggest the possible species of the log. However, additional information such as the route of shipping container, can be communicated to the forensic service provider through the service request process.

Items collected in the field should be relevant to testing the investigation hypothesis. While some hypotheses may not be formed until further laboratory and investigative work is performed, judgement calls must still be made in the field regarding what items are deemed evidence and worthy of collection. The scene processors must document, including photographing (using only approved equipment, file storage and transfer methods) any items that are not collected, and they must detail the reasons for not collecting them. If there is any doubt about the relevance of an item, it should be collected.

Preparing samples for transport to the laboratory

Place each sample in its own evidence container. Include a desiccant for wet/ moist samples and note details in the officer's notebook or other recording device as appropriate.

Each individual item of evidence must be placed in a separate forensic sampling jar or evidence bag. If forensic bags are unavailable, small samples can be placed in separate plastic bags or envelopes. Dry wood samples will require no preservation for transport to the laboratory for diagnostic identification. If samples are moist in any way, an appropriate desiccant should be added to the evidence bags, such as silica beads, to prevent decay in transport. Once samples have been collected, they should be handled as evidence; all samples should be accurately labelled, documented and sealed at the crime scene. Ensure all samples are labelled with a unique sample number.

In the officer's notebook or other suitable recording device, record the following information about the samples taken:

- Unique number of the sample taken as recorded on the sample evidence bag
- Date, time and place where the sample was collected
- Name of the person who took the sample
- Short description of each sample, i.e. small wood core

If the sampling is incomplete at the end of the day, plans must be made to preserve and secure the seized load and any samples already collected. If the items in question have been fully sampled, the load may be moved to an environment suitable for safe keeping until decisions can be made regarding its longer term storage.

8. Chain of custody

A chain-of-custody record must be completed for each sample.

A chain of custody is required for every sample collected. This refers to the chronological and careful documentation of evidence, clearly showing details of its collection, custody, control, transfer, analysis and disposal. The chain of custody begins with the person who first collects the sample. Every time the sample is transferred, the transaction should be recorded with the date, time and name (typically a signature or initials) of the persons transferring and receiving the evidence item. A chain-of-custody form should be used to maintain a running record of custody for every sample collected from the scene. An example chain-of-custody form can be found in annex 13.

During transport of samples, packages with an official seal generally do not require signature by the carrier on the chain-of-custody record, provided that the sender and receiver can attest to the integrity of the seal. Legislation might differ from country to country; however, if in doubt, consultation with relevant judicial authorities is encouraged.

9. Transport of samples to the laboratory

Care must be taken when transporting samples to ensure that all packaging and documentation requirements are fulfilled, including permits, declarations and chain-of-custody forms.

Prior to transportation to the laboratory, place the collected samples in a secured location along with a copy of the chain-of-custody form. For transportation to a local facility, samples can be delivered by hand or sent through a secure courier or postal service. When delivering by hand, the receiving laboratory should sign the chain-of-custody documentation (see section 8, annex 13). Copies of the documentation should be retained by the laboratory and the original kept by law enforcement as part of their case file.

Special considerations are required when samples are transported from a country of seizure to a different country for laboratory analysis. It is vital that the correct procedures are followed and precautions are taken, including obtaining the correct import and export permits, where required, and following national biosecurity protocols.

The following measures will help ensure that valuable samples are not damaged, delayed, lost or refused entry into the analysing country:

- Line each box with a plastic bag.
- Place an absorbent liner inside the bag (newspaper or other paper products can also be used).
- Place all samples inside the bag, ensuring that all vial lids, plastic bags or other sample containers are tightly closed.
- Place a copy of the chain-of-custody form inside the box with the samples.
- Include an official statement explaining that the package contains wood samples of unknown origin being sent for forensic analysis to determine identity—this statement should circumvent the requirements of most countries that all imports be declared to species level.
- Externally reinforce the box with sturdy tape on all sides; the carrier may request to see the contents, so only perform this step after the carrier has agreed to accept it.
- Place the laboratory name and address on the outside of the box.
- Place all required documentation in an envelope marked "For the Attention of Quarantine" and secure to the outside of the package using a protective transparent sleeve, ensuring that the writing on the envelope can clearly be seen.
- Where possible, photocopy and scan all relevant documents and send electronically to the laboratory prior to sending the physical samples.
- Inform the laboratory via e-mail or telephone of the name of the carrier and the tracking number.

10. Communicating with the timber identification service provider

When communicating with a potential service provider, present the specific forensic questions and establish whether the methodology in question can provide the required identification outcome. Use the suggested questions in this section to further establish whether the resulting evidence will be appropriate for submission as evidence to court.

Most forensic timber identification requirements will start with an initial taxonomic identification, which can usually be best achieved through wood anatomical identification and is most frequently accurate to the genus level. All law enforcement organizations involved with the identification of timber should have a relationship with a provider of wood anatomical forensic timber identification services, ideally these services are provided locally or nationally, but in many cases the required expertise can only be accessed internationally. The CITES Management Authority within each country should be able to advise on an appropriate wood anatomy service provider, even for species that are not currently under CITES control.

When communicating with the service provider, present them with the specific forensic questions that have been formulated in regard to the case (see section 6) and ask them which question(s) they are able to answer with the methodologies they employ. If the methodologies employed are unable to answer the specific forensic questions formulated, seek advice on what other providers may be able to assist, or whether particular identifications are simply not possible for the taxa involved. If other providers have been contacted previously, be prepared to discuss the outcomes of those interactions.

Once the scientific feasibility of addressing some or all of the forensic questions with the laboratory service provider has been established, ensure that the following issues are addressed before deciding to utilize their services. Note that procedural rules, evidentiary limitations, and foundation requirements may differ in each jurisdiction.

1. Has the proposed method, as undertaken in the laboratory in question by the analyst in question, been accepted as evidence in a court of law in the country of seizure in support of an illegal timber trading prosecution?

    - If so, there is reasonable cause to be confident in the suitability of the analyses. Reviewing the remaining questions with the service provider is still advised in the first instance.
    - If not, the analysis may still be appropriate, but caution should be exercised when deciding what constitutes an appropriate forensic timber identification service. Proceed to question 2.

2. Has the basis of the method been published in the peer-reviewed scientific literature, even if the publication was not focused on the species/genus in question?

    - If so, this fulfils one of the criteria usually used to assess the admissibility of scientific evidence into court. Proceed to question 3.
    - If not, the evidence may not be accepted in court.

3. Has the method been forensically validated?

    - If so, this fulfils one of the criteria usually used to assess the admissibility of scientific evidence into court. Proceed to question 4.
    - If not, the evidence may not be accepted in court.

4. Is the laboratory accredited to any known national or international standards?

- If so, this will assist in proving appropriate procedures are in place in the laboratory and that staff are appropriately competent. Reviewing the remaining questions with the service provider is still advised in the first instance.
- If not, additional confirmation is required of suitability of laboratory procedures and staff competency. Proceed to question 5.

5. Are there established standard operating procedures followed in the laboratory when undertaking the required forensic analysis?

- If so, this will help establish that the test was undertaken in accordance with established practices. Proceed to question 6.
- If not, careful and detailed descriptions and justifications of the specific analyses performed will be required as part of the case file. Proceed to question 6.

6. Will the results of the analysis be presented as a forensic report suitable for court evidence submission?

- If so, this will help ensure that results are presented in accordance with established forensic reporting protocols. Proceed to question 7.
- If not, the forensic evidence will not be appropriate for submission as evidence in court. If one is to pursue acquisition of this analysis, arrangements must be made for appropriate reporting of results to be available. Proceed to question 7.

7. Is the analyst prepared to testify as an expert witness should the case go to court?

- If so, proceed to question 8.
- If not, seek an analyst who is appropriate for court appearance or consider that the results of the test may be appropriate for investigative purposes only and will not be suitable for evidence submission in court. Proceed to question 9.

8. Has the analyst testified as an expert witness before?

- If so, this will help establish the analysts experience with the justice system and the protocols in place for appearance as an expert witness. Details of that previous experience should be discussed to satisfy any concerns. Consider contacting the law enforcement and legal team involved in the previous case(s) to obtain an independent critique of the analyst's previous court appearance. Proceed to question 9.

- If not, the analyst's court performance skills are untested and consideration should be given to whether their background presents any credibility risks (e.g. previous criminal convictions) or what training they may require to ready them for a successful court appearance in the case. Proceed to question 9.

9. Is the analyst certified by any recognized forensic body or do they participate in any proficiency testing schemes for the forensic identification method in question?

- If so, this helps provide confidence that the analyst has been independently shown to be competent when applying the analyses in question, proceed to question 10.
- If not, the analyst's competence may be called in to question and other evidence to support their claim of competency may be required. Proceed to question 10.

10. Is the analyst a member of a recognized forensic science society?

- If so, this helps to provide confidence in the analyst's professional and ethical integrity, proceed to question 11.
- If not, the analyst's professional and ethical integrity may be called in to question and other evidence to support their claim of competency may be required. Proceed to question 11.

11. Will all appropriate chain-of-custody requirements be fulfilled within the laboratory?

- If so, this will help to ensure that the results of the analyses are not challenged on the basis of potential sample mix-up or tampering.
- If not, the evidence may be challenged and the defence may claim that there is reasonable doubt that the results obtained are actually from the sampled evidence. If one is to pursue acquisition of this analysis, arrangements must be made for appropriate chain-of-custody documentation and procedures to be in place at the laboratory.

Part II. Undertaking forensic timber identification: Information for scientists

Part II of the Guide is aimed at scientists undertaking forensic identification tests, or those who seek to do so in the future and wish to be well prepared. Some information in this part is also relevant to research scientists involved in the development of identification methodologies but who may not necessarily undertake forensic case work. The information may also be of interest to front-line officers, prosecutors and members of the judiciary, to provide insight and advance understanding of the challenges faced by scientists in the forensic identification of timber. The information presented here is not intended to replace any formal scientific or forensic training and scientists are encouraged to seek expert advice on specific legal issues pertinent to relevant jurisdictions. Additionally, scientists should consult the body of peer-reviewed scientific literature for the latest advances in particular scientific fields.

11. Available methods for forensic timber identification

Methods of forensic timber identification include a range of visual, chemical and genetic approaches to determine the taxonomic, geographic and individual sources of timber material as well as its age (see annex 8 for details of which forensic identification methods may be able to answer specific identification questions). In this section the various approaches are summarized as an introduction to the associated disciplines, see [4] for a published review of forensic timber identification and [5] for a published review on timber tracking technologies. It is not anticipated, nor recommended, that a scientist seek to undertake an analysis that is not in line with their current expertise. As such, these descriptions are given as context, and to facilitate understanding of the other available methodologies, such that it may be useful to recommend exploring their utility to a particular case if your own methods are unable to reach the required identification outcome. All methods rely on extensive reference databases containing data derived from reference material. With the exception of wood anatomy, radiocarbon and genetics, most disciplines have so far developed very limited databases, which in turn limit the scope of the application of the associated identification methods.

Wood anatomy

Wood anatomy involves the study of the structure of timber at the micro- and macroscopic levels. Determinations are based on a large set of wood anatomical characters. Each anatomical character has a relative degree of environmental and genetic influence, and as such, specific combinations of characters can serve as diagnostic identifiers of certain taxonomic groups. Wood anatomy primarily focuses on examination of the shape, size, arrangement and contents of the various cell and tissue types found in wood. For more information on the history of wood anatomy as a discipline, see Carlquist [6] and references therein.

Wood anatomical characters can be examined at both the macroscopic and microscopic levels. Macroscopic examination can be undertaken with the naked eye, or with the aid of a small magnifying hand lens. More specific information on CITES-listed timbers and a range of lookalike species, which can be distinguished using macroscopic wood anatomy, can be found in annex 10. Information about the 100 most important timbers in trade, which can be distinguished using macroscopic wood anatomy, can be found in annex 11.

Microscopic identification requires sectioning a sample, the staining of those sections where required and observation under a light microscope. In order to achieve a definitive identification, usually to the genus level, microscopic examination is preferred over macroscopic observation in most instances.

Wood anatomical characters are described according to the standard terminology of the International Association of Wood Anatomists (IAWA) [7-9] and identification to the appropriate taxonomic level can be aided by comparison of unknown samples to extensive reference materials collections and descriptions. These comparisons are facilitated by access to samples and pre-prepared microscope slide collections, as well as various published papers, timber atlases and on- or offline computerized databases (see annexes 9 and 15).

Wood identification through automated "machine vision" technology is a relatively new area of wood anatomical research that is showing much promise. The basic principles underlying the approach are reviewed in Hermanson and Wiedenhoeft [10], but in summary, the system captures images of the wood under conditions of strict light control, and uses signal processing approaches to extract information from the image. The resulting data are used to establish a classification scheme. The system relies on the input of high quality reference images of the taxa to be classified and is then able to assign unknown images to these reference groups. Because the machine-vision system has the ability to "see" and quantify variations humans cannot perceive, it is plausible that future research will demonstrate resolution (e.g. species identification, provenance) greater than is available in traditional wood anatomical identification, at least in some cases.

Examination of wood anatomy generally facilitates identification to genus level [11], as wood characters tend to be highly conserved within genera—this in turn generally prohibits definitive identification to the species level [12]. Wood anatomy typically cannot identify the provenance of timber, unless the potential range of the identified taxon is so restricted that provenance is obvious.

Dendrochronology

Dendrochronology is the study of tree growth increments. The science of dendrochronology is based on analysis of the periodic, often annual growth increments (tree rings) formed in most temperate and some tropical tree species. The characteristics of individual tree rings can provide information on the growing conditions at the time and the sequence (or "chronology") of these rings can provide a rich record of information on the tree and its environment. Although generally applied to the study of past climates and other environmental events, dendrochronology also has the potential to give specific information on tree age and provenance [13].

By comparing the tree-ring series of a sample to reference chronologies from specific regions, it is sometimes possible to determine whether the pattern is consistent with a particular area, although this is typically only done for old timbers of archaeological importance and in temperate regions with clear tree rings [14]. It is also possible to determine the minimum age of a tree by counting its growth rings and if the bark and outermost ring are present, it may be possible to determine when it was felled [15, 16], although caution is required regarding the error margins in such calculations [17]. Comparisons of tree ring patterns between different wood surfaces can sometimes be used to identify individuals, i.e. the pattern on a log where it was cut from a tree, and that on its associated stump could be positively matched. Traditional dendrochronological methods can only be applied to trees that form periodic growth rings. The majority of tropical timbers (which are generally those most at threat from illegal logging) do not produce growth rings. Chemical dendrochronological methods can also be applied but are more useful if dated tree rings are already available. See subsections on stable isotopes and radiocarbon below.

Mass spectrometry

This method of timber identification uses mass spectrometry to characterize phytochemicals present in the heartwood, often termed extractives and exudates, or metabolites. These extractives are laid down during heartwood formation and are largely responsible for its durability. Extractives can be measured through mass spectrometry to generate a chemical profile or fingerprint. Statistical analyses of these profiles can be optimized to cluster together taxonomically related individuals. Mass spectrometry ionizes chemical compounds to generate charged molecules and measures the mass-to-charge ratios. Traditionally, mass spectrometry required extensive sample preparation steps due to the requirement for ionization in a vacuum [18]. However, more recently ambient atmospheric ionization techniques have been developed that minimize sample preparation steps and provide very fast results; specifically the

Direct Analysis in Real Time, Time of Flight Mass Spectrometer (DART TOFMS) [19, 20] has shown great promise when used for timber identification [21].

Optimized clustering of the chemical fingerprints can be used to assign unknown samples to reference groups. Depending on the natural variation in extractives present in the timber samples, various different levels of taxonomic identification may be possible, and these have been demonstrated in a number of key publications, e.g. genera [22, 23], species [18, 24-27], and even wild vs. cultivated [28]. However, it is important to note that classification models are only valid for taxa included in the reference dataset.

Near infrared spectroscopy

Near infrared spectroscopy (NIRS) measures the absorption spectra of materials when exposed to near infrared electromagnetic energy. NIRS can be applied to solid timber, as well as particles such as pulp, and when used on solid timber it returns information derived from both the chemical and physical structure of the wood. NIRS has been used extensively in the wood sciences to estimate its properties, but less routinely for taxon identification [29, 30]. The raw spectroscopic outputs are rarely directly informative and must be used in conjunction with appropriate multivariate analyses to in order to obtain meaningful results [31]. Data are analysed to determine the likely taxon when compared with reference datasets.

This technology has the potential to return accurate results with minimal sample processing and specialized skills required of the operator. However, the use of the technology for timber identification is only at the prototype stage at present. The results obtained in field trials so far have shown that accurate timber identification to the family and species levels are possible. NIRS has been demonstrated to distinguish between individuals of different genera [31-33], different species within the same genus [34], and between the same species in different regions [35].

Stable isotopes

Chemical compounds synthesized by trees obtain their raw constituent elements from the surrounding environment. Elements can have multiple isotopes, meaning they have the same number of protons and electrons, but a different number of neutrons, and thus a different atomic mass. The ratios of the various stable isotopes fluctuate in nature and are often correlated with various climatological, biological and geological variables. For example, in precipitation, the stable isotope ratios of hydrogen and oxygen are predominantly dependent on temperature [36], but also altitude, latitude and continental effects [37]. The oxygen isotope ratio of plant tissues reflect the isotopic composition of the plant's source water as well as the effect of transpiration, which is influenced by climate [38]. The ratios of the various carbon stable isotopes are primarily determined by the photosynthetic pathways employed by the plant [39], but are impacted to a lesser degree by climatological factors, which effect stomatal conductance such as humidity [40].

By looking at these ratios in a given area, an isotopic “fingerprint” for that location can be determined. By combining multiple stable isotope analyses, including elements such as sulphur [41] and strontium [42-44], the spatial granularity of the isotope signature can be improved. On this basis, it is possible to use stable isotopes to identify or rule out particular regions of timber provenance. Stable isotopes can also be analysed separately from different annual growth rings [45], a form of chemical dendrochronology (see subsection on dendrochronology above). Stable isotopes are suited to addressing questions of geographic provenance at the broad regional level [45-48] where appropriate reference databases exist. Stable isotopes have no ability to determine genus, species or individuals.

The use of stable isotope analyses can potentially be augmented by including analyses of trace elements to improve granularity, e.g. [49-51]. Trace elements and stable isotopes together can be considered “Geochemistry”. Although it has not been tested, it is likely that trace element analyses could also augment other methodologies that seek to determine timber provenance, such as DNA analyses (see subsection on population genetics and phylogeography below).

Radiocarbon

Along with stable isotopes (see subsection on stable isotopes above), the element carbon also occurs naturally in the environment as the radioactive isotope ^{14}C, termed “radiocarbon”. ^{14}C has a half-life of 5730 ± 40 years [52] and naturally decays to ^{14}N, a stable isotope of the element nitrogen. ^{14}C is constantly being produced in (predominantly) the upper atmosphere via natural nuclear interactions and, after oxidization to CO_2, is mixed throughout the atmosphere and hence throughout the biosphere including the oceans and terrestrial soils. Once produced, ^{14}C decays following its half-life and the balance between production, mixing and decay results in quasi-constant ^{14}C concentrations in various carbon pools of the Earth’s system. All organisms incorporate carbon into their bodies throughout their lifetimes, and in the case of plants, this is fixed from CO_2 in the atmosphere via photosynthesis. Once carbon has been sequestered and is no longer exchanged with the environment via processes such as respiration, it remains in situ in the body of the organism (e.g. tree trunk). Levels of ^{14}C in the tissue begin at some relative proportion of the natural atmospheric abundance in accord with various fractionation levels, depending on trophic level, and decay predictably to ^{14}N in accordance with the half-life of ^{14}C. By measuring the ratio of the number of ^{14}C and ^{12}C atoms (and separately the ratio of ^{13}C and ^{12}C atoms, to enable correction for any mass-dependent fractionation) and comparing this to known standards, it is possible to calculate a “radiocarbon age” of organic material [53]. IntCal04 (northern hemisphere) and SHCal04 (southern hemisphere) are two internationally agreed calibration curves (data sets) which can be used to convert radiocarbon ages into calendar ages, based on independently dated tree-ring and marine samples [54, 55].

The natural formation of ^{14}C in the upper atmosphere was substantially augmented in the late 1950s and early 1960s (predominantly the latter) by ^{14}C generated by nuclear bomb testing [56], creating what is now referred to as the "bomb peak" in ^{14}C calibrations [57, 58]. This spike in ^{14}C and its subsequent reduction, provide unique opportunities to accurately date modern materials to within a few years [59], and have gained attention in forensic applications [60-62]. The steady decrease in ^{14}C concentration in the atmosphere since this peak is due to the uptake of atmospheric CO_2 with elevated ^{14}C levels into the other reservoirs of the earth's carbon system (e.g. oceans, soils) and the compensatory transfer of non-^{14}C-elevated carbon from those carbon pools back into the atmosphere.

Radiocarbon dating has the potential to determine the time before present (when calibrated) that a given portion of the tree was formed [61, 63, 64]. This ability can be particularly important in determining whether laws apply to specific pieces of timber; timber harvested before the implementation of legislation is often exempt.

DNA barcoding

DNA barcoding is built on the premise that particular gene regions show sufficient genetic variation to enable members of one species to be reliably distinguished from members of another species [65]. DNA barcoding is now a global initiative with the mitochondrial cytochrome oxidase (CO1) gene region chosen as the standard for animals. Two chloroplast gene regions maturase K (*mat*K) and ribulose-bisphosphate carboxylase (*rbc*L) are currently the standard markers for plants, however they are only able to distinguish approximately 70 per cent of plants and often require local barcodes (additional gene regions) to facilitate determination to species level [66]. DNA barcoding can be used as part of a species discovery process or for specimen identification [67]. For the purposes of forensic timber identification, it is the latter application that applies, although species discovery utilizing DNA barcoding will likely constitute a proportion of the background taxonomic research required to underpin robust species identification.

DNA barcoding is most appropriate for identifying to the species level or higher, although it can be informative at the phylogeographic (regional) level within species. In timber, DNA barcoding has been trialled in the mahogany family using the gene region ITS with promising results [68] and more recently *Aquilaria* spp. (CITES-listed) have been distinguished from other closely related species using *trn*L-*trn*F and ITS1 regions using DNA extracted from xylarium specimens [69]. Most recently, the standard *mat*K and *rbc*L regions were used to develop a reference library of the trees of the tropical evergreen forest of India, to which sapwood samples were correctly assigned [70].

Population genetics and phylogeography

Tree species in natural forests usually exhibit spatial genetic structure to a greater or lesser extent and these patterns can be observed at both local and regional scales

[71, 72]. The term spatial genetic structure describes the tendency for individuals of the same species to be more genetically similar, the closer they are geographically. The overall genetic composition of natural populations is influenced by a range of factors, predominantly migration and extinction history [73, 74], as well as gene flow via pollen and seed dispersal [75]. By using molecular markers, ideally from neutral regions across the genome (i.e. not under natural selection), and screening a large number of individuals from different areas across the range of a species, it is possible to create a genographic map of that species [76, 77]. These maps have traditionally been used to elucidate the history of these species, but their utility for verifying the origins of timber have been realized more recently, starting with Oak [78, 79]. Depending on the spatial resolution afforded by the reference database (which will depend on both the underlying genetic structure and the number of populations used to construct it, [80]), unknown individuals genotyped with the same genetic markers can be assigned back to their population of origin with a high degree of statistical confidence. This same principle can be applied to assign individuals to their species of origin, or even hybrid status, based on their membership of one or more independent genetic clusters [81].

Population genetics and phylogeography are able to answer questions around the provenance of timber. Depending on the scale of the question, and the granularity inherent in the reference database, these techniques can be used to determine country of origin [82], within country region [83, 84], and even down to the forest concession level [85]. Population genetics is also a very powerful tool for determining what constitutes independent gene pools and can be used to assign individuals to their appropriate species pools or hybrid classes [81, 86, 87]. This application can be particularly important for establishing hybrid status in law, as hybrid individuals are usually exempt from species-specific trade laws.

DNA profiling for individualization

DNA profiling is the method by which an organism is genotyped across a range of genetic loci (markers) to develop their individual genetic “fingerprint”. Originally developed in the 1980s [88, 89], DNA profiling is now the mainstay of human forensic science [90]. DNA profiling for forensic purposes aims to enable the identification or exclusion of an individual from an investigation based on a comparison of their DNA with that found at the crime scene [91]. The loci examined in DNA profiling are ideally chosen for their high variability between individuals, and their low differentiation between populations; the ideal marker is hypervariable but this variation is not noticeably geographically structured [92]. However in practice, many genetic marker sets are successfully used for both DNA profiling and population genetic purposes. By genotyping a broad enough set of representative reference samples, it is possible to calculate the theoretical probability of a different unrelated individual providing a DNA profile that is identical to the one in question. This probability is usually vanishingly small, leading to the general acceptance of DNA profiling as a robust form of evidence.

Microsatellite loci are used most frequently in DNA profiling, however single nucleotide polymorphisms (SNPs) are becoming more frequently used in humans [93, 94]. Although each SNP locus provides less information than a single microsatellite locus, comparable power can be obtained by including more loci [95]. SNPs also require shorter fragments of template DNA to successfully amplify, making them more suitable for work on degraded samples [96].

In principle, DNA profiling for timber identification should work in the same way as for human identification. In practice, there are two issues that make it more complex. Firstly, humans are a diploid species, meaning they have two sets of chromosomes, one from each parent. At a single locus therefore, a human can only expect to produce a maximum of two different alleles. In plants, polyploidy is much more frequent [97], meaning that many more than two alleles could potentially be found at any one locus in an individual, and in many cases, the ploidy level is simply not yet known. Secondly, DNA profiling in humans is built almost exclusively on microsatellite genotyping, but the poor quality DNA that can be extracted from timber is generally not ideal for this purpose so SNP markers are preferred.

DNA profiling can be used in forensic timber identification to establish whether or not the DNA in a particular piece of timber or timber product matches the DNA in another. This capability may be important for linking material seized from suspects with the stumps of illegally felled trees. This technology also presents opportunities for independent chain-of-custody verification along supply chains, where DNA profiling can be used to confirm that legal shipments remain intact and are not augmented with additional illegal material as they pass through the supply chain [98].

12. Resources for acquiring reference material

The development and application of forensic timber identification methodologies generally requires access to high quality reference material. For most disciplines, this is required in the form of timber, similar in character to those materials expected to be received for casework, e.g. if heartwood is likely to be encountered in trade, scientists will usually require heartwood reference samples to develop forensic identification tests. Genetic methods can use other plant tissue to extract reference DNA (such as leaves, or cambium) but still require validation of timber material to prove their effectiveness for forensic purposes. Isotopic analyses (stable isotopes and radiocarbon) require calibration standards for analyses. Reference material can either be obtained from an existing collection, or sourced as part of the research.

Existing collections

Timber

Scientific collections of timber are housed and curated by xylaria. A list of xylaria worldwide can be found online [99] and a link is provided in annexes 9 and 15).

Individual xylaria should be contacted for information regarding their specimen availability, loans policies and procedures. For dendrochronological samples, larger intact cross-sections of timber are required (also known as stem disks), which are less commonly collected and curated. Links to institutions involved in the study of dendrochronology can be found online [100] and individual institutions should be contacted for information regarding their specimen availability, loans policies and procedures. Out of date scientific names can be considered synonyms and in many cases can still accompany original xylarium specimens. A database of the names and associated basic bibliographical details of plants can be found online [101]. As correct identification to the species level is not usually possible from visual examination of the timber alone (diagnostic features such as leaves, fruits and flowers are generally required) it is very important to consider the validity of the species determination provided with any wood sample. The most robust identifications are facilitated when a timber sample is accompanied by a voucher specimen from the same tree which exhibits diagnostic characters such as leaves, fruits and flowers, housed and curated in a herbarium (see following subsection on plant material).

Plant material

Scientific collections of plants, including trees, are housed and curated by herbaria. These differ from xylaria in that they rarely house timber; instead, for trees they collect small examples of branches and leaves, ideally along with fruits, flowers, bark and other diagnostic features that facilitate identification. A list of current herbaria worldwide can be found online [102]. Individual herbaria should be contacted for information regarding their specimen availability, loans policies and procedures. Plant taxonomy is a dynamic field and the agreed scientific names of particular species can change as new information is discovered. Out of date scientific names can be considered synonyms and in many cases can still accompany original herbarium specimens. A database of the names and associated basic bibliographical details of plants can be found online [101].

Isotopic materials

For the application of stable isotope and radiocarbon analyses, reference standards are required for calibration which can be provided by various agencies [103].

New collections

Field

Most existing collections do not contain sufficiently large quantities of reference material to facilitate robust or timely development of new forensic timber identification methods, and so researchers frequently must source additional material independently. Where this is required, accurate taxonomy is critical. Reference material should be collected by (or in collaboration with) experts on field identification of the taxa in question. Where possible, trees already taxonomically verified can be utilized, such as those that are part of permanent study plots or botanic gardens (although use of botanical garden specimens should be considered carefully as misidentifications can occur, and should be avoided altogether for anatomical or provenance research where the garden is outside of the taxon's natural range). When collecting from standing trees that have not yet been taxonomically identified, herbarium voucher specimens should be collected to allow post-hoc confirmation of identity by herbarium taxonomists. Where it is impractical to collect vouchers for all specimens (e.g. where foliage is high in a dense canopy), identification should be confirmed through other means by checking that samples cluster with taxonomically verified individuals, such as through various genetic or chemical profiling approaches.

Trade

Where reference material is scarce for particular taxa, researchers may find that examples are available through commercial timber suppliers. Extreme caution must be exercised when utilizing this material, as there is no robust chain of custody associated with the sample. There is a high risk that timber other than that which was requested may be provided. This risk is significant regardless of how honest the trader may be; most illegal logging and supply chain augmentation occurs without the explicit knowledge of retailers. Researchers should consider that through a purchase, particularly of very high value and/or rare timbers, they may be inadvertently funding illegal logging activities.

The use of reference material that cannot be traced back to its point of origin also presents a potential legal challenge to the use of any derived forensic tests reliant on data from that material. The inadvertent inclusion of data from reference material that does not come from its supposed point of origin can invalidate, or at least negatively impact the power and reliability of derived forensic timber identification methodologies.

If there is no alternative to a commercial supply of reference material, several verification steps should be employed to mitigate some of the associated risk. It should be noted that the risk of purchasing the correct species of wood, but from a geographic origin different from that advertised is particularly of concern for the acquisition of reference material. Utilization of such material in the development of tests designed to identify geographic origin should be avoided, unless other validated methods already exist to verify its origins (such as stable isotope or population genetic analysis).

In general, the following steps should be followed:

- Obtain examination by an expert wood anatomist to confirm the genus (and any further taxonomic information they can provide, such as species in some cases).
- If sequence data is available, check the species identity of the wood using DNA barcoding.
- Obtain examination by a dendrochronologist to confirm that each piece is not obviously from the same tree (this will usually only be detectable where pieces were adjacent to one another in the original tree, and even then, the trajectory of sampling can have a significant influence). Inclusion of multiple samples from the same tree in the development of a forensic test constitutes pseudo-replication.
- If used as part of population level characterization studies, check that the samples cluster as expected with other, taxonomically verified, members of the same taxa.
- If geographic provenance methodologies are available for the taxa, utilize them to confirm the geographic source of the material. If they are not, avoid using results from this sample when drawing inferences or conclusions regarding geographic provenance.
- Adjust the weight of importance placed on the results derived from commercially sourced timber as compared to taxonomically verified samples when conducting your research.
- Ensure that your results and subsequent publications (including submissions to reference databases) clearly state the origins and subsequent verifications employed in the acquisition of your reference samples.

13. Resources for acquiring reference data

Reference data, as opposed to reference material, refers to the results of previously analysed reference material, such as macro- and microscopically photographed timbers, DNA sequences, chemical/spectral profiles and isotopic compositions. When utilizing externally generated and analysed reference data, it is important to consider carefully the source and reliability of the data. Can the results be traced back to taxonomically validated reference material? Have the methods used been peer-reviewed and published? Have the performed analyses been thoroughly explained and justified? Use of external reference data should follow an internal validation study in order to determine that the results obtained in the analyses are comparable to the reference data being used. More details on validation studies are provided in section 14. A list of online resources for the acquisition of reference data can be found in annex 16.

14. Laboratory procedural requirements for undertaking forensic work

This section details the main requirements for scientists undertaking forensic case work. Readers are encouraged to also consult part III, section 20 for details on the legal perspective of many of these issues.

Unique challenges to forensic casework

Undertaking forensic casework is qualitatively different from undertaking scientific research. The scrutiny to which the results may be subjected is significant; every aspect of the work undertaken may be the subject of criticism and legal challenge, including the personal lives of any and all people who came into contact with the evidence, or analysed data in any way. The criticism is usually focused upon four general areas:

- The chain of custody was not intact for the evidence items.
- The science utilized for the analysis is unreliable.
- The science utilized is reliable, but the required procedures for sampling, preparation or analysis were not followed; hence, the results are not an accurate representation of what was sampled.
- The laboratory did not employ sufficient safeguards to prevent cross-contamination, accountability or intentional misconduct; hence, the results are not an accurate representation of what was sampled.

Most laboratories undertaking research into identification methods for timber are not forensic laboratories set up to undertake casework. As forensic timber identification methodologies are not yet routine, there is little short-term prospect that they will be broadly incorporated into the suite of tests undertaken by dedicated forensic facilities. It is therefore necessary that the laboratories which currently have the scientific capacity to address timber identification requirements put in place the required forensic work flows to meet legal requirements. The remainder of section 14 describes some of the fundamental requirements and recommendations for working in forensic science.

Secure chain of custody

Chain of custody is a critical concept in law, and refers to the intact record of the location and custodian of any evidential material at all times. The requirement for this is obvious; there must be no opportunity for samples or information to be lost or tampered with in any way. For forensic purposes the chain-of-custody trail does not end when the samples are received by the laboratory; tracking of samples throughout all analyses is necessary. When the laboratory fails to follow these procedures, questions are raised regarding cross-contamination by other samples, or it is suggested that the analysis results may not be for the samples in question, or that the samples have been switched.

Laboratory personnel who initially receive samples should record (usually in a laboratory notebook or form specifically designated for samples received) the condition of the samples and the transportation container. For example, whether a sample container seal was intact or broken. Laboratory numbers should be assigned to each sample, which could be the same number assigned by the samplers or a laboratory unique number. When a different laboratory number is assigned to a sample, there should be notation of the original sample number and the new laboratory number on the same document to avoid confusion as to where this sample was taken after the analysis.

Samples should be kept in a manner that limits access, for example in a secure room, sealed container or locked refrigerator as necessary. Whenever a sample or a portion of the sample is taken for analysis, a laboratory chain-of-custody form should be completed stating that fact. If only a portion of the sample is taken, a sub-number or letter should be added to the laboratory number for the partial sample and recorded on the laboratory chain-of-custody form. Analytical results should be identified by the laboratory number and sub-number or letter. The purpose of this procedure is to ensure that the analytical results can be documented back to the original sample received by the laboratory.

Method validation and verification

Before a forensic identification test can be undertaken for the production of evidence intended for court, the test first must undergo validation and generally prove acceptance by the scientific community, usually by peer-reviewed publication of the method. Validation can be summarized as assessing the ability of a test to achieve reliable results, determining the conditions under which the test can be performed, and defining the limitations of the test. Validation typically involves assessing the rates of false positives and false negatives, and demonstrating the reproducibility, robustness and reliability via studies of the sensitivity, stability and specificity of the test in question. Tests that are derived directly from published academic (non-forensic) literature are usually insufficient and so additional validation studies are required before legally compliant evidence can be derived. Once a test has been initially validated, it must then be verified by each new institution seeking to utilize it, or each time significant changes to the procedure or equipment are made. This verification procedure is also often referred to as "internal validation".

Standard operating procedures

Laboratories require written standard operating procedures (SOPs) for each analytical method they employ that precisely define how a test should be performed and how the results should be analysed and interpreted, including considerations of possible sources of error and conditions that may affect the accuracy of the results. Once established, SOPs become the standards to which the application of all tests must adhere. SOPs can be modified and improved over time but these changes must be carefully documented and it must be clear at all times exactly which SOP (including the specific version) was followed in each case.

Legal challenges to scientific evidence very often focus on how closely a laboratory adhered to its own SOPs. For example, depending upon the analytical procedure being employed, there may be certain sample preparatory treatments that must be conducted in a particular chronological order before a sample is subjected to analysis. A timber sample may need to be cut into smaller pieces, ground into a powder, or mixed with a solution before analysis. Case notes must contain sufficient evidence that these steps were employed. Similarly, the calibration of analytical equipment can be another area of scrutiny. If an SOP requires that the equipment is cleaned and/or calibrated before use, this must be documented.

Casework documentation

All forensic casework must be documented and authenticated throughout the analytical process. This documentation forms the basis of forensic reports and should be available to investigators, prosecutors and the court, and include details of:

- Investigative request(s)
- The chain of custody (evidence receipt and control within the laboratory)
- Analytical methods employed
- Analytical results obtained
- The interpretation of the obtained results
- Specific protocols employed
- Specific persons involved in any and all aspects of the case within the laboratory
- All communication regarding the case including e-mails and a log of all calls

Proficiency testing

Through regular proficiency testing, laboratories and their staff demonstrate their proficiency in undertaking particular forensic tests. Participants are asked to perform tests on materials known to the testing administrator and present their findings as they would in any normal test on an unknown sample. Where the correct answer is returned, the participant is considered proficient. Where an incorrect answer is returned, remedial action can be taken and appropriate education programmes instated to ensure proficiency is obtained and maintained. The most reliable proficiency testing schemes are administered externally to the organizations undertaking the tests. Proficiency testing is a requirement for certification (see subsection below on certification) and for ISO/IEC 17025 accreditation (see subsection below on quality assurance and accreditation).

Certification

Certification of forensic analysts is common in human forensics and increasing within the wildlife forensic sciences community. Certification is the means by which individual analysts, independently of their organization, can be recognized as fit to undertake forensic case work. Certification is administered by a recognized external body [104]. The decision to award certification status is based on assessment of the applicant's education, proficiency, experience, performance, ethical integrity and standing within the forensic science community.

Quality assurance and accreditation

Quality assurance (QA) is the concept of using systems and procedures to control quality and maintain continuous improvement of a product or service. QA is normally ensured in a laboratory testing environment through the design and implementation of a quality management system (QMS). The QMS includes all of the protocols, standard operating procedures, method validation documents and reporting criteria that are operated by a laboratory. For performing forensic casework analysis, it is essential that the laboratory operates the key features of a QMS. To demonstrate that a laboratory has established and follows a QMS, the laboratory may seek accreditation by an external assessment body under one of a number of international standards. ISO/IEC 17025 is the standard that describes the requirements for the competence of testing and calibration laboratories and the main international standard to which laboratories undertaking forensic science testing services become accredited. Laboratories with this accreditation are able to demonstrate strict chain of custody, fundamental validation of all results, and have an effective quality management system in place. Gaining accreditation is not a legal prerequisite for providing forensic evidence, but by doing so laboratories remove (or at least substantially reduce) the likelihood of their evidence being challenged in court on the grounds of bad laboratory practice. However, accreditation (e.g. under ISO/IEC 17025) is time consuming, expensive and requires dedicated internal resources that many small wildlife forensic laboratories may not be able to commit.

An alternative to formal accreditation has been developed by the Society for Wildlife Forensic Science in the form of standards and guidelines for forensic analysts performing botany identifications using morphology, anatomy, DNA or chemistry. The

Standards and Guidelines encompass the essential aspects of the broader ISO17025 standard that are relevant to performing forensic casework, and they are provided as a method to achieve the minimum level of quality assurance considered necessary for different wildlife forensic science disciplines. These Standards and Guidelines cover laboratory practices, evidence handling, and training, which are central to all forensic laboratories. They also include critical considerations of phylogeny, taxonomy and reference collections that are specific to botanical forensic science. The Standards and Guidelines are available from www.wildlifeforensicscience.org/swgwild/swgwild-work-products.

15. Guidance on communicating with law enforcement

Communication with law enforcement will usually begin with an approach from an investigator enquiring about the availability of forensic timber identification services. The law enforcement officer will provide some context of the case and a forensic question (or set of forensic questions) for which they are seeking an answer (see part I, section 6 on formation of the forensic question). What motivates law enforcement investigators is often different to that which motivates scientists, and an appreciation of these differences is important to a successful and rewarding working relationship.

Law enforcement motivators

With respect to forensic timber identification, law enforcement officers are primarily interested in ascertaining whether a crime has been committed, and if so, acquiring forensic evidence to support prosecution. The nuance of the science that may be able to assist in acquiring such evidence is generally out of the scope of interest and expertise of law enforcement personnel. Similarly, scientific results that are not fit for submission as legal evidence in a court of law are of little (if any) value to law enforcement in most instances. An officer will generally be required to produce an official report at the start of an investigation to explain their rationale. Similarly, they will be required to explain any evidence pertinent to a case and how it was obtained, including the results of scientific analyses. As such, it is imperative that the investigator understands the content of forensic reports.

Communicating the science

The law enforcement officer who initially contacts a forensic service provider may have very little prior knowledge about the methodology employed and may have only a very rudimentary basic science education. It is important to remember the audience when discussing specific areas of expertise with law enforcement. In general, explanations aimed at intelligent lay-people are appropriate. Scientists should adjust their communication styles accordingly. Technical jargon, acronyms and other field-specific terms that the officer will be unlikely to have encountered before should be avoided. Any new terms should be explained carefully. If providing routine forensic services to law enforcement, organizations should consider producing explanatory material that can be made available to law enforcement agencies so that officers can become familiar with the important concepts where necessary.

Confirming the forensic questions

All forensic timber identification requirements can be broken down into the need for information in one or more of the following areas:

- Genus (or higher level taxonomic identification) of the evidence
- Species of the evidence
- Geographic provenance of the evidence
- Age of the evidence
- Individual from which the evidence originates

Further, forensic questions can be considered to be either questions of full-identification, where information on the exact nature of the evidence is required or questions of verification, where information is required on whether evidence matches a specific claim or query. This is a very subtle but important distinction, which can affect the time and resources required to arrive at the desired answer. Most forensic questions will initially be focused on verification, with the requirements for further full-identification at the discretion of the investigator.

For example, if customs stop a shipment containing timber claimed to be *Dalbergia latifolia* but believe it may be CITES-listed *Dalbergia nigra*, their immediate question is one of species verification. The verification could be phrased in two ways:

1. Is the evidence *Dalbergia nigra*? If it is, a CITES infringement has occurred.
2. Is the evidence *Dalbergia latifolia*? If it is, the shipment is in order.

In each case, if the evidence is not verified as the queried species, the investigator may choose to have the evidence further verified (e.g. is the evidence one of the other CITES-listed *Dalbergia* species?) or fully identified (what species is the evidence?), or they may choose to close the case without obtaining further information if they deem it unnecessary.

In every case, an initial genus (or higher taxonomic level) determination, usually through wood anatomical analyses, will be the first requirement, as this information is required input for the application of most other methods.

When communicating with the officer, the shared goal should be to determine which questions are applicable to the case and which answers (if any) particular specialist methods can provide. Ideally, these questions have been formulated independently by the investigator beforehand, but if not, this must be the first point of clarification through discussion of the officer's working hypotheses in the case.

Legal expectations

In part I, section 10 (communicating with the timber identification service provider), there is a suggested list of questions for law enforcement to ask potential forensic service providers before engaging their services. This list of questions is designed to address the forensic requirements of timber identification services to ensure that both law enforcement and the science provider understands the legal expectations associated with providing evidence. The questions centre on:

- Previous forensic experience of the analyst
- Validity of the method
- Chain-of-custody control
- Existence of and adherence to standard operating procedures
- Production of forensic reports
- Suitability and willingness of analyst to appear as expert witness

It is important that this list (part I, section 10) is also considered by scientists to ascertain the applicability and suitability of their analysis for the enforcement purposes.

Managing expectations

Before arranging to undertake an analysis, the following points should be discussed and agreed upon to ensure that both parties understand what is required of them in order to facilitate a useful result.

- *Cost*. How much will analyses cost the law enforcement agency, including any incidental costs? Expected ranges are listed in annex 8, but individual laboratories may not comply with these averages.
- *Time*. How long will an analysis take? When can the officer expect to receive their results? Expected ranges are listed in annex 8, but individual laboratories may not comply with these averages.
- *Sampling*. What is the sample size needed? Will destructive testing be employed?

- *Logistics*. How should the officer transport the samples to the laboratory? Consider appropriate biosecurity requirements relevant to your jurisdiction.

- *Follow-on analyses*. If multiple timber identification methodologies will need to be employed to answer the full set of forensic question (e.g. wood anatomy to determine genus followed by DNA barcoding to determine species), what are the arrangements for organizing follow-up analyses? Who will be responsible for sending samples on?

16. Guidance on communication of scientific results

The interpretation of scientific data in connection to forensic evidence is the process that links laboratory analysis to the investigative question. It is crucial that scientists clearly communicate the meaning and relevance of their findings to law enforcement officers, lawyers and the judiciary. There are several principles that should be applied to the interpretation of results for all tests, to ensure clarity and to minimize the risk of miscommunication or misunderstanding.

These include:

- *Avoid the "prosecutor's fallacy"*. Scientists should restrict their interpretation of results to commenting on the strength of the evidence under different scenarios, rather than commenting on the probability of a particular scenario (guilt or innocence) given the evidence. Doing the latter instead of the former, often referred to as the "prosecutor's fallacy", can be quite subtle, but is critical to the correct application of forensic evidence. For a full discussion, see Evett and Weir [105].

- *Always attempt to evaluate the evidence with respect to alternative propositions*. This helps ensure that the scientist applies an unbiased approach to result interpretation. One proposition is usually directed towards the scenario described by the investigator and is referred to as the "prosecution hypothesis". For example, where the investigator asks, "Is this wood from a tree of the genus *Gonystylus*?" the appropriate prosecution hypothesis would be: "The wood originated from a tree of the genus *Gonystylus*." An alternative proposition in this case, referred to as the defence hypothesis, would be: "The wood originated from a tree of a different genus." The role of the scientist is to evaluate the probability of observing the forensic evidence under these alternative propositions [105-107].

- *It is essential that interpretation of results follows an approach accepted by the legal system of the prosecuting country*. The commonly accepted approach is to present evidence in the form of a likelihood ratio, which allows the likelihood of observing the evidence under prosecution and defence hypotheses to be directly compared. Care is needed in interpreting likelihood ratios, but DNA evidence can produce very large ratios. In certain countries, evidence may be presented as probabilities of a match (i.e. this profile occurs 1 in x of the population), rather than using a likelihood ratio.

- *Language used to communicate results should be unambiguous, concise and must not extend beyond the scope of the scientific method employed*. Forensic evidence that is not presented correctly will normally be rejected by the court.
- *Conclusions should be clear, conservative and carefully worded*. Following the interpretation of results, scientists are often required to state their conclusions. Conclusions must not be based on assumptions; they cannot say more than the analysis allows. Although there will be considerable variation in conclusion statements, all statements should be conservative and clearly state the final result.

For each of the scientific methods for forensic timber identification considered in this Guide, examples of clear and concise conclusions are given below, considering the intended purpose of the applied method. Note that forensic reporting differs among countries and scientists providing analytical results for law enforcement should always refer to relevant national standards.

Genus identification (wood anatomy)

The anatomical features of exhibit X are characteristic of the genus *Dalbergia*. Exhibits were identified via observation of macroscopic and microscopic anatomical characteristics and compared to reference material. None of the observed characteristics contradict the conclusions.

Genus identification (DNA barcoding)

The DNA sequence obtained from exhibit X is characteristic of variants found in the genus *Gonystylus*. The sequence(s) identified in this report possess a higher degree of homology with the identified genus than with sequences that have been reported for any other genus.

Genus identification (mass spectrometry)

Comparison of the mass spectrometer results obtained from exhibit X to an extensive collection of eight different *Dalbergia* species and six other lookalike species indicates that exhibit X is indistinguishable from other members of the genus *Dalbergia*.

Genus identification (near infrared spectroscopy)

Comparison of chemometric analysis results of the near-infrared spectra obtained from botanically identified material of all species of the genus *Swietenia* and six lookalike species (*Cedrela odorata, Erisma uncinatum, Micropholys melinoniana, Carapa guianensis, Eucalyptus grandis, Hymenaea courbaril*) with at least 20 samples of different trees, and three spectra per sample, determines that exhibit X is distinguishable as the genus *Swietenia*.

Species identification (mass spectrometry)

Comparison of the mass spectrometer results obtained from exhibit X to an extensive collection of *Dalbergia* species from all parts of the range indicates that exhibit X is indistinguishable from *Dalbergia cochinchinensis*.

Species identification (near infrared spectroscopy)

Comparison of chemometric analysis results of the near-infrared spectra obtained from botanically identified material of *Swietenia macrophylla* and six lookalike species (*Cedrela odorata, Erisma uncinatum, Micropholys melinoniana, Carapa guianensis, Eucalyptus grandis, Hymenaea courbaril*) with at least 20 samples of different trees, and three spectra per sample, determines that exhibit X is distinguishable as the species *Swietenia macrophylla*.

Species identification (DNA barcoding)

The DNA sequence obtained from exhibit X is characteristic of variants found in *Gonystylus bancanus*. The sequence(s) identified in this report possess a higher degree of homology with the identified species than with sequences that have been reported for any other species.

Geographic provenance identification (dendrochronology)

Using classical tools and methods of dendrochronology, we determined that exhibit X of species *Abies guatemalensis* was felled in region A. We came to this conclusion after matching the tree-ring series of exhibit X with several existing reference tree-ring chronologies on the species in different regions. Those reference tree-ring chronologies were extracted from the International Tree-Ring Database (ITRDB) or published in a peer-reviewed scientific journal [add the publications in attachment of the report].

And

The mathematical variables that describe the match between tree-ring series of exhibit X and the reference chronology of region A confirmed the origin of exhibit X with a 95 per cent probability.

Or

The mathematical variables that describe the match between tree-ring series of exhibit X and the reference chronologies of region A and B show significantly higher values for variables from region A compared to B. Only for region A, the variables confirmed matching tree-ring series with a 95 per cent probability.

Geographic provenance identification (mass spectrometry)

Comparison of the mass spectrometer results to an extensive collection of *Dalbergia* species from all parts of the range indicates that exhibit X is indistinguishable from *Dalbergia sp.* originating from Madagascar.

Geographic provenance identification (stable isotopes)

Comparison of the mass spectrometer results to an extensive collection of *Dalbergia* species from all parts of the range indicates that exhibit X is indistinguishable from *Dalbergia* spp. originating from Madagascar.

Geographic provenance identification (population genetics/ phylogeography)

Substantiating a provenance claim

The DNA profile for exhibit X was Y times more likely to be seen if the tree of origin was growing in Location A, than if it were from Location B.

And

The DNA profile for exhibit X was excluded from originating from a tree in Location B with a probability greater than 95 per cent.

Identifying provenance in the absence of a claim

The DNA profile for exhibit X, when compared against DNA profiles from all geographic locations for which comparative data is available, was found to be most similar to, and not significantly different from, DNA profiles from Location A. In the absence of a claim by the defendant regarding the geographic origin of the exhibit, it is concluded that the probability of observing the DNA evidence is highest, if the exhibit originated from Location A.

And

The DNA profile for exhibit X was excluded from originating from a tree in any other location for which comparative data is available, with a probability greater than 95 per cent.

Age determination (dendrochronology)

Relative age

Using classical tools and methods of dendrochronology, we determined that exhibit X of species *Abies guatemalensis* showed Y annual tree rings. We conclude that the tree from which exhibit X was derived had an age of at least Z years at the time of felling. The true age will be Z plus the number of years the tree took to grow to the height at which exhibit X was taken.

Absolute age

Using classical tools and methods of dendrochronology, we determined that the most recently formed tree ring of exhibit X of species *Abies guatemalensis* can be dated back to year A. As the sample includes bark, this means that the tree of exhibit X was felled in the year A. This date was concluded after matching the tree-ring series of exhibit X with an existing reference tree-ring chronology on the same species and region, available from [insert ITRDB, or data published in a peer reviewed journal] and/or checked against a constructed tree-ring chronology of the same species (stumps) in the forest from which exhibit X originates. The mathematical variables that describe the match between the tree-ring series of exhibit X and the reference chronology confirmed the year of felling with a 95 per cent probability.

Age determination (radiocarbon)

Results from the radionuclide analysis show that the tree from which exhibit X was derived was living after 1952. The most probable years of felling are shown (1980-1985) with a 95 per cent confidence level.

Individualization (dendrochronology)

Specimens W, X, Y and Z were analysed to determine if they are from the same tree by comparing growth-increment widths, increment outlines, and heartwood-sapwood transition. The concordance in measurements between specimens W and Y indicate that they are from the same parent tree. More specifically, specimen Y is a board cut from the [left] side of specimen W, representing growth increments 17-79, counting inward from the bark. Specimens X and Z are not a match to each other or to specimens W and Y.

17. Guidance on presenting as an expert witness

If providing forensic evidence on a case that eventually goes to court, analysts are likely to be required to appear as witnesses at trial. If required to testify, the prosecutor will provide analysts with preparatory information specific to the jurisdiction in question. Alternatively, scientific services might be utilized by a defence team, who should similarly prepare the analyst for appearance in court. As a general Guide, the following principles should be taken into account.

Expert vs. fact witness

In most jurisdictions, analysts providing forensic expertise are considered expert witnesses. An expert witness is qualitatively different to a witness of fact, in that expert witnesses are allowed to give their opinions on matters of which they are an expert. In general, the expert witness must demonstrate the following to the court:

- That the opinion they are giving is relevant to their area of expertise
- That they are an expert in that area based on specific training, study and/or experience
- That the opinion is based on facts which are proved to the court
- How the opinion was derived from those facts
- Impartiality of expert witnesses

Although it is likely that scientific services will have been engaged by law enforcement and the prosecutorial legal team, it is important for analysts to remember at all times that they do not represent the prosecution (or the defence, if their services have been engaged through the defence team). The analyst is not an advocate for the cause of particular parties and must remain completely impartial. The analyst's responsibility is only to the truth of the scientific evidence that is presented. If an expert witness can be shown to be biased or characterized as an advocate rather than an impartial witness, their testimony can be undermined and in some cases rejected as inadmissible.

Reliability of expert witnesses

In attempts to discredit expert witness testimony, opposing counsel can often target the personal lives of expert witnesses, seeking to demonstrate bias, advocacy, dishonesty, poor judgment or criminal behaviour. It is important to realize that no area of an analyst's life is out-of-bounds when it comes to potential questions they may be obliged to answer in court; any publicly available information, including social media profiles and personal websites, can be used to inform questioning. Ideally the suitability of an analyst as an expert witness should be determined in consultation with law enforcement prior to the commencement of any forensic testing.

Part III. Forensic timber identification evidence in court: Information for law enforcement, prosecutors and the judiciary

Part III of the Guide is aimed at law enforcement, prosecutors and the judiciary, and is focused on appropriate considerations when preparing an illegal timber case for court. The information may also be of interest to front-line law enforcement and scientists who would like to better understand the legal importance of the work they do and how they do it. Part III provides an overview of the various forensic identification methods available and key forensic requirements are covered. Specific legal considerations regarding the use of forensic timber identification services are discussed and a final checklist presented.

18. Overview of timber identification techniques and relevant considerations

This section briefly covers each of the available forensic identification methods and presents specific considerations when using this type of evidence. See annex 8 for summary details of which forensic identification methods may be able to answer to specific identification questions.

Wood anatomy

This means of identification is based on visual perception and recognition of macroscopic and microscopic features that are diagnostic to the specific genus (and occasionally species) of timber. Inexpensive identification to genus can be performed comparing wood characters of the timber and comparing them to established reference material.

Considerations:

- The technique must be carried out by a trained and experienced wood anatomist following a standardized protocol.
- The technique can reliably determine the genus of timber in most cases, and the species occasionally.

- The technique cannot determine the provenance of timber, except inasmuch that genera have finite geographical distributions.
- The technique cannot determine the specific individual or age of timber.

Dendrochronology

Identification through dendrochronology is based on examination of periodic growth rings which are laid down in most temperate and some tropical tree species. By comparing the tree-ring series of a sample to reference chronologies from specific regions, it may be possible to determine whether the pattern is consistent with a particular area. It may also be possible to determine the minimum age of a tree by counting its growth rings; if the bark and outermost ring are present, it may be possible to determine when it was felled. Comparisons of tree ring patterns between different wood surfaces can also be used to identify individuals; i.e., the pattern on a log and its associated stump could be positively matched, although this application is seldom utilized due to the variability of tree ring widths.

Considerations:

- The technique must be carried out by a trained and experienced dendrochronologist following a standardized protocol.
- The technique can only be applied to timber that produces growth rings.
- Provenance can only be determined to be consistent (or not) with particular regions where chronologies have been developed; other areas where no chronologies exist cannot be excluded.
- When estimating felling date, factors such as loss of bark, wood decay and lack of ring formation prior to tree death can affect the precision and/or accuracy of results.
- Individual identification can only be definitively determined where the two pieces of wood to be matched (i.e. stump and log) were originally adjacent to one another in the standing tree.

Mass spectrometry

This method of timber identification characterizes extractives laid down during heartwood formation using mass spectrometry to generate a chemical profile or fingerprint. Statistical analyses of these profiles can be optimized to cluster together taxonomically related individuals. Mass spectrometry ionizes chemical compounds to generate charged molecules whose mass-to-charge ratios are measured. Depending on the natural variation in extractives present in the timber samples, various levels of identification may be possible, including genus, species and provenance.

Considerations:

- The technique must be carried out by a trained and experienced chemist following a standardized protocol.
- The technique will only be applicable in taxa where there are detectable diagnostic differences in extractives between groups of interest—more likely to apply to fragrant woods.
- Discrimination at the level of genera is restricted only to those species within each genera used as reference material.

Near infrared spectroscopy

Near infrared spectroscopy (NIRS) measures the absorption spectra of material when exposed to near infrared electromagnetic energy and returns information derived from both the chemical and physical structure of the wood. Raw spectroscopic outputs are rarely directly informative and must be used in conjunction with appropriate multivariate analyses to obtain meaningful results. NIRS can distinguish between individuals of different genera, different species within the same genus and between the same species in different regions.

Considerations:

- The underlying models must be developed by trained and experienced chemists.
- After model development, the method must be carried out by a trained analyst following a standardized protocol.
- Discrimination at the level of genera is restricted only to those species within each genera used as reference material.
- For any given spectral output from an unknown sample, NIRS can only determine its best fit to a reference set of predetermined groups, such as potential species. Thus, if the correct species is not part of the model, it cannot be correctly identified.

Stable isotopes

Chemical compounds synthesized by trees obtain their raw constituent elements from the surrounding environment. Elements generally have multiple naturally occurring isotopes and by looking at the ratios of relative amounts of these isotopes in a given area, an isotopic "fingerprint" for that location can often be determined. By combining multiple stable isotope analyses, the spatial granularity of the isotope signature can be improved. Stable isotope analysis is a technique that can be useful in answering specific compliance questions regarding whether a sample comes from a specific region. It may provide reliable evidence of a geographic area as a sample's source or exclude a geographic area as a source or origin.

Considerations:

- The technique must be carried out by a trained and experienced chemist following a standardized protocol.
- Multiple isotope testing can greatly improve the predictive power of using isotopes in provenance studies.
- The assignment of a sample is based on nearest neighbours, which means that samples with similar isotopic signatures are likely derived from the same place of origin.
- Assignment is not continuous and sampling efforts of reference material from certain regions is low or non-existent (thus, certain areas are statistically inert until comprehensive sampling has been undertaken).
- The utility of stable isotopic signatures derived for one species for identifying the geographic provenance of another has not yet been determined.
- Stable isotopes can be measured separately from different aged tissues and may provide varying results, due to changes over time in environmental and physiological processes.

Radiocarbon

Radiocarbon dating may be used to determine the age of timber. By measuring the ratio of carbon isotopes and comparing to known standards, it is possible to calculate a "radiocarbon age" of organic material. Where a claim is made regarding the age of timber, this analysis can be used to support or disprove the claim. Two samples from different aged tissues (e.g. growth rings) may be required to definitively determine age.

Considerations:

- The technique must be carried out by a trained and experienced scientist following a standardized protocol.
- Radiocarbon analysis of timber will produce a year range for age of the tissue(s) tested; in general, there would be a 95 per cent probability that the year of growth of that tissue occurred within the determined year range.
- As tree species can live for tens to hundreds of years, the part of the tree tested for analysis will have a large effect on the resultant age determination; samples from close to the centre (pith) of the tree will be the oldest;

only tissue taken from the outer most tissue of the trunk will reflect the age of the tree near its felling date.

DNA barcoding

As with almost all biological materials, timber contains DNA that can be recovered and analysed to aid identification. DNA barcoding is built on the premise that particular gene regions show sufficient genetic variation to distinguish taxonomic groups. Two chloroplast gene regions maturase K (*mat*K) and ribulose-bisphosphate carboxylase (*rbc*L) are currently the standard markers for plants; however, they are only able to distinguish approximately 70 per cent of plants and often require local barcodes (additional gene regions) to facilitate determination to the species level. Once DNA from timber has been extracted and appropriate barcoding loci amplified, the resulting DNA sequence is matched against a reference sequence database to infer the taxonomic origin of an evidence sample.

Considerations:

- The technique must be carried out by a trained and experienced biologist following a standardized protocol.
- DNA from timber is generally degraded and amplification of long gene regions is challenging.
- As with any species identification, the sequence should be compared against that from a known voucher specimen.
- The authenticity of reference data used for comparison needs to be established.
- Due to sequence variation within species, the DNA sequence of an evidence item may differ from the reference sequence of that species, without excluding it from belonging to that species. Similarly, in more highly conserved gene regions, the DNA sequence of an evidence item may be identical to the reference sequence of a particular species but instead derive from a closely related but different species. In such situations, the relative level of difference between the evidence sequence and different candidate reference sequences must be considered.

Population genetics and phylogeography

A DNA profile consisting of measurements at multiple DNA markers can be produced from an individual timber sample. This DNA profile may then be assigned to probable geographic origin by comparing it with a database of geo-referenced DNA profiles from individuals of the same species. The data analysis estimates the geographic origin of the DNA profile.

Considerations:

- The technique must be carried out by a trained and experienced biologist following a standardized protocol.
- The DNA profile from the sample must be typed with the same markers as the DNA profiles in the reference database.
- Analyses conducted between laboratories require that allele calls for all loci be calibrated to assure that allele calls between laboratories are identical.
- The assignment of a sample is based on differences among DNA profiles at different locations; it does not take any account of political (national) boundaries.
- The assignment result is not absolute, but rather gives the best estimate with the available data.

DNA profiling for individualization

A DNA profile consisting of measurements at multiple DNA markers can be produced from an individual timber sample. The probability that two trees carry the same DNA profile can be calculated and should be extremely low, except where the tree is clonally propagated. DNA profiles can therefore be used to match a timber sample to a poached timber stump. Counting different DNA profiles allows a minimum count of trees to be made, for example, from numerous processed timber products.

Considerations:

- The technique must be carried out by a trained and experienced biologist following a standardized protocol.
- The strength of evidence associated with matching DNA profiles is associated with the ratio of the probability that the profiles came from the same tree to the probability that they came from different trees and match by chance. The higher the ratio, the stronger the evidence for a true match.
- Close relatives have a much higher chance of sharing DNA profiles than two unrelated trees. This should be considered when matching individual samples.

19. Overview of key forensic requirements

As a preface to this section, and section 20 below, it is important to bear in mind that procedural rules, evidentiary limitations and foundation requirements will differ in each jurisdiction. While certain general considerations are most likely to be applicable across jurisdictional boundaries, the existence of significant differences between different legal systems and traditions cannot be denied. Accordingly, it is imperative that prosecutors check with the appropriate legal authorities in the jurisdiction where laboratory analytical results are to be introduced as to the specific requirements of that jurisdiction with respect to key forensic, evidentiary and procedural requirements.

It is important that prosecutors and the judiciary be aware of the requirements for forensic evidence to be admissible in court and some of the key concepts related to those requirements.

In order for forensic evidence to be admissible, prosecutors must prove that:

- The evidence was legally seized (seizure authority).
- The evidence at trial is the same as the evidence originally seized and representative of the material at issue (chain of custody and sampling plan).
- The evidence was in substantially the same condition when tested as when it was seized (chain of custody).
- The evidence is what the prosecution or defence says it is (forensic analysis).

Seizure authority, previously discussed in part I, is typically a legal question usually decided by a judge in advance of trial. In order for forensic evidence to be admitted, the prosecution must demonstrate that the evidence was lawfully obtained.

Proof of a chain of custody is required when the evidence to be introduced at trial is not unique (e.g. timber) or where the relevance of the evidence depends on its analysis after seizure. Proving proper chain of custody requires three types of testimony: *(a)* testimony that a piece of evidence is what it purports to be; *(b)* testimony of continuous possession by each individual who has had possession of the evidence from the time it is seized until the time it is presented in court; and *(c)* testimony by each person who has had possession that the particular piece of evidence remained in substantially the same condition from the moment that person took possession until the moment that person released the evidence into the custody of another (for example, testimony that the evidence was stored in a secure location where no one but the evidence custodian had access to it).

In some circumstances, it will be impractical to submit all of the evidence for laboratory analysis (e.g. a large timber shipment.) In such circumstances, sampling plans should be used to ensure that samples collected are representative of the evidence at issue (further information on sampling plans can be found in part I, sections 5, 6 and 7).

20. Legal considerations

The judiciary acts as the "gatekeeper" of the evidence presented at trial and determines whether evidence is admissible. When evaluating a case for prosecution, the following evidentiary issues should be considered.

Sampling plan

In many instances it is impractical for law enforcement to request forensic testing of all articles within a shipment. Instead, representative samples of the shipment are selected for analysis pursuant to a sampling plan.

In assessing the appropriateness of a sampling plan, the issue will be whether there was a reasonable attempt to obtain a sample that was representative of the object(s) sampled. In answering that question, a court will consider the following:

- Was the plan reasonable under the circumstances?
- Is there an established sampling plan protocol for timber already recognized and accepted in the scientific community?
- Did the utilized sampling plan adhere to a recognized sampling plan?
- If there was no recognized sampling plan, did the sampling plan utilized follow a logical procedure?

Some randomness in the number of samples taken is less important than that the approach was a good faith effort under the circumstances to obtain representative samples. For example, when developing a sampling plan for a stack of wood planks, samples should be taken from each group of wood that differs in size, appearance and/or location in the load. The sampling plan should not give the appearance that it was subjectively designed to mischaracterize the contents of the wood shipment being sampled. See part I, sections 5. 6 and 7 for further information on the implementation of a sampling plan.

Sampling protocols

Sampling protocols are procedures put in place to ensure that the manner in which evidence is collected does not contaminate or otherwise taint the collected samples. In other words, did the procedures used to take the physical samples from the original shipment allow accurate testing of the material? Or did the method used to obtain the samples skew the subsequent analyses?

Challenges to sampling procedure frequently focus upon how closely the sampling protocol used fits the subsequent laboratory method of identification. Basic cross-contamination prevention procedures should always be followed. In some countries, failure to follow recognized sampling protocols might result in a court's rejection of the entire body of evidence that flows from it. In some jurisdictions, failure to adhere to sampling protocols does not affect admissibility but rather goes to the weight of the evidence, meaning the evidence can be introduced but the trier of fact may consider it less persuasive (see part I, section 7 for further information on sampling protocols).

Shipment of samples

The transportation of samples from the field to the laboratory is another area that can be the subject of legal scrutiny. In short, was the sample that arrived at the laboratory the same sample that was obtained at the crime scene? It is strongly suggested that any sample taken be distinctly marked with a unique number, placed in a sealed bag, and stored securely. A copy of the chain-of-custody form should accompany the samples at all times, through storage and shipment (see part I, section 7 for further information on shipment of samples).

Chain of custody

All forensic casework should be documented and authenticated throughout the analytical process. This documentation forms the basis of subsequent forensic reports and will in most cases be made available to the court and the defence. It should include details of:

- Investigative request
- Chain of custody (evidence receipt and control in laboratory)
- Analytical methods
- Analytical results
- Results interpretation
- Protocols used
- Persons involved

Most legal challenges to the admission of laboratory analytical results arise from the failure to document the procedures used, rather than the results themselves. Therefore, prosecutors should review the forensic case file at the earliest opportunity to identify any issues that might affect the admissibility of laboratory analytical results.

Proof of proper chain of custody is one of the most important facts that must be documented. The custody of samples, like the custody of any other evidence, is a very important part of any investigation and serves as proof of who had what in their possession and when. Proof of proper chain of custody is a prerequisite for the admission of evidence in court. An example of a chain-of-custody form is included in annex 13.

Proof of chain of custody is required for every sample collected that is to be offered as evidence. It requires the careful, chronological documentation of how the evidence was collected to establish its connection to the alleged crime. This includes documenting all the details of its collection, custody, control, transfer, analysis and disposal. From the beginning to the end of the forensic process, it is crucial to be able to demonstrate every single step undertaken to ensure traceability and continuity of the evidence from the crime scene to the courtroom.

Proper chain-of-custody documentation begins with the person who first collects a sample at the scene. Thereafter, every time a sample is transferred, the transaction should be recorded with the date, time and name (typically a signature or initials) of the persons transferring and receiving the evidence item. A chain-of-custody form should maintain a running record of custody for every sample collected from the scene ensuring that the sample is under the control of specified individuals and in a secured location at all times in order to prevent unauthorized alteration, tampering or loss.

Proof of chain of custody also requires the tracking and documentation of every sample received and maintained by a laboratory throughout all laboratory testing procedures.

Attorneys should consider the following chain-of-custody issues when reviewing laboratory case files:

- Were the samples correctly recorded upon arrival to the testing facility including details of their condition and whether seals were present/intact?
- If unique laboratory numbers have been assigned to evidence, can the samples be reliably tracked back their original sample number designations as provided by the agency responsible for collecting the original evidence?
- Can all subsamples be reliably tracked back the original evidence?
- Can the secure storage of samples be demonstrated at all times whilst the evidence was being analysed by the laboratory?

The analytical procedure

One legal challenge to the admissibility of laboratory analytical results is the reliability of the scientific premise underlying the analysis.[2] For example, is microscopic

[2]In some countries the analytical methods to be utilized for the identification of a substance are referenced or included in the regulations by the appropriate overseeing government agency. To date there are no such requirements for wood identification. However, it is important to determine if that condition has changed.

wood anatomical identification a reliable method for reaching the conclusion that the sample is a certain type of timber? Depending upon the jurisdiction, the judiciary may consider a number of issues including:

- Has the analytical procedure been codified?
- If not, is this procedural method accepted in the scientific community?
- Are the results capable of being duplicated?
- Is the method reasonable under the circumstances?
- How great is the margin of error?
- Is the method being misapplied (i.e. the scientific method is reliable for determining a scientific genus, but not a species)?

In common law jurisdictions, this challenge is usually considered a question of law. Accordingly, it is usually raised in preliminary proceedings and decided by the court and not a jury. It may be determined at a hearing where testimony and oral argument is part of the evidence or it may be determined solely through the submission of papers. The prosecutor should internally raise this issue early on with the investigation team and be prepared to identify and introduce the appropriate testimony of expert witnesses, affidavits and/or publications to demonstrate that the analytical procedure used was accurate and reliable.

Laboratory operating procedures and quality assurance

Another basis to challenge the admissibility of laboratory analysis results is the conditions under which the testing was done and whether the laboratory followed its own procedures.

Quality assurance (QA) is the concept of using systems and procedures to control quality and maintain continuous improvement of a product or service. QA is normally ensured in a laboratory testing environment through the design and implementation of a quality management system (QMS). The QMS includes all of the protocols, standard operating procedures, method validation documents and reporting criteria that are operated by a laboratory.

In order to demonstrate that a laboratory has established and follows a QMS, the laboratory may seek accreditation by an external assessment body under one of a number of international standards. ISO/IEC 17025 is the standard that describes the requirements for the competence of testing and calibration laboratories, and it is the main international standard to which laboratories undertaking forensic science testing services become accredited. However, accreditation is time consuming, expensive and requires dedicated internal resources that many small wildlife/timber forensic laboratories may not be able to commit. An alternative to formal accreditation has been developed by the Society for Wildlife Forensic Science in the form of Standards and Guidelines for forensic analysts performing botany identifications using morphology, anatomy, DNA or chemistry (SWFS Standards and guidelines for forensic botany identification, available from www.wildlifeforensicscience.org/swgwild/swgwild-work-products).

Regardless of accreditation status, laboratories should have written, standard operating procedures (SOPs) for each analytical method they employ and most legal challenges to laboratory procedures will focus on this area.

Attorneys should consider the following standard operating procedural issues when reviewing laboratory case files:

- For the test methods applied to the evidence, do SOPs exist that precisely define how a test should be performed and how the results should be analysed and interpreted, including considerations of possible sources of error and conditions that may affect the accuracy of the results?
- Were test methods validated prior to use and are the validation protocols and reports available for inspection? Test methods should ideally be published in peer-reviewed scientific journals before use in forensic analysis and can be accredited.
- Were all sample required preparatory steps undertaken prior to analysis (e.g. timber samples ground into a powder, mixed with a buffer solution etc.)?
- Was all equipment used in the analyses appropriately maintained (e.g. calibration and cleaning schedules adhered to and documented)?

Laboratories may or may not be accredited for the particular sampling method or procedure used for a particular analysis, and lack of accreditation may be used by the defence to argue that the analysis is unreliable and should not be admitted into evidence. Laboratory accreditation can be an expensive proposition; hence, in most cases, a laboratory only obtains accreditation for analytical procedures it does routinely. Very few laboratories have accreditation for a wide range of procedures.

Cross-examination often focuses upon a laboratory that has employed a procedure for which it has not obtained accreditation. This is relevant because many timber identification procedures are relatively new, not routinely applied and accordingly not accredited. However, lack of accreditation should not be fatal to the case, as long as the proper procedures required for the particular analysis were followed; it is simply another area for raising doubt concerning the accuracy of the analytical results.

One way to counter the argument that the application of a non-accredited procedure is not valid may be to use procedural analogies. For example, the timber analytical procedure (or part of it) may be similar to the procedure used for a comparable type of analytical test for which the laboratory is accredited. Therefore, the basic science is not new; its applicability has simply been broadened. In presenting new analytical procedures there are usually some factors that are useful in establishing reliability and providing such evidence should be sufficient to answer most questions of admissibility based upon reliability of the science objections. Useful information for establishing reliability may include:

- Evidence of peer review
- Evidence of known error rate
- Evidence of reproducibility of results

Presentation of the laboratory analytical results in a judicial proceeding

Having satisfied the threshold questions of reliability, integrity and accuracy of sampling and analysis, the issue next becomes one of interpretation and presentation. Ultimately, laboratory analytical results need to be interpreted or explained to the trier(s) of fact (judge and/or jury). This requires an "expert" witness who can testify about his or her opinion as to the significance of the results when applied to the facts of the case.

Most witnesses at a trial are "fact" witnesses, meaning that they can only provide testimony as to what they personally experienced or observed. Expert witnesses, on the other hand, are permitted to testify as to their professional opinions concerning facts that they may not have directly experienced, but that they are qualified to interpret based upon their training, skill, education or experience. In most jurisdictions, a witness has to be qualified as an expert witness before being allowed to express an opinion. Whether a witness is qualified as an expert is established through a series of foundation questions regarding the witness' background.

One of the most common areas of cross-examination of expert scientific witnesses concerns the witnesses' degree of certainty in his or her opinion. Most scientists do not speak of scientific results in terms of 100 per cent accuracy. They are used to dealing with degrees of certainty and margins of error. However, at a trial accuracy and certainty are the issues by which all evidence presented is weighed. The less certain the witness is about their testimony, the greater the probability that it will be questioned and challenged. Accordingly, it is essential that the attorney and the scientist spend some time discussing these issues in preparation for trial. Often a compromise can be reached with which both sides can be comfortable regarding the manner in which the evidence is presented.

Checklist of considerations when dealing with forensic evidence

- Was the evidence legally obtained?
- Was the evidence collected pursuant to an appropriate sampling plan?
- Was proper chain of custody of samples maintained and documented?
- Was analytical testing performed pursuant to proper laboratory SOPs?
- Was a comprehensive forensic case file maintained?
- Was the employed test fit for purpose and did a competent authority approve it?
- Was the test performed by a competent person with sufficient training and experience in that type of test?
- Were alternative interpretations of the data considered?

Part IV. International cooperation

The illegal trade in timber transcends national boundaries; its transnational nature necessitates a common and coordinated global response. Cross-border cooperation is required to ensure the appropriate identification, investigation and prosecution of forest offences. International cooperation is required not only within legal authorities and the scientific community, but between legal and scientific communities as well.

Figure 7. International cooperation stakeholders

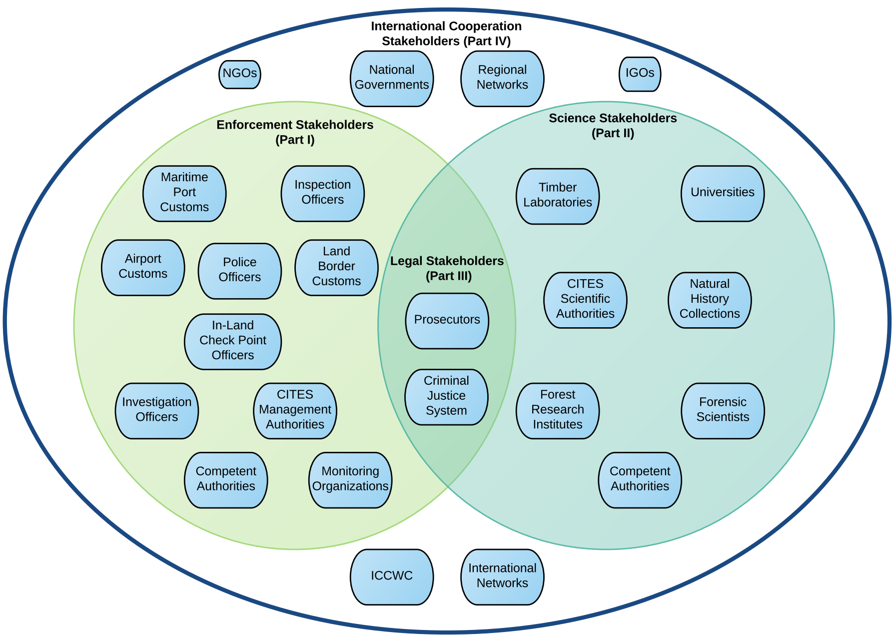


Figure 7 illustrates the multitude of stakeholders to be potentially engaged for effective international cooperation, and facilitates an understanding of the complementarity of actors and areas of expertise, as well as the complexity and need for cooperation.

The development of this Guide aims to provide support towards achieving a standardized approach that will underline and facilitate international cooperation in response to the challenges faced in tackling the illegal trade in timber at the global level. Part IV covers relevant international legal frameworks, which form the basis for cooperation between countries and at the global level for regulation, communication, exchange of information and mutual assistance to tackle transnational organized crime. Part IV outlines some of the benefits, challenges and opportunities to improve cooperation, communication and collaboration internationally. In addition, information is provided on networks, mechanisms and other tools and services available for countries and individuals seeking to obtain legal or scientific assistance from another country.

21. International legal frameworks

For international judicial cooperation or international cooperation between law enforcement agencies, domestic or international frameworks are required that provide a legal basis for seeking assistance from another country. Domestic laws detailing the requirements and mechanisms for mutual legal assistance in criminal matters are available in most jurisdictions. Bilateral agreements can be concluded for general enforcement issues or for more specific purposes associated with the tackling of wildlife and forest crime. Instruments such as the United Nations Convention against Transnational Organized Crime and the United Nations Convention Against Corruption, can be of assistance, subject to the conditions of their applicability.

Convention on International Trade in Endangered Species of Wild Fauna and Flora

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is a multilateral treaty to protect endangered plants and animals. With 182 Parties, CITES remains one of the world's most powerful tools for biodiversity conservation through the regulation of international trade in wild fauna and flora. CITES regulates international trade in over 35,000 species of plants and animals, including their products and derivatives, ensuring their survival in the wild through strictly regulating legal trade and combating illegal trade. The degree of monitoring and protection status given to a species depends on whether the species is listed under CITES appendix I, II or III. Appendix I-listed species are generally prohibited from trade, while appendix II is subject to controls and determination of sustainability of the species in the wild, and appendix III listings are requests of CITES Parties for assistance in monitoring trade in species traded from their country.

Although CITES is legally binding on the Parties, it does not take the place of national laws. Rather it provides a framework to be respected by each Party, which has to adopt its own domestic legislation to ensure that CITES is implemented at the national level. Several strategies have been developed to deal with infractions by Parties, the most severe under its compliance measures is a recommendation to suspend trade by the CITES Standing Committee.

An important element of the CITES framework is the creation or identification of national agencies charged with the administration and execution of CITES obligations. Article IX, paragraph 1 *(a)*, specifies that each Party to the Convention is required to designate a domestic agency mandated with the management of CITES. Its responsibilities include the:

- Authorization and issuing of permits and certificates of approval
- Communication of information to other Parties and the CITES Secretariat
- Reporting on CITES compliance matters

The way in which the Management and Scientific Authorities are designed and designated is left to the discretion of the individual Party.

United Nations Convention against Transnational Organized Crime

The United Nations Convention against Transnational Organized Crime—also known as the Palermo Convention—is the main instrument in the fight against transnational organized crime, including illegal trade in fauna, flora, and their parts and derivatives. At the time of its adoption, the General Assembly of the United Nations, in the preamble to its resolution 55/25 of 15 November 2000, recognized the Convention as "an effective tool and the necessary legal framework for international cooperation" in combating such criminal activities as the illegal trafficking of protected species of wild flora and fauna, in furtherance of the principle of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

The Convention against Transnational Organized Crime adopts a flexible approach, which takes into account the seriousness of the acts it covers, rather than limiting itself to a predetermined and rigid list of offences. Its broad scope enables its application to offences established by it and its Protocols (article 37) and any other serious crime (as defined in article 2), where the offence is transnational in nature and involves an organized criminal group (article 3).

Pursuant to article 3, paragraph 2, an offence is transnational in nature if: *(a)* it is committed in more than one State; *(b)* it is committed in one State, but a substantial part of its preparation, planning, direction or control takes place in another State; *(c)* it is committed in one State, but it involves an organized criminal group that engages in criminal activities in more than one State; or *(d)* it is committed in one State but has substantial effects in another State.

The Convention also defines an "organized criminal group" as a structured group of at least three persons, existing for a period of time and acting in concert with the aim of committing one or more serious crimes or offences established in accordance with the Convention, in order to obtain a financial or other material benefit (article 2).

Pursuant to article 2, paragraph *(b)*, of the Convention, "serious crime" means conduct constituting an offence punishable by a maximum deprivation of liberty of at least four years or a more serious penalty. The definition of serious crime, thus, does not contain any requirements in relation to the gravity, motivation or content of the offence, other than the criminal penalty (at least four years of imprisonment) associated with it. Consequently, the inclusion of the notion of "serious crime" in the Organized Crime Convention enables the application of the Convention to a broad range of offences, including illegal trade in fauna, flora, and their parts and derivatives, in particular for international cooperation.

States may also find that new forms and dimensions of transnational organized crime, such as that of illegal trade in fauna, flora, and their parts and derivatives, may pose more challenges to effective investigations and prosecutions, and to international cooperation than more traditional ones. That is an additional reason for exploring methodologies to analyse, pursuant to article 28 of the Convention, trends in organized crime in their territory, the circumstances in which organized crime operates, as well as the professional groups and technologies involved, and sharing such analytical expertise with each other and through international and regional organizations.

In the area of international cooperation, the provisions of the Convention against Transnational Organized Crime are aimed at playing a key role in harmonizing obligations and addressing legal gaps in the field of international cooperation in criminal matters. The Convention provides a basis for extradition (article 16) and mutual legal assistance (article 18), as well as other forms of cooperation, such as joint investigations (article 19) and controlled deliveries (article 20), in addition to obligations resulting from other bilateral or multilateral agreements related to international cooperation in criminal matters into which States Parties have entered.

As of May 2016, the Convention has been ratified, or acceded to, by 186 Member States in recognition of the seriousness of the problems posed by organized crime, as well as the need to foster enhanced international cooperation. The Convention also seeks to streamline the coordination of national legislative, administrative and enforcement measures relating to transnational organized crime, and to ensure a more efficient and effective global effort to prevent and suppress it.

United Nations Convention Against Corruption

In order to assess the applicability of the United Nations Convention Against Corruption is useful to bear in mind that corruption can occur at all stages of a process of exploitation of natural and other resources—before, during and after.

The United Nations Convention Against Corruption can provide an important legal basis for combating forest offences connected with corrupt practices. This Convention, which is the first global legally binding instrument against corruption, builds on the precedent of the Convention against Transnational Organized Crime and incorporates a substantial number of similar provisions. As of May 2016, the United Nations Convention Against Corruption had 178 States Parties.

The Convention sets out a great range of preventive anti-corruption measures and measures relating to criminalization and law enforcement, international cooperation, asset recovery, technical assistance and information exchange.

The Convention contains a comprehensive set of preventive measures aimed at establishing integrity, transparency and accountability that can help to curb corruption in the agencies involved in the fight against forest offences, such as law enforcement agencies, customs, wildlife and forestry departments, but also prosecutors and the judiciary.

The Convention also includes a comprehensive set of criminalization provisions, both mandatory and optional, covering a wide range of acts of corruption. By virtue of article 65, paragraph 2, of the Convention, each State party may adopt more strict or severe measures for preventing and combating corruption. Therefore, the Convention does not hinder the adoption and implementation of criminalization measures with a wider scope, encompassing a much broader range of crimes or offences against the public administration, or even private interests, related to corruption.

The comprehensiveness of the international cooperation provisions of the Convention Against Corruption, which build on the precedent of the corresponding provisions of the Convention against Transnational Organized Crime, provides further added value. Article 46 of the Convention Against Corruption, on mutual legal assistance, is a typical example of what may be called a “mini mutual legal assistance treaty”. In addition, article 44 of the Convention sets a basic minimum standard for enhancing the efficiency of extradition mechanisms in relation to the offences established by the two conventions. Furthermore, chapter V (Asset recovery) of the Convention contains comprehensive provisions laying down specific measures and mechanisms for cooperation in asset recovery.

Within the context of the first review cycle of the Implementation Review Mechanism of the United Nations Convention Against Corruption, particular attention has been given to the structure and role of central and/or competent authorities as key institutions for the effective implementation of chapter IV of the Convention on international cooperation. Some States Parties give their central authority a purely administrative role, whereby the authority is only in charge of receiving and sending mutual legal assistance requests, while in other States parties, central authorities may be responsible for the execution of requests, the substantive coordination or the follow-up to the request among national institutions. Those different roles have an impact on the communication of the central authorities with their foreign counterparts and on their participation in regional or international cooperation networks that might help to facilitate the mutual legal assistance process.

22. Factors impacting international cooperation

In order to enable effective international cooperation, multiple factors should be considered. These range from a country's capacity to respond to major timber seizures, to the benefits of cooperating with other countries and regions, and should include considerations on support that might be needed as well as any potential barriers that could be encountered.

National capacity

In considering this Guide, countries should reflect on the following areas considering the strengths and challenges at the national level to enable streamlined and effective collaboration and the support required:

- How would my country respond to a major seizure of illegal timber? Does my country have the forensic and scientific capabilities to follow these best practices?
- If my country cannot follow these best practices, what assistance can it obtain from international partners? Where can my country get information about potential international partners and how should they be approached?
- What is my country's long-term plan for building the necessary national capacity? What organizations or institutions could assist in creating and implementing a long-term plan for training and capacity-building?

The following are some questions for authorities to consider when determining their country's national capacity to use forensic methods to combat wildlife and forest crime:

- Are dedicated crime scene investigation services available?
- Are first responders trained and equipped to isolate and protect scenes of illegal timber and forest crime?
- Who is called first when a potential offence is discovered?
- Is there a procedure for requesting technical expertise?
- Do investigators have access to crime scene investigation kits and materials?
- Do investigators preserve crime scenes so that they remain suitable for forensic examination?

- Are investigators trained in what to look for and are they aware of the potential and limitations of forensic examinations and evidence?
- Are investigators familiar with forensic evidence gathering procedures, preservation of evidence and chain of custody? If not, can investigators access crime scene investigation training?
- Do responsible officers have a mechanism for sharing seizure information with INTERPOL?
- Are there national forensic laboratories and qualified staff to analyse the samples? If not, are there laboratories in other countries willing to provide analysis services?
- Which agency facilitates the analyses?
- Do enforcement officers, customs and the police responsible for wildlife and forest investigations have access to existing forensic laboratory services and facilities?
- Does the laboratory have a quality-management system in place and does it work according to accredited or recognized best practice standards?
- Are there external reviews and audits of laboratory work in order to ensure that techniques are implemented correctly?
- What forensic support is available? (For example, anatomical analysis, chemical profiling, genetic profiling.)
- Are laboratory personnel trained in the mechanisms of prosecutions and the presentation of evidence in court?
- Are there national databases for forensic data from wildlife and forest offences?
- Do national enforcement action plans and budgets make provision for the collection and submission of samples to designated forensic laboratories?

While the provision of advice on establishing forensic laboratory facilities lies outside of the scope of this guide, it is recognized that many countries are still at a stage of developing such capacity and that this represents a significant investment in national infrastructure. A number of different models exist for establishing timber forensic services, from conversion of existing research facilities through to the construction of dedicated laboratories (see [108] for a discussion on the options specifically for DNA identification laboratories). Sharing forensic service provision across multiple agencies within a country, or at a regional level between countries should also be considered. Organizations such as SWFS, ITTO/CITES, UNODC and TRACE have a mandate to advise on forensic capacity-building, and have extensive experience in the practicalities of setting up forensic wildlife and timber laboratories. Consultation with such international expertise should be initiated in the early stages of laboratory development.

Benefits of cooperation

“International cooperation should be seen as an opportunity rather than an obstacle” [109]. Benefits of bilateral cooperation at the regional or international levels include:

- Capacity-building and training from partnerships with advanced research institutions and crime investigation experts
- Possible financial support for sampling and/or laboratory equipment (instruments and manpower)
- Possible partnerships in research activities
- Mutual support for law enforcement operations to disrupt crime networks in the country (or countries)
- Assistance to address the challenging seizure event
- Support in protection of forests through joint conservation activities with relevant organizations and networks

Potential challenges

Officials in a country involved in large-scale timber seizures might encounter a number of challenges, particularly related to the size of the seizure, which could include:

- Securing the seized timber to preserve evidence
- Adequate, secure storage facilities for the seized exhibits
- Extracting, documenting and processing forensic evidence
- Collecting timber samples for forensic analysis
- Processing samples or shipping them to processing labs
- Adequate financial budgets to cover the costs of storage, handling, shipment and laboratory analysis
- Subsequent investigations and prosecutions
- Provisions for transit, import, export and re-export of the samples, e.g. CITES permits
- Deciding about further actions, such as controlled deliveries or dispatch of targeted law enforcement to identified illegal logging hotspots

Challenges may also arise in connection with forensic method development and related research projects, including:

- Collecting timber samples for forensic analysis, including documentation

- Processing samples or shipping them to processing laboratories in other countries
- Covering the costs of handling, shipment and laboratory analysis
- Provisions for transit, import, export and re-export of the samples, e.g. CITES permits

While countries can benefit from international cooperation, there are potential barriers that can hinder the process, such as:

- National sensitivities or restrictions to accepting international assistance in general or from specific countries
- Reluctance to release laboratory results that might be perceived as having other intellectual property value
- Considerations on export or import of timber as either scientific research objects or law enforcement exhibits
- Restrictions against releasing material from a crime scene to an institution in another country for forensic analysis
- Stricter domestic measures on national implementation of CITES adopted in some countries
- Delayed access to seized timber for forensic analysis
- Sensitivities about loss of control over use of expatriated timber samples
- Concern about destructive sampling of timber
- Restrictions on international information-sharing about crime suspects
- Barriers to the international transfer of physical evidence
- Lack of relevant information related to a specific timber seizure that can be shared for research activities
- International agreements on the exchange of genetic material that can become an obstacle to trade samples for scientific research or forensic work

23. Scientific areas requiring international cooperation

To increase global capacity in forensic timber identification, a set of priority areas and associated actions have been identified that should be addressed through international cooperation and collaboration in science.

Reference sample collections

The development and application of forensic timber identification methodologies generally requires access to high quality reference material. For most disciplines, this is required in the form of timber, similar in character to those materials expected to be received for casework, e.g. if heartwood is likely to be encountered in trade, scientists will usually require heartwood reference samples to develop forensic identification tests. There is a need to improve the quantity, quality, and access to scientific reference materials both nationally and internationally (see section 12 for more information). Actions towards this goal should include:

- Collaborative reference sample collection efforts, e.g. [110]. Accessing remote locations usually poses the greatest challenges to collection efforts, not least due to the expense incurred. By maximizing the suites of species and kinds of samples and information collected, and curating collections in a way that allows maximum utilization, greater returns on collection effort investments can be achieved.
- Streamlining the permit system for the collection, exchange and loaning of reference material. The collection and sharing of reference materials is crucial to the development of forensic timber identification technologies, however the processes in place to facilitate export of samples, especially for CITES species, are often time and resource intensive, sometimes resulting a complete inability to obtain the required reference materials. Streamlining of these processes would facilitate more research into forensic timber identification methods.
- Digitization and online access to collection records. The digitization of existing records can provide a fast and accurate way to share reference data without requirements for permits. Although some resources exist (see annex 16), greater utilization of these resources should be encouraged, both in terms of using and contributing data. However, great care is required in curation of data to ensure that they are fit for purpose.

Technical capacity

There is a need to increase the technical capacity of scientists, law enforcement personnel and industry to identify timber. A greater capacity in this area would improve correct identification at the point of harvest, increase illegal timber detection and subsequent prosecution rates, and facilitate the effective exchange of information and knowledge between entities and authorities. Actions towards this goal should include:

- Wood scientists should be trained for routine identification work.
- Metrics for wood scientists doing identification work should be developed to improve recognition of their value.

- Within-forest identification should be improved through training of loggers (incorporating indigenous local knowledge and parataxonomy). By training legitimate loggers to better identify trees in the field, harvesting of the correct species can be increased and species information can more easily accompany the timber along supply chains.
- Research should be undertaken to support the development of techniques for identifying the components of wood composite materials (see annex 2).

Forensic science capacity

There is a need to increase the capacity of experts in timber identification to undertake their work in a forensically sound manner, to ensure that results are appropriate for use in supporting legal cases. Through international cooperation, approaches can be standardized to ensure that information can be exchanged meaningfully and that the quality of results is consistent between jurisdictions. This Guide presents a significant step forward in this area, and further actions should include:

- Forensic validation studies to be completed for all timber identification methods
- Coordination of proficiency testing programme(s) in forensic timber identification
- Increase uptake of suitable forensic standards and guidelines for laboratory identification work (see SWFS Standards and guidelines for forensic botany identification, available from www.wildlifeforensicscience.org/swgwild/swgwild-work-products)

Coordination

There is a need to improve the overall coordination of efforts in the space of forensic timber identification in order to maximize synergies and collaborative opportunities and minimize redundant efforts. Greater coordination would improve correct identification at the point of harvest, increase illegal timber detection and subsequent prosecution rates, and facilitate the effective exchange of information and knowledge between entities and authorities. Actions towards this goal should include:

- Support efforts that further integrate major international stakeholders
- Actively engage with the private sector to develop policies and technologies relevant to timber forensic identification
- Ensure that future work focuses on species of importance within the timber trade, including both CITES and non-CITES-listed taxa

24. Legal areas requiring international cooperation

In investigating and prosecuting timber crimes, legal personnel cannot afford to be focused only on the law enforcement and scientific tools available within their own countries. Increasingly, assistance must be sought from other countries to successfully investigate and prosecute cases. Criminals engaged in timber crime do not respect borders. To the contrary, they use geographic boundaries to conceal their illegal activities and to provide safe havens for themselves and assets derived from their crimes. Therefore, effective investigators and prosecutors must develop a working knowledge of foreign laws and legal standards and the tools available to secure evidence and witness testimony from witnesses in other countries.

For example, prosecution in multiple countries is often necessary to deter both the supply and demand sides of timber crimes. However, the laws, required evidence, and burdens of proof necessary to obtain a criminal conviction can vary widely from country to country. In addition, these prosecutions usually involve the same physical evidence. Therefore, it is important to understand the legal standards applicable in each country that may bring a prosecution to ensure that they do not do anything that might preclude prosecutions in other countries (e.g. destruction of evidence during testing).

Some areas that frequently require international cooperation include:

- Obtaining documentary evidence
- Witness interviews
- Conducting depositions
- Subpoenas
- Gaining custody of targets
- Recovering assets and proceeds of a crime
- Interpretation of the national laws of an exporting country and of grounds for violation

Sovereignty issues

Improper efforts by an investigator or prosecutor to investigate crime or gather evidence in a foreign country can be considered a violation of that country's sovereignty, which can result in diplomatic protests, denial of access, or even arrest. Sovereignty is legal concept that holds a government possesses full control over its affairs within its country, without any interference from outside sources or bodies. There are several methods that prosecutors and investigators can use to obtain the aid of a foreign country without raising sovereignty issues.

Making contact with foreign agencies—informal

Person-to-person contacts are often the quickest way to get information from another country. Obtaining information in real time can also help a prosecutor determine whether a more formal request would be useful.

Examples of the sort of useful information that can be obtained through informal contacts include:

- Identification of targets and witnesses
- Interviews by local police
- Location of assets and property
- Criminal histories

Pre-existing contacts are usually the best way to make informal contact with counterparts in other countries as there is already a rapport and basis of trust between the two parties. Establishing these relationships before a case arises is strongly encouraged. By establishing such contacts proactively, through trainings, conferences and other international capacity-building activities, a prosecutor can ensure that foreign assistance will be available when needed.

If an investigator or prosecutor does not have a pre-existing contact in a foreign country, he can also submit a request for assistance via INTERPOL through his country's National Central Bureau (NCB). They will then make contact with the other country's NCB, who will make sure the request gets to the appropriate agency.

While the informal route is often the quickest way to obtain information, it has one significant drawback. Evidence obtained informally is usually not admissible in court, as the rules of evidence in most countries require that testimony and evidence be offered only through a live witness. In addition, this informal method does not provide an enforcement mechanism, such as the ability to enforce a subpoena for a witness to testify in another country. As a result, prosecutors must turn to more formal methods to obtain admissible evidence and ensure the appearance of witnesses at trial.

Making contact with foreign agencies—formal

Letters rogatory

One formal method of obtaining admissible evidence and testimony involves the use of letters rogatory. Letters rogatory are requests from courts in one country to the courts of another country for the performance of an act which, if done without the sanction of the foreign court, could constitute a violation of that country's sovereignty. Letters rogatory may be used to effect service of process or to obtain evidence if permitted by the laws of the foreign country. They are the customary means of obtaining judicial assistance from another country in the absence of a treaty or other agreement.

Before initiating the letters rogatory process, prosecutors should determine whether the country where they are seeking to serve process or take evidence is a party to any multilateral treaties on judicial assistance, such as the Hague Service or Evidence Conventions, or the Inter-American Convention on Letters Rogatory and Additional Protocol. Streamlined procedures for requesting judicial assistance under these conventions greatly reduce the time and burden associated with traditional letters rogatory. (See below–MLAT requests.)

Typically letter rogatory requests must contain the following information:

- A statement that a request for international judicial assistance is being made in the interests of justice
- A brief synopsis of the case, including identification of the parties and the nature of the claim and relief sought to enable the foreign court to understand the issues involved
- The type of case, e.g. civil, criminal, administrative
- The nature of the assistance required, e.g. compel testimony or production of evidence, service of process
- Name, address and other identifiers, such as corporate title, of the person overseas to be served or from whom evidence is to be compelled, documents to be served
- A list of questions to be asked, where applicable, generally in the form of written interrogatories
- A list of documents or other evidence to be produced
- A statement from the requesting court expressing a willingness to provide similar assistance to judicial authorities of the receiving State
- A statement that the requesting court or party is willing to reimburse the judicial authorities of the receiving state for costs incurred in executing the requesting court's letters rogatory

Unfortunately, the letters rogatory process is lengthy. Execution of letters rogatory may take a year or more. Letters rogatory are customarily transmitted via diplomatic channels, a time-consuming means of transmission.

In addition, foreign courts will generally execute letters rogatory in accordance with the laws and regulations of the foreign country. In compelling evidence, for example, many foreign courts do not permit foreign attorneys to participate in their court proceedings. Not all foreign countries utilize the services of court reporters or routinely provide verbatim transcripts. Sometimes the presiding judge will dictate his or her recollection of the witness' responses, which may not be considered competent evidence in other countries. A further complication is that letters rogatory assistance is often restricted to securing evidence and testimony only for trial rather than during the investigation.

Lastly, letters rogatory are only requests from one court to another. Foreign courts are not required to provide the requested assistance. For these reasons, prosecutors may prefer to obtain evidence and testimony through the use of mutual legal assistance treaty requests.

Mutual legal assistance treaties

A mutual legal assistance treaty (MLAT) is an agreement between two or more countries that allows for the exchange of evidence and information in criminal matters. MLAT requests are requests for assistance in obtaining evidence for criminal investigations and prosecutions, such as witness statements and the service of documents. Such assistance may also take the form of examining and identifying people, places and things, custodial transfers, and the immobilization of the instruments of criminal activity.

Unlike letters rogatory, MLAT requests are not made to, or through, the courts. Instead they are made through the designated "central authority" of each country. Terms of an MLAT can vary—for example, some MLATs exclude specific types of crimes. One advantage of MLAT requests is that assistance is usually obligatory. Another is that MLAT assistance is available during both the investigative and trial stages of a case.

Summary of international issues and solutions that can arise in a criminal prosecution

This section has covered just some of the many international issues and solutions that can arise in a criminal prosecution. The important practice pointers for investigators and prosecutors are:

- Consider potential adverse consequences their actions might have on related cases in other countries.
- Become familiar with different tools, both formal and informal, available to secure evidence and witness testimony from foreign countries.
- Work proactively to develop relationships with relevant international partners so that they have resources they can access when specific cases arise.

25. Support available: networks, tools and communication mechanisms

One of the most effective means of facilitating international cooperation is through regional and international coordination mechanisms and networks. At the operational level, regional cooperation arrangements may include the designation of international cooperation focal points, communication of national requirements and procedures for cooperation, creation of secure communication channels or platforms, and mechanisms for handling cases and sharing experiences between authorities of participating States. Such activities may focus on the facilitation of formal judicial cooperation and informal or formal law enforcement cooperation and intelligence-sharing. Those activities are not necessarily dependent upon a treaty basis and may exist alongside or in the absence of regional cooperation treaties.

In general, regional cooperation networks can play a significant role in pursuing transnational or regional approaches to criminal investigations, whether these networks comprise of enforcement personnel, scientists or multidisciplinary groups. Regional networks enhance personal contacts, build mutual trust between practitioners and are conducive to forming a better understanding of their respective legal and scientific procedural and operational requirements.

This section outlines some of the numerous networks, mechanisms and tools currently available to facilitate regional and international cooperation and communication, for enforcement and for science. Their functions range from awareness-raising, capacity-building and best practice implementation to the handling of country- or region-specific and transnational crime cases. Listing all those available is beyond the scope of this Guide; however, a selection of those considered most relevant to tackling timber crime are elaborated below.

International Consortium on Combating Wildlife Crime

Established in 2010, the International Consortium on Combating Wildlife Crime (ICCWC) is the collaborative effort of the CITES Secretariat, INTERPOL, UNODC, the World Bank and the World Customs Organization, working to bring coordinated support to the national wildlife law enforcement agencies and to the subregional and regional networks that, on a daily basis, act in defence of natural resources (for more information see www.cites.org/eng/prog/iccwc.php). Improving cooperation is at the centre of the ICCWC mission "to provide a catalyst for significantly enhanced global cooperation and capacity to combat wildlife and forest crimes". The ICCWC Strategic Programme 2016-2020 identifies improving the use of knowledge and innovation to inform contemporary approaches to wildlife and forest crime as a focus area for ICCWC activities. Increasing the use of forensic technology is highlighted as a priority area for action in 2016-2020 and ICCWC will offer support to countries as necessary.[3]

ICCWC's collective efforts to promote international cooperation as well as the tools and support available from the individual partner organizations, are outlined below.

Wildlife Incident Support Team

CITES 16th Conference of the Parties adopted Decision 16.40, paragraph a) on Enforcement matters calling for the deployment of Wildlife Incident Support Teams (WISTs), composed of enforcement staff or relevant experts, to be dispatched at the request of countries affected by significant poaching of CITES specimens, or that have made large-scale seizures of such specimens, to assist, guide and to facilitate appropriate follow-up actions in affected countries in the immediate aftermath of an incident. WISTs can be deployed by ICCWC upon request and subject to available resources. In particular, such deployments could be mobilized to provide assistance with investigative support, evidence collection and/or assistance to pursue forensic analysis.

Requests for the deployment of a WIST can be directed to the CITES Secretariat or to the INTERPOL General Secretariat via the INTERPOL National Central Bureau of the country concerned. It is of utmost importance that seizures be treated as a crime scene and be appropriately preserved until arrival of the international expert assistance team.

ICCWC Wildlife and Forest Crime Analytic Toolkit

The ICCWC Wildlife and Forest Crime Analytic Toolkit [109] is a technical resource that assists Member States to complete a national analysis of current preventive and criminal justice responses related to wildlife and forest crime. The Toolkit assists in evaluating the following areas relevant to combating wildlife and forest crime:

- Legislation
- Law enforcement matters
- Prosecutorial and judicial capacities
- Factors that drive offences and the effectiveness of preventative interventions
- The availability and analysis of data and other relevant information

[3]See focus area 5 of of the ICCWC Strategic Programme 2016-2020, www.cites.org/sites/default/files/eng/prog/iccwc/ICCWC_Strategic_Programme_2016-2020_final.pdf

Using analysis results, ICCWC and relevant authorities identify key areas for strengthening the national response to wildlife and forest crime. ICCWC uses results to design specific work plans for national capacity-building and technical assistance.

CITES Secretariat

The CITES Secretariat has a pivotal role to assist CITES Parties implement the Convention[4] and offers a variety of tools, expertise, documents and training. A number of these are highlighted below.

Legislative assistance

The Secretariat has developed a template for a model law[5] on international trade in wild fauna and flora that can be used by States Parties in order to develop new, and analyse existing, legislation. The Secretariat has also issued a legislation checklist[6] to review domestic CITES laws. It contains 70 items for review that are based on resolutions of the CITES Conference of Parties and on the “Guidelines for legislation to implement CITES”. The checklist contains items relating to the general design and application of domestic CITES laws; management and scientific authorities; permit requirements; the form and validity of permits and certificates; the revocation, modification and suspension of permits; exceptions to permit requirements; border controls; the control of consignments and permits; enforcement and penalties; the disposal of confiscated specimens; the acceptance and refusal of foreign permits; reports; and financial matters. The Convention’s primary mechanism for encouraging and assisting Parties’ legislative efforts is through its National Legislation Project, the aim of which is to ensure that all Parties have a solid legal foundation for regulating international wildlife trade.[7]

CITES Virtual College

The CITES Virtual College, hosted by the International University of Andalusia, has become an essential resource in efforts to enhance capacities of Parties, increase awareness of the Convention and provide learning and training materials on CITES. It includes a number of interactive courses and training materials online and can be accessed via the CITES website.[8]

[4] www.cites.org/eng/disc/sec/index.php

[5] www.cites.org/sites/default/files/eng/prog/Legislation/E-Model%20law-updated-clean.pdf

[6] www.cites.org/sites/default/files/eng/prog/Legislation/ChecklistEN.pdf

[7] www.cites.org/legislation

[8] www.cites.unia.es/cites/

Directory of enforcement focal points

National focal points have been identified to improve collaboration and communication on a number of specific enforcement issues between agencies responsible for wildlife law enforcement in different countries. The Secretariat has prepared a directory of wildlife enforcement network focal points and a directory of national enforcement authority focal points, to facilitate increased collaboration at the subregional, regional and international levels.[9]

CITES – ITTO Programme

CITES is undertaking significant work in partnership with the International Tropical Timber Organization (ITTO) to assist countries to implement forensic and non-forensic timber identification and tracking tools. For more information, please see: www.itto.int, www.cites.org.

INTERPOL

INTERPOL has a global membership of 190 States, the majority of which have established a national central bureau (NCB) to act as focal point for cooperation with its General Secretariat and other NCBs. NCBs can act as points of liaison between wildlife and forest enforcement units.

INTERPOL can facilitate cross-border law enforcement and assist countries in gathering evidence, locating offenders and their assets. Through its Environmental Security Programme, INTERPOL coordinates the actions of multiple countries in cases with international implications.

INTERPOL Wildlife Crime Working Group

The INTERPOL Wildlife Crime Working Group brings together specialized criminal investigators from around the world to carry out measures to improve the exchange of information on:

- Persons or companies involved in the illegal trade in fauna and flora
- Organizations involved in illegal trade in fauna and flora
- Methods of illegal trade in fauna and flora

Participation in the Wildlife Crime Working Group is open to all INTERPOL member States and regional representatives; participation is encouraged from

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[9]www.cites.org/eng/resources/enforcement_focal_points

environmental experts across the world to maximize the global impact of current projects and to devise new initiatives.

Ecomessage

The Ecomessage is a structured format for reporting cases related to illegal trade in endangered species, CITES infractions and other forms of environmental crime using the secure INTERPOL Global Communication System 24/7 (I-24/7). It is a tool to facilitate the exchange of information on international environmental crime cases and to improve the collection, storage, analysis and circulation of such information. These messages can be passed from an enforcement agency in one country, via INTERPOL National Central Bureaus, to the relevant agencies in the other countries concerned.

Global Communication System 24/7 (I-24-7)

INTERPOL developed the I-24/7 global police communications system to connect law enforcement officers in member countries. It enables authorized users to share sensitive and urgent police information with their counterparts around the globe, 24 hours a day, 365 days a year. I-24/7 is the network that enables investigators to access INTERPOL's range of criminal databases. Authorized users can search and cross-check data in a matter of seconds, with direct access to databases on suspected criminals or wanted persons, stolen and lost travel documents, stolen motor vehicles, fingerprints, DNA profiles and stolen administrative documents. With I-24/7 installed at all 190 National Central Bureaus, INTERPOL is also working with many countries on extending access to INTERPOL services beyond the NCB and out to front-line officers such as customs officials.

Confidential and sensitive law enforcement information related to the illegal trade in endangered species or other forms of environmental crime can be passed from an enforcement agency in one country, via INTERPOL National Central Bureaus, to the relevant agencies in the other countries concerned, using the secure INTERPOL I-24/7 communications system.

United Nations Office on Drugs and Crime

Established in 1997 through a merger between the United Nations Drug Control Programme and the Centre for International Crime Prevention, UNODC is a global leader in the fight against illicit drugs and international crime, operating in all regions of the world through an extensive network of field offices. UNODC is the guardian of the United Nations Convention against Transnational Organized Crime and the United Nations Convention Against Corruption, which are highly relevant to addressing wildlife and forest crime.

UNODC promotes and facilitates formal and informal cooperation between different types of authorities of countries. UNODC also acts as a liaison between States and international organizations and facilitates regional networks of cooperation against organized crime around the world. In May 2014, UNODC launched its "Global Programme for Combating Wildlife and Forest Crime". The Global Programme acts as the overarching umbrella programme for UNODC activities on wildlife and forest crime.

Sharing Electronic Resources and Laws On Crime

The Sharing Electronic Resources and Laws on Crime (SHERLOC) knowledge management portal was developed by UNODC to facilitate the dissemination of information regarding the implementation of the United Nations Convention against Transnational Organized Crime and its three Protocols. SHERLOC hosts the case law database, the database of legislation, the bibliographic database; and the directory of competent authorities. In addition to granting users direct access to individual laws and cases on wildlife and forest crime, SHERLOC facilitates cooperation in tackling wildlife and forest crime because it also provides users with:

- National, regional and global overviews of relevant laws that criminalize wildlife and forest crime
- Relevant jurisprudence on wildlife and forest crime, which countries with similar legal systems can rely on in court
- Legislative assistance, in that drafters may refer to the manner in which the criminalization of wildlife and forest crime has been approached by various countries
- Lessons learned and best practices, as the cases listed in SHERLOC highlight reasons behind the successes of countries during international cooperation

Directories of Competent National Authorities

Competent National Authorities under the Convention against Transnational Organized Crime

This directory lists the competent national authorities designated to receive, respond to and process requests for mutual legal assistance, extradition, transfer of sentenced persons, as well as contact points to facilitate international cooperation within the application of the Organized Crime Convention for the purpose of preventing and combating trafficking in cultural property. The legal bases for designating these authorities include the United Nations Convention on Transnational Organized Crime (articles 16, 17, 18 and 31) and General Assembly resolution 68/186 (paragraph 6).

The directory can be accessed via the UNODC website here: https://www.unodc.org/compauth/en/index.html

Competent National Authorities under the United Nations Convention Against Corruption

This directory lists the competent national authorities designated to receive, respond to and process requests for mutual legal assistance and asset recovery, as well as requests for sharing national experience in developing and implementing specific measures for the prevention of corruption. The legal bases for designating these authorities are the United Nations Convention Against Corruption (articles 6 and 46), and paragraph 18 of Resolution 4/4 on International Cooperation in Asset Recovery adopted by the Conference of States Parties to the Convention. The directory can be accessed via the UNODC website here: www.unodc.org/compauth_uncac/en/index.html

Mutual Legal Assistance Request Writer tool

As part of its legal assistance services to States to help effectively implement those instruments, UNODC has developed a Mutual Legal Assistance Request Writer Tool to help practitioners prepare in a timely manner proper, complete and effective requests, thus streamlining the MLA process. The Tool is designed to cover all serious offences, not just those established in accordance with international treaties or conventions.

The Tool guides practitioners step-by-step through the drafting process, using screen templates. The drafter selects drop-down menus in each template and fills in the various data fields provided. These fields can be easily adjusted to meet the legal and procedural requirements of the Requesting State. The Tool requires drafters to complete each screen sequentially to avoid incomplete requests and minimize risks of delay or refusal.

Once the drafter finishes entering the data, the Tool consolidates all data, and generates a draft request for final editing and signature. All requests written with the Tool can be saved into a database and accessed at any later time.

If there is uncertainty as to whether the information required from the Requested State needs the submission of a formal MLA request or, instead, an informal request suffices, the practitioners in the Requesting State should check in advance with the central authority of the Requested State whether a formal or informal request is needed.

The MLA Tool is currently available in English, French, Spanish, Russian, Portuguese, Bosnian, Croatian, Montenegrin and Serbian and has been revised to include additional elements/modules on asset recovery, digital evidence, transfer of criminal proceedings, joint investigations, controlled delivery and videoconferencing. It can be accessed on the UNODC website at: www.unodc.org/mla/en/index.html

Support to Regional Networks

At the regional level, UNODC has continued to support Member States in setting up informal networks of prosecutors and central authorities to facilitate international cooperation, such as the Central American Network of Prosecutors against Organized Crime and the Network of West African Central Authorities and Prosecutors.

UNODC has also been working in promoting the so-called "networking the networks" initiative. The initiative is aimed at building stronger cooperation links between various regional and international law enforcement organizations to ensure interregional criminal intelligence-sharing and to support multilateral joint or coordinated operations. Moreover, it facilitates the building of contacts and links between law enforcement, prosecutorial and financial intelligence networks, with a view to efficiently targeting transnational organized crime.

UNODC's experience with supporting regional networks suggests that key features for success include the embedding of the network in an existing institutional structure, such as the Central American Council of Public Prosecutors in the case of the REFCO scandal. Clear founding documents, regulations and strategic plans are also critical to effective network operation. Where networks are based on links between central authorities, they may include contact point specialization for specific crimes such as terrorism or corruption, but should seek to address all forms of transnational crime. This approach can lead to a strengthening of central authorities as a single contact point for international judicial cooperation in criminal matters. In addition, whilst some forms of crime require a specific regional focus, transnational crime is increasingly demanding a global and interregional response. Once established, regional arrangements must therefore be progressively outward looking, including through the development of connections between different regional networks. Such a "networking of networks" approach may offer one route to enhanced global cooperation in criminal matters.

UNODC-WCO Container Control Programme

The UNODC-WCO Container Control Programme (CCP) supports countries in the creation of container profiling inter-agency port units at selected container terminals in seaports or dry ports to minimize the exploitation of high-risk containers for the illicit trafficking of drugs and other transnational organized crime activities. In doing so, emphasis is placed on training customs and law enforcement agencies in the application of efficient risk profiling and inspections of high risk cargo containers at sea, land and airports.

At the core of the CCP is the establishment of Port Control Units (PCUs), comprised of various law enforcement agencies, which undergo a standardized, phased training programme. In addition, specialized training programmes and study visits are provided to the PCUs.

Part of the CCP's training programme is an increased awareness and knowledge of the risk indicators of environmental crime. During the theoretical classroom training, as well as advanced specialized training, sessions are dedicated to CITES and wildlife crime, of which the issues of illegal timber logging and trade are an integral part.

Officials of various PCUs have already successfully applied their acquired skills in the area of timber trafficking, using risk management and inspecting suspicious containers, which resulted in the seizure of tons of illicit timber and other wildlife products.

Improved international cooperation and information sharing are the best ways to increase the capacity of law enforcement agencies to identify high-risk containers. The PCUs are therefore trained in exchanging information with other PCUs and law enforcement agencies, including through the use of tailored information systems such as ContainerCOMM (developed by the World Customs Organization). Such information shared amongst law enforcement agencies worldwide, provides the vital data and intelligence that enables the targeting and interdiction of illicit goods. In addition, study tours to other ports and PCUs are regularly undertaken to exchange experiences and information. As a result, seizures based on information exchange through ContainerCOMM have been observed following such visits.

Countries can join the CCP upon request. The CCP team will assess and discuss national needs and develop an implementation plan with the country concerned (based on available funding). The Programme is currently operational in 28 countries.

World Customs Organization

The World Customs Organization (WCO) is an independent intergovernmental body whose mission is to enhance the effectiveness and efficiency of customs administrations. WCO have developed tools to enhance communication between customs officials, other law enforcement authorities and international organizations.

Customs Enforcement Network

The Customs Enforcement Network (CEN) is a global network for gathering customs-related data and information. Operated by WCO, CEN enables customs officers around the world to exchange information on customs offences and to share intelligence in a timely, reliable and secure manner with direct access available 24 hours per day. CEN is Internet-based and uses effective database protection norms, using encryption technology to protect communication and data transfers.

Tools available on CEN include:

- The CEN database records customs seizures and offences classified under 13 different headings covering the main fields of customs enforcement activity, including the trade in endangered species of fauna and flora under CITES. Pictures illustrating concealment methods and X-ray images are also available. All pictures can be downloaded and used for training purposes.
- The CEN website contains alerts on enforcement-related issues, as well as intelligence needed by customs services. It comprises a reference system, alert messages, situation sheets, dedicated pages for regional liaison offices, links to other organizations and so forth.
- The communication application is a tool that facilitates the exchange and use of any information in a timely, reliable and secure manner.

The CEN system electronically links customs administrations through the WCO network of regional intelligence liaison offices. WCO members and regional intelligence liaison offices can report seizure information to the CEN database. They, in turn, benefit by being able to use the database to conduct national, regional and interregional analysis and publish alerts. Each participating WCO member nominates a national contact point that acts as a hub between the national customs administration and the relevant regional intelligence liaison offices.

ENVIRONET

ENVIRONET is a global real-time communication tool for use in the fight against cross-border environment-related offences, operated by WCO. ENVIRONET provides a secure, Internet-based platform for customs officials, other law enforcement authorities and international organizations, as well as their regional networks, to cooperate with one another and share information in the course of their daily operations. Information related to all commodities that have the potential to damage the environment and that are covered by trade-related multilateral environment agreements can be exchanged via ENVIRONET. This includes endangered fauna and flora, and issues such as ozone-depleting substances, hazardous waste and materials, pesticides, chemical weapons and living, modified organisms. To increase coordination and streamline activities, the CITES Secretariat recently integrated its Enforcement Forum with ENVIRONET. ENVIRONET now includes specific folders on CITES Notifications on enforcement matters, alerts issued by the CITES Secretariat, CITES sample permits and certificates and other relevant materials and information.[10]

[10]For further information see: www.cites.org/sites/default/files/notif/E-Notif-2015-039.pdf

Regional Intelligence Liaison Office

The exchange of intelligence at national, regional and international levels is a critical mechanism employed by customs authorities to create conditions for more efficient enforcement actions and controls, and to secure the optimum use of available resources. WCO established the first Regional Intelligence Liaison Office (RILO) in 1987 with the intent of creating a Global Intelligence Network. Today the RILO network has grown to 11 offices providing effective coverage throughout all six WCO regions.

Each of the 11 RILO offices covers a number of WCO member States and responds to their intelligence needs at the regional level. The RILO network also supports its WCO member administrations by providing them operational support, designing and implementing target-oriented intelligence analysis projects and regional intelligence-led operations, facilitating mutual administrative assistance and promoting and maintaining regional cooperation with other law enforcement agencies and organizations. The RILO network often uses the CEN database to analyse seizures and develop regional intelligence products while the CENcomm platform serves to exchange operational information and facilitate secure communications among members and partners.

World Bank

World Bank is a vital source of financial and technical assistance to developing countries around the world and an important partner in the fight against forest crime.

Program on Forests

Well-managed forests have the potential to reduce poverty, spur economic development and contribute to a healthy local and global environment. The Program on Forests (PROFOR) was created in 1997 to support in-depth analysis, innovative processes and knowledge-sharing and dialogue, in the belief that sound forest policy can lead to better outcomes on issues ranging from livelihoods and financing, to illegal logging, biodiversity and climate change. Since 2002, the program has been managed by a core team based at the World Bank, with support from multiple donors. PROFOR encourages a big-picture approach to forest conservation and management in developing countries, with a particular focus on four themes: livelihoods; financing sustainable forest management; across sectors; and governance. For more information see: www.porfor.info

Forest Law Enforcement and Governance

Forest Law Enforcement and Governance (FLEG) processes are regional initiatives coordinated by the World Bank and organized in cooperation with governments and consumer countries. Today, regional FLEG initiatives have been developed in Africa, Europe, Latin America, North Asia, and South-East Asia. The objectives of the FLEG processes are to improve governance in the forest sector and to foster international dialogue and cooperation to fight illegal logging and trade between wood producer and consumer countries by improving linkages and harmonizing regulations. The FLEG processes emphasize support for developing an understanding between producing and consuming countries and for developing schemes designed to ensure that only legal timber enters the markets of consumer countries. Implementation of FLEG in Europe and North Asia has been supported by the European Union through a collaborative arrangement with national governments and other stakeholders, the World Bank, the International Union for Conservation of Nature and the World Wildlife Fund. For more information see: www.worldbank.org/en/topic/forests/brief/fleg-regional-forest-law-enforcement-governance

Wildlife Enforcement Networks and Groups

Capacity-building and the sharing of resources can be facilitated by dedicated wildlife enforcement networks (WENs). A number of regional WENs have been established to facilitate cross-border cooperation among agencies involved in preventing and suppressing wildlife crime, including timber crime. Networks have been created in a number of regions across the world, in Asia, Africa, Europe as well as in South, Central and North America.

WENs and other wildlife enforcement groups coordinate the regional response to illegal trade in protected species. They provide a mechanism by which countries can share information and best practices as well as improve coordination and collaboration of law enforcement agencies within the respective regions.

Scientific and Forensic Networks

The Society for Wildlife Forensic Science (SWFS) is an international organization with the mission of developing wildlife forensic science into a comprehensive, integrated and mature discipline. Membership of SWFS is open to forensic practitioners and other stakeholders in the wildlife forensics community. SWFS works to ensure that forensic standards are met and has developed standards and guidelines for forensic analysts performing botanical identifications, as a method to achieve the minimum level of quality assurance considered necessary for performing wildlife forensic casework (see SWFS Standards and guidelines for forensic botany identification, available from www.wildlifeforensicscience.org/swgwild/swgwild-work-products). SWFS promotes international cooperation and collaboration between laboratories and convenes meetings on a biannual or triennial basis. For more information see: www.wildlifeforensicscience.org. A regional wildlife forensic network has been established in South-East Asia, and an African wildlife forensic network is currently being promoted. For more information see www.tracenetwork.org.

There are multiple regional forensic networks that do not have dedicated working groups on timber specifically. However, they are entities that can assist in forensic scientific issues. The International Forensic Strategic Alliance (IFSA) is a multilateral partnership between the regional networks of operational forensic laboratories. IFSA represents a cooperative entity comprising the member networks with the aim to create opportunities for strategic collaboration across the global forensic science community. IFSA has issued minimum requirements for forensic laboratories starting with three areas: crime scene, DNA and drugs. Both crime scene and DNA are relevant to any forensic case with the aim to enhance basic capacity and a standardized approach that enables international cooperation. For more information see: www.ifsa-forensics.org.

The Global Timber Tracking Network (GTTN) is an open, informal network of scientists and other stakeholders who are working on technologies and policies to reduce illegal logging and associated trade worldwide. It is a global platform bringing together the science, scientists, policymakers and other key players to address the issues in a coordinated and holistic way. For more information see www.globaltimbertrackingnetwork.org.

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Annex 1. Glossary

Accreditation: Specifically for laboratories. A process in which laboratories can demonstrate their competence through adherence to specific standards, e.g. ISO/IEC 17025.

Allele: Name for alternative forms of the same gene or locus (same position on homologous chromosomes).

Annotations: Specifically CITES. Information regarding the specific circumstances in which the CITES Convention applies for specific species, e.g. may exclude specific product types or geographical regions.

Appendices: Specifically CITES. Appendices I, II and III to CITES are lists of species afforded different levels or types of protection from over-exploitation through the Convention.

Barcoding: Specifically DNA. Sequencing of short sections of DNA from standardized regions of the genome that can be used to identify different Taxa.

Certification: Specifically for analysts. A process in which analysts can demonstrate their competence through adherence to specific standards, e.g. SWFS Wildlife Forensic Scientist Certification.

CO1: Mitochondrial cytochrome oxidase gene region chosen as the standard barcoding region for animals.

Codified: Arranged into a systematic code.

Controlled deliveries: The technique of allowing suspect consignments to pass out of, through, or into the territory of one or more countries with the knowledge and under the supervision of their competent authorities, with a view to identifying persons involved in the commission of offences.

Dendrochronology: The study of tree growth increments. The science of dendrochronology is based on analysis of the periodic, often annual growth increments (tree rings) formed in most temperate and some tropical tree species.

Forensic: Term used to denote something that is related to or used in courts of law.

Genetic marker: a region of DNA that is known to vary between individuals, e.g. *Microsatellite*, *Single Nucleotide Polymorphism*.

Genus: A principal taxonomic category that ranks above species and below family, and is denoted by a capitalized Latin name, e.g. *Dalbergia*.

Groups: Specifically as determined through a timber inventory. A group is a set of items in a load that share defining characteristics, e.g. unprocessed logs, planks, and picture frames would all constitute separate groups.

Heartwood: Heartwood is wood nearer the pith of a trunk or branch of a tree, generally different in colour from sapwood.

Herbarium: A systematically arranged and curated collection of dried plant materials that is available to the scientific community for study.

HS Code: Harmonized System (HS) Code, or The Harmonized Commodity Description and Coding System of tariff nomenclature is an internationally standardized system of names and numbers to classify traded products.

Inspection: The act of careful examination of documents, or the contents of a load, vehicle, or premises in accordance with the legal powers granted to the person undertaking the inspection. See *Search*.

Identification: To establish the identity of an unknown material e.g. timber. Compare with *Verification*.

Individualization: The process of identifying specific individuals of a species.

Increment core: Wood sample obtained through use of an increment borer or coring drill. The core typically transects multiple tree rings and facilitates dendrochronological and radiocarbon analyses.

Law enforcement: Includes police, customs officers, detectives and a range of authorities tasked with enforcing laws.

Letters rogatory: The customary means of obtaining judicial assistance from another country in the absence of a treaty or other agreement. Letters rogatory may be used to effect service of process or to obtain evidence if permitted by the laws of the foreign country.

Load: The contents or cargo of any storage facility or means of transport, e.g. a shipping container, an aircraft hold, a trailer, a shed.

Load map: Diagrammatic representation of the contents of a load, developed by law enforcement and showing the original locations of items as found in the load, along with how they were unpacked and which items were sampled for analysis.

Macroscopic: With specific reference to wood anatomy, the macroscopic structure is that which can be observed with the naked eye, or minimal magnification such as a hand lens.

Management authority: Specifically CITES. National management authority designated in accordance with article IX, CITES.

Mass spectrometry: Ionization of chemical compounds to generate charged molecules and measurement of the mass-to-charge ratios.

matK: maturase K, one of the two chloroplast gene regions chosen as standard barcoding regions for plants. See also *rbc*L.

Microsatellite: Also termed Simple Sequence Repeat (SSR) or Short Tandem Repeats (STR). See *Genetic marker*.

Microscopic: With specific reference to wood anatomy, the microscopic structure is that which can only be observed through use of a microscope.

Mutual Legal Assistance Treaty: MLAT. An agreement between two or more countries that allow for the exchange of evidence and information in criminal matters.

Near Infrared Spectroscopy: NIRS. Measurement of the absorption spectra of materials when exposed to near infrared electromagnetic energy.

Officer: A person holding a position of authority within law enforcement.

Parataxonomy: the use of less-qualified, non-professional taxonomists to undertake classification work, generally in the field. Parataxonomy utilizes less specialized (but more readily available) human resources to identify recognizable taxonomic units. Compare with *Taxonomy*.

Phylogeography: The study of the historical processes that shape contemporary geographic distributions of individuals, particularly by considering the geographic distribution of individuals and their genetics.

Pith: The centre of a tree trunk, around which growth rings emanate. The pith is the remains of the original stem.

Population genetics: The study of the distribution and change in frequency of alleles within populations of organisms.

Proficiency testing: A means of assessing the ability of laboratories and analysts to competently perform specific tests and measurements.

Profiling: Specifically DNA. The method by which an organism is genotyped across a range of genetic markers to develop their individual genetic “fingerprint”.

Provenance: Specifically timber. The place of origin. Provenance can refer to multiple geographic scales, e.g. country, forest, concession, plantation.

Quality assurance: QA. The concept of using systems and procedures to control quality and maintain continuous improvement of a product or service.

Radiocarbon: Specifically dating. Determining the age of an object using ^{14}C (a radioactive carbon isotope).

rbcL: Ribulose-bisphosphate carboxylase, one of the two chloroplast gene regions chosen as standard barcoding regions for plants. See also *mat*K.

Reference material: Examples of known materials (e.g. timbers of particular species) that can be used to develop and calibrate identification tests.

Sample: Analytically, equivalent to *Specimen*, it is a representative portion of the whole material to be tested. Statistically, it is a set of data obtained from a population.

Sapwood: The softer outer layers of recently formed wood between the *Heartwood* and the bark of a tree.

Search: The act of careful examination of the contents of a load, vehicle, or premises in accordance with the legal powers granted to the person undertaking the search. See *Inspection*.

Shipment: A specific kind of load that will be transported through shipping.

Single Nucleotide Polymorphism: SNP. See *Genetic marker*.

Species: The principal natural taxonomic unit, ranking below a genus and denoted by a Latin binomial, e.g. *Dalbergia nigra*. Most restrictions on the trade of plants and animals are concerned with the species level of identification; under CITES, the term includes any species, subspecies or geographically separate population thereof.

Specimen: Analytically, equivalent to *Sample*. In the context of this Glossary, any biological material for examination, study or analysis. Under CITES, any animal or plant, whether alive or dead. In the case of a plant: for species included in appendix I, any readily recognizable part or derivative thereof; and for species included in appendices II and III, any readily recognizable part or derivative thereof specified in appendices II and III in relation to the species.

Stable isotopes: Elements can have multiple isotopes, meaning they have the same number of protons and electrons, but a different number of neutrons, and thus a different atomic mass. The ratios of the various stable isotopes fluctuate in nature and are often correlated with various climatological, biological and geological variables.

Stem disk: A cross-sectional portion of a tree trunk.

Taxonomy: The classification of organisms. See also *parataxonomy*.

Taxa: From *Taxonomy*. Taxonomic groups of any rank, e.g. species, genus.

Timber: Wood prepared or intended for use in building and carpentry. Timber is generally the heartwood and sometimes sapwood of a tree. It does not include the bark, although this is often intact on raw logs in trade.

Timber inventory: Documentation by law enforcement of the exact contents of a timber load, including the quantities, dimensions and weight. Where samples are taken for analysis, the timber inventory (in conjunction with a load map if relevant) can be used to indicate exactly from where samples originated.

Validation: Specifically *Forensic*. The performance of laboratory tests to verify that a particular methodology is working properly. Validation experiments typically examine precision, accuracy, and sensitivity, which relate to the reliability, reproducibility and robustness of the methodology. Validation is a requirement for all forensic testing.

Verification: To verify whether a declaration or claim is correct, e.g. the authenticity of documents, the claimed identity of a material such as timber. Compare with *Identification*.

Wood anatomy: Wood anatomy involves the study of the structure of timber at the micro- and macroscopic levels.

Xylarium: A systematically arranged and curated collection of wood specimens that is available to the scientific community for study.

Annex 2. Non-timber forest products and identification considerations

This annex, along with annex 3, is intended provide information about products in trade that are made from timber as a raw material, but do not necessarily have the features or qualities required to facilitate identification via the methods described in this guide. This annex is aimed at people interested in understanding more about the various wood product types available in trade, how they differ from solid timber with respect to treatment and processing, and how these factors can impact the applicability of forensic timber identification methodologies. Further inquiries about the specific options for forensic identification of non-timber forest products should be directed to an appropriate expert in wood anatomy. Details of global curated wood collections and wood anatomy contacts can be found in annexes 9 and 15, which may assist in locating a suitable expert.

Introduction

This guide is concerned with the applicability of various scientific forensic techniques to timbers, which are sufficiently large, sound, solid pieces of stem wood such that they don't impose any artificial limitations on the application of the science. Such specimens represent only a part of the trade and are not representative of many of the wood-based products on the international market. Because of this, there are a number of factors that must be considered when determining the suitability of a technique for a specific piece of evidence.

The primary considerations are *(a)* the form of the wood in the product; *(b)* its original position within the tree; *(c)* the degree to which it has been physically, chemically or biologically altered; and *(d)* how the wood product was produced and finished. A critical secondary concern is the degree of damage that is permissible during examination and analysis. For example, some components of a musical instrument may have been steam-bent, some glued together, others stained or painted, and for all of these components it may not be possible to sample in such a way as to expose unmodified wood for analysis. In such cases, the total range of techniques that could be applied is narrower.

This annex contains a short discussion of each of the limits imposed by conditions and product types and is followed at the end by a table for quick reference, which details the applicability of various forensic methods to the various product types.

Product condition

Surface contamination

Regardless of the product type and the nature of wood in the product, the general condition of the product can influence the range of applicable techniques. For example, surface contamination (paint, tar, finish, wax, dirt, debris, etc.) can obscure the features necessary for any of the rapid-field-identification techniques, and penetration of these materials into the wood itself can limit even laboratory tests, unless it is possible to remove enough contaminated wood to expose uncontaminated good quality wood beneath.

Moisture content

Moisture content is the fraction of the total weight of a piece of wood at a certain set of conditions relative to the oven-dry weight of the product. In wood, these values can range from zero (completely dry, which will never be found in trade) to 200 per cent or more, for lower density timbers that are green (never dried) or other products that have been saturated with water. Anatomical techniques are not appreciably affected by moisture content, but other approaches such as near-infrared spectroscopy (NIRS) are. The kind of drying in wood processing (air drying, kiln-drying, microwave drying) can influence the extractives present in products or could alter the quality of DNA extractable from wood, thus influencing the applicability of these techniques. High moisture content in wood products also establishes conditions suitable for biological contamination.

Biological contamination

Biological contamination of wood can include mould, bacteria, blue-stain fungi, decay fungi and a range of insect pests. While insect pests are a profound global phytosanitary concern, their effect on wood with regard to wood forensics is typically limited. The larger concerns are bacterial and fungal growth. Both bacteria and fungi can metabolize many extractives, possibly changing chemical profiles of wood. Bacteria and most fungi, including moulds, lack the biochemical machinery to truly degrade the wood substance itself, but can result in significant contamination and degradation of DNA. Mould and mildew fungi are typically restricted to the surface of wood and wood products, and so they can be easily removed by exposing the uncontaminated wood underneath. Wood-inhabiting fungi, however, cannot be so readily removed. Both blue-stain fungi (which do not eat the wood substance) and decay fungi (which do) grow inside the wood cells and colonize the wood in an ordered fashion, first eating the contents of the living cells. Their growth can extend from millimetres to metres from the surface, and the damage to the wood (especially chemical damage and DNA degradation) can be severe. Specimens that are thought to be decayed should be clearly noted as such so that forensic staff can examine them and determine the best application of effort given the likely limitations.

Biological position of wood from within the tree

Another biological consideration is the portion of the tree from which the wood for a given product was derived. Some aspects of tree structure, chemistry and DNA quantity/quality change from one part to another (e.g. stem to branch, pith to bark, heartwood to sapwood, normal wood to reaction wood, juvenile wood to mature wood) so the origin of the wood within the original tree can influence the applicability of techniques. At the point of inspection and specimen selection, there is no control over this, but notes and images should be taken about the apparent position of specimens with respect to its origin in the tree, if such information is known.

Wood processing and product types

Processing of wood raw material as an input to a product (sawn, veneered, glued, chipped, flaked, ground, powdered, crushed, pulped, milled) directly affects the range of forensic techniques applicable to the product.

Solid wood

For our purposes, solid wood is timbers, boards, pieces or components of wood, the smallest dimension of which typically exceeds 8 mm and which are typically produced by sawing. In this way, a product such as an engineered floorboard could have both solid wood (the top wear layer, which might exceed 8 mm in thickness) and a plywood base, with individual plies perhaps only 2-4 mm each in thickness. A wider range of techniques could be applied to the solid wood surface layer than to the thin plies beneath.

Veneers

Veneers are thin sheets, rolls, or strips of wood in which two dimensions are typically on the order of centimetres to metres, and the smallest dimension is generally between 0.25 mm and 8 mm. Veneers are typically produced either by removing a long, continuous sheet of tangentially oriented wood (peeled veneers) or by cutting a veneer flitch with a large knife and removing individual sheets of wood (sliced veneer). In both cases, it is common for logs to be boiled, steamed, or otherwise heated with moisture to make the wood easier to cut. Heating wood can drive off volatile extractives, and heat may also damage DNA quality or cause other chemical changes. Loose veneers that have not been glued together to form plywood or to some other substrate may be more like solid wood, especially thicker veneers. Once glued into products (often at high temperature and pressure), the expected range of applicable techniques is diminished.

For both solid wood and veneers, individual pieces may be glued together into larger composite products (e.g. laminated veneer lumber, parallel strand lumber, finger-jointed moulding, plywood, etc.). It is becoming more common to find chemically altered solid wood products, such as acetylated wood, in some high-value forest products, and other common products are often chemically treated (e.g. creosote-treated railroad cross ties, preservative-treated building timbers). All of these chemically altered products should be considered unknown territory until techniques developed on solid wood are vetted for each product and application.

Comminuted wood (chips and flakes, particles, flour)

Many wood products are made by re-forming small pieces of wood, often with glues, binders, waxes, plastics or other non-wood components, into larger products. The three classes of comminuted wood are "chips and flakes", "particles" and "wood flour". Comminuted wood is typically generated mechanically by breaking the wood into smaller pieces. For "chips and flakes", individual pieces often have their longest two dimensions in the order of centimetres and their smallest dimension in the order of millimetres. Individual chips and flakes are mechanically weaker than solid wood pieces of the same size, which limits the ease with which they can be prepared for microscopy, but does not otherwise much alter the structure or chemistry of the material.

"Particles" are many times smaller than "flakes and chips" generally ranging from 0.5-8 mm in a single maximum dimension, but with the other two dimensions from 0.5-2 mm. Although there is no appreciable chemical modification of the wood when "particles" are made, it is extremely common that even a small volume (e.g. 50 cm^3) would contain wood from many different individual trees, and even many species. Because of this, most identification techniques other than traditional wood anatomy are not suited to forensic analysis of "particles". For traditional wood anatomy, every "particle" is a distinct specimen too large for direct analysis, instead requiring individual sectioning and preparation; thus, the labour burden even to survey the woods in a "particle" product is significant.

"Wood flour" is wood powder or dust formed by grinding and sieving wood. Individual "wood flour" particles are measured in microns and cannot be processed individually. Because many different trees, possibly from many different species, are likely to be present in "wood flour", only traditional wood anatomy is likely to be applicable in most contexts.

Fiberized wood

Fiberized wood can be generated using chemical, mechanical or combined chemi-mechanical methods. The fiberization process can be completed, reducing wood to its component cells as in chemical pulping to make pulp and paper products, or it can generate individual cells, broken cell fragments, and clusters of many cells, as in most mechanical or chemi-mechanical processes. Depending on the chemistry and physical properties of the wood fibre, the material could be used to make paper, cardboard or a range of fibreboard products. Such products can be made with various binders, filling agents, resins, waxes, or with no additives, and may involve the application of high temperatures and pressures (e.g. some fibreboards) or may occur largely at ambient temperature (some papermaking processes). For chemically pulped wood fibre, DNA will have been destroyed, extractives are removed or significantly modified, and cell-to-cell positional relationships that are the foundation of most anatomical identification are gone. Fibre identification by means of traditional wood anatomy is thus a reduced case of solid wood identification, generally to a less specific end result. Other forensic techniques applied to mechanically-processed wood fibre are likely to show the same limits as to wood particles or wood flour for similar reasons of wood mixing in the process.

Industrial processes to generate the product itself (heating, extracting, gluing, pressing, drying, painting, etc.)

Regardless of the product condition or the wood processing and product type, the industrial processes to form a final wood product can either fail to alter or can reduce the range of forensic techniques applicable. Many products, as noted above, require heating, gluing, finishing, treating, or otherwise physically and/or chemically altering the wood substance. High pressures, and typically high temperatures and moisture contents are involved in the production of panel products such as plywood, chip- and flakeboards, and fibreboards. Wood-plastic composites require high temperatures and complete encasement of the wood components in plastic, often in a molding or extrusion process. Even the painting, staining or gluing of solid wood products can influence the applicability of forensic techniques. Be mindful of the likely limitations imposed by industrial processing, and don't hesitate to contact your forensic expert for clarification.

Quick-reference table of wood, products and forensic techniques

Table A2.1 provides a quick-reference table of wood, products and forensic techniques. The various types of wood (heartwood, sapwood) or sizes of wood after processing are shown as rows, and the forensic techniques and context (i.e. to determine botanical identity or provenance) are shown as columns. In each cell is a short description of the applicability of the technique to the product in that particular context.

Note that the table includes a section on the material necessary to develop a reference dataset to be used in forensic applications. This is included for the sake of completeness and highlights one of the benefits of DNA-based techniques, specifically that destructive sampling is not required (i.e. the tree can remain standing), which is particularly important for rare, threatened or endangered species. Where the term “frequently” is used, it denotes that a given technique often works in those circumstances but sometimes does not, depending on the specific technique or test, biological variability or changes to the wood during processing (e.g. DNA techniques will frequently but not always work with solid wood heartwood). Where the term “rarely” is used, it means that in most cases, a technique will not be applicable. The term “maybe” indicates that currently scientists do not know whether a technique will work but expect that sometimes it will (e.g. with machine vision and determination of provenance, no one has yet tried, but genus/species resolution is high, so there is an expectation that it will work at least sometimes for provenance).

Further inquiries about the specific options for forensic identification of non-timber forest products should be directed to an appropriate expert in wood anatomy. Details of global curated wood collections and wood anatomy contacts can be found in annexes 9 and 15, which may assist in locating a suitable expert.

Table A2.1 A quick-reference table of wood, products and forensic techniques

				Genus/species identification of wood							Determination of provenance of wood						
Objective of analysis	Materials used in the analysis		Wood/ Product	Wood anatomy	Machine vision	Dendro-chronology	Stable isotopes	Genetics	Mass spectrometry	NIR spectroscopy	Wood anatomy	Machine vision	Dendro-chronology	Stable isotopes	Genetics	Mass spectrometry	NIR spectroscopy
Reference database	Nature of material	Solid wood	Heartwood	Yes	Yes			Frequently	Yes	Yes		Maybe	Yes	Yes	Frequently	Yes	Yes
			Sapwood	Yes	Yes			Yes	No	No		Maybe	Yes	Yes	Yes	No	No
		Non-wood	Leaves, flowers, fruits, bark	No	No			Yes	No	No		No	No	No	Yes	No	No
Forensic application	Nature of wood material	Solid wood	Heartwood	Yes	Yes			Frequently	Yes	Yes		Maybe	Rarely	Yes	Frequently	Yes	Yes
			Sapwood	Yes	Yes			Yes	Frequently	No		Maybe	Rarely	Yes	Yes	Frequently	No
			Veneers	Yes	Maybe			Frequently	Yes	Yes		Maybe	No	Yes	Frequently	Yes	Yes
		Comminuted wood	Chips/Flakes	Yes	No			Frequently	Yes	Maybe		No	No	Yes	Frequently	Yes	Maybe
			Particles	Yes	No			Maybe	Frequently	Maybe		No	No	Maybe	Maybe	Frequently	Maybe
			Wood flour	Yes	No			Maybe	Maybe	Maybe		No	No	Maybe	Maybe	Maybe	Maybe
		Fiberised wood	Mechanical fibres	Yes	No			Maybe	Frequently	Maybe		No	No	Maybe	Maybe	Frequently	Maybe
			Chemi-mechanical fibres	Yes	No	No	No	No	No	No	No	No	No	Maybe	No	No	No
			Chemical pulp	Yes	No			No	No	No		No	No	Maybe	No	No	No
	Type of wood product	Solid wood	Solid wood	Yes	Yes			Frequently	Yes	Yes		Maybe	Rarely	Yes	Frequently	Yes	Yes
		Wood composites	Plywood/LVL	Yes	Maybe			Maybe	Yes	Yes		Maybe	No	Yes	Maybe	Yes	Yes
			OSB/ Flakeboard	Yes	No			Maybe	Yes	Maybe		No	No	Maybe	Maybe	Yes	Maybe
			Particleboard	Yes	No			Maybe	Yes	Maybe		No	No	Maybe	Maybe	Yes	Maybe
			Fibreboards	Yes	No			No	Maybe	Maybe		No	No	Maybe	No	Maybe	Maybe
			Wood-Plastic Composites	Yes	No			No	Maybe	Maybe		No	No	No	No	Maybe	Maybe
		Pulp and paper	Paper	Yes	No			No	Maybe	Maybe		No	No	Maybe	No	Maybe	Maybe
			Pulp	Yes	No			No	Maybe	Maybe		No	No	Maybe	No	Maybe	Maybe

Annex 3. Non-timber forest products of CITES-listed species

This annex, along with annex 2, is intended provide information about products in trade that are made from timber as a raw material, but do not necessarily have the features or qualities required to facilitate identification by the methods described in this guide. This annex is aimed at people interested in specific information about a selection of CITES-listed tree species that are commonly used to produce non-timber products. The information contained here is not necessarily exhaustive; other CITES-listed tree species may also be used to produce non-timber wood products. Further inquiries about the specific options for forensic identification of non-timber forest products should be directed to an appropriate expert in wood anatomy. Details of global curated wood collections and wood anatomy contacts can be found in annexes 9 and 15, which may assist in locating a suitable expert.

Description of CITES-protected timber that is mainly used for non-timber forest products

This information has been taken from the reference databases CITESwoodID and macroHOLZdata (see references).

Aniba rosaeodora (Pau rosa): CITES II

Family: LAURACEAE. Synonym(s): Aniba duckei; A. rosaeodora var. amazonica.

Further trade and local names: Pau rosa verdadeiro, pau rosa imbaúba, pau rosa itaúba, pau rosa mulatinho (BR); bois de rose (FR); cara-cara (GY); bois de rose femelle (GF).

This species grows in the tropical rain forests of the Amazon basin, primarily in Brazilian territory, but in smaller quantities also in neighbouring countries such as Peru, Columbia, Ecuador, Venezuela, in the Guyanas and Surinam.

The most important product prepared from this plant is a **highly priced essential oil** used in the **perfume industry** and occasionally for therapeutic purposes. There are, however, indications that solid wood is also traded occasionally for use in furniture manufacturing, parquet flooring, and for turned decorative objects.

Aquilaria spp., *Gyrinops* spp. (Adlerholz, eaglewood): CITES II

Family: THYMELAEACEAE.

Further trade and local names: Trâm huong, dó bâu (VN); aloewood, agarwood (GB, US); bois d'aigle, bois d'aloès (FR); karas, kayu garu (MY); gaharu mengkaras (MY-SWK); akyau (MM); tanduk, udúr (IN); kaju alim, kaju gaharu (ID); Chan krasna (KH); tengala (BN).

The geographic distribution of the two genera *Aquilaria* (19 species) und *Gyrinops* (9 species) extends over large parts of South and tropical Southeast Asia, from northern India to the island of New Guinea. Species of both genera have in common the presence of included phloem, visible on transverse sections as diffusely distributed, tangentially extended islands.

The light weight and light coloured normal wood is not traded. Only small and dark, oleoresin **impregnated fragments** are important for commerce; they result from a traumatic reaction of the living tree to injury and subsequent fungal infection. This abnormal wood is traded either as entire fragments, as chips or ground powder, or as extracted oleoresin.

Bulnesia sarmientoi (Palo santo): CITES II

Family: ZYGOPHYLLACEAE.

Other trade relevant species: *Bulnesia arborea* (the wood of this species, commonly traded as "vera", cannot be distinguished from *B. sarmientoi* as regards colour, weight and macro structure. However, it is available in higher quantities and more common in the market).

Further trade and local names: Ibiocaí (AR); Paraguay lignum-vitae (trade).

Bulnesia sarmientoi is naturally distributed in the Chaco region in nothern Argentina, Paraguay and southern Bolivia (Plurinational State of). It is employed for engraving work and for the making of durable turnery, mortars and pestles, etc. From its wood, also, a type of **oil known as oil of guaiac (or guayacol)** is produced, to be used as an **ingredient for soaps and perfumes**. Its resin can be obtained by means of organic solvents and is employed to make varnishes and dark paints.

Guaiacum spp. (Pockholz, Lignum Vitae): CITES II

Family: ZYGOPHYLLACEAE.

Other trade relevant species: important trade species: *G. officinale*, *G. sanctum*, *G. coulteri*. Further trade and local names: guajak (CZ, RU, HU); gaiac (FR); guaiacum wood (GB); pockhout (NL); gwajak (PL); guaiac (RO); guayacan (ES, VE); palo santo, guayacancillo (CU, MX); Domingo- Jamaika- Panama Pockholz, Franzosenholz (DE).

Geographic distribution: Mexico and Central America to Caribbean to tropical South America. The wood is usually marketed as blocks (billets) or planks up to 3 m long and is particularly suitable for: tool handles, sports items, wheelwright's shop (sole of wooden planers, bowling balls), turnery, mortars and pestles, (specialty timber for ship propeller bushings and bearings). The extractives are used for medicinal purposes and essences (colour, fragrance) in the manufacture of alcoholic beverages.

Prunus africana (African cherry, bitter almond, pygeum, red stinkwood): CITES II

Family: ROSACEAE.

Further trade and local names: Afrikaans (rooistinkhout); Amharic (tikur inchet); English (red stinkwood, iron wood, bitter almond); Luganda (ntasesa, ngwabuzito); Swahili (mueri, mkomahoya, kiburraburra).

The geographic distribution extends over large regions of tropical Africa: Angola, Cameroon, Congo basin, Equatorial Guinea, Ethiopia, Kenya, Madagascar, Malawi, Mozambique, Sudan, Uganda, United Republic of Tanzania, Zambia and Zimbabwe.

Prunus africana is mainly used for **medicinal purposes** and traded in the form of bark chips or powdered bark impeding a wood anatomical identification. The liquid extracts from the bark are used in the treatment of benign prostatic hyperplasia and prostate gland hypertrophy. The by-product "wood" is locally manufactured into furniture, flooring, turnery, mouldings, poles and mortars.

Pterocarpus santalinus (Red sanders): CITES II

Family: FABACEAE-FABOIDEAE.

Further trade and local names: Kaliaturholz, rotes Sandelholz (D); red sandalwood, India sandalwood (GB); sandal rouge (FR); sandalo rosso (IT); chandaman, panaka (IN).

This species, not to be mistaken for the "true" sandalwood *Santalum album*, is endemic to the Indian subcontinent and the island of Sri Lanka. The timber has a long tradition as a precious wood for high-end cabinetwork in China and Japan, as a **dyewood for textiles, colouring agent for tinctures and liqueurs, and also for diverse applications in medicine and cosmetics**. Nowadays the small quantities of heartwood still available are mainly marketed as chips or wood powder. There are, however, some indications that solid wood is still traded for manufacturing luxury furniture as well as for parts of musical instruments and turned decorative objects.

Taxus spp. (Eibe, yew): CITES II

Family: TAXACEAE.

Of the presently recognized nine species of the genus Taxus, four are distributed in North America, one in Europe and the Middle East, and four in Asia. Only the latter (*T. cuspidata, T. fuana, T. sumatrana* and *T. wallichiana* with three varieties) are subject to CITES annex II regulations. The European yew (*Taxus baccata*) has been placed on the Red List of endangered plants by Germany, Austria, Poland, Czech Republic, Slovakia, Romania and the Russian Federation and is protected under the pertinent national regulations. In the United States of America, the Florida yew (*Taxus floridana*) is listed as critically endangered on the IUCN red list and as endangered by the State of Florida. In Canada, specifically in the Province of Prince Edward Island, regulations exist concerning the Canada yew, also known as "ground hemlock" (*Taxus canadensis*).

The wood is particularly suitable for decorative veneers (for high priced furniture, especially for corpus parts of keyboard instruments), furniture, tool handles, sports items, wheelwright's shop (competition bows and arrows), turnery, other applications (measuring instruments, inlaying). **Certain compounds found in the bark of yew trees were discovered to have efficacy as anti-cancer agents**. The precursors of the chemotherapy drug paclitaxel (taxol) can be synthesized easily from the extracts of the leaves of other yew species, which is a more renewable source than the bark of the Pacific yew.

References

1. Richter, H.G., Gembruch, K., and Koch, G. CITESwoodID: descriptions, illustrations, identification, and information retrieval (2014 onwards). Version: 16th May 2014. In English, German, Spanish and French. Available at delta-intkey.com/citesw.

2. Richter, H., and M. Oelker. 2002 onwards. macroHOLZdata, Commercial timbers: descriptions, illustrations, identification, and information retrieval. Version: 2014. In English and German. Available for purchase from the Thünen Institute www.ti.bund.de/en/hf/.

Annex 4. List of common risk indicators for trafficking of illegal timber and timber products

This annex is intended to provide information that may be useful for risk-profiling purposes when dealing with shipments of timber and timber products. High-risk consignments represent only a very small proportion of the total amount of freight passing through international borders. Therefore, it is necessary to apply a selection process in order to identify these high-risk shipments for examination. Agencies responsible for determining which shipments should be subject to further scrutiny may find this information relevant. Not every point listed on its own will necessarily identify a risk on which it is worth taking further action, but cumulatively these could indicate increased possibility of a shipment containing illegal timber or timber products. These indicators are primarily relevant for import/export-related risks. The risks listed are not exhaustive and are intended to augment rather than replace existing risk profiling strategies.

Agencies are advised to consult:

- World Customs Organization (WCO)
  - WCO Customs Enforcement Network (CEN): Global database of customs enforcement information
  - WCO Iris: Tool which aggregates open source customs information
  - WCO I2C: Information and intelligence centre which facilitates communication and coordination on customs compliance and law enforcement-related matters
- International trend alerts
  - The International Criminal Police Organization (INTERPOL) Purple Notices: Notices which seek or provide information on modus operandi, objects, devices and concealment methods used by criminals.
  - The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Alerts: Documents containing illicit trade intelligence obtained through analyses of data supplied to the CITES Secretariat's Trade Infraction and Global Enforcement Recording System (TIGERS)

- Existing international, national and local resources as appropriate
  - Risk assessments
  - Risk profiles
  - Intelligence reports
  - Seizure notifications
- Annexes 4 and 5 to the Guide, for information on CITES-listed tree species, their native distributions and some known areas of cultivation.

Claimed load/goods

- Known to be used as cover loads for smuggled goods (e.g. waste paper, scrap plastic, tea, coffee beans, charcoal, foodstuffs, handicrafts, used tyres)
- Suitable for smuggling and load density not susceptible to control without considerable delay (unloading takes a lot of time).
- Heavier weight than is normal for the declared commodities
- High shipping costs for declared low value consignment

Routing

- Loads/goods coming from high-risk countries of origin or of transit. For further information, see WCO resources listed in the introduction, also www.forestlegality.org/risk-tool and www.timbertradeportal.com
- Use of unusual or new routing (in order to avoid customs intervention, criminals can use unusual routes and change them regularly)

Importer/exporter

- Fictitious names/incomplete details (name/address)
- First time import
- History of import (e.g. changes in business type)
- Identity hijacking of well-known importer/exporter
- Use of a new or first time use of a shipping agent
- Shipment is inconsistent with the importers declared business
- Fraudulent use of genuine company details
- Unsubstantiated requests for urgent clearance through border controls

Certain industries/users are high risk for certain timber species, for example:

- Antique restoration
- Ships and yachts
- Musical instruments
- Furniture
- Flooring
- Perfumery
- Wood carving
- Health medications

Examples of illegal timber trading modus operandi:

- Counterfeited or fraudulent use of certification, e.g. Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification (PEFC)
- Counterfeited or fraudulent use of CITES export permit system
- Fraud in customs declarations, e.g. in relation to using different Harmonized System (HS) codes, especially codes with a lower rate of customs import duty
- Illegal timber hidden in a shipment of legal timber, e.g. CITES-listed ramin (*Gonystylus* spp.) within a shipment of non-CITES-listed meranti (*Shorea* spp.)
- Mislabelled packaging
- Timber species identifying features concealed by painting, varnishing or staining.
- Poorly packed load within the container
- Use of incorrect tradenames
- Use of incorrect scientific names
- Use of incorrect country of origin
- Use of incorrect CITES appendix
- Use of incomplete information
- CITES permit not endorsed at export
- CITES permit used after validity date expired.

- Shipments weight is greater than declared
- Incorrect use of weight conversion codes (e.g. weight declared in kilograms on invoice, CITES permit in m^3)
- Lack of required official documentation
- Timber processed to end product and declared as product not timber, e.g. billiard cues made of CITES-listed ramin (*Gonystylus* spp.)
- Abuse of CITES annotation, i.e. claiming non-annotated CITES timber products as annotated products
- Use of fictitious address/fictitious name
- Use of permit issues by incorrect authority
- Fraudulent use of timber concession information
- Shipment of timber is used as a cover load for concealing narcotics or cigarettes
- Pallets or packing material made from restricted timber species

Annex 5. Information on CITES-listed tree species

This annex is intended to provide information on the tree species listed in the appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as of Conference of the Parties (CoP) 16, held in 2013. The most accurate listings can be found on the CITES website www.cites.org/eng/app/appendices.php and the Species+ website, www.speciesplus.net, which should be consulted wherever possible. Species listed in these appendices are subject to trade controls and may require export and/or import permits. This annex includes a table that presents each listed tree species, grouped into families and notes some common names (table A5.1). The relevant CITES appendix is indicated along with information on any relevant annotations. Specific risk indicators and other pertinent information are also given. Readers should also note that not all tree species listed here are used for timber. This annex may be of interest to anyone seeking to verify whether a particular tree species and product is restricted by CITES. Further information on the native distributions and some known areas of cultivation of the CITES-listed tree species can be found in annex 6.

Annotations

When a species is included in CITES appendix I, II or III, all parts and derivatives of the species are also included in the same appendix unless the species is annotated to indicate that only specific parts and derivatives are included. An explanation of the CITES annotations can be found in CITES Resolution Conf. 10.13 (Rev. CoP15): "Implementation of the Convention for timber species" available at www.cites.org/eng/res/10/10-13R15.php. In the context of these annotations, the term "extract" refers to any substance obtained directly from plant material by physical or chemical means regardless of the manufacturing process. An extract may be solid (e.g. crystals, resin, fine or coarse particles), semisolid (e.g. gums, waxes) or liquid (e.g. solutions, tinctures, oil and essential oils). The term "woodchips" refers to wood that has been reduced to small pieces.

Notes on annotations as described in table A5.1

#1 Designates all parts and derivatives, except:

(a) Seeds, spores and pollen (including pollinia);

(b) Seedling or tissue cultures obtained in vitro, in solid or liquid media, transported in sterile containers;

(c) Cut flowers of artificially propagated plants; and

(d) Fruits and parts and derivatives thereof of artificially propagated plants of the genus *Vanilla*.

#2 Designates all parts and derivatives, except:

(a) Seeds and pollen; and

(b) Finished products packaged and ready for retail trade.

#3 Designates whole and sliced roots and parts of roots, excluding manufactured parts or derivatives, such as powders, pills, extracts, tonics, teas and confectionery.

#4 Designates all parts and derivatives, except:

(a) Seeds (including seedpods of *Orchidaceae*), spores and pollen (including pollinia). The exemption does not apply to seeds from *Cactaceae* spp. exported from Mexico, and to seeds from *Beccariophoenix madagascariensis* and *Neodypsis decaryi* exported from Madagascar;

(b) Seedling or tissue cultures obtained in vitro, in solid or liquid media, transported in sterile containers;

(c) Cut flowers of artificially propagated plants;

(d) Fruits and parts and derivatives thereof of naturalized or artificially propagated plants of the genus *Vanilla* (*Orchidaceae*) and of the family *Cactaceae*;

(e) Stems, flowers, and parts and derivatives thereof of naturalized or artificially propagated plants of the genera *Opuntia* subgenus *Opuntia* and *Selenicereus* (*Cactaceae*); and

(f) Finished products of *Euphorbia antisyphilitica* packaged and ready for retail trade.

#5 Designates logs, sawn wood and veneer sheets.

#6 Designates logs, sawn wood, veneer sheets and plywood.

#7 Designates logs, woodchips, powder and extracts.

#8 Designates underground parts (i.e. roots, rhizomes): whole, parts and powdered.

#9 All parts and derivatives except those bearing a label "Produced from *Hoodia* spp. material obtained through controlled harvesting and production in collaboration with the CITES Management Authorities of Botswana/Namibia/South Africa under agreement no. BW/NA/ZA xxxxxx”.

#10 Designates logs, sawn wood, veneer sheets, including unfinished wood articles used for the fabrication of bows for stringed musical instruments.

#11 Designates logs, sawn wood, veneer sheets, plywood, powder and extracts.

#12 Designates logs, sawn wood, veneer sheets, plywood and extracts. Finished products containing such extracts as ingredients, including fragrances, are not considered to be covered by this annotation.

#13 Designates the kernel (also known as “endosperm”, “pulp” or “copra”) and any derivative thereof.

#14 Designates all parts and derivatives, except:

(a) Seeds and pollen;

(b) Seedling or tissue cultures obtained in vitro, in solid or liquid media, transported in sterile containers;

(c) Fruits;

(d) Leaves;

(e) Exhausted agarwood powder, including compressed powder in all shapes; and

(f) Finished products packaged and ready for retail trade, this exemption does not apply to beads, prayer beads and carvings.

Table A5.1. Information on tree species listed in the appendices to CITES as of CoP 16, held in 2013

Family	Species	Annotation	CITES	Common name	Risk indicators	Particulars
ANACARDIACEAE	*Operculicarya decaryi*		II	Jabihy	Live plants, charcoal	Endemic to Madagascar, often grown as bonsai trees
	Operculicarya hyphaenoides		II	Jabihy	Live plants, charcoal	Endemic to Madagascar, often grown as bonsai trees
	Operculicarya pachypus		II	Tabily	Live plants, charcoal	Endemic to Madagascar, often grown as bonsai trees
ARAUCARIACEAE	*Araucaria araucana*		I	Chili pine, Monkey puzzle	Seeds, paperpulp, wood	All populations (Endemic Chile, Argentina)
BERBERIDACEAE	*Podophyllum hexandrum*	#2	II	Himalayan may-apple		Rare in timber, more common in pharmaceuticals
CARYOCARACEAE	*Caryocar costaricense*	#4	II	Ajillo		Very difficult to discriminate from other species within genus
CUPRESSACEAE	*Fitzroya cupressoides*		I	Alerce, lahuán, lahuen	Pre-Convention stock (2014/002; Cites.org)	Endemic to Chile and Argentina
	Pilgerodendron uviferum		I	Pilgerodendron, Ciprès	Boats, furniture, poles, bridges	Endemic to Chile and Argentina
DICKSONIACEAE	*Dicksonia spp.*	#4	II	Tree ferns		Only American population
DIDIEREACEAE	*DIDIEREACEAE spp.*	#4	II	Alluaudias, didiereas		Only Madagascar population
EBENACEAE	*Diospyros spp.*	#5	II	Ebonies		Only Madagascar population
FAGACEAE	*Quercus mongolica*	#5	III (Russian Federation)	Mongolian oak		Only Russian Federation
JUGLANDACEAE	*Oreomunnea pterocarpa*	#4	II	Gavilan, Aniba duckei, Pau rosa	Essential oil	

LAURACEAE	*Aniba rosaeodora*	#12	II	Brazilian rosewood		
LEGUMINOSAE	*Caesalpinia echinata*	#10	II	Brazilwood, Pernambuk		Violin bow
	Dalbergia cochinchinensis	#5	II	Thailand rosewood	Mainly from Cambodia, Lao People's Democratic Republic, Thailand and Viet Nam	
	Dalbergia darienensis	#2	III (Panama)			
	Dalbergia granadillo	#6	II	Granadillo rosewood		Mostly musical instruments
	Dalbergia nigra		I	Rio palisander, Brazilian rosewood	Pre-convention specimens	Rosewood, antique restorers
	Dalbergia retusa	#6	II	Cocobolo		Mostly musical instruments
	Dalbergia spp.	#5	II	Madagascar palisander, Madagascar rosewood	Shipments via United Republic of Tanzania and Kenya to Far East	Only Madagascar population
	Dalbergia stevensonii	#6	II	Honduras palisander, Honduras rosewood	Mainly from Belize, Guatemala, Mexico	Mostly musical instruments, tone wood
	Dalbergia tucurensis	#6	III (Nicaraqua)	Yucatan rosewood		
	Dipteryx panamensis		III (Costa Rica/ Nicaragua)	Almendro		

Table A5.1. Tree species listed in the appendices to CITES as of CoP 16, held in 2013 *(continued)*

Family	Species	Annotation	CITES	Common name	Risk indicators	Particulars
	Pericopsis elata	#5	II	Afrormosia	Mainly from Dem. Rep of Congo and Cameroon.	
	Platymiscium pleiostachyum	#4	II	Cristóbal, ñambar		
	Pterocarpus santalinus	#7	II	Red sanders, red sandalwood, agaru		Also pharmaceuticals
MAGNOLIACEAE	*Magnolia liliifera var. obovata*	#1	III (Nepal)	Balukhat, Branthuri, Safan		
MELIACEAE	*Cedrela fissilis*	#5	III (Bolivia)	Cedar, cedrela, cédrat, etc.		
	Cedrela lilloi	#5	III (Bolivia)	Cedar, cedrela, cédrat, etc.		
	Cedrela odorata	#5	III (Bolivia (Pluri-national State of, Brazil, Columbia, Guatamala, Peru)	Spanish cedar, cedar, cedrela, etc.		Also planted in Côte d'Ivoire, plantation stock are still CITES controlled.

	Swietenia humilis	#4	II	Honduras mahogany	Antique restoration, musical instruments, furniture, ship builders/restorers From America to EU/Far East	
	Swietenia macrophylla	#6	II	Brazilian mahogany, Bigleaf mahogany	Antique restoration, musical instruments, furniture, ship builders/restorers From America to EU/Far East	Also planted in Far East, plantation (NON CITES) Endemic to neotropics
	Swietenia mahagoni	#5	II	Cuban mahogany	Antique restoration, musical instruments, furniture, ship builders/restorers From America to EU/Far East	
OLEACEAE	*Fraxinus mandshurica*	#5	III (Russian Federation)	Manchurian ash		
PALMAE	*Beccariophoenix madagascariensis*	#4	II	Manarano		Endemic to Madagascar Rare in timbers
	Chrysalidocarpus decipiens		I	Butterfly palm		Rare in timbers
	Lemurophoenix halleuxii		II	Hovitra varimena		Rare in timbers
	Marojejya darianii		II	Ravimbe		Rare in timbers

Table A5.1. Tree species listed in the appendices to CITES as of CoP 16, held in 2013 *(continued)*

Family	Species	Annotation	CITES	Common name	Risk indicators	Particulars
	Neodypsis decaryi	#4	II	Triangle palm		Rare in timbers
	Ravenea louvelii		II	Lakamarefo		Rare in timbers
	Ravenia rivularis		II	Gora		Rare in timbers
	Satranala decussilvae		II	Satranabe		Endemic to Madagascar Rare in timbers
	Voanioala gerardii		II	Voanioala		Endemic to Madagascar Rare in timbers
PINACEAE	*Abies quatemalensis*		I	Guatemalan fir	Charcoal, shingles, tools, wood carvings, Christmas trees	
	Pinus koraiensis	#5	III (Russian Federation)	Korean nutpine	Paper pulp, rail-ways, bridges, flooring, plywood	
PODOCARPACEAE	*Podocarpus neriifolius*	#1	III (Nepal)	Yellow wood		
	Podocarpus parlatorei		I	Parlatore's podocarp		
ROSACEAE	*Prunus africana*	#4	II	African cherry		Also in pharmaceuticals and food supplements
RUBIACEAE	*Balmea stormiae*		I	Ayugue, Balmea stormae Martínez		El Salvador, Guatemala, Mexico

SANTALACEAE	*Osyris lanceolata*	#2	II (Burundi, Ethiopia Kenya, Rwanda, Uganda, Tanzania	East African sandalwood		
TAXACEAE	*Taxus chinensis*	#2	II	Chinese yew		
	Taxus cuspidata	#2	II	Japanese yew		
	Taxus fuana	#2	II	Tibetan yew		
	Taxus sumatrana	#2	II	Sumatran yew		
	Taxus wallichiana	#2	II	Himalayan yew		
THYMELAEACEAE	*Aquilaria spp.*	#14	II	Agarwood, Gaharu		
	Gonystylus spp.	#4	II	Ramin		
	Gyrinops spp.	#14	II	Agarwood		
TROCHODEN-DRACEAE	*Tetracentron sinense*	#1	III (Nepal)			
ZYGOPHYLLACEAE	*Bulnesia sarmientoi*	#11	II	Gayak, Holy wood	Guaiac oil from Paraguay to Europe	
	Guaiacum spp.	#2	II	Lignum-vitae		

Annex 6. Native geographic distributions and known areas of cultivation of CITES-listed tree species

This annex is intended to provide information on native distributions and known areas of cultivation of the tree species listed in the appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as of Conference of the Parties (CoP) 16, held in 2013 (table A6.1). Additionally, some species that do not appear on the CITES appendices are controlled by the EU Wildlife Trade Regulations (species marked with an asterisk (*) in table A6.1). The most accurate species listings can be found on the CITES website www.cites.org/eng/app/appendices.php and the Species+ website, www.speciesplus.net, which should be consulted wherever possible. Species listed in these appendices are subject to trade controls and may require export and/or import permits. Information in this annex details where these CITES-listed tree species grow naturally and where they are currently known to be cultivated outside of their natural range. New areas of cultivation may be developed at any time so this list should not be taken as necessarily complete. Readers should also note that not all tree species listed here are used for timber. The information in this annex may be of interest to law enforcement agencies as well as the scientific community.

Table A6.1 Information on native distributions and known areas of cultivation of the tree species listed in the appendices to CITES as of CoP 16, held in 2013: The Americas

		Continent: The Americas																							
	Species	North America	Caribbean (Cuba, Haiti, Dominican Republic, Aruba, Curaçao, Bonaire)	Tropical Central America	Central America	Mexico	Guatemala	Belize	Honduras	El Salvador	Nicaragua	Costa Rica	Panama	Tropical South America	South America	Venezuela (Bolivarian Republic of)	Guyana	Colombia	Brazil	Paraguay	Bolivia (Plurinational State of)	Peru	Chile	Argentina	Amazon
1	*Operculicarya decaryi*																								
2	*Operculicarya hyphaenoides*																								
3	*Operculicarya pachypus*																								
4	*Araucaria araucana*																		X	X			X	X	
5	*Podophyllum hexandrum*																								
6	*Caryocar costaricense*											X	X				X	X							X
7	*Fitzroya cupressoides*																						X	X	
8	*Pilgerodendron uviferum*																						X		
10	*DIDIEREACEAE*																								
11	*Cibotium barometz*																								
12	*Diospyros* spp.																								

13	*Quercus mongolica*																								
14	*Oreomunnea pterocarpa*				X	X	X		X		X	X	X												
15	*Aniba rosaeodora*																		X						
16	*Caesalpinia echinata*																		X						
17	*Dalbergia cochinchinensis*																								
18	*Dalbergia darienensis*												X												
19	*Dalbergia granadillo*				X																				
20	*Dalbergia louvelii*																								
21	*Dalbergia monticola*																								
22	*Dalbergia nigra*													X											
23	*Dalbergia normandii*																								
24	*Dalbergia purpurascens*																								
25	*Dalbergia retusa*			X																					
26	*Dalbergia* spp.																								
27	*Dalbergia stevensonii*			X		X	X	X	X																
28	*Dalbergia xerophila*																								
29	*Dipteryx panamensis*										X	X													
30	*Pericopsis elata*																								
31	*Platymiscium pleiostachyum*									X	X	X													
32	*Pterocarpus santalinus*																								
33	*Magnolia liliifera var. obovata*																								
34	*Cedrela fissilis*			X										X											
35	*Cedrela lilloi*			X										X											
36	*Cedrela odorata*			X										X				X				X			

Table A6.1 Native distributions and known areas of cultivation of the tree species listed in the appendices to CITES as of CoP 16, held in 2013: The Americas *(continued)*

		Continent: The Americas																							
	Species	North America	Caribbean (Cuba, Haiti, Dominican Republic, Aruba, Curaçao, Bonaire)	Tropical Central America	Central America	Mexico	Guatemala	Belize	Honduras	El Salvador	Nicaragua	Costa Rica	Panama	Tropical South America	South America	Venezuela (Bolivarian Republic of)	Guyana	Colombia	Brazil	Paraguay	Bolivia (Plurinational State of)	Peru	Chile	Argentina	Amazon
37	*Cedrela montana**			X																					
38	*Cedrela oaxacensis**			X																					
39	*Cedrela salvadorensis**			X																					
40	*Cedrela tonduzii**			X																					
41	*Swietenia humilis*				X	X	X		X		X	X	X												
42	*Swietenia macrophylla*														X		X	X	X	X	X	X	X	X	X
43	*Swietenia mahagoni*		X																						
44	*Fraxinus mandshurica*																								
45	*Beccariophoenix madagascariensis*																								
46	*Chrysalidocarpus decipiens*																								

47	*Neodypsis decaryi*																								
48	*Ravenea louvelii*																								
49	*Ravenea rivularis*																								
50	*Satranala decussilvae*																								
51	*Voanioala gerardii*																								
52	*Abies guatemalensis*				X	X	X		X																
53	*Pinus koraiensis*																								
54	*Podocarpus neriifolius*																								
55	*Podocarpus parlatorei*					X						X									X	X	X		
56	*Prunus africana*																								
57	*Balmea stormiae*			X	X	X	X			X															
58	*Osyris lanceolata*																								
59	*Taxus chinensis*																								
60	*Taxus cuspidata*																								
61	*Taxus fuana*																								
62	*Taxus sumatrana*																								
63	*Taxus wallichiana*																								
64	*Aquilaria* spp.																			X					
65	*Gonystylus* spp.																								
66	*Gyrinops* spp.																								
67	*Tetracentron sinense*																								
68	*Bulnesia sarmientoi*															X		X						X	
69	*Guaiacum* spp.	X	X		X	X																			

Table A6.2 Native distributions and known areas of cultivation of the tree species listed in the appendices to CITES as of CoP 16, held in 2013: Asia

		Continent: Asia																		
	Species	Asia	South-East Asia	Indonesia	Viet Nam	Cambodia	Lao People's Democratic Republic	Thailand	Malaysia	China	Tibet	Japan	India	Nepal	Himalayas	Bhutan	Bangladesh	Myanmar	Philippines	Russian Federation
1	*Operculicarya decaryi*																			
2	*Operculicarya hyphaenoides*																			
3	*Operculicarya pachypus*																			
4	*Araucaria araucana*																			
5	*Podophyllum hexandrum*	X								X			X	X		X				
6	*Caryocar costaricense*																			
7	*Fitzroya cupressoides*																			
8	*Pilgerodendron uviferum*																			
10	*DIDIEREACEAE*																			
11	*Cibotium barometz*	X	X																	
12	*Diospyros* spp.																			
13	*Quercus mongolica*																			X
14	*Oreomunnea pterocarpa*																			
15	*Aniba rosaeodora*																			

16	*Caesalpinia echinata*																			
17	*Dalbergia cochinchinensis*	X			X	X	X	X												
18	*Dalbergia darienensis*																			
19	*Dalbergia granadillo*																			
20	*Dalbergia louvelii*																			
21	*Dalbergia monticola*																			
22	*Dalbergia nigra*																			
23	*Dalbergia normandii*																			
24	*Dalbergia purpurascens*																			
25	*Dalbergia retusa*																			
26	*Dalbergia* spp.																			
27	*Dalbergia stevensonii*																			
28	*Dalbergia xerophila*																			
29	*Dipteryx panamensis*																			
30	*Pericopsis elata*																			
31	*Platymiscium pleiostachyum*																			
32	*Pterocarpus santalinus*												X							
33	*Magnolia liliifera var. obovata*													X						
34	*Cedrela fissilis*																			
35	*Cedrela lilloi*																			
36	*Cedrela odorata*		(X)																	
37	*Cedrela montana**																			
38	*Cedrela oaxacensis**																			
39	*Cedrela salvadorensis**																			

Table A6.2 Information on native distributions and known areas of cultivation of the tree species listed in the appendices to CITES as of CoP 16, held in 2013: Asia *(continued)*

		Continent: Asia																		
	Species	Asia	South-East Asia	Indonesia	Viet Nam	Cambodia	Lao People's Democratic Republic	Thailand	Malaysia	China	Tibet	Japan	India	Nepal	Himalayas	Bhutan	Bangladesh	Myanmar	Philippines	Russian Federation
40	*Cedrela tonduzii**																			
41	*Swietenia humilis*																			
42	*Swietenia macrophylla*																			
43	*Swietenia mahagoni*	(X)																		
44	*Fraxinus mandshurica*																			X
45	*Beccariophoenix madagascariensis*																			
46	*Chrysalidocarpus decipiens*																			
47	*Neodypsis decaryi*																			
48	*Ravenea louvelii*																			
49	*Ravenea rivularis*																			
50	*Satranala decussilvae*																			
51	*Voanioala gerardii*																			
52	*Abies guatemalensis*																			
53	*Pinus koraiensis*		X																	X
54	*Podocarpus neriifolius*	X												X						

55	*Podocarpus parlatorei*																			
56	*Prunus africana*																			
57	*Balmea stormiae*																			
58	*Osyris lanceolata*																			
59	*Taxus chinensis*									X										
60	*Taxus cuspidata*											X								
61	*Taxus fuana*										X									
62	*Taxus sumatrana*			X																
63	*Taxus wallichiana*														X	X	X	X		
64	*Aquilaria* spp.	X	X	X																
65	*Gonystylus* spp.		X	X					X										X	
66	*Gyrinops* spp.			X									X							
67	*Tetracentron sinense*									X	X	X	X	X	X					
68	*Bulnesia sarmientoi*	X	X	X	X	X	X	X	X											
69	*Guaiacum* spp.																			

Table A6.3 Information on native distributions and known areas of cultivation of the tree species listed in the appendices to CITES as of CoP 16, held in 2013: Africa

		Continent: Africa													
	Species	Africa	Madagascar	West Africa	Ghana	Cote d'Ivoire	Congo	Democratic Republic of the Congo	Central Africa	Ethiopia	Kenya	Uganda	Rwanda	Burundi	United Republic of Tanzania
1	*Operculicarya decaryi*		X												
2	*Operculicarya hyphaenoides*		X												
3	*Operculicarya pachypus*		X												
4	*Araucaria araucana*														
5	*Podophyllum hexandrum*														
6	*Caryocar costaricense*														
7	*Fitzroya cupressoides*														
8	*Pilgerodendron uviferum*														
10	*Didiereaceae*		X												
11	*Cibotium barometz*														
12	*Diospyros* spp.	X	X												
13	*Quercus mongolica*														
14	*Oreomunnea pterocarpa*														

15	*Aniba rosaeodora*														
16	*Caesalpinia echinata*														
17	*Dalbergia cochinchinensis*														
18	*Dalbergia darienensis*														
19	*Dalbergia granadillo*														
20	*Dalbergia louvelii*		X												
21	*Dalbergia monticola*		X												
22	*Dalbergia nigra*														
23	*Dalbergia normandii*		X												
24	*Dalbergia purpurascens*		X												
25	*Dalbergia retusa*														
26	*Dalbergia* spp.		X												
27	*Dalbergia stevensonii*														
28	*Dalbergia xerophila*		X												
29	*Dipteryx panamensis*														
30	*Pericopsis elata*			X	X	X	X	X							
31	*Platymiscium pleiostachyum*														
32	*Pterocarpus santalinus*														
33	*Magnolia liliifera var. obovata*														
34	*Cedrela fissilis*														
35	*Cedrela lilloi*														
36	*Cedrela odorata*					(X)									
37	*Cedrela montana**														
38	*Cedrela oaxacensis**														

Table A6.3 Information on native distributions and known areas of cultivation of the tree species listed in the appendices to CITES as of CoP 16, held in 2013: Africa *(continued)*

		Continent: Africa													
	Species	Africa	Madagascar	West Africa	Ghana	Cote d'Ivoire	Congo	Democratic Republic of the Congo	Central Africa	Ethiopia	Kenya	Uganda	Rwanda	Burundi	United Republic of Tanzania
39	*Cedrela salvadorensis**														
40	*Cedrela tonduzii**														
41	*Swietenia humilis*														
42	*Swietenia macrophylla*														
43	*Swietenia mahagoni*	(X)													
44	*Fraxinus mandshurica*														
45	*Beccariophoenix madagascariensis*		X												
46	*Chrysalidocarpus decipiens*		X												
47	*Neodypsis decaryi*		X												
48	*Ravenea louvelii*		X												
49	*Ravenea rivularis*		X												
50	*Satranala decussilvae*		X												
51	*Voanioala gerardii*		X												
52	*Abies guatemalensis*														
53	*Pinus koraiensis*														

54	*Podocarpus neriifolius*														
55	*Podocarpus parlatorei*														
56	*Prunus africana*	X	X												
57	*Balmea stormiae*														
58	*Osyris lanceolata*								X	X	X	X	X	X	X
59	*Taxus chinensis*														
60	*Taxus cuspidata*														
61	*Taxus fuana*														
62	*Taxus sumatrana*														
63	*Taxus wallichiana*														
64	*Aquilaria* spp.														
65	*Gonystylus* spp.														
66	*Gyrinops* spp.														
67	*Tetracentron sinense*														
68	*Bulnesia sarmientoi*														
69	*Guaiacum* spp.														

Annex 7. Guidance for search of containers, freight vehicles and premises

This annex provides general guidance for all types of evidentiary search and more specific guidance for searches of containers, freight vehicles and premises. The information here is intended for law enforcement agencies and officers who may undertake searches in connection with suspected illegal timber. The information may also be of interest to prosecutors and the judiciary involved in the prosecution of timber-related crimes. The information here has been adapted from the United Kingdom Border Force Enforcement Handbook (unpublished), is for reference only and is not intended to replace or nullify any existing protocols or procedures in place. Before adopting any of the suggested procedures, consultation with appropriate experts and authorities is recommended to ensure procedures comply with all local requirements.

Introduction

The power to search containers, vehicles and premises is an essential evidence gathering tool. The procedures described here must be followed, otherwise the whole examination could become valueless.

Physical examination should always be carried out methodically and thoroughly with the expectation of discovering prohibited or undeclared goods and other irregularities.

When examining, use your own senses of sight, smell, touch and hearing, for they are invaluable.

If damage is caused during the search, it must be recorded and the driver or owner must be informed and told of his rights to complain or to compensation.

Legality

Before conducting a search, officers must be:

- Certain of the provision under which they intend to search
- Aware of any requirements or limitations which those provisions impose upon the exercise of the power of search

- Certain of the authority they need to execute the search, and
- Absolutely satisfied that any necessary authority has been obtained

Failure to do so could render any evidence discovered during that search inadmissible. This may also leave the department and the officer open to criticism in court and liable to claims for compensation.

It is important that the use of any power to search is proportionate to the suspected offence and that there are sufficient grounds to authorize and "invade" a person's privacy.

Risk assessments/health and safety

Officers should be aware of the physical and environmental risks when searching. Health and safety are of paramount importance to you and your colleagues but also to bystanders.

The officer in overall charge of the case must ensure that risk assessments are in place for each operation. All managers should have a comprehensive set of generic risk assessments to deal with all operational activities.

All officers involved in the search must have access to a copy of the risk assessment at the pre-operational briefing prior to deployment. This will ensure that officers are fully aware of any risks as well as their responsibilities. The assessment should be attached to the briefing sheet or a copy issued to each officer. If this is not practicable, officers must be orally briefed on its contents. Officers should, where a risk assessment supports this, comply with all decisions to wear personal protective equipment (PPE) (e.g. hard hats, gloves, goggles) in specific operational circumstances.

Shed floors and examination areas should be clean and there should be adequate space to store goods removed from containers and for use of X-ray equipment. Officers should be wary of other obstacles in sheds, e.g. tugs, forklifts, etc. and always:

- Wear the PPE provided
- Remove all jewellery and tie back hair
- Be aware of the location of fire extinguishers and of first aid boxes
- Have vaccinations against tetanus, hepatitis, etc.
- Try to keep the examination areas tidy to prevent the risks of accidents

Equality and diversity

Where operationally possible, officers conducting searches should give due regard to the declared ethnic or religious status of the building or the person linked with the vehicle or premises being searched.

However, officers should not be put off searching items merely because it is claimed they have religious significance, especially where there are indications or suspicion that the said item or area is being used to facilitate a smuggling offence or to conceal evidence of an offence. Finally, officers should also be mindful that in some cultures it may be felt inappropriate for a male officer to question a female.

Security

In view of the highly sensitive nature of operations, it is imperative that any detection made is not discussed other than with those persons directly involved in the case.

Remember, someone may be watching you.

As soon as possible, the goods should be transported to the storage warehouse. It is recommended that the detecting officer (who will be exhibiting the goods in his witness statement) accompany them in order to clearly maintain the chain of custody.

If in doubt when doing something, officers must seek the assistance of colleagues or expert advice.

Records

It is essential that notebooks are maintained at the time of the examination so that the best evidence can be presented at any subsequent proceedings, including but not limited to the following information:

- Date of the search
- Address of premises searched, when applicable
- Times of entry and exit
- Officers present
- Other persons present (e.g. specialists such as locksmiths, engineers, etc.)
- Dogs used
- A sketch plan of the layout of the premises to enable the exact location of the property uplifted to be accurately identified, when applicable. Number the rooms on the plan from left to right and top to bottom, when applicable.

(Whatever method is employed it is essential that consistency is maintained throughout officers' notebooks)

- Small amounts of cash counted (including a list of the denominations of the notes)
- Persons present during specific parts of the search (e.g. when drugs are found or cash is counted)
- Witness statements
- Any existing damage to the containers, vehicles or premises
- Any damage caused by officers or the owner during the search
- Any complaint made by the occupants of the premises and any other details officers deem relevant

Guidance for search of containers

Container selection

When examining containers, the method (door check, partial or full unloading) can vary according to the reason for the examination.

This is a non-exhaustive list of reasons to search:

- Random check, e.g. statistically selected percentage
- Local parameters
- Officers decision
- Special criteria, e.g. risk analysis
- Nature, quantity, origin or value of the goods
- Country whence consigned
- High freight cost
- Previous history, e.g. known containers
- Suspect operations
- Intelligence from other areas of Her Majesty's Revenue and Customs, customs authorities, or other national and international agencies
- Freight selection hubs
- Joint targeting teams
- Profiling

- Search theory
- Irregularities in documentation

General

Scanning a picture of the load may point to areas of anomaly and may also be useful in identifying additional health and safety issues such as a shifted load leaning against the doors. Be aware the load may have shifted whilst being moved from the scanner site to the examination site.

When a container is first produced for examination, the following questions should be considered:

- How many people are required for the search?
- Is a dog available?
- Is there relevant documentation (bill of lading, import-export or transit declarations)? If the documentation indicates a hazardous load, you should consider obtaining specialist advice or assistance.
- Is a specialist required (locksmith, engineer, etc.)?
- What equipment is necessary to carry out the exam (X-ray, probe, etc.)?

Officers should be nominated for the operation of equipment, such as X-ray van, camera, bolt-croppers, etc.

Be aware of fumigation stickers and signs. All containers should be gas checked for the presence of fumigants. Vent container if any doubt until nil reading is given.

In cases where the container has been approved for transport under customs seal, care must be taken to avoid breaching the standards of that approval, when drilling or otherwise physically altering the structure of the container. If such a container is found to be "innocent", any repair which is necessary must be made in accordance with the Container Convention Rules.

Loading and unloading of containers

Goods in containers should normally be removed and repacked by the appropriate company or wharfinger on behalf of the importer. Only in exceptional circumstances (i.e. for anti-smuggling purposes) and with management approval should this be done by customs officers, taking into account manual handling considerations.

If nothing is found during the examination, the container should be repacked by the wharfinger and resealed as soon as possible.

Action if irregularities are detected

The aim is to apprehend and successfully prosecute all offenders concerned in the illegal importation.

On making a detection of prohibited or uncustomed goods as a result of a container examination, the following action should be taken: stop the examination immediately.

The detecting officer should remain with the prohibited items for chain-of-custody purposes whilst another officer notifies HQ of the detection. HQ will notify an investigation team for further action. The officer should then wait to receive further instructions.

The examining officer will still play an important part in the investigation. The investigators will probably require photographic evidence of the method of concealment. It is therefore crucial that examining officers do not tamper with the consignment without specific instructions from the investigating team or case officer.

On discovery of a suspected concealment only a small sample of the substance should be removed for field testing. At this stage items should only be handled by one person wearing gloves as there may be a need for fingerprinting and other forensic analysis.

The detecting officer and possibly other examining officers will be required to write witness statements.

It is important to share basic information about seizures with detection and intelligence colleagues in other container ports, as this may enable them to identify similar consignments which may be imminent or already unloaded.

Guidance for search of freight vehicles

Vehicle selection

The criteria for container selection are also applicable for vehicle selection (see section above).

General

Due to their size, heavy goods vehicles are made up of a number of natural and adapted spaces that can be used to smuggle goods. Through training and experience officers will learn how to identify where these voids and spaces are and how to access them safely.

Officers should establish what normal is and challenge the abnormal.

The following lists of reminders are not definitive.

Always:

- Ensure the parking brake has been applied.
- Chock the wheels of the tractor unit (preferably the rear wheels on the driver's side).
- Ensure the driver is out of the cab and the keys are removed from the ignition prior to commencing the search. The officer leading the search should control the driver and ask them to open any padlocks, trailer locks and lockers.
- Take care when entering and leaving the cab, always exiting backwards.
- Let your colleagues know if you are going to examine underneath the trailer. Where practicable, prior to commencing the search ask the driver to apply the trailer park brake.
- Ask the driver to open any doors and lockers.
- Vent trailers before entering.
- Ask the driver to switch off the fridge motor when dealing with refrigerated trailers.
- Attempt to examine air bags. Where in doubt consult more experienced colleagues or experts.
- Beware of moving vehicles and the driver's limited vision, especially when reversing on to the examination bays or sheds.
- Beware of the trailer's cargo and how it is loaded and the potential risks including poorly stacked pallets and hanging garments.
- Beware of dangerous goods within the cargo. Do not open packages of chemicals but seek expert advice.
- Beware of dust within cargo; fine dusts are invisible and easily inhaled and can cause respiratory problems.
- Beware of inflammable dust and liquid that could easily ignite.
- Beware of electronically operated vehicles such as forklift trucks.
- Beware of green loads (vegetables) that absorb oxygen within a refrigerated trailer.

Never:

- Smoke near vehicles and examination areas.
- Put your hands into areas where you cannot see.

- Touch any sensitive electrics in the cab.
- Use equipment for which you have not been trained or authorized to use.
- Touch the parking brake.
- Stand too close to trailer doors when they are being opened.
- Attempt to examine air bags. Where in doubt consult more experienced colleagues or experts.
- Climb on to vehicles, use the approved steps provided.
- Go under the tractor unit cab until it is fully tilted.
- Go under the fuel tanks of the tractor unit (the air suspension on the rear axles may Lower as the air pressure drops and there is a danger of being crushed).
- Touch frozen metal with your bare hands.
- Touch burnt vehicles or plastic (hydrofluoric acid is produced when certain plastics are burnt, which is very corrosive to skin and flesh).
- Go into confined spaces.
- Walk behind hydraulic rams in glass carriers.
- Climb on top of vehicles and tankers without first conducting a health and safety risk assessment.
- Open the hatches of liquid tankers (due to the build-up of pressure).

Search procedure

1. Initial questioning of the driver

The following non-exhaustive list of questions may be useful when making an assessment of the vehicle or load:

- What route did the vehicle take?
- Did the driver see the goods loaded?
- Was the driver present when the vehicle was loaded?
- Has the vehicle stopped anywhere?
- Is the load a regular collection or delivery?
- Who owns the vehicle?
- Has the vehicle been left unattended for any length of time?
- Has the vehicle been subject to any repair work recently?

Officers should observe the driver's demeanour and response to questioning. Behavioural indicators that may give rise to suspicion could include:

- Avoiding eye contact
- Sweating
- Being evasive when questioned
- Being overhelpful or uncooperative

Officers should ask to see all paperwork in support of the load. Based on the initial assessment, officers should consider:

- What action is necessary
- Whether the vehicle requires further examination (to varying depths) until satisfied
- Enhanced credibility checks of the documentation

2. Search of interior of cab

Before commencing a search of the cab interior, officers must establish whether all the contents of the vehicle belong to the driver and are reminded that the cab is the driver's living area as well as their workplace.

Officers must not:

- Remove their boots, but offer to protect the seats and floor by using e.g. disposable covers.
- Wear dirty overalls when searching the cab.

Officers must:

- Always enter the cab forwards and exit backwards using the handrails.
- Search the cab systematically ensuring that all areas are checked until satisfied.

It is good practice to wear gloves in order to protect the driver's personal belongings and officer's personal safety. Should a detection be made, officers must wear gloves in accordance with the guidance.

Most modern tractor units are fitted with high-tech equipment such as airbags and GPS receivers. Computers and electronics are now commonplace in operating the vehicle. With training and experience officers will be able to identify where the spaces are and how to access them safely.

When examining the cab officers must consider examining the following areas in this non-exhaustive list:

- Driver's baggage
- Lockers
- Cubby holes
- Top bunk
- Under the bed or bunk
- Seats and backrests
- Side wall trims and panels
- Foot wells
- Fridges
- Dashboard

3. Search of exterior (tractor unit and trailer) and interior (trailer and load)

Before commencing the search, officers should always check the wheel of the tractor unit, preferably the rear wheel on the driver's side. Officers should systematically search the exterior starting at a fixed point on the vehicle, either at the front or the back. Subsequently the interior of the trailer and the load should be checked.

Action if irregularities are detected

The same actions should be taken as when irregularities are detected in containers.

Guidance for search of premises

The main difference between searching containers and vehicles, and premises, is that premises are never randomly selected for search. This type of search requires significantly more planning and additional manpower. Search of premises is a sensitive issue and it can be an unpleasant experience for the person whose premises are being searched.

Preparation before a search of premises or crime scene

During the course of an investigation it may be necessary to conduct a search of premises for evidence of an offence or for goods liable to forfeiture.

The case officer should be clear about the purpose and reasons for the search, the likely extent of the search, the practicalities involved and what might be found on the premises.

Search teams

The case officer or case manager in consultation with the officer in overall charge of the investigation should nominate an officer who is in charge of the search at each premises or crime scene. Ideally this should be an officer from the case team.

Officers conducting the search have to be carefully briefed as to the nature of the material for which the search is to be made, and how the material is thought to relate to the investigation. This will give them a better understanding and help them conduct the search more effectively.

Designated property control point and property officer

The case officer or case manager in consultation with the officer in overall charge of the investigation should designate a property control point where property will be brought following the search. In practice, this should be a locked room in the building from which the case team operates, where property can be securely stored and access to it controlled.

Scenes of crime examination

You should consider at an early stage whether to invite a forensic adviser to the pre-knock meeting since they can give advice on the type of evidence that may be available at the scene of a crime and how best to preserve it. The use of forensic support at this stage may avoid evidence being compromised or reduce the resources required to prove the crime at a later stage. For example, it may be possible to uniquely mark documents, consignments, etc. in the build-up to the knock. During the search, the use of scientific support to assist in the early assessment and interpretation of evidential materials can greatly speed up and enhance the investigation. The crime-scene examination officer may also need to remove items to the laboratory to apply more sophisticated techniques for the recovery of marks, etc. in order to obtain the best evidence.

Digital forensics group

If premises are known to contain computers or computer equipment or if it is suspected that relevant material may be stored on computer, you should consider whether it is necessary for a member of the digital forensics group to:

- Give advice to officers at briefings on procedures and how to deal with specific items, etc.
- Be available to provide technical advice over the telephone to officers on the ground.
- Accompany the search team to ensure proper interrogation of the computer records.

Procedures for dealing with cash

If it is anticipated that cash will be found in premises, officers should be briefed on procedures to follow.

Interpreters

If it is anticipated that language could pose a challenge, an interpreter should accompany the search team if possible. If officers plan to take an interpreter with them to a search of premises, it should be included on the search warrant application if required by legislation.

Additional resources

This may include, for example, the number of officers necessary to complete the search, the need for an accompanying arrest team, backup or reserve team, dog handlers, photographer, police presence or armed response team/tactical team, fire brigade, custody officer and equipment such as knock kits, handcuffs, gloves, search documentation, plastic bags/tamper evidence bags, seals and specialist tools, etc.

Briefings before the search

A formal briefing should precede every search of premises once authority has been granted. Where time does not permit this, an informal briefing must be carried out. While the case officer can provide guidelines concerning the search, (for example, the legal basis on which entry and search is to take place), it is the search officers who are responsible for complying with the law and ensuring that they do not go beyond the statutory limitations imposed. The officer in charge of the search must ensure that both the extent and limits relating to the search, and to the seizure of items are fully understood by the search team.

Third parties attending the search

If it is necessary for a third party (e.g. a lawyer from the solicitor's office, a police officer, an interpreter) to accompany the team conducting a search using a search warrant, the person concerned must be identified by name or designation on the warrant and the reasons given for their attendance, in the information. Failure to do so may result in a claim of trespass and any evidence obtained being ruled inadmissible.

Third parties attending a crime scene should not be placed in a position where their safety may be compromised.

Before the search begins

A search of premises must be made at a reasonable hour unless this might be detrimental to the purpose of the search.

The officer in charge must first attempt to communicate with the occupier or any other person entitled to grant access by explaining the authority under which entry to the premises is sought and ask the occupier to allow access, unless:

- The premises to be searched are known to be unoccupied.
- The occupier and any other person entitled to grant access are known to be absent.
- There are reasonable grounds for believing that to alert the occupier or any other person entitled to grant access by attempting communication would impede the object of the search or endanger the officers concerned or other persons.

Where the premises are occupied, officers and people accompanying them must identify themselves. Where an interpreter is present a brief statement is to be made in the search officer's notebook confirming that the interpreter explained the purpose of the search and the occupier's rights.

If the occupier wishes a third party to witness the search, that person must be allowed to act as a witness unless the officer has reasonable grounds for believing that the presence of the person asked would seriously hinder the investigation or endanger the officers concerned or other people. A search need not be unreasonably delayed for this purpose. If the officer in charge of the search refuses the occupier's request, the reasons for doing so must be entered on the search record.

Searches involving forced entry

Where the statutory power allows, reasonable and proportionate force may be used, if necessary, to enter the premises where:

- The occupier or any other person entitled to grant access has refused a request to allow entry to the premises.

- It is impossible to communicate with the occupier or any other person entitled to grant access.
- The premises to be searched are known to be unoccupied.
- The occupier and any other person entitled to grant access are known to be absent, or
- There are reasonable grounds for believing that to alert the occupier or any other person entitled to grant access by attempting communication would impede the object of the search or endanger the officers concerned or other persons.

Before any forced entry is made, the officer in charge of the search must be satisfied that one of the conditions above is met and that the address is that which is specified in any warrant.

If there is a risk of serious injury to officers or members of the public during the execution of forced entry, officers trained in method of entry (MOE) using the appropriate equipment and protective clothing should be deployed. Only in exceptional circumstances, and with proper authority, may untrained officers without specialist equipment conduct forced entry procedures.

Conduct of the search

Premises may be searched only to the extent necessary to achieve the purpose of the search, having regard to the size and nature of whatever is sought.

A search may not continue under:

- A warrant's authority once all the things specified in that warrant have been found, and
- Any other power once the object of that search has been achieved.

No search may continue once the officer in charge of the search is satisfied, whatever is being sought is not on the premises. This does not prevent a further search of the same premises if additional grounds come to light supporting a further application for a search warrant or exercise or further exercise of another power, e.g. when, as a result of new information, it is believed articles previously not found or additional articles are on the premises.

Leaving premises

If premises have been entered by force, before leaving the officer in charge of the search must make sure they are secure by:

- Arranging for the occupier or their agent to be present, or
- Any other appropriate means.

Any significant occurrence including damage to premises or use of an occupier's property should be recorded in a notebook and countersigned by the occupier.

Search team responsibilities

The officer in charge of the search team is responsible for the search and:

- Ensuring that the premises are controlled.
- Any persons present are under control.
- Checking for any items that might cause harm and ensuring that these are dealt with properly, and
- Ensuring all property is returned to the designated property control point and that any items such as drugs, cash, firearms or ammunition or other valuables or high value goods are brought to the attention of the property officer. If firearms are found they should not be touched and assistance sought from the police.

The officer in charge of the search must ask the occupier (if present) before the search commences if there are any drugs, firearms, cash or valuables on the premises. These items should be secured and recorded in the presence of the owner or occupier before they are removed to limit the claim of theft, etc. and to prevent any possible discrepancies that might occur at a later date.

Each member of the search team is responsible for the continuity of the evidence. Officers should be objective and take their time about the property they uplift. They should try to sift property on the premises and uplift what is relevant based on the knowledge of the case, rather than sweep up material. In case of doubt, officers should consult members of the case team. This will reduce the problem of irrelevant material being uplifted which may have disclosure or resource implications later on.

Post search de-briefing

A formal de-briefing should be conducted following the search with the aim of highlighting any good or bad practices identified.

Annex 8. Forensic identification method capabilities, approximate costs and lead times

This annex provides information on which forensic identification test may be able to answer to specific identification questions when undertaken by an expert scientist trained in the application of the method (table A8.1). Also listed are approximate cost ranges for the different techniques and minimum lead times based on the time required to complete the laboratory tests (table A8.2). Not all methods will be able to find answers in every circumstance, due to the progress of development of these approaches for different species in different areas. Instead, the information here refers to what the methods can achieve given all the required reference information. These cost and time ranges are correct as of time of publication, however costs can fluctuate in both directions due to improvements in efficiencies and general inflation. Exact costs should be confirmed with the service provider. The information here may be of interest to law enforcement officers as a first step when assessing which forensic identification test may be suitable for their investigations. The scientific community may find this information useful when considering which methods may be complementary, and prosecutors and the judiciary may find the information useful for assessing the suitability of the testing undertaken and whether further testing may strengthen a case.

Table A8.1 Method capabilities

Identification need	Wood anatomy	Machine vision	Dendro-chronology	Mass spectrometry	Near infrared spectroscopy	Stable isotopes	Radiocarbon	Genetics
Genus	Yes	Yes	No	Yes	Yes	No	No	Yes
Species	Occasionally	Occasionally	No	Yes	Yes	No	No	Yes
Provenance	Occasionally	Unknown	Occasionally	Yes	Yes	Yes	No	Yes
Individuals	No	No	Yes	No	No	No	No	Yes
Age	No	No	Yes — with growth rings	No	No	No	Yes	No

Table A8.2 Method costs and lead times

Forensic identification method	Approximate cost per sample including expertise (US$)	Minimum time required for process
Wood anatomy (including machine vision/ dendrochronology	<$100	Minutes–days
Mass spectrometry	<$1–$100	Minutes–days
Near infra-red spectroscopy	<$1–$50	Minutes–days
Stable isotopes	$100–$400	Several days
Radio-carbon	$300–$400	Several days
Genetics	$100–$300	Several days

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1. Dormontt, E.E., et al., *Forensic timber identification: it's time to integrate disciplines to combat illegal logging*. Biological Conservation, 2015. 191: p. 790-798.

Annex 9. Resources to assist rapid-field identification of timber and timber products

Initial proficiency with rapid-field identification of timber should be attained through training by professional wood anatomists. This annex is intended to provide references for resources that may assist with the ongoing work of trained field identifiers of timber and timber products. Anyone trained in the rapid identification of timber may find these useful, including but not limited to front-line law enforcement agencies, customs, competent authorities, management authorities, foresters, scientists, certification bodies, auditors and the general public. The resources are organized into *(a)* manuals, books and publications; *(b)* interactive reference databases; *(c)* posters; *(d)* websites; and *(e)* a list of curated wood collections and wood anatomy contacts. This annex is not exhaustive and is intended only to indicate potentially useful resources, not to endorse any particular product or to recommend the use of these resources to the exclusion of others.

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CITESwoodID. Website providing descriptions, illustrations, identification, and information on CITES wood species and various lookalike species. Available in English, German, Spanish and French delta-intkey.com/citesw

The Gymnosperm Database. Website providing information on the classification, description, ecology and uses of gymnosperms (group of seed-producing plants that includes conifers, cycads, Ginkgo, and Gnetales). In English. Available at www.conifers.org

Hobbit House Wood ID Site. Website to help with colour matching of wood as well as basic guides to macroscopic wood anatomy www.hobbithouseinc.com/personal/woodpics

Identificação Anatômica de Madeiras. Video on wood identification. In Portuguese. Available from www.youtube.com/watch?v=94QP-zc05kg

The International Association of Wood Anatomists (IAWA). Website of the society containing links to relevant information associated with the study of wood anatomy. May assist in locating an expert that can undertake wood identification services. Available at iawa-website.org

The International Tropical Timber Organization (ITTO) Lesser Used Species Atlas. Website designed to inform on the properties, uses and availability of lesser-used tropical timber species. In English, French, Spanish and Portugese. Available at www.tropicaltimber.info

Tervuren Xylarium Wood Database. Website providing images of trees, wood samples and wood anatomy of selected species, predominantly from Central Africa. In English. Available at www.africamuseum.be/collections/browsecollections/naturalsciences/earth/xylarium

The Wood Database. Website detailing the appearance, qualities and geographic distributions of around 500 species of traded woods www.wood-database.com

Wood Identification from the Forest Research Institute Malaysia (FRIM). Website providing and introduction to macroscopic wood anatomy and an identification key to 54 timber species commonly available in Malaysia. Available in English from info.frim.gov.my/woodid

List of curated wood collections (museums of wood, or "xylaria") and wood anatomy contacts

Index Xylariorum 4.1. Online document detailing global wood collections both historic and current. May assist in locating institutions that can provide expert wood identification services. Available at www.iawa-website.org/downloads.html

List of wood anatomical experts around the world. An excel file contains a number of IAWA members who are interested to share their wood anatomical expertise to solve problems related to illegal logging. Available at www.iawa-website.org/downloads.html

Annex 10. CITES-listed timbers and lookalikes documented in CITESwoodID

This annex provides information, in the form of lists and a table (A10.1), on CITES-listed timbers and lookalikes documented in the macroscopic wood identification computerized database CITESwoodID [1]. The common names listed are not necessarily exhaustive. This information may be useful to law enforcement officers interested in understanding which CITES timber species and lookalikes can be identified using macroscopic wood anatomy. Additionally, law enforcement agencies may find this information useful when considering whether or not to invest in training staff on the use of these resources, which can serve as a rapid-field-identification tool. Annex 11 provides similar information on the most important traded (but not necessarily CITES-listed) timbers. See annex 9 for more information on resources available to aid rapid-field identification of timber.

List of 28 traded CITES-listed timbers documented in CITESwoodID (update 2015) in alphabetical order according to the botanical/scientific names

1. *Aniba rosaeodora* **(Pau rosa)** - CITES Annex II(B)
2. *Aquilaria* spp.*, Gyrinops* spp. **(Adlerholz, eaglewood)** - CITES Annex II(B)
3. *Araucaria araucana* **(Pehuén, pino araucano)** - CITES Annex I(A)
4. *Bulnesia sarmientoi* **(Palo santo)**- CITES Annex II(B)
5. *Caesalpinia echinata* **(Pau Brasil, Fernambuc)** - CITES Annex II(B)
6. *Cedrela odorata* **(Cedro)** - CITES Annex III(C)
7. *Dalbergia cochinchinensis* **(Burma rosewood)** - CITES Annex II(B)
8. *Dalbergia nigra* **(Rio Palisander, Brazilian rosewood)** - CITES Annex I(A)
9. *Dalbergia retusa, D. granadillo* **(Cocobolo)** - CITES Annex II(B)
10. *Dalbergia* spp. *Madagascar* **(Palissandre de Madagascar)** - CITES Annex II(B)
11. *Dalbergia stevensonii* **(Honduras rosewood)** - CITES Annex II(B)
12. *Dalbergia tucurensis* **(Korallen-Palisander, Guatemalan rosewood)** - CITES Annex III(C)

13. *Diospyros* spp. *Madagascar* **(Ébène de Madagascar)** - CITES Annex II(B)
14. *Dipteryx oleifera* **(Almendro)** - CITES Annex III(C)
15. *Fitzroya cupressoides* **(Alerce)** - CITES Annex I(A)
16. *Fraxinus mandshurica* **(Mandschurische Esche, Manchurian ash)** - CITES Annex III(C)
17. *Gonystylus* spp. **(Ramin)** - CITES Annex II(B)
18. *Guaiacum* spp. **(Pockholz, Lignum Vitae)** - CITES Annex II(B)
19. *Osyris quadripartita* **(Ostafrikanisches Sandelholz, Eastafrican sandalwood)** - CITES II Annex II(B)
20. *Pericopsis elata* **(Afrormosia, Kokrodua)** - CITES Annex II(B)
21. *Pilgerodendron uviferum* **(Ciprés de las Guaitecas)** - CITES Annex I(A)
22. *Pinus koraiensis* **(Korea-Kiefer, Korean pine)** - CITES Annex III(C)
23. *Platymiscium* spp. **(Granadillo)** - (CITES II p.p.) CITES Annex II(B); or not protected
24. *Podocarpus* spp. **(Podo, Maniu)** - CITES I + III CITES Annex I(A); or CITES Annex III(C)
25. *Pterocarpus santalinus* **(Red sanders)** - CITES II listed in Annex II(B)
26. *Quercus mongolica* **(Mongolische Eiche, Mongolian oak)** - CITES III CITES Annex III(C)
27. *Swietenia* spp. **(Echtes Mahagoni, True Mahogany)** - CITES II Annex II(B)
28. *Taxus* spp. **(Eibe, yew)** - CITES Annex II(B)

List of 34 lookalike species which are also documented in the database CITESwoodID (update 2015) in alphabetical order according to the botanical/scientific names

1. *Acosmium* spp. **(Lapachillo, Lapachín)** not protected — lookalike: “Afrormosia”
2. *Agathis* spp. **(Kauri, Damar-minyak)** not protected — lookalike: “Pehuén, pino araucano”
3. *Alstonia* spp. - *section Alstonia* **(Pulai)** not protected — lookalike: “Ramin“
4. *Antiaris* spp. **(Ako)** not protected — lookalike: “Ramin“
5. *Araucaria angustifolia* **(Parana pine)** not protected — lookalike: “Pehuén, pino araucano”
6. *Brosimum rubescens Taub.* **(Satiné)** not protected — lookalike: “Pau Brasil, Fernambuc”
7. *Caesalpinia* spp. **(Chakté viga)** not protected — lookalike: “Pau Brasil, Fernambuc”
8. *Carapa guianensis* **(Andiroba)** not protected — lookalike: “True Mahogany”
9. *Chlorocardium rodiei* **(Greenheart)** not protected — lookalike: “Lignum Vitae, Palo santo”
10. *Chrysophyllum* spp. **(Aningré blanc)** not protected — lookalike: “Ramin“
11. *Cordia glabrata* **(Louro preto)** not protected — lookalike: “Brazilian rosewood, D. etc.”
12. *Dalbergia cearensis* **(Kingwood)** not protected — lookalike: “Brazilian rosewood, D. etc.”
13. *Dalbergia latifolia* **(Indian rosewood)** not protected — lookalike: “Brazilian rosewood, D. etc.”
14. *Dalbergia spruceana* **(Amazonas rosewood)** not protected — lookalike: “Brazilian rosewood, D. etc.”
15. *Dyera costulata* **(Jelutong)** not protected — lookalike: “Ramin“
16. *Endospermum* spp. **(Sesendok)** not protected — lookalike. “Ramin“
17. *Entandrophragma angolense* **(Tiama)** not protected — lookalike: “True Mahogany”

18. *Entandrophragma cylindricum* **(Sapeli)** not protected — lookalike: “True Mahogany”
19. *Entandrophragma utile* **(Sipo, Utile)** not protected — lookalike: “True Mahogany”
20. *Guarea* spp. **(Bossé)** not protected — lookalike: “True Mahogany”
21. *Handroanthus* spp. **(Ipê, Lapacho)** not protected — lookalike: “Afrormosia”
22. *Khaya* spp. **(Khaya, African Mahogany)** not protected — lookalike: “True Mahogany”
23. *Machaerium scleroxylon* **(Santos Palisander)** not protected — lookalike: “Brazilian rosewood”
24. *Neolamarckia cadamba* **(Kadam)** not protected — lookalike: “Ramin“
25. *Ocotea rubra* **(Louro vermelho, Wane)** not protected — lookalike: “True Mahogany”
26. *Pterocarpus macrocarpus* **(Amboina)** not protected — lookalike: “Red sanders”
27. *Pterocarpus soyauxii* **(African Padouk)** not protected — lookalike: “Red sanders”
28. *Pterygota* spp. **(Kasah, Koto)** not protected — lookalike: “Ramin“
29. *Sequoia sempervirens* **(Redwood)** not protected — lookalike: “Alerce”
30. *Simarouba amara* **(Simaruba, Marupá)** not protected — lookalike: “Ramin“
31. *Tectona grandis* **(Teak)** not protected — lookalike: “Cedro“
32. *Terminalia superba* **(Limba)** not protected — lookalike: “Ramin“
33. *Thuja plicata* **(Western Red Cedar)** not protected — lookalike: “Alerce”
34. *Toona* spp. **(Suren, Toon)** not protected — lookalike: “Cedro“

Table A10.1 Alphabetical list of CITES timbers (in bold print) and respective similar timbers

Botanical name	Status
Aniba rosaeodora	**CITES**
Aquilaria spp., Gyrinops spp.	**CITES**
Araucaria araucana	**CITES**
Araucaria angustifolia	similar
Agathis spp.	similar
Bulnesia sarmientoi	**CITES**
Bulnesia arborea	similar
Chlorocardium rodiei	similar
Guaiacum spp. (CITES)	similar
Tabebuia spp.	similar
Caesalpinia echinata	**CITES**
Caesalpinia spp.	similar
Brosimum rubescens	similar
Cedrela odorata	**CITES**
Swietenia spp. (CITES)	similar
Tectona grandis	similar
Toona spp.	similar
Dalbergia cochinchinenesis	**CITES**
Dalbergia nigra	**CITES**
Cordia glabrata	similar
Dalbergia latifolia	similar
Dalbergia madagascariensis	similar
Dalbergia spruceana	similar
Dalbergia stevensonii (CITES)	similar
Machaerium scleroxylum	similar
Platymiscium spp. (CITES p.p.)	similar
Dalbergia retusa, D. granadillo	**CITES**
Dalbergia spp. Madagascar I	**CITES**
Dalbergia stevensonii	**CITES**
Dalbergia latifolia	similar
Dalbergia cearensis	similar
Dalbergia spruceana	similar
Platymiscium spp. (CITES p.p.)	similar
Diospyros spp. Madagascar	**CITES**
Fitzroya cupressoides	**CITES**

Sequoia sempervirens	similar
Thuja plicata	similar
Gonystylus spp.	**CITES**
Alstonia spp.	similar
Antiaris spp.	similar
Chrysophyllum spp.	similar
Dyera costulata	similar
Endospermum spp.	similar
Neolamarckia cadamba	similar
Pterygota spp.	similar
Simarouba amara	similar
Terminalia superba	similar
Guaiacum spp.	**CITES**
Bulnesia spp. (CITES p.p.)	similar
Chlorocardium rodiei	similar
Tabebuia spp.	similar
Pericopsis elata	**CITES**
Acosmium spp.	similar
Tabebuia spp.	similar
Podocarpus spp.	**CITES**
Pterocarpus santalinus	**CITES**
Pterocarpus macrocarpus	similar
Pterocarpus soyauxii	similar
Swietenia spp.	**CITES**
Carapa guianensis	similar
Cedrela odorata (CITES)	similar
Entandrophragma angolense	similar
Entandrophragma cylindricum	similar
Entandrophragma utile	similar
Guarea spp.	similar
Khaya spp.	similar
Ocotea rubra	similar
Taxus spp.	**CITES**

References

1. Richter, H.G., Gembruch, K., and Koch, G. CITESwoodID: descriptions, illustrations, identification, and information retrieval (2014 onwards). Version: 16th May 2014. In English, German, Spanish and French. Available at delta-intkey.com/citesw.

Annex 11. One hundred important traded timbers documented in *macroHOLZdata*

This annex provides information on the 100 most important traded timbers documented in the macroscopic wood identification computerized database *macroHOLZdata* [1]. The common names listed are not necessarily exhaustive. This information may be useful to law enforcement officers interested in understanding which commonly traded timbers can be identified using macroscopic wood anatomy (although there are many more that are less commonly traded, which can be identified by an expert in wood anatomy). Additionally, law enforcement agencies may find this information useful when considering whether or not to invest in this resource, which can assist in rapid-field identification of these timbers. Annex 10 provides similar information on CITES-listed timbers and lookalike species. See annex 9 for more information on resources available to aid rapid-field identification of timber.

List of 100 traded timbers documented in macroHOLZdata *in alphabetical order according to the common German names*

1. Abachi, **obeche** (*Triplochiton scleroxylon*)
2. Afzelia, **doussié** (*Afzelia* spp.)
3. Ahorn, **maple, sycamore** (*Acer* spp.)
4. **Angelim vermelho** (*Dinizia excelsa*)
5. **Angélique**, basralocus (*Dicorynia guianensis*)
6. **Balau**, bangkirai (*Shorea* spp., section Shorea)
7. **Balsa** (*Ochroma pyramidale*)
8. **Berangan** (*Castanopsis* spp.)
9. Bilinga, **opepe** (*Nauclea diderrichii*)
10. **Bintangor** (*Calophyllum* spp., *Asia*)
11. Birke, **birch** (*Betula* spp.)
12. Birnbaum, **pear** (*Pyrus communis*)
13. Bongossi, azobé, ekki (*Lophira alata*)

14. Brasilkiefer, **Parana pine** (*Araucaria angustifolia*)
15. Bubinga, **kevazingo** (*Guibourtia* spp.)
16. Buche, **European beech** (*Fagus sylvatica*)
17. **Cedro** (*Cedrela odorata, Cedrela fissilis, Cedrela* spp.)
18. Eiba, **fromager** (*Ceiba pentandra*)
19. **Cumarú** (*Dipteryx odorata*)
20. Douglasie, **Douglas fir** (*Pseudotsuga menziesii*)
21. **Eastern redcedar** (*Juniperus virginiana*)
22. Ebenhölzer, gestreift; **East Indian ebony** (*Diospyros* spp.)
23. Ebenhölzer, schwarz; **black ebony** (*Diospyros* spp.)
24. Edelkastanie, **chestnut** (*Castanea sativa, Castanea* spp.)
25. Eibe, **yew** (*Taxus baccata*)
26. Erle, **alder** (*Alnus glutinosa, Alnus* spp.)
27. Esche, **ash** (*Fraxinus* spp.)
28. Eukalyptus, **eucalyptus** (*Eucalyptus grandis, Eucalyptus saligna*)
29. Fichte, **Norway spruce** (*Picea abies*)
30. Framiré, **idigbo** (*Terminalia ivorensis*)
31. Garapa, **grapiá** (*Apuleia leiocarpa*)
32. Gonçalo **alves** (*Astronium* spp.)
33. Hainbuche, **common hornbeam** (*Carpinus betulus*)
34. **Hard pines** (*Pinus* spp.; section Taeda)
35. **Hemlock, western** (*Tsuga heterophylla*)
36. Hevea, **rubberwood** (*Hevea brasiliensis*)
37. **Hickory** (*Carya* spp.)
38. Ipê, **lapacho** (*Tabebuia* spp.)
39. Iroko, **kambala** (*Milicia excelsa*)
40. **Itaúba** (*Mezilaurus itauba*)
41. **Jatobá** (*Hymenaea* spp.)
42. **Kapur** (*Dryobalanops* spp.)
43. Kasai, **taun** (*Pometia* pinnata)
44. Khaya, **African mahogany** (*Khaya* spp.)

45. **Kedondong** (*Canarium* spp.)
46. **Keruing** (*Dipterocarpus* spp.)
47. Kiefer, **Scots pine** (*Pinus sylvestris*)
48. Kirschbaum, **cherry** (*Prunus* spp.)
49. Kosipo, **omu** (*Entandrophragma candollei*)
50. **Koto**, Kasah, Farinha-seca (*Pterygota* spp.)
51. Lärche, **larch** (*Larix decidua*)
52. Limba, **afara** (*Terminalia superba*)
53. **Louro faia** (*Roupala* spp.)
54. **Louro vermelho**, wane (*Ocotea rubra*)
55. **Machang** (*Mangifera* spp.)
56. Mahagoni, echtes; **American mahogany** (*Swietenia macrophylla*)
57. **Mandioqueira** (*Qualea* spp.)
58. **Mangium** (*Acacia mangium*)
59. **Marupá** (*Simarouba amara*)
60. **Massaranduba** (*Manilkara bidentata*)
61. **Medang** (*Cinnamomum* spp.)
62. **Melina** (*Gmelina arborea*)
63. **Mengkulang** (*Heritiera* spp.)
64. **Merbau** (*Intsia* spp.)
65. **Merpauh** (*Swintonia* spp.)
66. Nussbaum, **walnut** (*Juglans regia, Juglans nigra*)
67. **Nyatoh** (*Palaquium* spp.)
68. **Okan** (*Cylicodiscus gabunensis*)
69. **Ovengkol** (*Guibourtia ehie*)
70. **Padouk** (*Pterocarpus soyauxii, Pterocarpus osun*)
71. Pappel, Espe; **poplar**, aspen (*Populus* spp.)
72. **Paulownia**, kiri (*Paulownia* spp.)
73. Platane, **plane** (*Platanus* spp.)
74. Pockholz, **lignum vitae** (*Guaiacum* spp.)
75. **Punah** (*Tetramerista glabra*)

76. **Radiata pine** (*Pinus radiata*)
77. **Ramin** (*Gonystylus bancanus*)
78. **Red Meranti** (*Shorea* spp., section rubroshorea)
79. Palisander, **rosewood** (*Dalbergia* spp.)
80. Robinie, **robinia** (*Robinia pseudoacacia*)
81. Roteiche, **red oak** (*Quercus rubra, Quercus* spp.)
82. Sapelli, **sapele** (*Entandrophragma cylindricum*)
83. **Schima** (*Schima wallichii*)
84. **Sen** (*Kalopanax septemlobus*)
85. Sipo, **utile** (*Entandrophragma utile*)
86. **Soft pines** (*Pinus* spp.; section Strobus)
87. Spießtanne, Chinesische; **China fir** (*Cunninghamia lanceolata*)
88. Tanne, **silver fir** (*Abies alba*)
89. **Tatajuba** (*Bagassa guianensis*)
90. **Teak** (*Tectona grandis*)
91. **Tembusu** (*Fagraea fragrans*)
92. Tiama, **gedu nohor** (*Entandrophragma angolense*)
93. Ulme, **elm** (*Ulmus* spp.)
94. Weißeiche, **white oak** (*Quercus*(w) spp.)
95. **Wengé** (*Millettia laurentii*)
96. **Western red cedar** (*Thuja plicata*)
97. Whitewood, **yellow poplar** (*Liriodendron tulipifera*)
98. White seraya, **gerutu** (*Parashorea* spp.)
99. Zebrano, **zingana** (*Microberlinia brazzavillensis, Microberlinia bisulcata*)
100. Zeder, echte; **cedar** (*Cedrus* spp.)

References

1. Richter, H., and M. Oelker. 2002 onwards. macroHOLZdata, Commercial timbers: descriptions, illustrations, identification, and information retrieval. Version: 2014. In English and German. Available for purchase from the Thünen Institute www.ti.bund.de/en/hf/.

Annex 12. Methods currently under development for rapid-field identification of timber

This annex provides information on two automated methods that are currently under development to assist in the rapid-field identification of timber. At the time of publication, these methods were not widely available for use by front-line law enforcement officers but it is hoped that in the coming years they will be. This information may be of interest to law enforcement agencies and scientists. For the latest information on these techniques, readers should consult the relevant peer-reviewed scientific literature and/or contact the institutions undertaking the research and developing the tools.

Automated macroscopic wood anatomical identification

Timber identification through the use of a handheld machine which compares the wood structure to a reference database and returns the most likely match.

"Machine vision" technology has potential for use as a handheld timber identification device (1). The system captures images under conditions of strict light control through its camera, and it uses signal processing approaches to extract information and then analyse in a way that establishes a classification scheme. A prototype device has been developed, which has been utilized in two field situations to test multiple specimens in real time. The potential accuracy of this method is excellent—as good, if not sometimes better, than that which can be achieved by a trained expert, due in part to the increased sensitivity to light of the optical receptors employed in the system when compared to the human eye. The skill level required to operate a functional system at the front line to obtain an identification is minimal, and comparable to that required to take macroscopic photographs suitable for off-site expert identification. However, the technology is at the prototype stage and has been tested on a limited number of species, so is not widely available at present.

Near infrared spectroscopy

Timber identification through the use of a handheld machine which compares the wood structure and chemistry to a reference database for that area and returns the most likely match.

Near infrared spectroscopy (NIRS) is applied to timber by use of a small handheld spectrometer device and returns information derived from both the chemical and physical structure of the wood. The returned spectrum of a sample is analysed to determine the likely taxon when compared with reference datasets, and the result is obtained in real time. This technology has the potential to return accurate results with minimal skills required of the operator and is currently at the pilot stage (2). Current research is focusing on how the methodology can be optimized for use in the field e.g. through the introduction of variables such as humidity and cutting direction in the discrimination model. Results obtained in the field have shown that correct identification of family and species is possible. Provenance has also been correctly identified, differentiating Brazilian mahogany wood from Mexico, Honduras, Peru and Venezuela. The technology is not currently widely available.

References

1. “Machine Vision” is being developed at the Center for Wood Anatomy Research of the US Forest Products Laboratory (CWAR-FPL).

2. Near infrared spectroscopy (NIRS) is being developed for timber identification purposes in the Forest Products Laboratory of the Brazilian Forest Service and University of Brasília.

Annex 13. Example chain-of-custody form

This annex provides an example evidence chain-of-custody form. When evidence is collected, in order for it to be admissible in court proceedings, intact chain of custody must be demonstrated. The location of evidence must be known and recorded at all times, and a chain of responsible custodianship proved to exist from initial sample collection, through analyses and eventually to court where necessary. Law enforcement agencies may find this example form useful, as may forensic scientists who need to record sample chain of custody in the laboratory. Most organizations who deal with evidence on a regular basis will have their own standard chain-of-custody form. The information presented here is for reference only and is not intended to replace or nullify any existing protocols or procedures in place. If choosing to utilize this form, consultation with appropriate experts and authorities is recommended to ensure chain-of-custody procedures comply with all local requirements.

<table>
<tr><td>AGENCY:</td><td colspan="3">CHAIN-OF-CUSTODY RECORD</td><td>CASE #</td></tr>
<tr><td>DATE AND TIME OF SEIZURE:</td><td colspan="2">REGION:</td><td colspan="2">EVIDENCE/PROPERTY SEIZED BY:</td></tr>
<tr><td>SOURCE OF EVIDENCE/PROPERTY (person and/or location):
☐ TAKEN FROM:
☐ RECEIVED FROM:
☐ FOUND AT:</td><td colspan="2">CASE TITLE AND REMARKS:</td><td colspan="2"></td></tr>
<tr><td>ITEM OR SAMPLE NO:</td><td colspan="4">DESCRIPTION OF EVIDENCE/PROPERTY (include seizure tag numbers and any serial numbers):</td></tr>
<tr><td rowspan="2">ITEM OR SAMPLE NO:</td><td>FROM:
(PRINT NAME, AGENCY)</td><td>RELEASE SIGNATURE</td><td>RELEASE DATE</td><td>DELIVERED VIA:
☐ MAIL
☐ IN PERSON
☐ OTHER:</td></tr>
<tr><td>TO:
(PRINT NAME, AGENCY)</td><td>RECEIPT SIGNATURE</td><td>RECEIPT DATE</td><td></td></tr>
</table>

ITEM OR SAMPLE NO:	FROM: (PRINT NAME, AGENCY)	RELEASE SIGNATURE	RELEASE DATE	DELIVERED VIA: ☐ MAIL ☐ IN PERSON ☐ OTHER:
	TO: (PRINT NAME, AGENCY)	RECEIPT SIGNATURE	RECEIPT DATE	
ITEM OR SAMPLE NO:	FROM: (PRINT NAME, AGENCY)	RELEASE SIGNATURE	RELEASE DATE	DELIVERED VIA: ☐ MAIL ☐ IN PERSON ☐ OTHER:
	TO: (PRINT NAME, AGENCY)	RECEIPT SIGNATURE	RECEIPT DATE	
ITEM OR SAMPLE NO:	FROM: (PRINT NAME, AGENCY)	RELEASE SIGNATURE	RELEASE DATE	DELIVERED VIA: ☐ MAIL ☐ IN PERSON ☐ OTHER:
	TO: (PRINT NAME, AGENCY)	RECEIPT SIGNATURE	RECEIPT DATE	
ITEM OR SAMPLE NO:	FROM: (PRINT NAME, AGENCY)	RELEASE SIGNATURE	RELEASE DATE	DELIVERED VIA: ☐ MAIL ☐ IN PERSON ☐ OTHER:
	TO: (PRINT NAME, AGENCY)	RECEIPT SIGNATURE	RECEIPT DATE	

Annex 14. Timber inventory and sampling data collection

This annex is intended to provide guidance on data collection for timber load inventories and associated sample collections. An inventory is an important step in detailing what is present in a timber load that may be the subject of a subsequent investigation. It can also form part of the justification for how samples were selected for testing (the sampling plan), allowing the results of any analytical services to be tracked back to the exact item and location in the original load. Agencies involved in inspecting timber loads may find this information useful and complementary to any existing policies and procedures in place. Depending on protocol and jurisdictional requirements, timber inventory and sampling information may be best recorded in a notebook or similar recording device, or on separate forms.

This annex is comprised of three parts: part A lists the kinds of information that should be recorded as part of a timber inventory and for the collection of samples for testing; part B provides an example timber inventory form; and part C provides an example sampling data collection form.

Part A. Information to be recorded in an inventory of a timber load and for the collection of samples for testing

The information recorded in a timber inventory is specifically about the contents of the load in question, and is in addition to other information required as part of a case. In addition to the timber inventory, information about the samples taken for analysis also require recording. The following list details information to be recorded in a timber inventory and when samples are taken for forensic analysis, but should not be considered necessarily exhaustive. Consultation with appropriate experts and authorities is recommended to ensure procedures comply with all local requirements.

List of important information to be recorded in an inventory of a timber load

Case title/number

Date of seizure

Location of seizure

Seized by (name, agency, contact information)

Date of inventory

Inventory taken by (name, agency, contact information)

Details of container or shipment e.g. vehicle registration number, container number, bill of lading number

Description of timber items, organized into numbered groups of items of the same kind
e.g. #G001 unprocessed logs, #G002 planks, #G003 picture frames

Quantity of items in each of the item groups
e.g. 2 unprocessed logs, 100 planks, 50 picture frames

Combined weight of each item group
e.g. 3 tonnes of unprocessed logs, 1 tonnes of planks, 150 kg of picture frames

Average dimensions of each item group
e.g. unprocessed logs approx. length 5 m, approx. diameter 1 m;
planks length 3 m, width 10 cm, depth 3 cm;
picture frames length 40 cm, width 20cm, depth 5 cm

Volume of each item group (can be calculated by dimensions and quantity)
e.g. unprocessed logs [quantity x length x area of the round face of the log calculated as πr^2 *where r is the radius (equal to half of the diameter)] =* $2 \times 5 \times \pi \times 0.5^2 = 7.85\ m^3$
planks [quantity x length x width x depth] = $100 \times 3 \times 0.1 \times 0.03 = 0.9\ m^3$
picture frames [quantity x length x width x depth] = $50 \times 0.4 \times 0.2 \times 0.05 = 0.2\ m^3$

Combined weight of load
e.g. 4.150 tonnes

Combined volume of load
e.g. $8.95\ m^3$

Additional observations and remarks (where relevent)
e.g. Handwritten code in blue permanent marker present on each log reads "XAX26"

Important notes:

1. Measurements can be recorded in whatever units are appropriate given the situation. However, when calculating combined/total weights or volumes, it is essential that the units used are consistent, or that an appropriate conversion factor is incorporated into the calculations.

2. Ensure that any handwritten markings or codes written on items are carefully recorded—this information is particularly important and must be documented exactly

as it can sometimes provide information regarding the origin or destination of the wood as well as the individuals or groups involved. Markings should also be photographed where possible, using only approved equipment, file storage and transfer methods.

List of important information to be recorded when samples are taken from the load for forensic analysis:

- Item group number
  e.g. G001 (Group 001) may represent the first group of items, which are all unprocessed logs in the load.
- Unique item number of sampled item
  e.g. iUL02 (item Unprocessed Log 02) could represent the specific log within G001 that was chosen for sampling. If applicable, this should be the number that was written on, affixed to, or otherwise assigned to the item as they were unpacked and through the development of a load map. If no numbers have previously been assigned. Assign a new number.
- Unique sample number
  e.g. S001 (Sample 001), every sample collected as evidence should have a completely unique identifying number to avoid any ambiguity regarding the origin of the sample.
- Description of the sample
  e.g. Small wood core drilled from long edge of log.
- Location of sample in original load (refer to load map and/or photographs)
  e.g. Location "A" on load map. Photograph "a111.jpg"
- Dimensions and weight of the item (information should have already been collected as part of the timber inventory)
  e.g. Weight, and length, width, depth, circumference (as appropriate) of the item

Important Note: Once samples are taken for analysis they require strict chain-of-custody recording. See the Guide part I, section 8 and annex 13 for further information.

Part B. Example timber inventory form

This form is an example template that may be used to record information collected as part of an inventory of a timber load and should be used in conjunction with the information provided in part A of this annex (and optionally part B). The exact format of the inventory is less important than the information is contains. Depending on protocol and jurisdictional requirements, timber inventory information may be best recorded in a notebook or similar recording device, or on a separate inventory form such as the example provided here. The information presented in this example form should not be considered necessarily exhaustive and consultation with appropriate experts and authorities is recommended to ensure inventory procedures comply with all local requirements.

Case information

Case title/ number:	
Date of seizure:	
Location of seizure:	
Seized by:	Name:
	Agency:
	Contact information:
Details of load:	Container number (where applicable):
	Bill of lading number (where applicable):
	Vehicle registration number (where applicable):
Inventory taken by:	Name:
	Agency:
	Contact information:

Timber information with example data

Item group #	Description of item group	Quantity	Weight (combined)	Dimensions (average)			Volume	Additional observations and remarks (optional)
				Length	Width (or diameter)	Depth (if applicable)		
G001	Unprocessed logs	2	3 tonnes	5 m	1 m	n/a	7.85 m^3	Handwritten code in blue permanent marker present on each log reads "XAX26"
G002	Planks	100	1 tonne	3 m	10 cm	3 cm	0.9 m^3	
G003	Picture frames	50	150 kg	40 cm	20 cm	5 cm	0.2 m^3	
	Total weight of load			Total volume of load				

Important note: Measurements can be recorded in whatever units are appropriate given the situation. However, when calculating combined/total weights or volumes it is essential that the units used are consistent, or that an appropriate conversion factor is incorporated into the calculations.

Part C. Example timber sampling data form

This form is an example template that may be used to record information on sampling from timber loads and should be used in conjunction with the information provided in part A of this annex (and optionally part B). It is essential that data regarding the sampling procedure (i.e. a sampling plan) be recorded exactly to ensure that any resulting forensic timber identification results can be reliably linked back to the original timber load. The exact format of the data capture is less important than the information it contains. Depending on protocol and jurisdictional requirements, details of sampling may be best recorded in a notebook or similar recording device, or on a separate form such as the example provided here. The information presented in this example form should not be considered necessarily exhaustive and consultation with appropriate experts and authorities is recommended to ensure procedures comply with all local requirements.

Case information

Case title/number:		
Date of seizure:		
Location of seizure:		
Seized by:	Name:	
	Agency:	
	Contact information:	
Details of load:	Container number (where applicable):	
	Bill of lading number (where applicable):	
	Vehicle registration number (where applicable):	
Inventory taken by:	Name:	
	Agency:	
	Contact information:	

Sampling information with example data

Date of sampling:		
Location of sampling:		
Samples taken by:	Name:	
	Agency:	
	Contact information:	
Data recorded by:	Name:	
	Agency:	
	Contact information:	

Item group #	Description of item group	Unique item # of sampled item	Unique sample #	Description of sample	Location of sample in original load (refer to load map and/or photographs)	Chain-of-custody record initiated?
G001	Unprocessed logs	iUL02	S001	Small wood core drilled from long edge of log	Location "A" on load map. Photograph "a111.jpg"	ü
G002	Planks	iPL005	S002	Small block sawn from end of plank	Location "B" on load map. Photograph "a222.jpg"	ü
G003	Picture frames	iPF20	S003	Small wood core drilled through corner of frame	Location "C" on load map. Photograph "a333.jpg"	ü

Important Note: Once samples are taken for analysis, they require strict chain-of-custody recording. See the Guide part I, section 8 and annex 13 for further information.

Annex 15. Resources to assist microscopic identification of timber and timber products

This annex is intended to provide references for resources that may assist in the identification of timber and timber products through the study of microscopic wood anatomy. Wood anatomy is a highly skilled profession and it is not anticipated that non-experts will utilize these resources frequently. Consultation with an experienced wood anatomist should be undertaken to verify any conclusions drawn as to the identity of timber by non-expert users. The resources are organized into *(a)* manuals, books and publications; *(b)* interactive reference databases; *(c)* websites; and *(d)* a list of curated wood collections and wood anatomy contacts. This annex is not exhaustive and is intended only to indicate potentially useful resources, not to endorse any particular product or to recommend use of these resources to the exclusion of others.

Manuals, books and publications

Benkova, V.E. and F. Schweingruber. Anatomy of Russian Woods (2004) Verlag Paul Haupt, Bern - Stuttgart - Wien. In English and Russian.

Crivellaro, A. and F.H. Schweingruber. Stem Anatomical Features of Dicotyledons - Xylem, Phloem, Cortex and Periderm Characteristics for Ecological and Taxonomical Analyses. (2015) Kessel Publishing House. In English.

Gregory M. Wood identification: an annotated bibliography. IAWA Bull. n.s. 1 (1980): 3–41.

Gregory M. Bibliography of systematic wood anatomy of Dicotyledons. IAWA Journal, Supplement 1. (1994) Leiden. 265 pp.Tropical Woods Keys. In English.

Greguss, P. Identification of living gymnosperms on the basis of xylotomy (1955). Akademiai Kiado, Budapest. In English.

Ilic, J. CSIRO Atlas of hardwoods (1991). CSIRO, Springer-Verlag.

Kribs, D.A. Commercial foreign woods on the American market; a manual to their structure, identification, uses, and distribution (1950). Edwards Brothers, Ann Arbor, MI. In English.

Miller, R.B. and M.C. Wiemann. Separation of Dalbergia nigra from Dalbergia spruceana. Research Paper FPL-RP-632 (1955). Madison, WI: US. Department of Agriculture, Forest Service, Forest Products Laboratory. In English. Available at www.fpl.fs.fed.us/documnts/fplrp/fpl_rp632.pdf

Neumann, K., W. Schoch, P. Détienne and F. Schweingruber. Woods of the Sahara and the Sahel (2001), Verlag Paul Haupt, Bern - Stuttgart - Wien. In English, French and German.

Phillips, E.W.J. Identification of softwoods by their microscopic structure. Forest Products Research Bull. No. 22 (1948). HMSO Department of Scientific and Industrial Research. In English.

Ravaomanalina, B. H., A. Crivellaro, and F. H. Schweingruber. Stem anatomy of Dalbergia and Diospyros from Madagascar with special focus on wood identification (2016). Springer Verlag, Germany. In English.

Richter, H. G., D. Grosser, I. Heinz, and P. E. Gasson. IAWA list of microscopic features for softwood identification. IAWA Journal, 25(1) (2004): 1-70.

Wheeler, Elisabeth A, Pieter Baas and Peter E Gasson. IAWA list of microscopic features for hardwood identification. IAWA Bulletin, New Series 10(3) (1989): 219-332.

Yale University School of Forestry. Tropical Woods Keys: Keys focused on the microscopic wood identification of Neotropical taxa, published in the journal Tropical Woods predomiantly in the first half of the 20th century. In English.

Interactive reference databases

Richter, H. G., and M.J. Dallwitz. Commercial timbers: descriptions, illustrations, identification, and information retrieval (2000 onwards). In English, French, German, Portuguese, and Spanish. Version. Available at delta-intkey.com/wood/index.htm

Wheeler, E. A. InsideWood - a web resource for hardwood anatomy. IAWA Journal 32(2) (2011): 199-211. Available at insidewood.lib.ncsu.edu (2004 onwards)

Websites

InsideWood. A web resource for hardwood anatomy (2004-onwards). Available at insidewood.lib.ncsu.edu

Commercial timbers. Descriptions, illustrations, identification and information retrieval (2000 onwards). Available at delta-intkey.com/wood/index.htm

The International Association of Wood Anatomists (IAWA). Website of the society containing links to relevant information associated with the study of wood anatomy. Available at iawa-website.org

Tervuren Xylarium Wood Database. Website providing images of trees, wood samples and wood anatomy of selected species, predominantly from Central Africa.

In English. Available at www.africamuseum.be/collections/browsecollections/naturalsciences/earth/xylarium.

List of curated wood collections (museums of wood, or "xylaria") and wood anatomy contacts

Index Xylariorum 4.1. Online document detailing global wood collections both historic and current. Available at www.iawa-website.org/downloads.html

List of wood anatomical experts around the world. An excel file contains a number of IAWA members who are interested to share their wood anatomical expertise to solve problems related to illegal logging. Available at www.iawa-website.org/downloads.html

Annex 16. Online resources for the acquisition of reference data

This annex provides information and links regarding the acquisition of scientific reference data for timber species (table A16.1). During the development of forensic timber identification methodologies, scientists may require access to existing reference data. The list of resources presented here is not necessarily exhaustive, and the reliability of the data obtained through such means should be independently assessed on a case-by-case basis.

Table A16.1 Links for the acquisition of scientific reference data for timber species

Identification method	Resource	Link	Comment
Visual	International Association of Wood Anatomists	www.iawa-website.org/links	The IAWA keeps up-to-date links to online resources
	InsideWood	insidewood.lib.ncsu.edu	Wood anatomical descriptions and pictures of many timber species
	International Tree-Ring Database ITRDB	www.ncdc.noaa.gov/data-access/paleoclimatology-data/datasets/tree-ring	Tree-ring chronologies from all continents that can be used to cross-date and match against
Chemical	Integrated Metabolite–Plant Species Database	kanaya.naist.jp/knapsack_jsp/top.html	Extensive plant database containing over 101,000 species-metabolite relationships

Genetic	National Center for Biotechnology Information (NCBI) databases	www.ncbi.nlm.nih.gov	Sequence and genotyping information for a wide range of organisms. Not taxonomically validated as a matter of course. Exercise extreme caution when utilizing these data
	DNA Data Bank of Japan	www.ddbj.nig.ac.jp	
	European Nucleo-tide Archive	www.ebi.ac.uk/ena	
	Barcode of Life Database (BOLD)	www.boldsystems.org	Sequence information for more rigorously taxonomically validated reference material
	Evolution of trees as drivers of terrestrial biodiversity (EVOLTREE)	http://www.evoltree.eu	Sequence and genotyping information for a selection of tree species using more rigorously taxonomically validated reference material

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UNODC
United Nations Office on Drugs and Crime

Vienna International Centre, P.O. Box 500, 1400 Vienna, Austria
Tel.: (+43-1) 26060-0, Fax: (+43-1) 26060-5866, www.unodc.org

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