

Opportunities for improved transparency in the timber trade through advanced DNA analysis

Prof. Andy Lowe



SOURCE: CIAT INTERNATIONAL CENTER FOR TROPICAL AGRICULTURE



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AUSTRALIA



Research themes

- **DNA timber tracking and genetic resources**

- Dr Elly Dormontt, Dr Kor Jent van Dijk, Dr Jen Young, Dr Bianca Dunker, Dr Rainbo Belton, Dr Patti Fuentes-Cross, Dr Craig Costion, Mr Duncan Jardine, Ms Marlee Crawford, Ms Melita Low

- **Plant and Ecosystem adaptation and restoration**

- Dr Martin Breed, Associate Professor Zdravko Baruch, Dr Nick Gellie, Dr Matt Christmas, Mr John McDonald, Mr Stefan Caddy-Retalic, Mr Jacob Mills, Ms Dona Kireta, Ms Kym McCallum

- **Ecosystem monitoring**

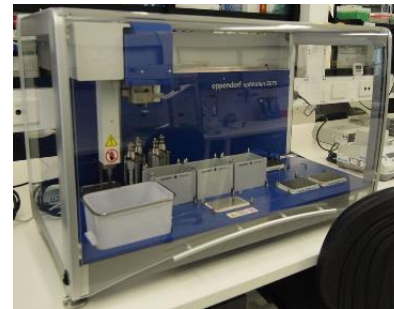
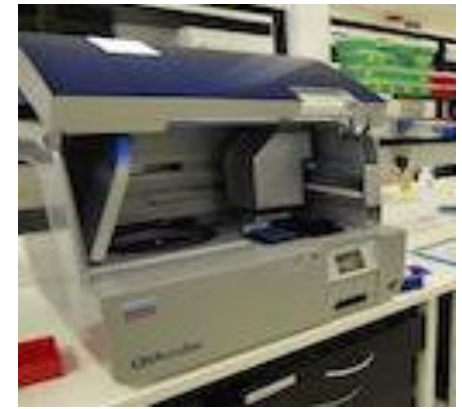
- Associate Professor Nikki Thurgate, Associate Professor Ben Sparrow, Ms Michelle Rodrigo, Dr Greg Guerin, Dr Jeff Foulkes, Dr Andrew Tokmakof, Mr Andrew White, Mr Ian Fox, Mr Jim Deed, Mr Caleb Coish, Mr Finn Hutchings, Mr Craig Walker, Dr David Turner, Dr Anita Smyth, Mr Emrys Leitch, Mr Mosheh Eliyahu, Mr Matt Schneider, Mr Tom Saleeba, Ms Christina Pahl, Ms Sally O'Neill, Mr Rick Filton,



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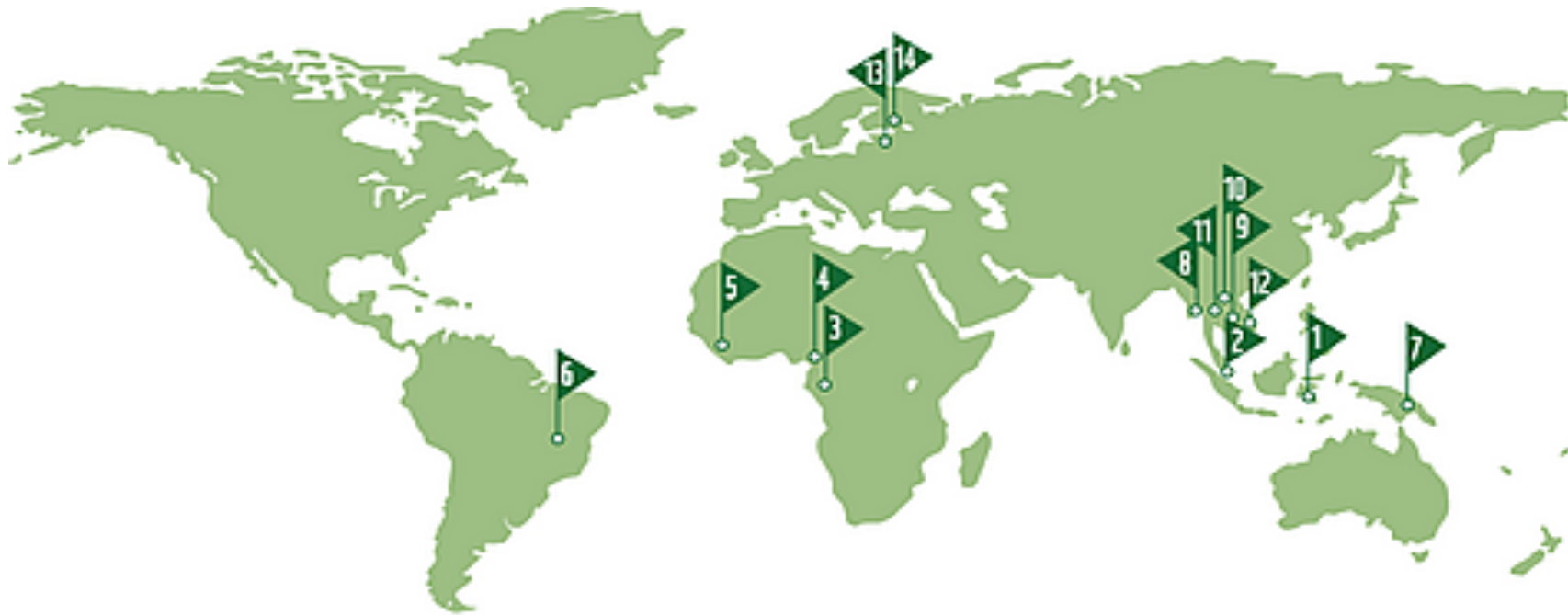
agrif
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Australian Government
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AUSTRALIAN MUSEUM



REPORT ESTIMATES: % OF ILLEGAL LOGGING

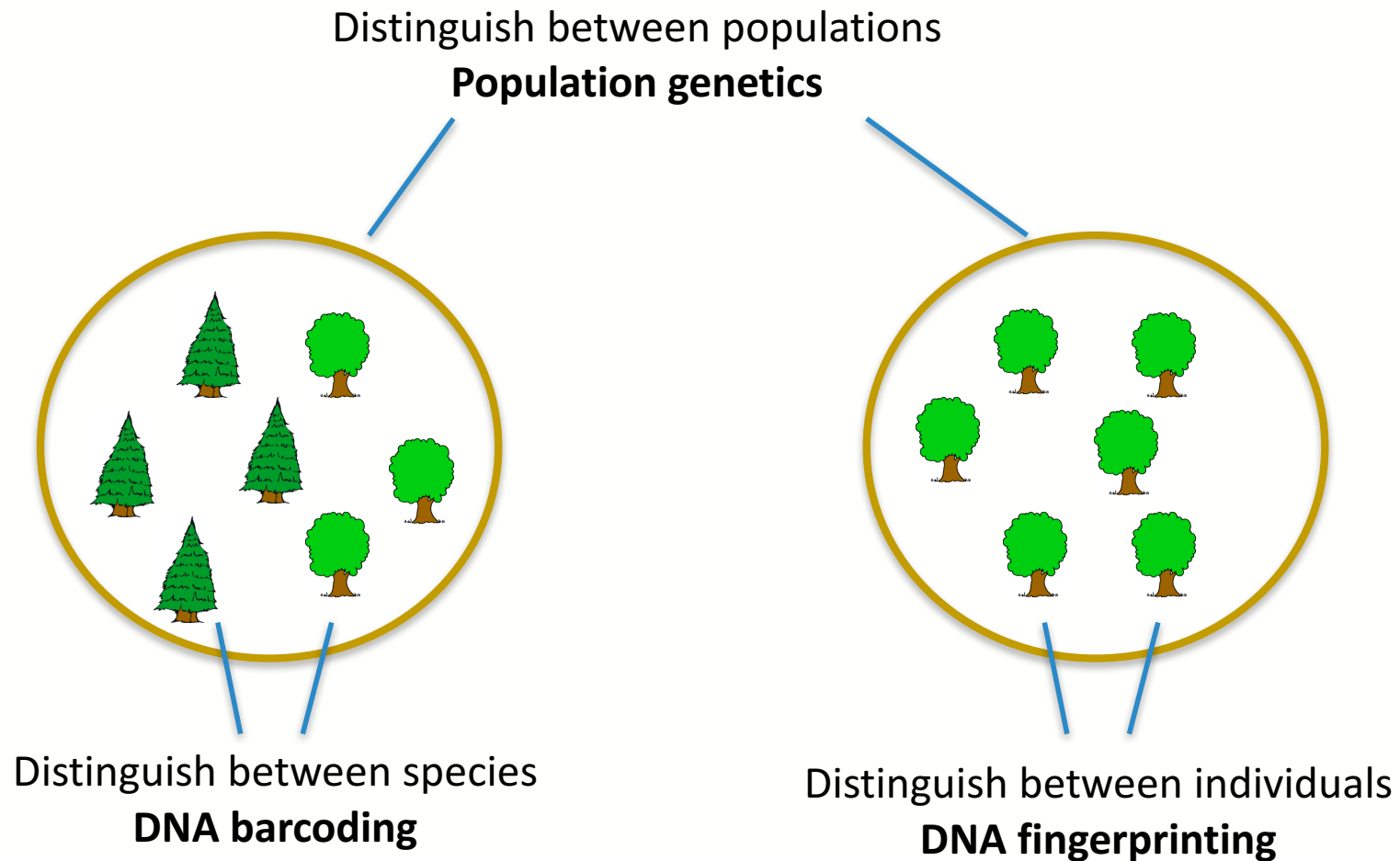
- 1.INDONESIA : 70 - 80% 2.MALAYSIA:UP TO 35% 3.GABON: 50 - 70% 4.CAMEROON: 50%
 5.LIBERIA: 80% 6.BRAZIL : UP TO 90% 7.PAPUA NEW GUINEA: 70% 8.MYANMAR : 50%
 9.CAMBODIA: 90% 10.LAOS: 45% 11.THAILAND: 40% 12.VIETNAM: 20 - 40%
 13.LATVIA: 20% 14.ESTONIA: 50%

\$30-100 billion per annum

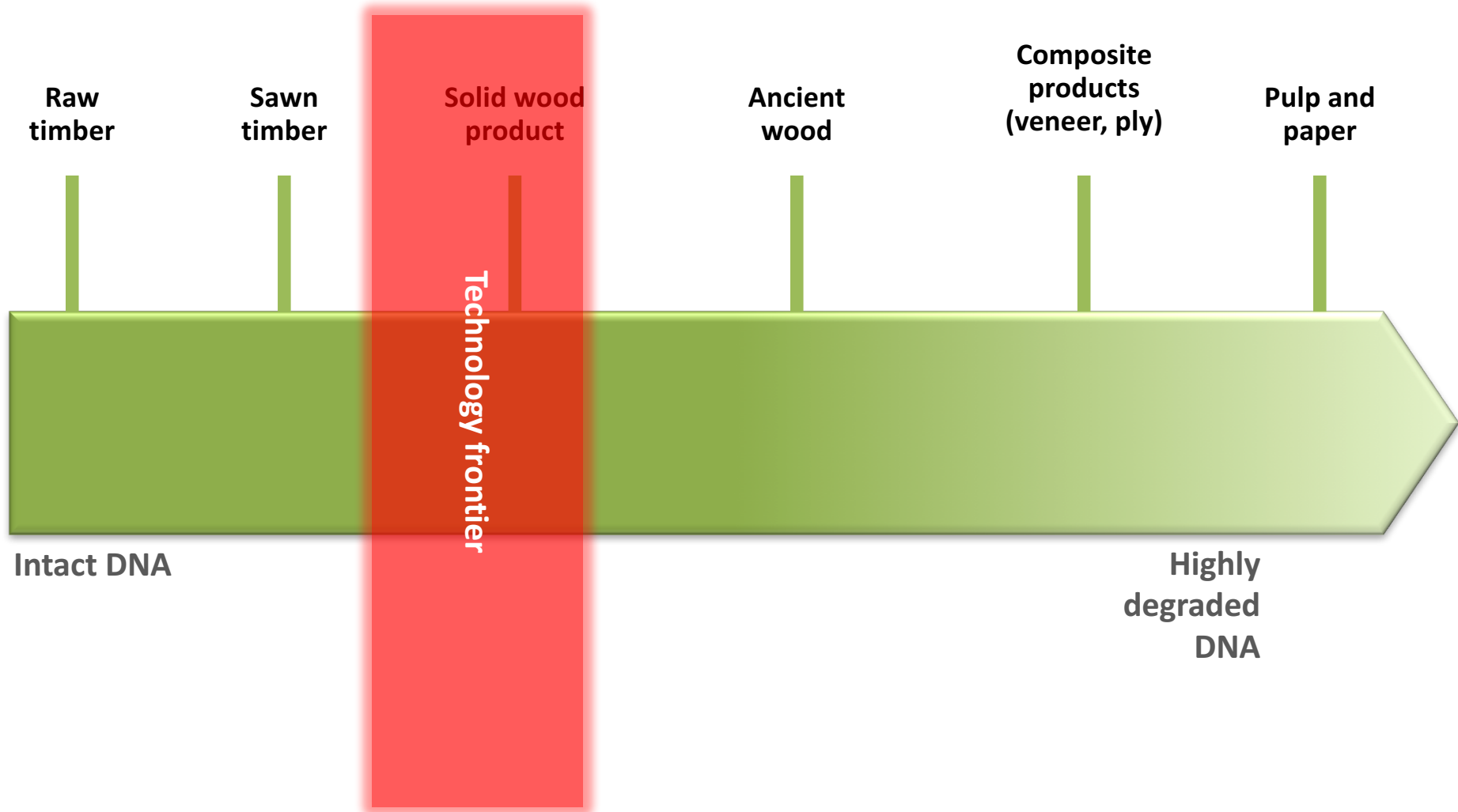


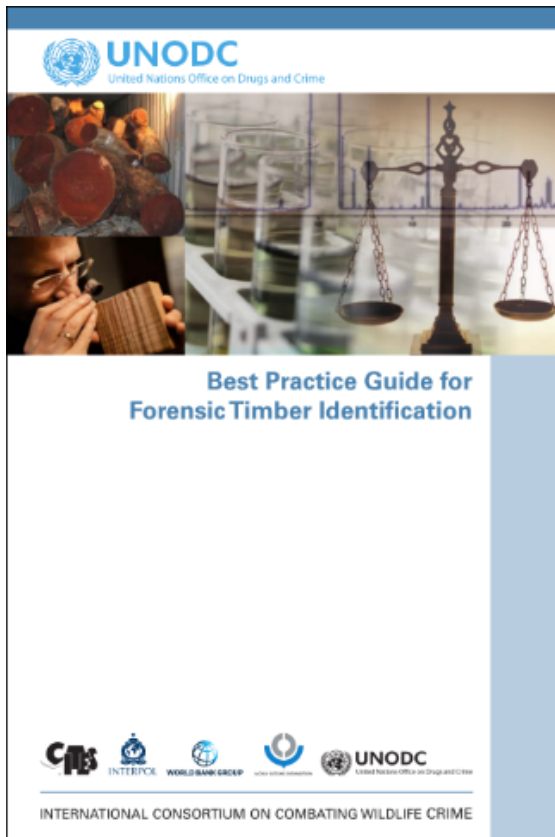
INTERPOL

DNA analysis – species, region and individuals



DNA extraction

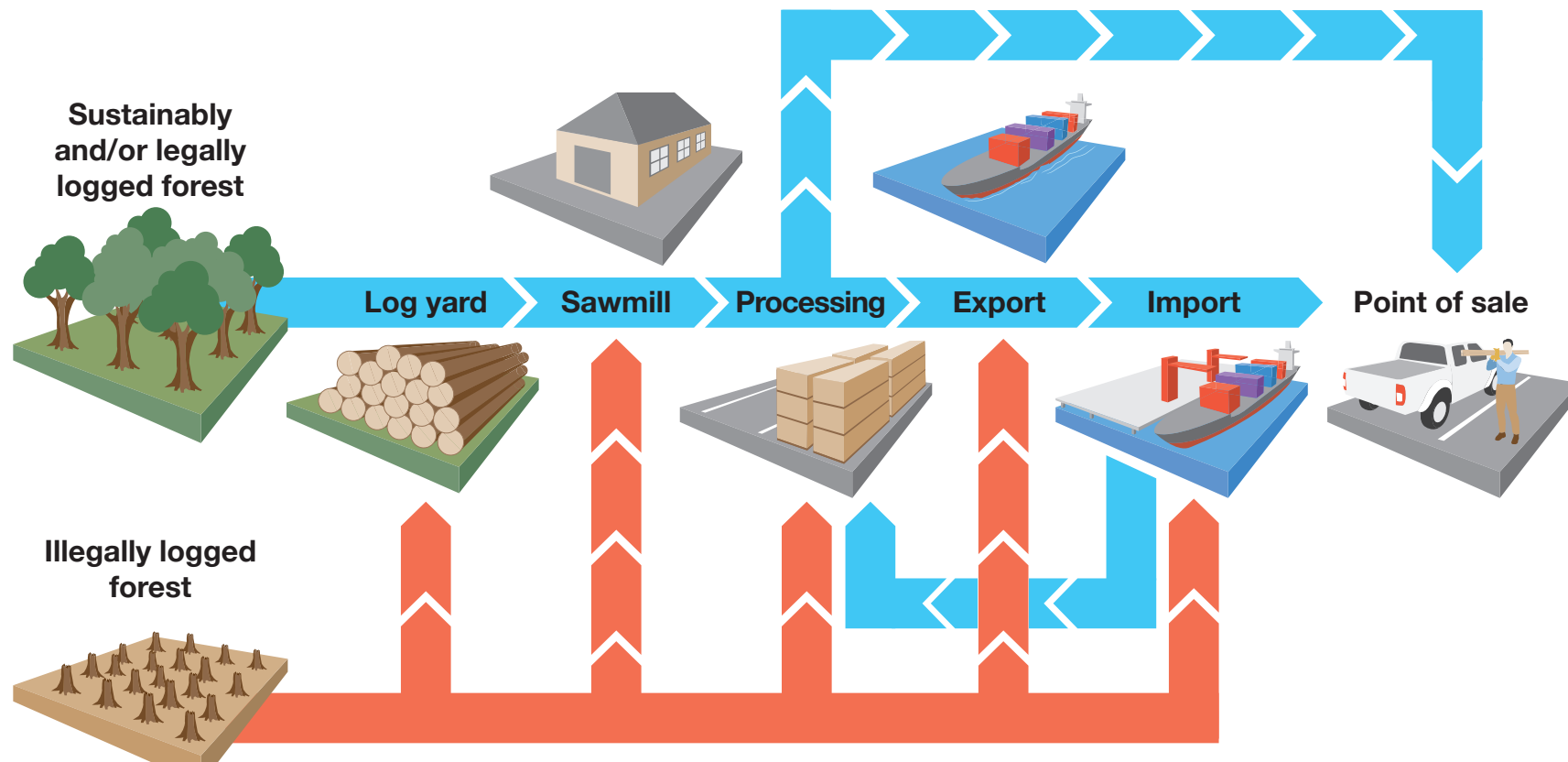




What can forensic timber identification offer law enforcement?

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

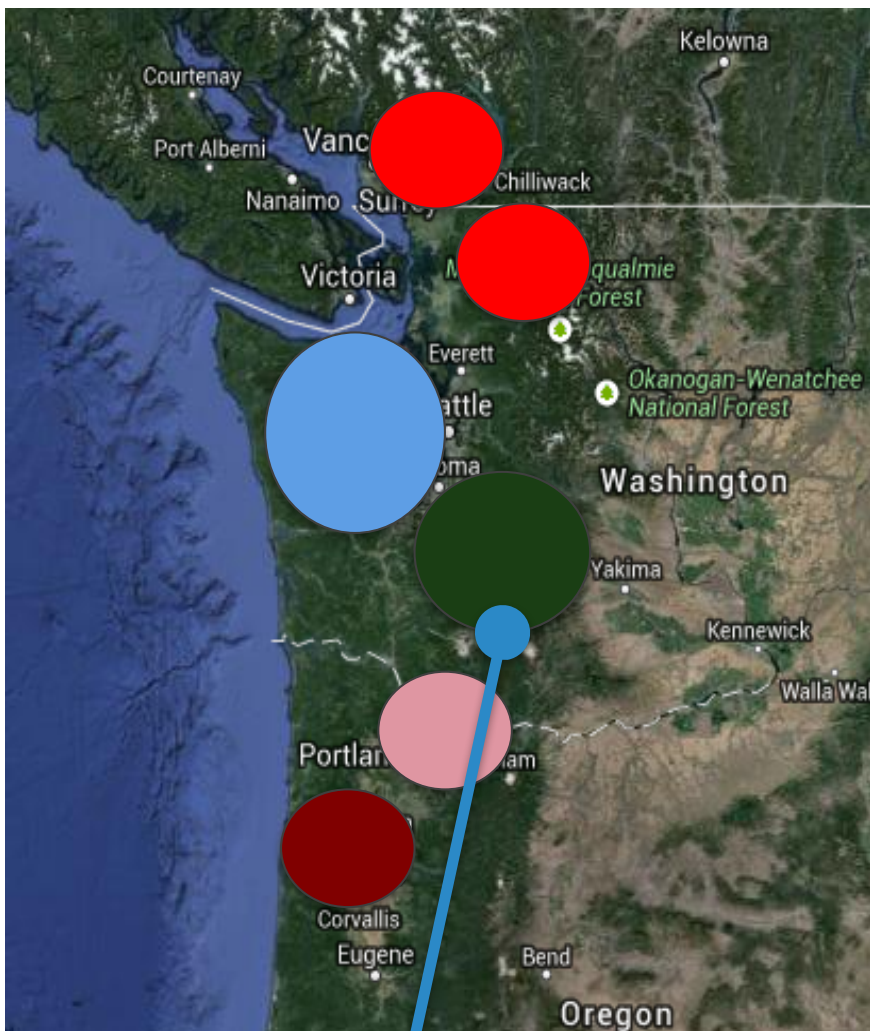


International Consortium on Combating Wildlife Crime

Source: Dormontt et al (2015) *Biological Conservation*. Lowe et al (2016) *BioScience*

Individual identity using DNA fingerprinting





Source: jardine et al., 2015



DNA fingerprinting developed

- 430 individuals from 40 populations
- 135 variable SNPs screened
- Significant genetic structure
- Individualisation probability 1×10^{23}



“... the government notes that it has produced over 3,500 pages of discovery, which includes expert reports on plant DNA analysis and an extensive timber valuation analyses. The government expects to call approximately 20 witnesses at trial.”

DNA evidence a big part of the case and potentially influential enough for J&L Tonewoods to plead guilty

Menu **The Seattle Times** Local News Log In | Subscri

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Local News | Northwest

Mill owner admits to buying maples illegally cut in national forest

Originally published November 17, 2015 at 9:09 am | Updated November 17, 2015 at 9:17 am

The U.S. Attorney's office says Harold Clause Kupers and his Winlock company, J&L Tonewoods, admitted to buying the highly prized wood without requiring sellers to show they had a special permit.



U.S. Attorneys » Western District of Washington » News

Department of Justice

U.S. Attorney's Office

Western District of Washington

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FOR IMMEDIATE RELEASE

Tuesday, April 19, 2016

Mill Owner Sentenced to Prison for Purchases and Sales of Stolen Figured Maple from National Forest

Made more than \$800,000 Buying and Selling “Music Wood”

A Winlock, Washington wood buyer was sentenced today in U.S. District Court in Tacoma to six months in prison, six months of home detention and three years of supervised release and \$159,692 in restitution for violating the Lacey Act by trafficking in big leaf maple illegally cut on national forest land,

Species identification using DNA barcoding

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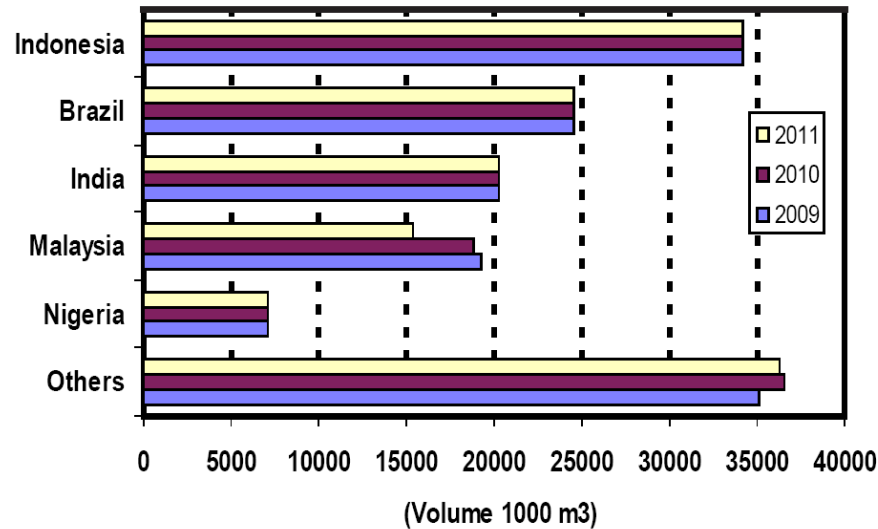
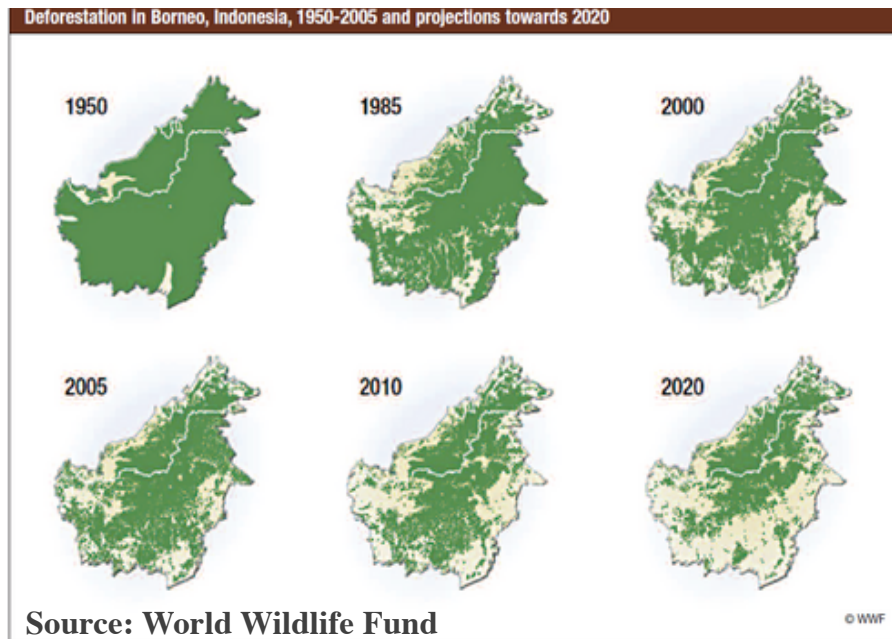


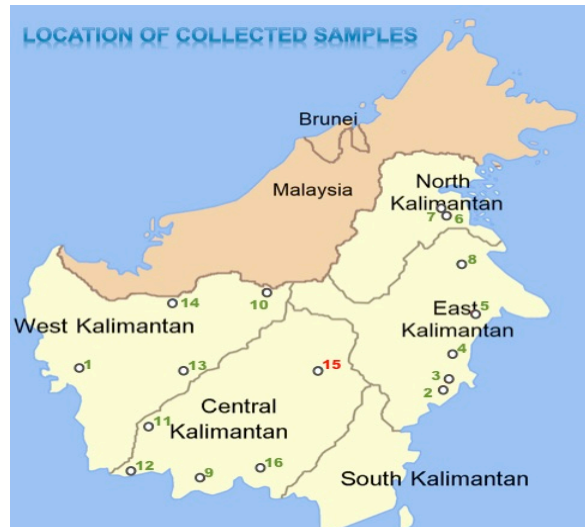
Table 1. Trade and species name and value of important SE Asian meranti timber species

Timber trade name	Species	Trade value (ITTO trade data US\$ Million)
Red meranti	<i>Shorea amplexicaulis</i> , <i>Shorea splendida</i> , <i>Shorea stenoptera</i>	71
Dark/light red meranti	<i>Shorea acuminata</i> , <i>Shorea beccariana</i> <i>Shorea hemsleyana</i> , <i>Shorea platycarpa</i> <i>Shorea palembanica</i> , <i>Shorea macrantha</i>	-
Light red meranti	<i>Shorea parvifolia</i> ssp. <i>parvifolia</i> <i>Shorea parvifolia</i> ssp. <i>velutinata</i> <i>Shorea ovalis</i> ssp. <i>sarawakensis</i> <i>Shorea ovalis</i> ssp. <i>sericea</i> <i>Shorea almon</i> , <i>Shorea dasphylla</i> <i>Shorea lepidota</i> , <i>Shorea leprosula</i> <i>Shorea quadrinervis</i> , <i>Shorea rubra</i> <i>Shorea scrabrida</i> , <i>Shorea smithiana</i> <i>Shorea teysmanniana</i>	34
Dark red meranti	<i>Shorea platyclados</i> , <i>Shorea pauciflora</i> <i>Shorea ovate</i> , <i>Shorea flaviflora</i> <i>Shorea curtisii</i> , <i>Shorea coriacea</i> <i>Shorea argentifolia</i> , <i>Shorea singkawang</i> <i>Shorea slootenii</i>	1
Yellow meranti	<i>Shorea faguetiana</i> , <i>Shorea acuminatissima</i> <i>Shorea balanocarpoides</i> , <i>Shorea gibbosa</i> <i>Shorea longisperma</i> , <i>Shorea maxima</i> <i>Shorea multiflora</i> , <i>Shorea richetia</i> <i>Shorea xanthophylla</i>	-
White meranti	<i>Shorea gratissima</i> , <i>Shorea agami</i> <i>Shorea assamica</i> , <i>Shorea bracteolate</i> <i>Shorea henryana</i> , <i>Shorea ochracea</i> <i>Shorea resinosa</i> , <i>Shorea roxburghii</i>	-
Other meranti	<i>Shorea pubistyla</i> , <i>Shorea rugosa</i> <i>Shorea uliginosa</i>	2



Project focus

- Reference draft genome
- SNPs - DNA barcodes > 100 species
- SNPs - Individual DNA tracking
- SNPs - Phylogeography of *Bangkerii*



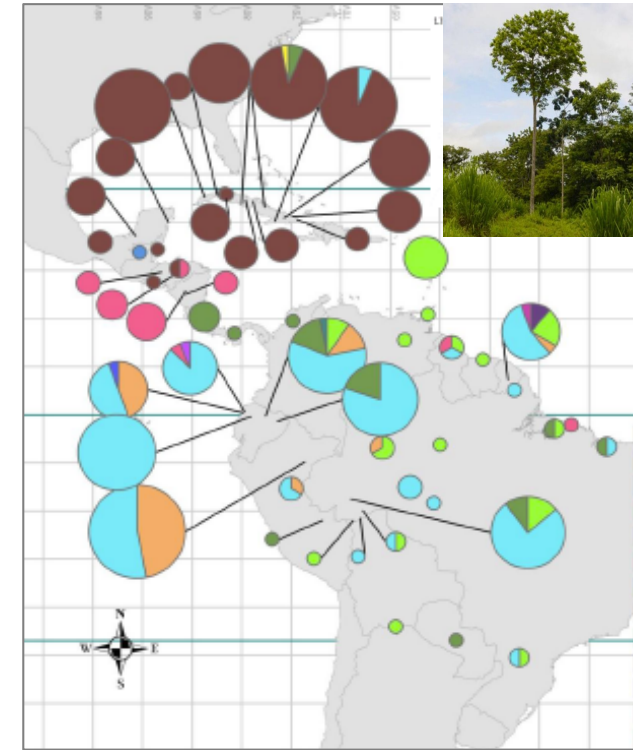
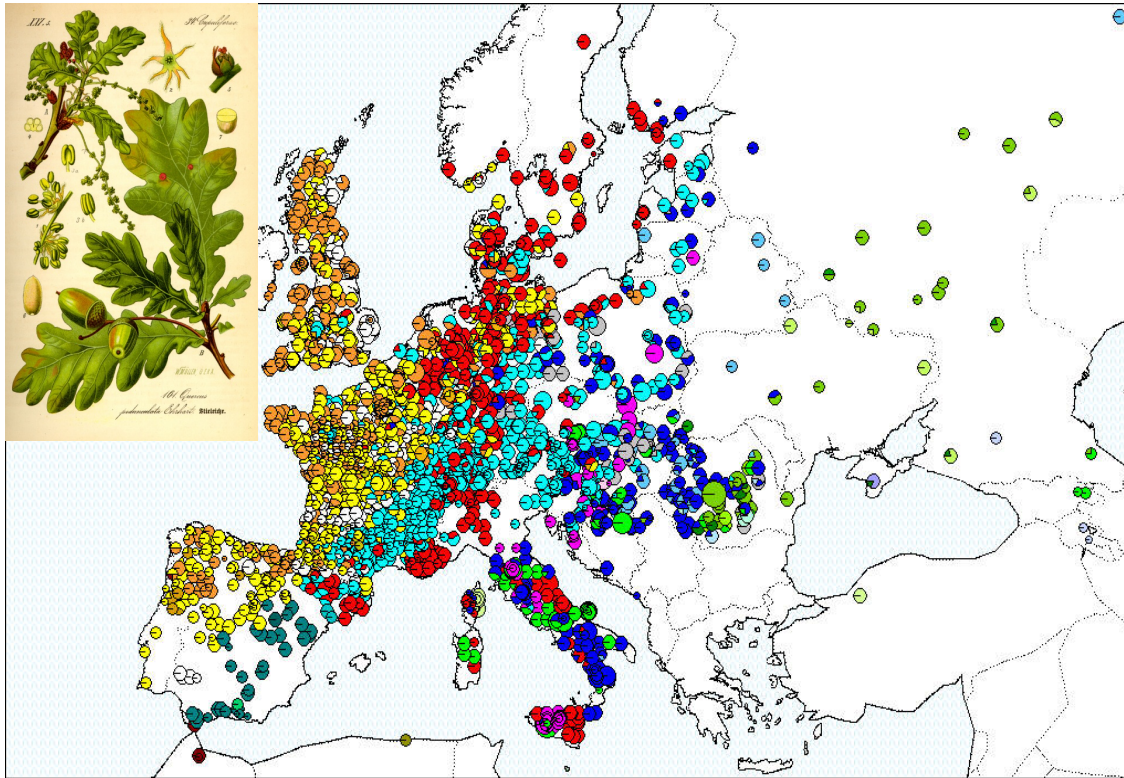
Collections (completed/planned)

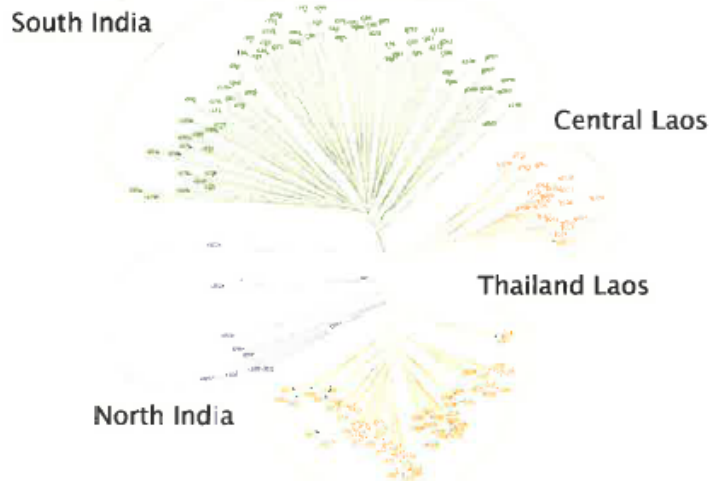
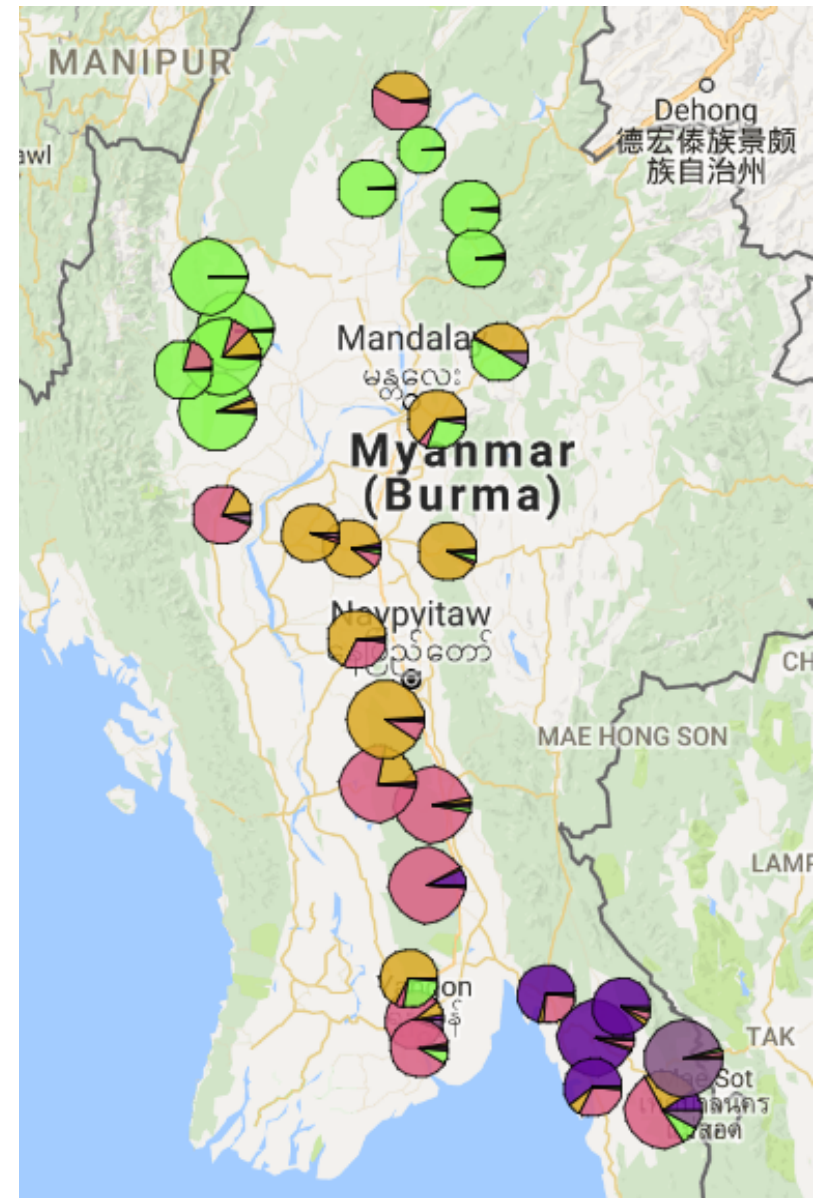
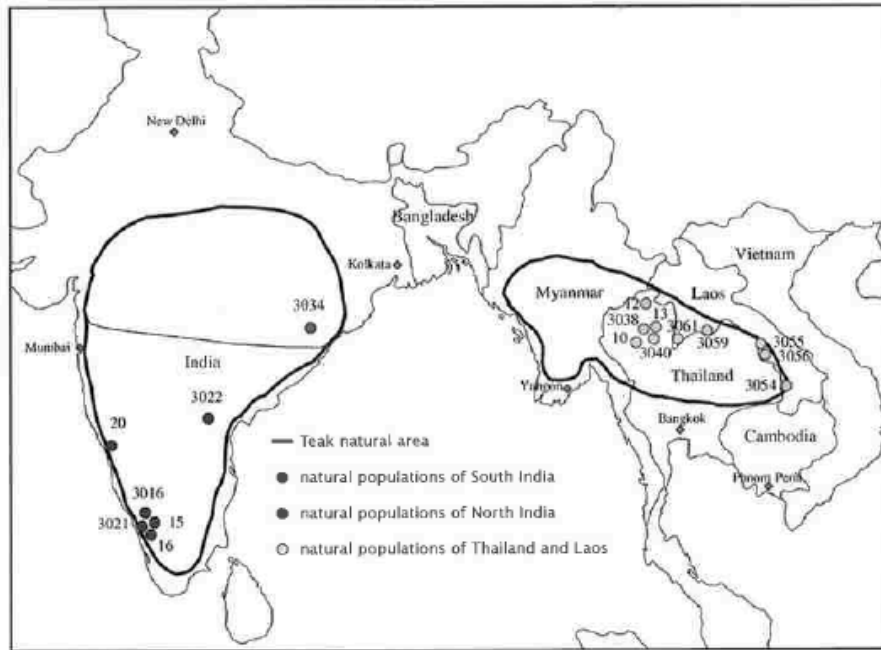
1. Gunung Palung NP
 2. Kutai NP
 3. Wartono Kadri
 4. Bukit Bangkirai
 5. Sungai Wain
 6. Intraca
 7. Inhutani
 8. STREK Plot, Berau
 9. PT. Sarpatim
 10. Betung Kerihun NP
 11. PT. SBK
 12. PT. Dasa Intiga
 13. Bukit Baka NP
 14. Kebun Raya Sambas, Bengkayang
 15. PT. Austral Bina
 16. Tanjung Puting NP
- Anisoptera costata*
Anisoptera marginata
Anisoptera reticulata
Cotylelobium melanoxylon
Dipterocarpus confertus
Dipterocarpus cornutus
Dipterocarpus crinitus
Dipterocarpus eurynchus
Dipterocarpus grandiflorus
Dipterocarpus humeratus
Dipterocarpus lowii
Dipterocarpus pahyphyllus
Dipterocarpus palembanicus
Dipterocarpus stellatus
Dipterocarpus sublamellatus
Dipterocarpus tempehes
Dipterocarpus validus
Dipterocarpus verrucosus
Dryobalanops oblongifolia
Dryobalanops beccarii
Dryobalanops lanceolata
Hopea ceruna
Hopea dryobalanoides
Hopea mengarawan
Hopea pachycarpa
Hopea rudiformis
Hopea sangal
Hopea semicuneata
Parashorea malaanonan
Parashorea smythiesii
Parashorea tomrntella
Shorea agamii
Shorea angustifolia
Shorea atrinervosa
Shorea beccariana
Shorea colaris
Shorea coriacea

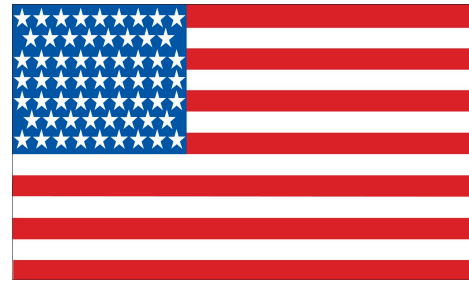
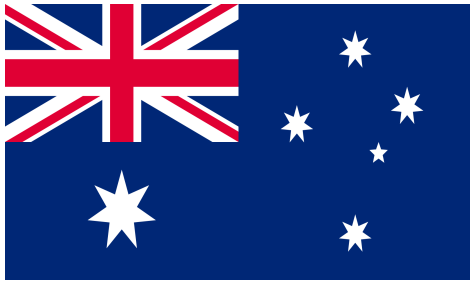
- Shorea exelliptica*
Shorea faguetlana
Shorea gratissima
Shorea hopeifolia
Shorea inappendiculata
Shorea johorensis
Shorea laevis
Shorea lamellata
Shorea leprosula
Shorea longisperma
Shorea macrophylla
Shorea macroptera
Shorea maxwelliana
Shorea mecystopteryx
Shorea mujongensis
Shorea ochracea
Shorea ovalis
Shorea parvifolia
Shorea parvistipulata
Vatica rassak
Shorea patoiensis
Vatica odorata
Shorea peltata
Shorea pinanga
Shorea platyclados
Shorea quadrinervis
Shorea retusa
Shorea rugosa
Shorea smithiana
Shorea stenoptera
Vatica javanica
Vatica micrantha
Vatica nitens
Vatica oblongifolia
Shorea pauciflora
Vatica sarawakensis
Vatica umbonata
Vatica vinosa



Region of origin using population genetics







Myanmar



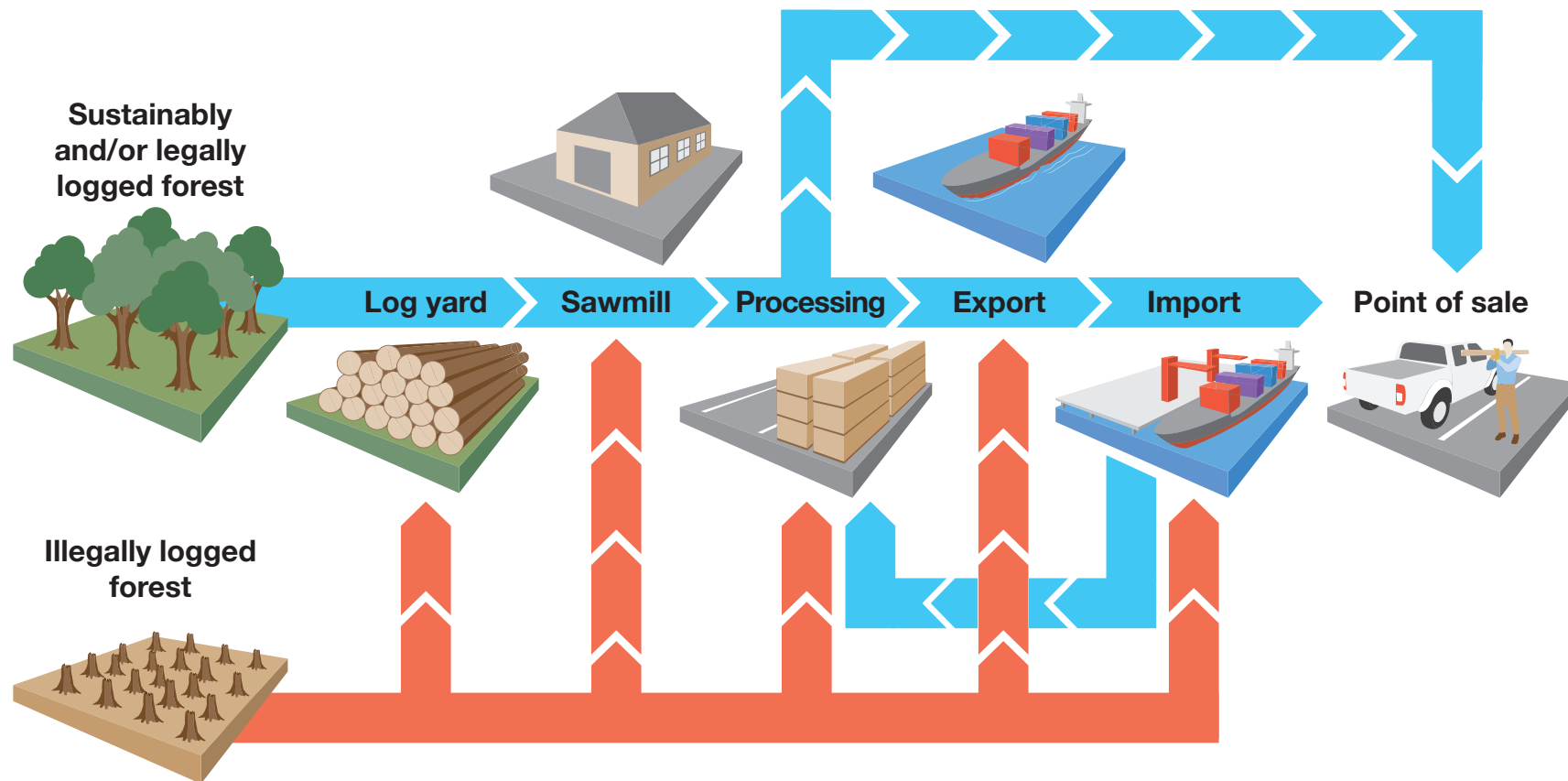
Solomon Islands



Common Name	Scientific Name	Barcoding	Genographic	Fingerprinting
Northern temperate forest				
Oak	<i>Quercus</i> spp.	✓	✓	✓
Larch	<i>Larix</i> spp.	✓	✓	
Poplar	<i>Populus</i> spp.	✓		
Maple	<i>Acer macrophyllum</i>		✓	✓
Neotropical forest				
Mahogany	<i>Swietenia</i> spp.	✓	✓	✓
Andiroba	<i>Carapa guianensis</i>		✓	✓
Cedro	<i>Cedrela fissilis</i>	✓	✓	✓
Cerdo-cheiroso	<i>Cedrela odorata</i>	✓	✓	
Angelim Vermelho	<i>Dinizia excelsa</i>		✓	✓
Jatobá	<i>Hymenaea courbaril</i>		✓	✓
Pará-pará	<i>Jacaranda copaia</i>		✓	✓
Maçaranduba	<i>Manilkara huberi</i>		✓	✓
Marupá	<i>Simarouba amara</i>		✓	✓
Ipê-amarelo	<i>Tabebuia serratifolia</i>		✓	✓
Cumala	<i>Virola surinamensis</i>		✓	✓
Cumarú/ Shihuahuaco	<i>Dipteryx odorata</i>		✓	✓
African tropical forest				
Doussie	<i>Azelia</i> spp.	✓		
Okan	<i>Cylicodiscus gabunensis</i>	✓		
Sepele/Sipo	<i>Entandrophragma</i> spp.	✓	✓	✓
Tali	<i>Erythrophleum ivorense</i>	✓		
African mahogany	<i>Khaya</i> spp.	✓	✓	
Azobé	<i>Lophira alata</i>	✓		
Iroko	<i>Milicia excels.</i> , <i>M. regia</i>	✓	✓	✓
Wenge	<i>Millettia laurentii</i>	✓		
Ayous	<i>Triplochiton scleroxylon</i>	✓	✓	✓
African Teak	<i>Pericopsis elata</i>	✓		✓
Padauk	<i>Pterocarpus soyauxii</i>	✓		
Prunus	<i>Prunus africana</i>		✓	✓
Sipo	<i>Entandrophragma utile</i>		✓	✓
Okoumé	<i>Aucoumea klainea</i>		✓	✓
Okan	<i>Cylicodiscus gabonensis</i>		✓	✓
Padouk	<i>Pterocarpus soyauxii</i>		✓	✓
Azobé	<i>Lophira alata</i>		✓	✓
Bilinga	<i>Nauclea diderrichii</i>		✓	✓
Khaya/Acajou	<i>Khaya invorensis</i>	✓	✓	✓
SE Asian tropical/Australasian forest				
Ramin	<i>Gonystylus bancanus</i>	✓		
Merbau	<i>Intsia bijuga</i> ,	✓	✓	✓
Sandalwood	<i>Santalum</i> spp.	✓	✓	✓
Teak	<i>Tectona grandis</i>		✓	✓
Meranti/Balau	<i>Shorea</i> spp.	✓	✓	✓
Bangkirai	<i>Dipterocarpus</i> spp.		✓	✓

Reference databases





Third party product verification for US and EU wood importers

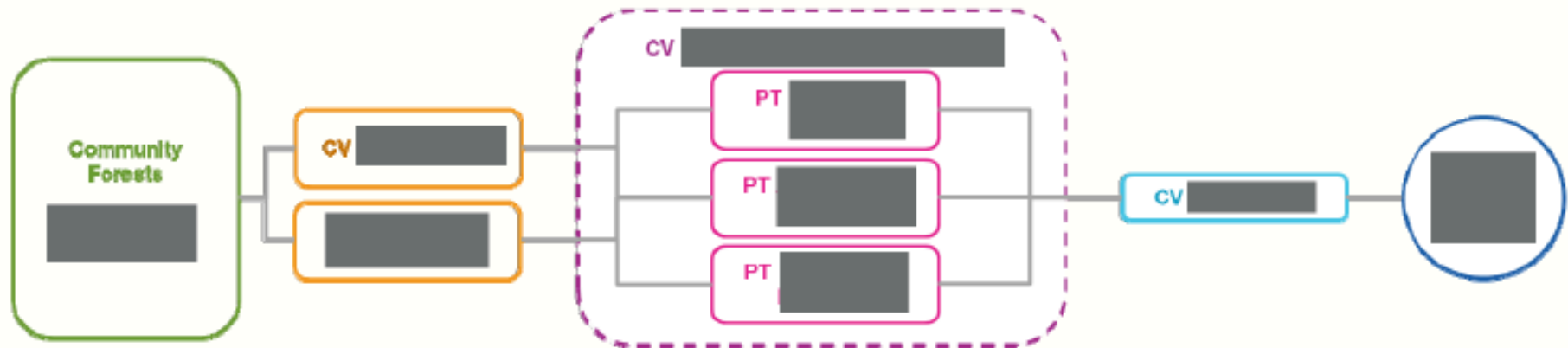


Product risk assessment

- **5-point risk assessment**
 - **Country**
of harvest
 - **Species**
vulnerability or confusion
 - **Market**
country of trade / manufacture
 - **External**
outside parties
 - **Supply chain**
transparency; traceability; legality



Deliverables

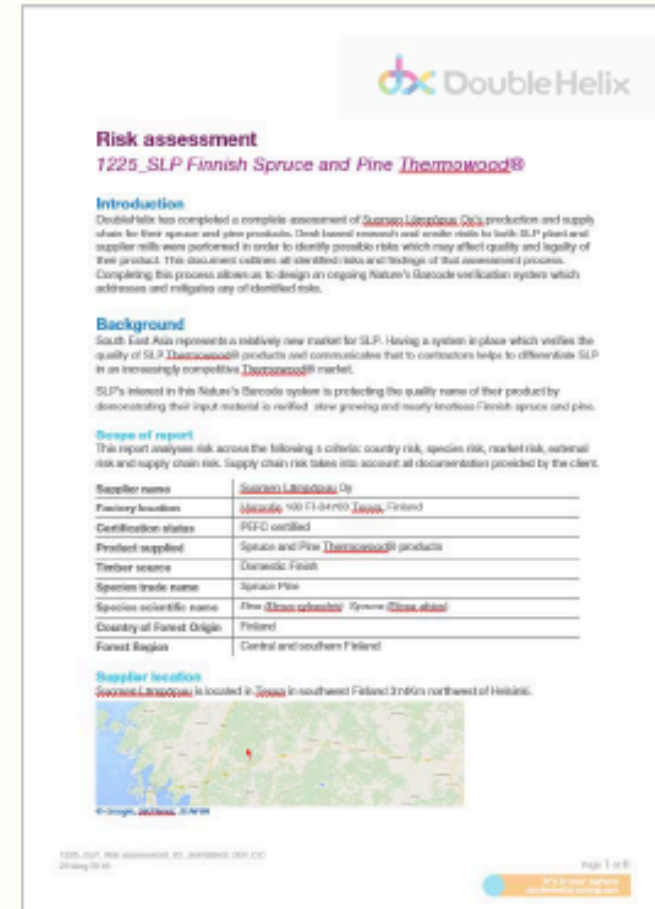


Forest sources: Indonesia	Primary sawmills: Indonesia	Manufacturers: Indonesia	Trader: Indonesia	Exporter: Indonesia	Buyer: Australia
Traceability documentation					
<ul style="list-style-type: none"> Farmer identification Transport documentation (SKAL) 	<ul style="list-style-type: none"> Supply contract (SKAL) Log receipt records Production records Output / stock control Sales invoice 	<ul style="list-style-type: none"> Nota / sales contract Sawn timber transport (SKSHH) Production records Output control 	<ul style="list-style-type: none"> Purchase order Contract with manufacturers Packing list Sales invoice 	<ul style="list-style-type: none"> Purchase Order / invoice Bill of lading / packing list Certificate of Origin Phytosanitary certificate V-Legal certificate 	<ul style="list-style-type: none"> Invoice / contract BL / Packing List Phytosanitary cert V-legal cert.
Licenses / Legal registration / Certificates					
<ul style="list-style-type: none"> Certificate of land ownership 	<ul style="list-style-type: none"> Deed of Incorporation Business license (SIUP) Company reg. (TDP) Industry permit (UI) Tax ID (NPWP) Env. Docs (UKL/UPL) Raw material purchasing planning and realization (RPBR) SVLK certificate 	<ul style="list-style-type: none"> Deed of Incorporation Business license (SIUP) Company reg. (TDP) Industry permit (UI) Tax ID (NPWP) Env. Docs (UKL/UPL) SVLK certificate 	<ul style="list-style-type: none"> Deed of Incorporation Business license (SIUP) Company reg. (TDP) Tax ID (NPWP) 	<ul style="list-style-type: none"> Deed of Incorporation Business license (SIUP) Company reg. (TDP) Tax ID (NPWP) Exporter license (ETPIK) SVLK certificate 	



Deliverables

- Full evidence of risk assessment, legality and traceability
 - Supply chain map
 - Register of information (legality and traceability)
 - Risk assessment and gap analysis



Double Helix

Risk assessment

1225_SLP Finnish Spruce and Pine ThermoWood®

Introduction

Double Helix has completed a complete assessment of **ThermoWood Oy** production and supply chain for their spruce and pine products. Desk based research and on-site visits to both SLP plant and supplier mills were performed in order to identify possible risks which may affect quality and legality of their product. This document outlines all identified risks and findings of that assessment process. Completing this process allows us to design an ongoing Nature's Barcode verification system which addresses and mitigates any of identified risks.

Background

South East Asia represents a relatively new market for SLP. Having a system in place which verifies the quality of SLP **ThermoWood®** products and communicates that to contractors helps to differentiate SLP in an increasingly competitive **ThermoWood®** market.

SLP's interest in this Nature's Barcode system is protecting the quality name of their product by demonstrating their input material is verified - slow growing and nearly knotless Finnish spruce and pine.


Scope of report

This report analyses risk across the following a climatic country risk, species risk, market risk, external risk and supply chain risk. Supply chain risk takes into account all documentation provided by the client.

Supplier name	ThermoWood Oy
Factory location	Uusikaupunki 16011-04100 Tampere , Finland
Certification status	PEFC certified
Product supplied	Spruce and Pine ThermoWood® products
Timber source	Domestic Finnish
Species trade name	Spruce Pine
Species scientific name	Pine (<i>Pinus sylvestris</i>) / Spruce (<i>Picea abies</i>)
Country of Forest Origin	Finland
Forest Region	Central and southern Finland

Supplier location

ThermoWood Oy is located in **Uusikaupunki** in southwest Finland 210km northwest of Helsinki.



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20240601_001

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Verification system design



Multiple verification methodologies

- Frequency of verification is a function of risk and volume of verified product shipped
 - Periodic, random document verification
 - Random log / timber reconciliation
 - Traceability “Backtrack” test
 - Desk-based and on-site assessment (at least once a year)
 - **Scientific testing**
 - *DNA*
 - *Chemical isotopes*
 - *Wood anatomy / microscopic analysis / mass-spectrometry*



The Nature's Barcode™ mark




- A gateway to access product information
 - Presents the detailed product story, using insight from the assessment process
 - Facilitates access to information and transparency
 - Enhances your reputation; builds trust



Outputs

Traceability docket



TRACEABILITY DOCKET

Docket number DX1225 - TD 001
Issue date 15 June 2016

Shipment information

Container no. / Shipment no. Shipment 178
 B/L number (if applicable) N/A
 Total product volume (CBM) 21,5800
 Verified product volume (CBM) 21,5800
 Product type(s) 32x118 S4E R3, pine, 32x112 Vingraave, pine, 18x141 Pinoo K&L R310, spruce, 18x141 S4E R3 K&L R310, spruce, 28x88 S4E R3 K&L R310, spruce

Manufacturer bundle ref. nos. H9301, H9306, F10296, F10311, F10312, F10317, F10322, F10380

Verified product bundle nos. 0000001, 0000002, 0000011, 0000052, 0000053, 0000054, 0000015, 0000056

Supply Chain Information

Species verified Pine (Pinus sp/indris), Spruce (Picea abies)
Origin of harvest Finland
Manufacturer Suomen Lämpöpuu Oy, Finland
Buyer Verisure Pte Ltd, Singapore

This docket has been produced for use of Suomen Lämpöpuu Oy and should not be copied or distributed in or by any other party without the prior written approval of DoubleHelix.

Verification Statement


The contents of the bundles listed above have been subject to independent verification using the Nature's Barcode™ system, to confirm the stated species and traceability back to stated origin of harvest.

Nature's Barcode™ provides assurance of product quality, consistency, and traceability. The product supply chain is monitored and controlled through a combination of document collection, on-site assessments and scientific testing applied using Statistical Process Control.

Full documentation is available on request by authorities to support this statement for every shipment with a Nature's Barcode™ docket.

Send enquiries to info@doublehelixtracking.com.

A service provided by
DOUBLE HELIX TRACKING TECHNOLOGIES PTE LTD



Bundle label

VERIFIED TIMBER PRODUCT



This product is subject to independent verification to confirm species and traceability back to origin of harvest. Claims were verified using the Nature's Barcode™ system.

Nature's Barcode™ provides assurance of product quality, consistency and traceability.

Species verified Teak (Tectona grandis)
Origin of harvest Indonesia
Manufacturer PT Kasella, Indonesia

Verification Code
0000000

SEND THIS PRODUCT TO www.doublehelixtracking.com TO VERIFY THE CODE.

A service provided by
DOUBLE HELIX TRACKING TECHNOLOGIES PTE LTD

Scan here to learn more about this product and Nature's Barcode™.




Outputs

Naturesbarcode.com

Nature's Barcode™ Product Verification

TUMAC LUMBER
Meranti plywood
Falcata core plywood with meranti face and back

WOOD UNITED
Bangkirai

slp Verified with **Nature's Barcode**

VERIFIED PRODUCTS
Thermowood® decking, cladding, siding

SPECIES
Pine (*Pinus sylvestris*), spruce (*Picea abies*)

ORIGIN OF HARVEST
Finland; 95% PEFC certified

Thank you for your interest in SLP Thermowood® spruce and pine products.
SLP is the first company in the world to use Nature's Barcode™ to independently verify the quality, species and origin of their Thermowood® spruce and pine products.



It's in our nature
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Outputs

Traceability and legality reports on-demand

DoubleHelix

MTE timber verification report

CONFIDENTIAL

Job no. + Client name
4 March 2016

It's in our nature
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MTE timber verification report.doc
4 March 2016
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DoubleHelix

Register of information

Suomen Liimoteppu Oy
1225_SLP_Pine and Spruce verification

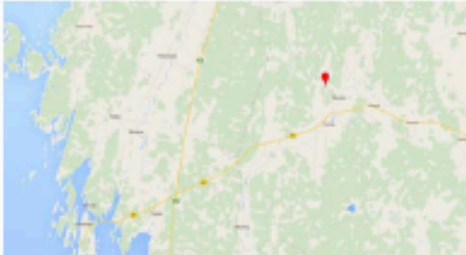
1. Introduction

About Suomen Liimoteppu Oy
Suomen Liimoteppu Oy (SLP) is a Finnish Thermo-wood manufacturer. They produce a wide range of ThermoWood® products, including cladding, decking, and construction material. SLP source spruce and pine timber input exclusively from Finland. SLP also source small volumes of other wood from other countries as inputs for products outside the scope of this assessment. To learn more, visit <http://www.suomenliimoteppu.com/en/the-company/>

Scope of work
DoubleHelix has been engaged to verify that SLP pine and spruce timber inputs for all ThermoWood® products sent to Northern EU are of Finnish origin. This Register of Information outlines all SLP sources and requests to establish complete traceability of product back to a chain-of-custody Finnish forest of origin-to-finished product. Based on these documents, we will establish and maintain an efficient collection for all timber input, as well as develop a scientific logging and control system to both verify the document-based claims and ensure that the properties of the timber consistent with Finnish pine and spruce. Outputs from generating this Register of Information map of SLP's entire timber input supply chain; create assessment of three major supplier risks; complete upstream and downstream risk analysis; and design and implementation of a ThermoWood® ongoing verification system.

2. General information

SLP is located in **Juusola** in southwest Finland, approximately one hour's drive from the port of Turku.



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Risk assessment

1225_SLP Finnish Spruce and Pine ThermoWood®

Introduction

DoubleHelix has completed a complete assessment of Suomen Liimoteppu Oy's production and supply chain for their spruce and pine products. Desk-based research and on-site visits to both SLP plant and supplier mills were performed in order to identify possible risks which may affect quality and legality of their product. This document outlines all identified risks and findings of that assessment process. Completing this process allows us to design an ongoing Nature's Barcode verification system which addresses and mitigates any of identified risks.

Background

South East Asia represents a relatively new market for SLP. Having a system in place which verifies the quality of SLP ThermoWood® products and communicates that to contractors helps to differentiate SLP in an increasingly competitive ThermoWood® market.

SLP's interest in this Nature's Barcode system is protecting the quality name of their product by demonstrating their input material is verified, slow growing and nearly knotless Finnish spruce and pine.


Scope of report

This report analyzes risk across the following 5 criteria: country risk, species risk, market risk, external risk and supply chain risk. Supply chain risk takes into account all documentation provided by the client.

Supplier name	Suomen Liimoteppu Oy
Factory location	33300000 66E-FI-64708-20000, Finland
Certification status	PEFC certified
Product supplied	Spruce and Pine ThermoWood® products
Timber source	Domestic Finnish
Species trade name	Spruce Pine
Species scientific name	Pine (<i>Pinus sylvestris</i>) / Spruce (<i>Picea abies</i>)
Country of Forest Origin	Finland
Forest Region	Central and southern Finland

Supplier location

Suomen Liimoteppu Oy is located in **Juusola** in southwest Finland 60km northwest of Helsinki.



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Legality assessment



- Applied all along the supply chain
- Harvest, processing, transport and trade
- **Generic legality standard¹** adapted to each country of harvest and manufacture

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¹ *NEPCon LegalSource™ Standard version 1* used and adapted under the Creative Commons Attribution Share-Alike 3.0 license.



Verification and certification

Nature's Barcode™	Certification
<ul style="list-style-type: none">• Compliance with national and international regulations	<ul style="list-style-type: none">• Compliance with a standard (FSC, PEFC, SVLK, CertiSource)
<ul style="list-style-type: none">• Verify by product supply chain	<ul style="list-style-type: none">• Certification granted to individual entities along the supply chain
<ul style="list-style-type: none">• Product traceability; supply chain transparency	<ul style="list-style-type: none">• Required policies and processes developed and applied
<ul style="list-style-type: none">• Mark of trust in <u>product</u> claim	<ul style="list-style-type: none">• <u>Process</u> claim. All entities comply with the standard requirements



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Thank you.

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Thanks

DNA timber tracking and genetic resources group

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