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Economic Cooperation

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Agenda Item: II.D

Korea's Efforts on Enhancing Legal Timber Trade - DNA Analysis and Other Wood Identification Technologies

Purpose: Information
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Korea’s Efforts on Enhancing Legal Timber Trade

DNA analysis and other wood identification technologies

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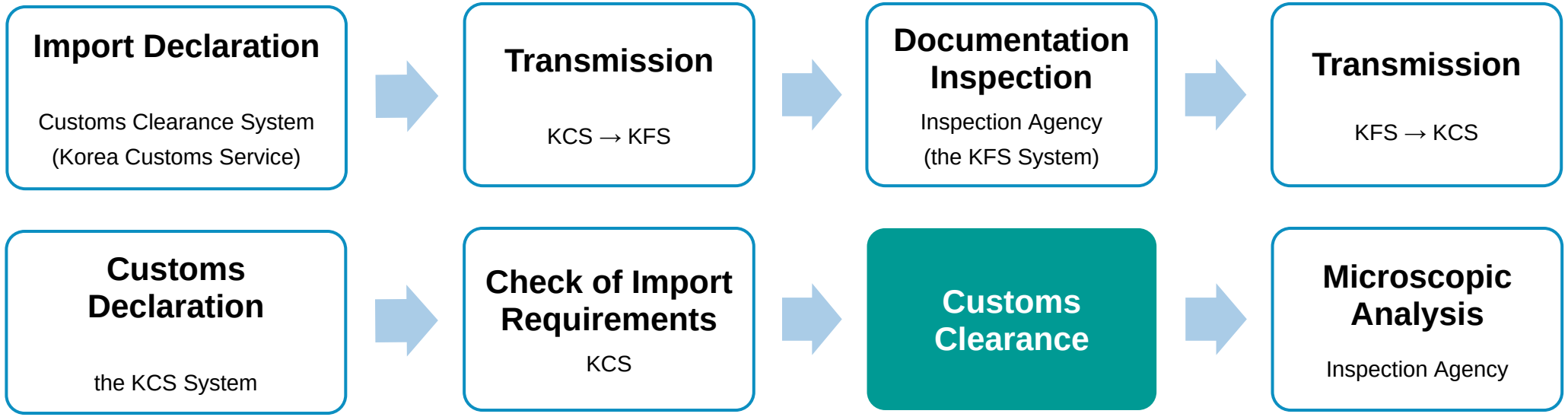
Korea's Verification System on Timber Legality

Korea Forest Service has been operating Verification System on Timber Legality since 2018

✓ According to *Act on the Sustainable Use of Timbers*, importers shall file an import declaration there of with the Minister of the Korea Forest Service before customs clearance

✓ The Inspection Agency (Korea Forestry Promotion Institute) investigates evidential documents

✓ After customs clearance, the agency analyzes samples of wood products with microscopes



Needs to Advance Wood Identification Technologies

Transparency & Traceability

- ✓ KFS expanded the range of items subject to the import inspection in 2023
- ✓ More advanced skills are needed to verify the information of complex products
- ✓ Wood species identification would support customs administration regarding tariff imposition

Regulated Item	HS code	Note
Wood pellets	4401.31	
Log	4403	
Sawn wood	4407	including preservative treated, fire-retardant, or laminated wood
Wood Sheet	**4408**	
Shaped Wood	**4409**	
Particleboard	**4410**	
Fibreboard	**4411**	
Plywood	4412	
Wood Pulp	**4701, 4702, 4703, 4704, 4705**	

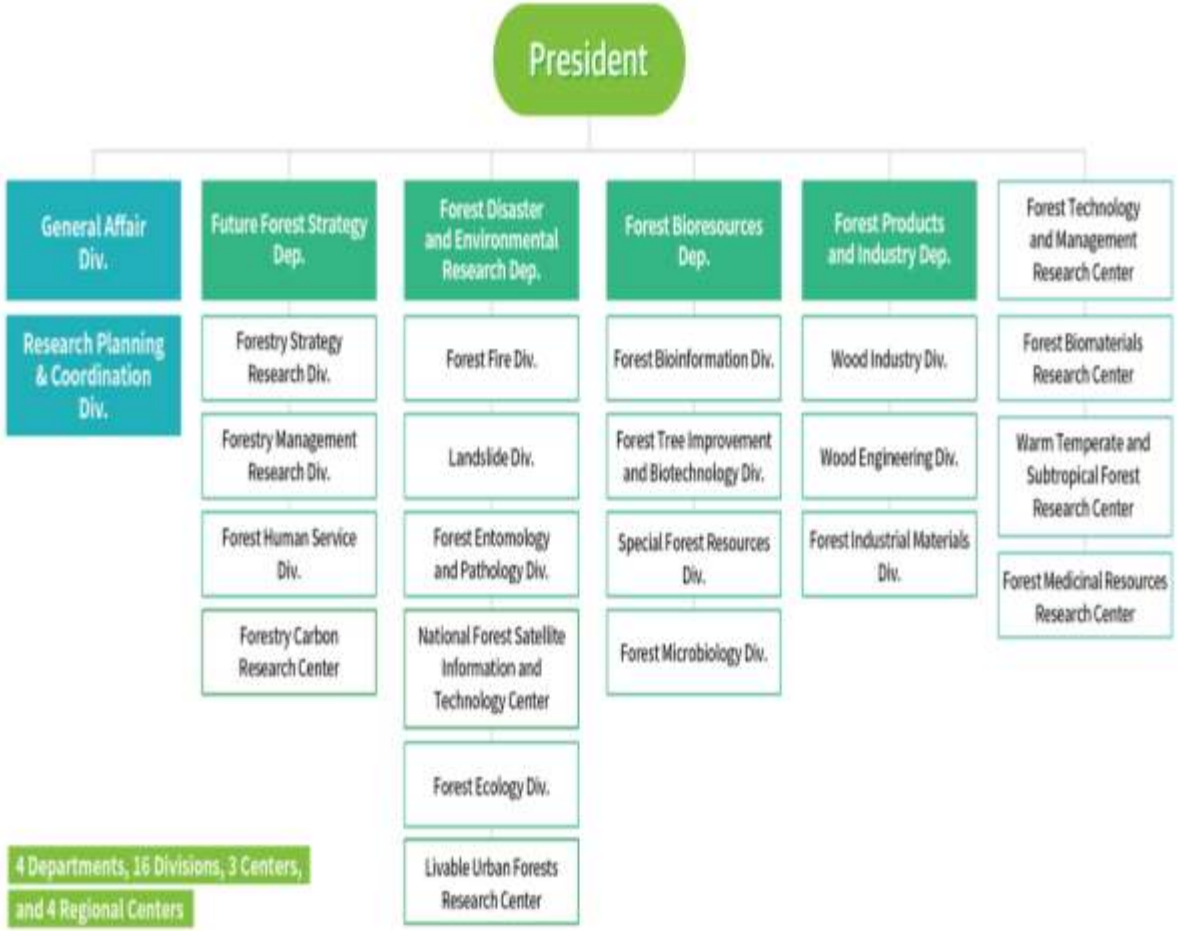
Role of National Institute of Forest Science (NIFoS)

Mission

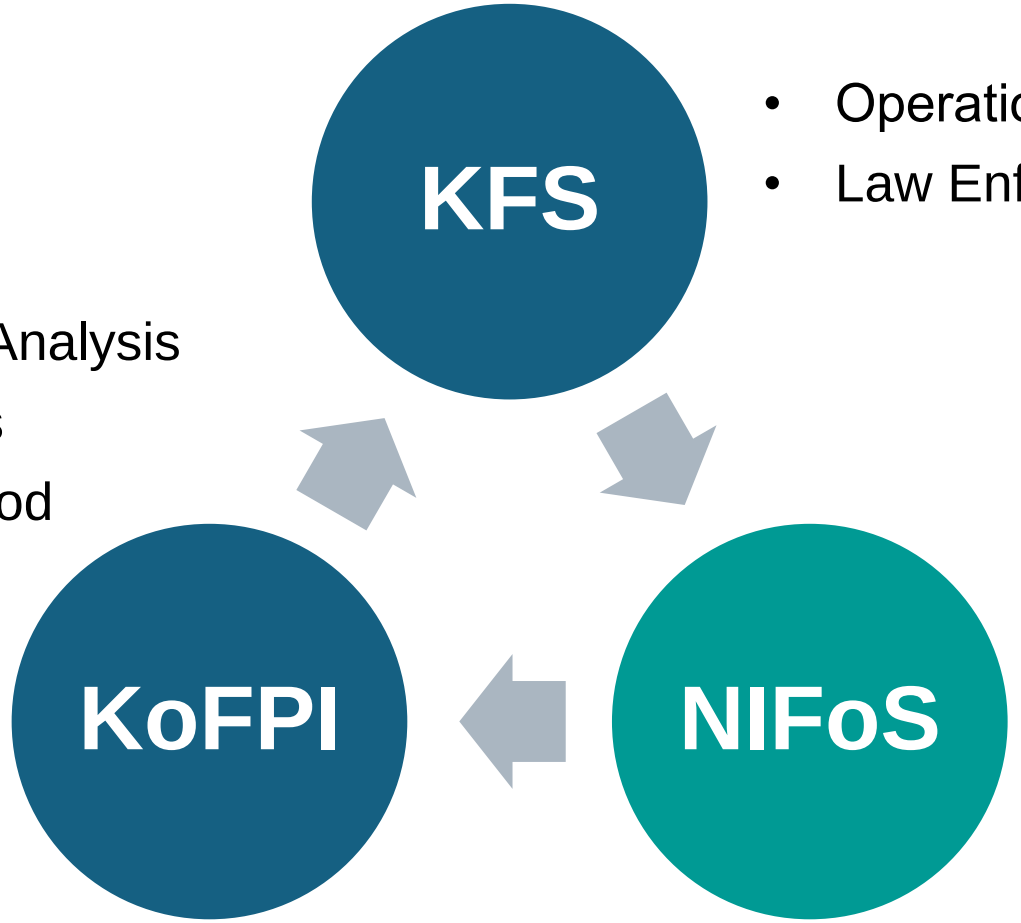
Research and Development of forest science and technology bringing **People's Happiness** and **Virtuous Circle of Forest Value**

Vision

Research Institute **for People** by creating future value with an **Innovative Science Technology**



Role of NIFoS



- Operation of Korea’s VTL system
- Law Enforcement & Implementation

- R&D of Wood Analysis
- Transfer of newly developed technologies to the Inspection Agency
- Helping the Agency to adapt to new technologies

- Utilization of Wood Analysis tools & technologies
- Development of Wood Species DB

DNA analysis cases in NIFoS

DNA is Key component of all living organism and provides information of both species and individual level

- ✓ Human Genome Project's main technology is DNA analysis

NIFoS developed DNA analysis technologies for various purposes

- ✓ (Case 1) Wood species identification for restoration of damaged cultural heritage (*Seoul Sungnyemun*)
- ✓ (Case 2) Developed male and female identification of Gingko tree and shared the tech to private sector to commercialize
- ✓ (Case 3) Construction of DNA fingerprint information to conserve and manage old big tree including natural monument

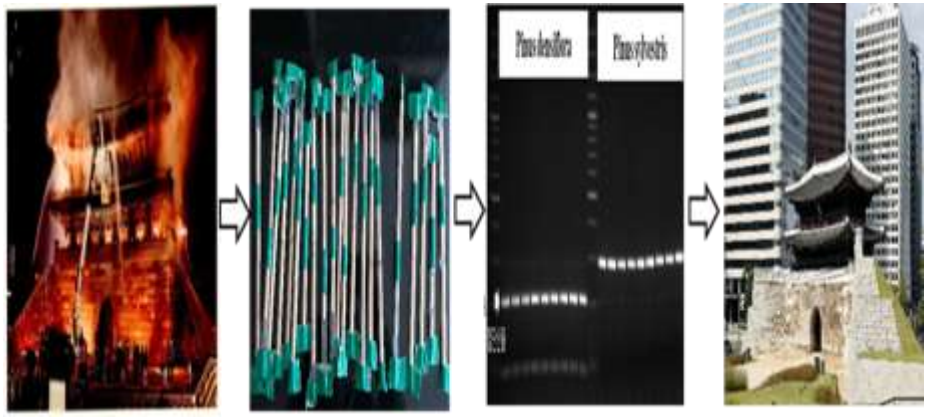


Figure of Case 1

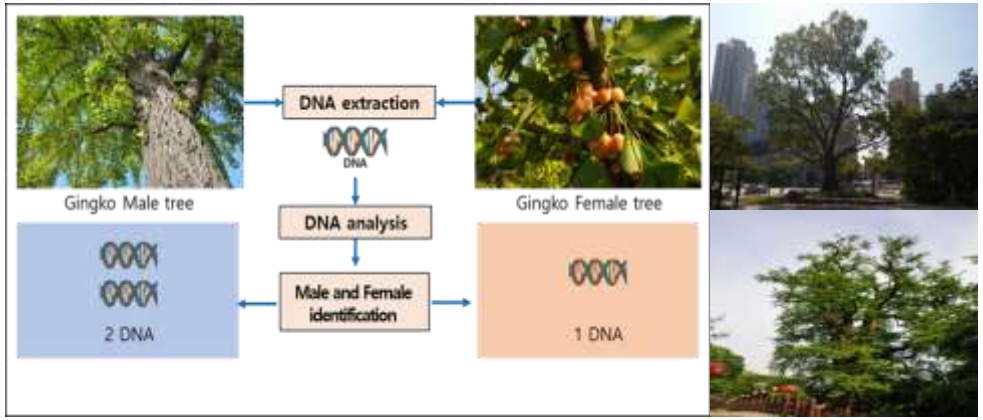


Figure of Case 2

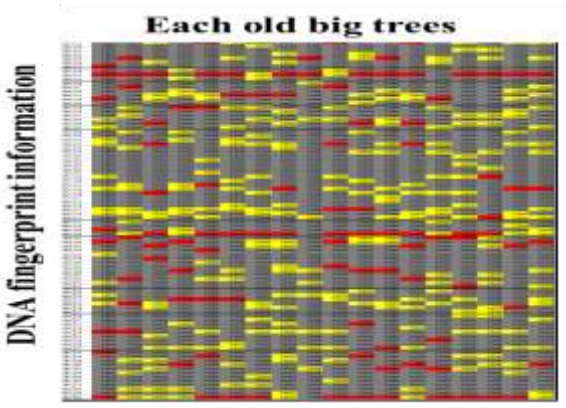


Figure of Case 3

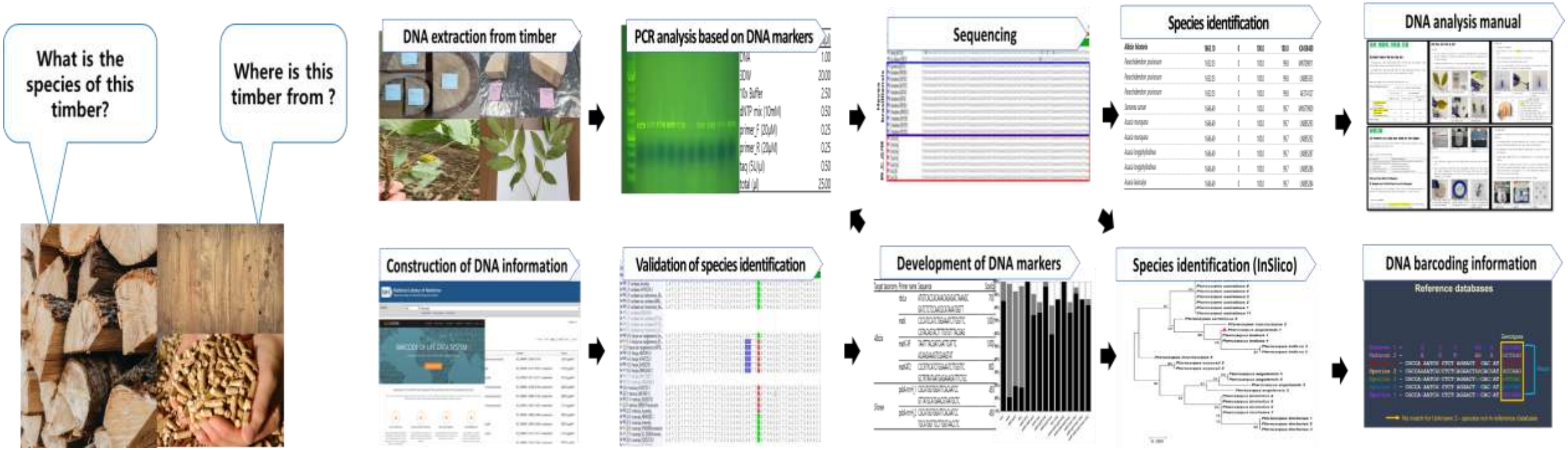
DNA analysis for wood species identification

DNA analysis is key technology to identify wood species

- Genus level (Anatomy) → Species, Habitat of origin level (machine vision, chemistry, isotope) → Species, Habitat of origin, and individual level (DNA)

DNA analysis development strategy for wood species identification

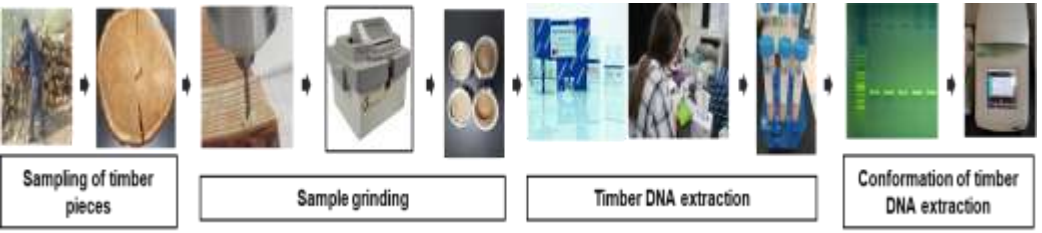
- Target species : Domestic and imported conifer tree -> Imported Broad-leaved tree



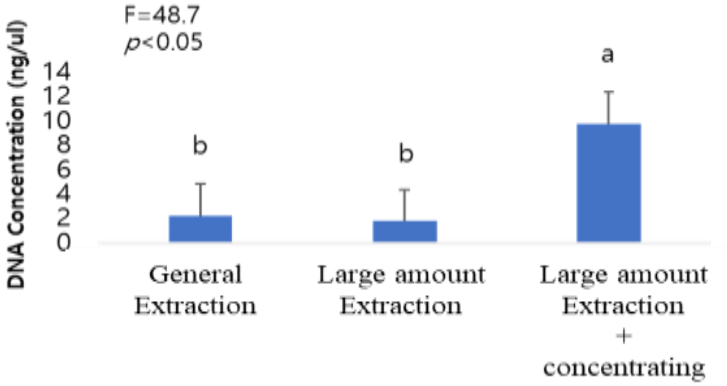
DNA analysis for wood species identification

- (Goal 1) What is the best method to extract stable DNA from timber with a few living cells than leaf ?
- (Goal 2) What is the best extraction methods from manufactured products (plywood, wood pellets)?

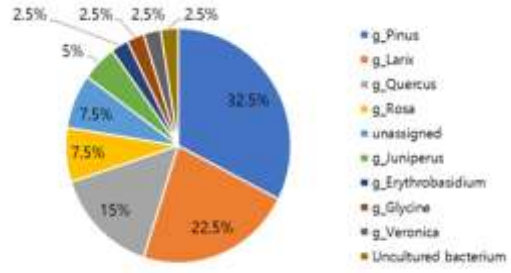
- (Result 1) Sapwood > Heartwood, Grinding sample preparation with drill, add Polyvinylpyrrolidone (PVP) and proteinase-K
- (Result 2) using large amounts of sample, 10 times concentrating of DNA, Short length PCR, Metagenomics (Identification of Genus level)
- (Prospect) Improving the efficiency of extracting timber products DNA and species-level identification



Manual of DNA extraction from Timber



Optimal conditions for extracting DNA from plywood



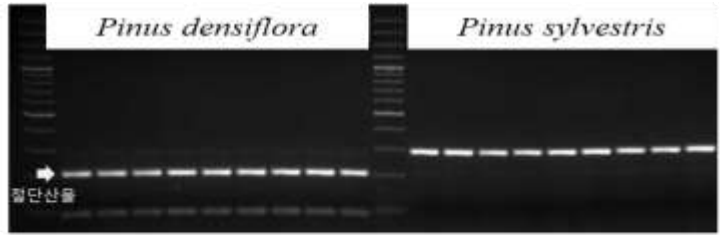
Metagenome analysis of Wood pellet DNA

DNA analysis for wood species identification

Development of wood species identification based on DNA marker

- (Goal 1) Development of species identification both domestic and imported coniferous Timber
- (Goal 2) Development of species identification both domestic and imported broad-leaved Timber

- (Result 1) Development of 20 DNA markers to identify 23 conifer species including *Pinus densiflora* , *Pinus sylvestris*
- (Current study) Development DNA marker to identify imported broad-leaved Timbers (*ex: Acacia, Meranti, rubber etc.*)
- (Prospect) Development of DNA analysis could be establish step-by-step species identification

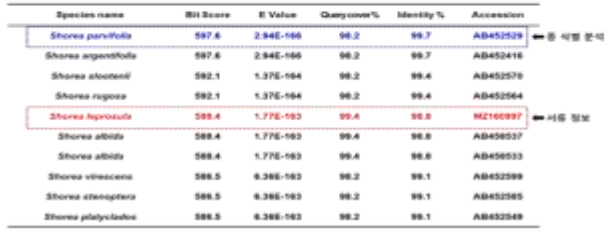


Anatomical characteristic to identify Red meranti

Species name	Vessel cell (mm)	Longitudinal parenchyma cell(um)	Ray parenchyma cell(um)	Fiber cell (um)
Shorea leprosula	0.91	22.68	19.03	1.81
Shorea parvifolia	1.05	21.52	17.84	1.84
Shorea johorensis	0.88	20.51	16.97	1.76
Shorea platyclados	1.15	21.18	17.50	1.83

Timber DNA analysis (NIFOS)

Document about Timber



Verification of Species identification

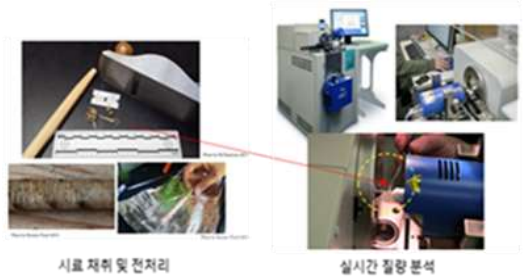
Chemical analysis for wood species identification

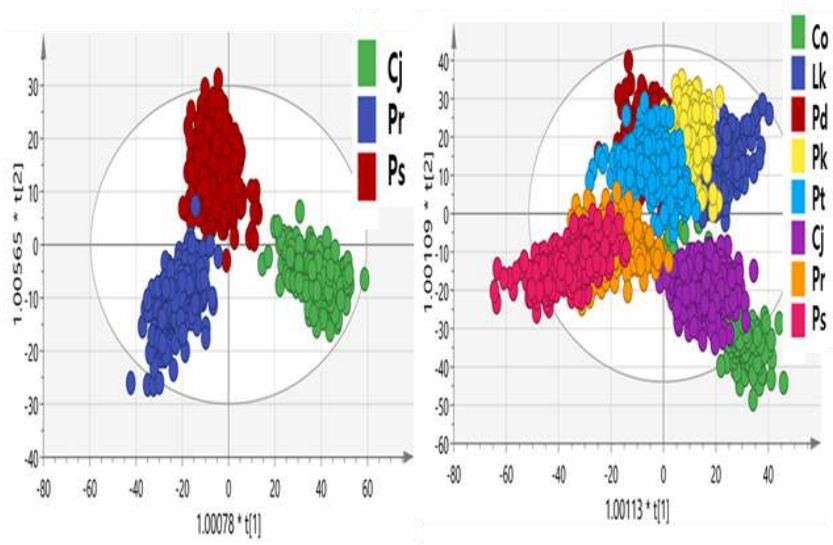
Chemical identification of wood species based on mass spectrometry methods

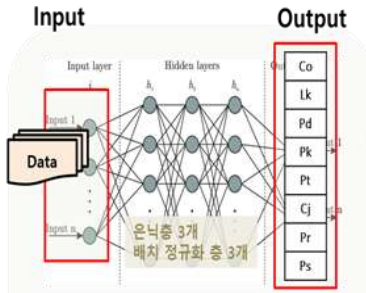
- DART-TOF-MS technique
  - ✓ Direct Analysis in Real Time coupled with a Time Of Flight Mass Spectrometry
- Fast, few preprocessing steps, accurate, but species-specific chemical mass information DB should be required
  - ✓ Previous study, 1) Construct representative spectral information for eight domestic and imported coniferous timber, 2) Develop identification model using an artificial neural network model
  - ✓ Current study, Develop identification for eight domestic and imported broad-leaved timber

● 수종식별 화학지문 분석

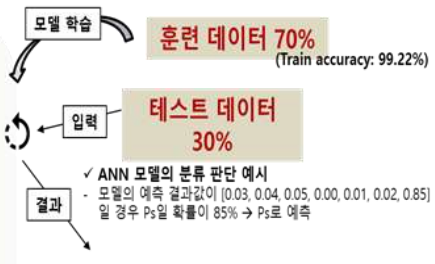
- 적용기술 : DART-TOF MS (Direct Analysis in Real Time-Time of Flight Mass Spectrometry)
  - 실시간 질량 분석 기술 -
- 실시간 이온화 기술을 이용한 질량 분석
  - 식품, 의학, 약학, 산업(방향, 물질분석), 환경, 법의학 등 다양한 분야에 활용되고 있음.
  - 전처리 과정이 거의 없고 분석시간이 매우 빠름(수초~수분)
  - 다수 시료의 화학지문 분석에 용이







- Input
  - 의미 : 목재의 실시간 질량 분석 결과
  - N x 4000의 행렬
- Output
  - 의미 : 각 목재 종류의 확률값
  - N x 8의 벡터



✓ ANN 모델의 분류 판단 예시
- 모델의 예측 결과값이 [0.03, 0.04, 0.05, 0.00, 0.01, 0.02, 0.85] 일 경우 Ps일 확률이 85% → Ps로 예측

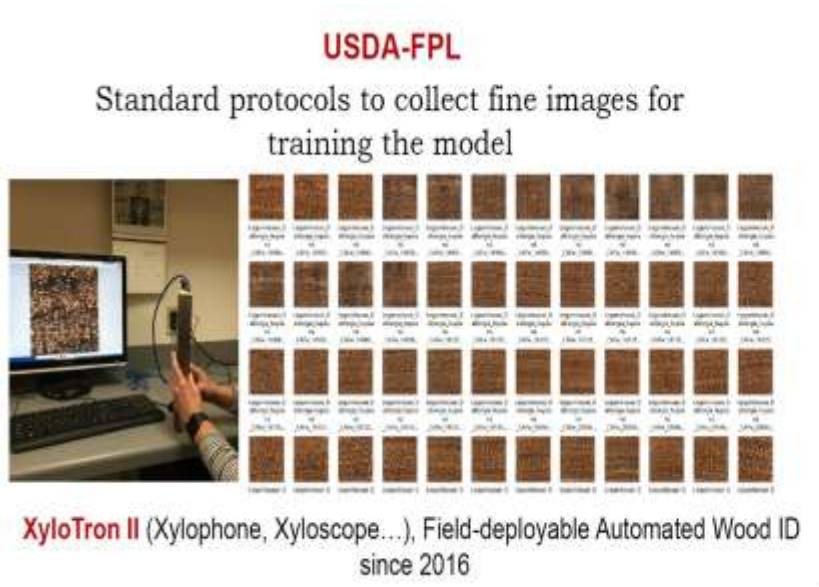
✓ ANN 모델의 목재 판별 분석 결과 (test accuracy: 98.43%)

Label	Total	Correct	Not Correct	Accuracy
Co	109	109	0	100.0%
Lk	86	86	0	100.0%
Pt	116	111	5	95.69%
Pd	97	95	2	97.94%
Pk	95	91	4	95.79%
Cj	62	62	0	100.0%
Pr	112	112	0	100.0%
Ps	88	87	1	98.86%

Development of AI wood identification

(New challenge) Development of automatic wood identification technology

- Anatomical + Big DATA + Machin learning
  - ✓ Construction big data based on anatomical characteristic image information (20 timber species)
  - ✓ Development of Algorithms for Automatic Tree Species Identification
  - → Establishment of timber Species identification Automation System in Republic of Korea



Case automatic timber species system on APEC-EGILAT Economies

Advances in Scientific Verification System

Collaboration to reinforce Timber legality management system

- Development of species identification technology (NIFoS)
  & Document inspection and technology utilization (Korea Forestry Promotion Institute : KoFPI)

NIFOS

Research, development, and commercialization of Timber species identification

Korea's Verification System on Timber Legality (Korea Forest Servise)

KOFPI

Inspection and legality management for imported timber

Strengthen management and promote legality for imported Timber and Timber product

Thank you for Listening!

Research Team for Wood Species identification of NIFoS
Special thanks to Ms. So-Yeon, Park of KoFPI