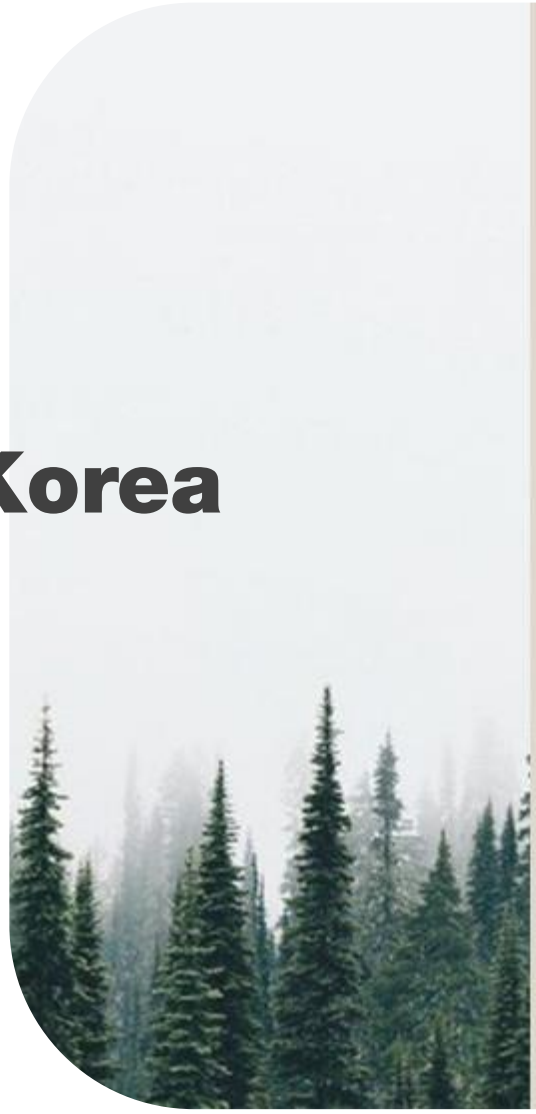
Impact of Introduced Pine Wood Nematode on Environment and Phytosanitary Measures in Rep. of Korea

Kyu-Ock YIM [1] Hyerim HAN [2]

1) Dept. of Plant Quarantine Animal and Plant Quarantine Agency /MAFRA

2) Div. of Forest Insect Pests and Diseases Korea Forest Research Institute
Korea Forest Service/MAFRA

Forest in Rep. of Korea



- Land area: 10,028,395 ha
- Forest land area: 6,368,843 ha (**63.5%**)
  - Coniferous forest: 2,580,629 ha (**25%**)
  - Broadleaf forest: 1,718,916 ha (64%)

Major Tree Species in Korea

Pinus densiflora
Korean Red Pine

Quercus serrata
serrate Oak

Quercus mongolica
Mongolian Oak

Zelkova serrata
Japanese Zelkova

Pinus koraiensis
Korean Pine

Taxus cuspidata
Japanese Yew

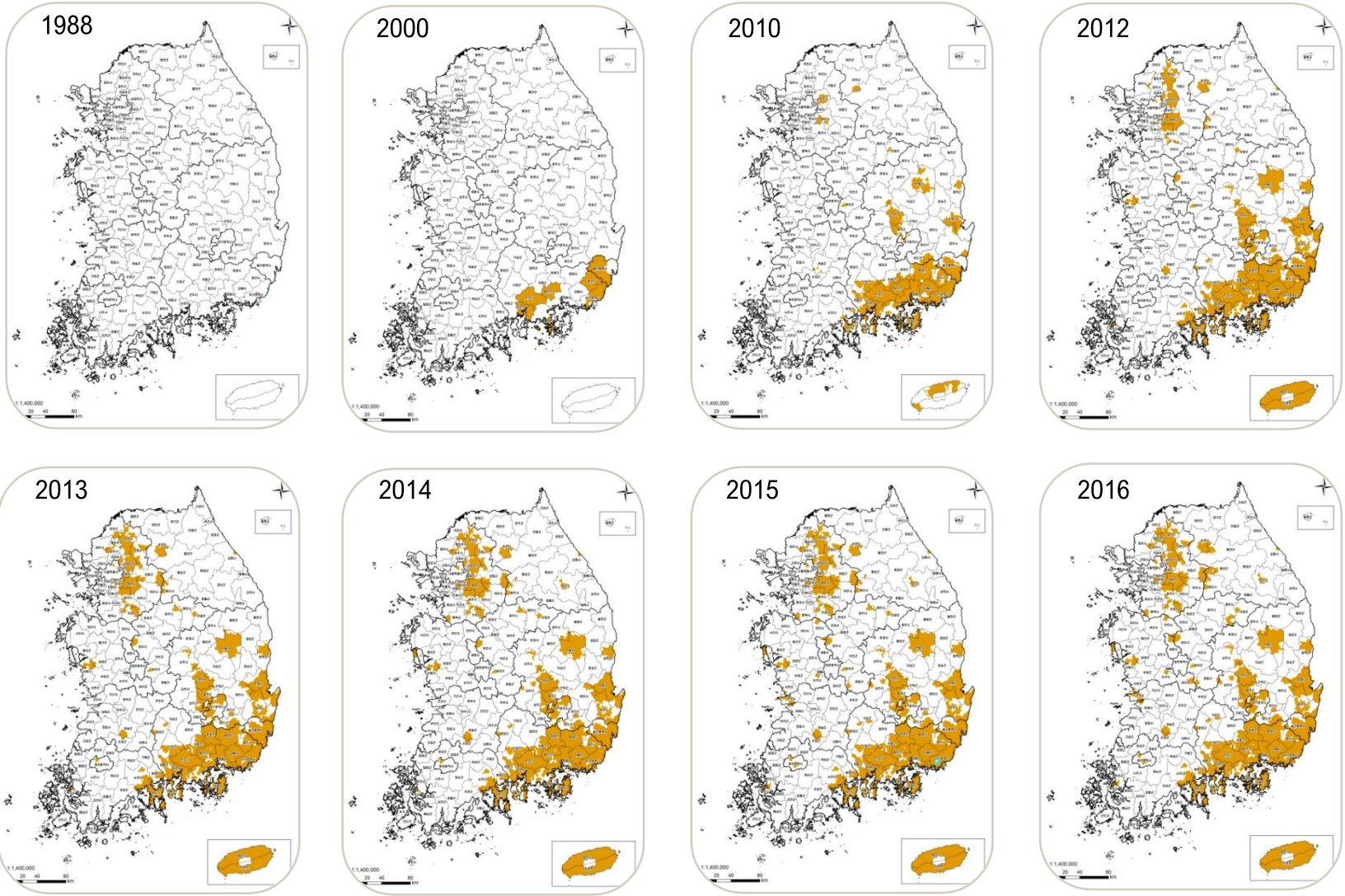
Quercus variabilis
Oriental Oak

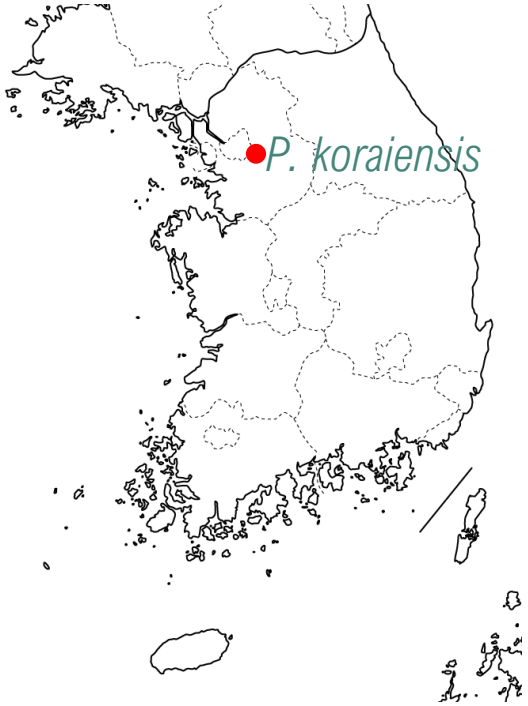
Pinus thunbergii
Korean Black Pine


한국학중앙연구원

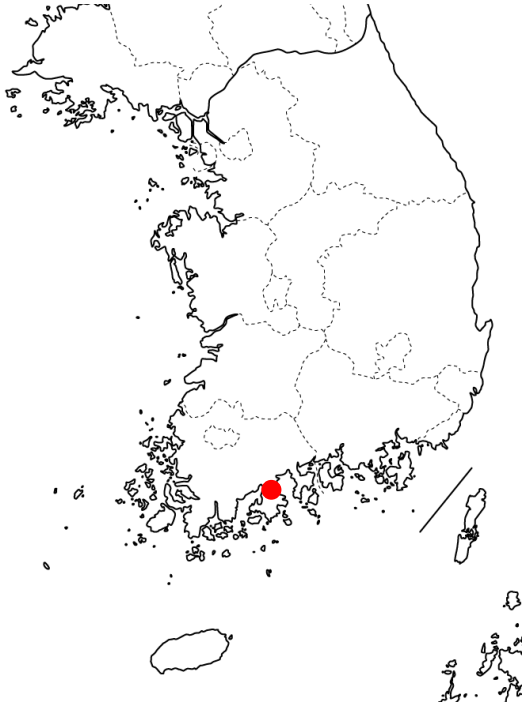
Outbreak of Pine Wood Nematode in Rep. of Korea

Spreading of PWN in Korea

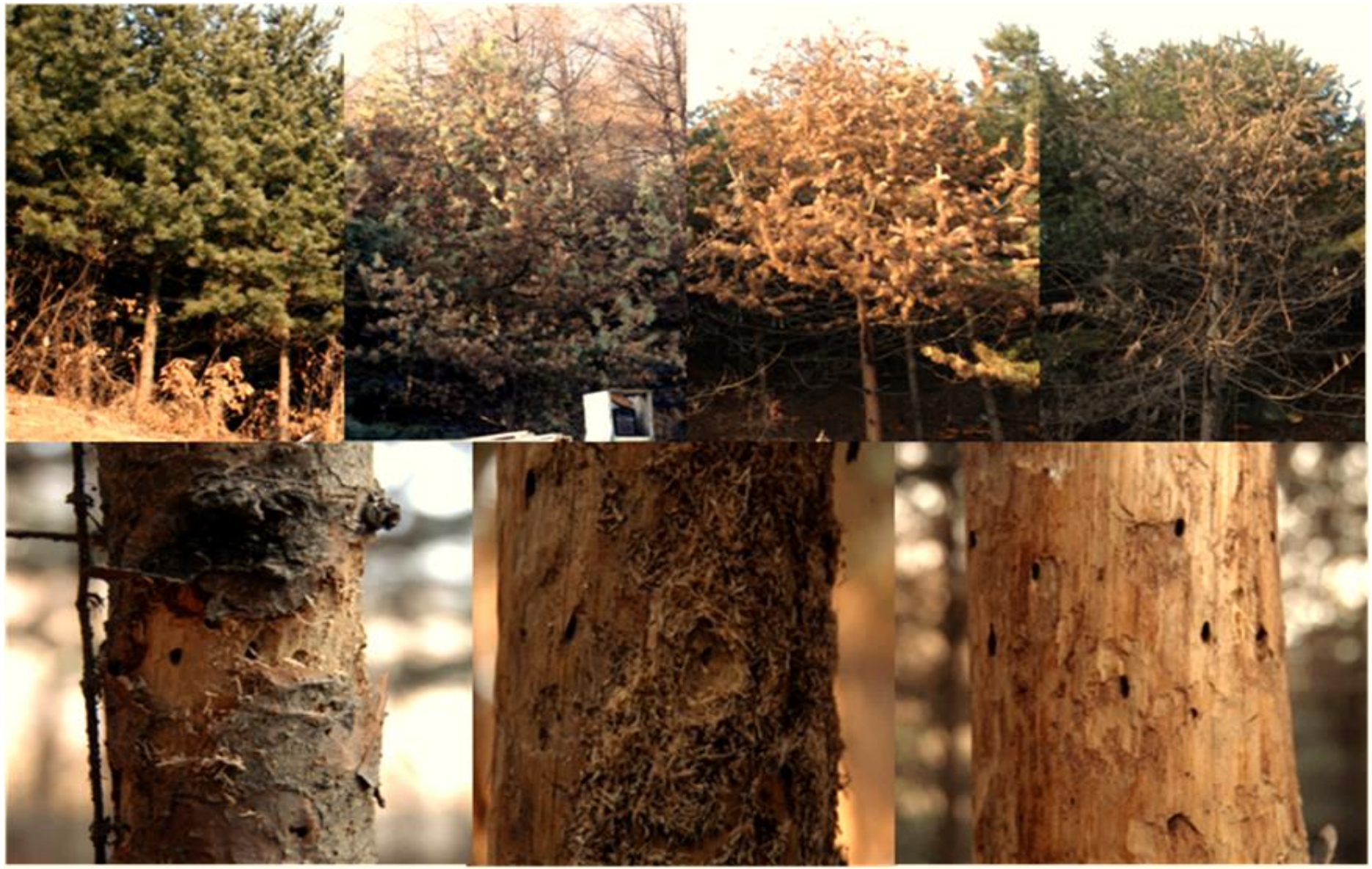




Kwangju, 2006



Yeosu, 2010



Major Tree Species in Korea

Red Pine

Quercus serrata
serrate Oak

Quercus mongolica
Mongolian Oak

Zelkova serrata
Japanese Zelkova

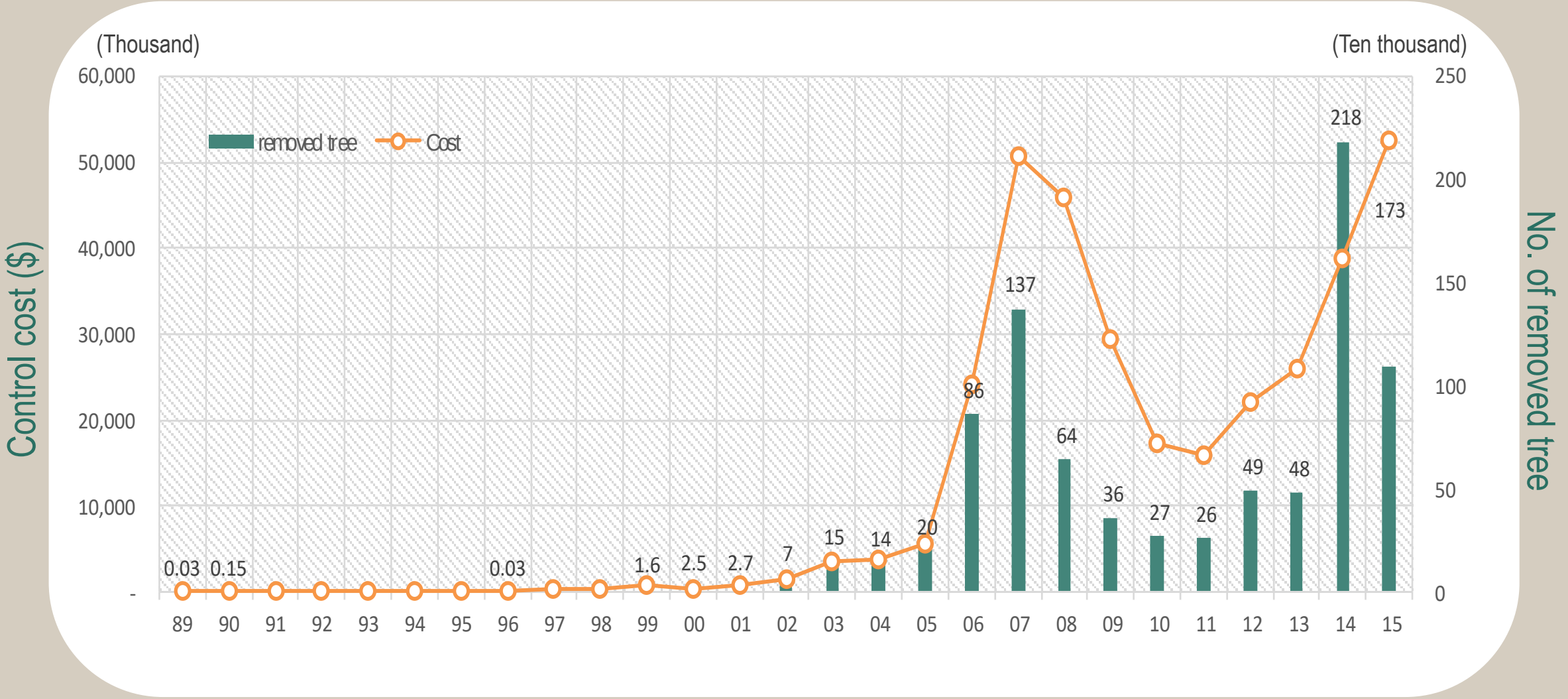
Korean Pine

Taxus cuspidata
Japanese Yew

Quercus variabilis
Oriental Oak

Black Pine

Annual changes of PWD infected trees and cost



Total number of removed tree :

10,662,293

Total control cost (direct) :

$609,385,833

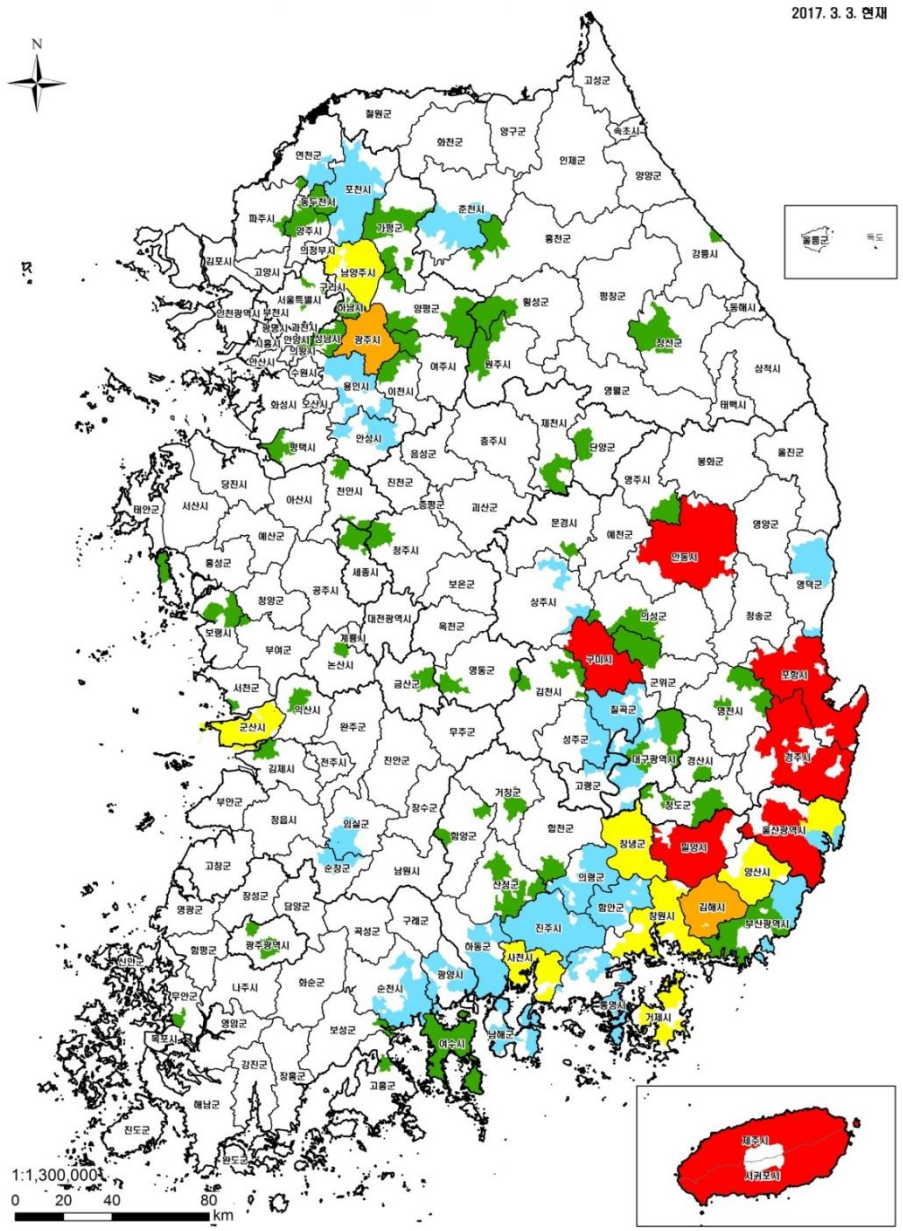
Origin of PWN: North America
(not cause mortality in endemic hosts)

Introduced into Japan (early 1900s):
cause serious mortality in susceptible native species

Identified as *Bursaphelenchus* sp. in Japan in 1960s

Spread to Rep. of Korea, China (Taipei China, Hong Kong)

through Wood packaging material, Timber?



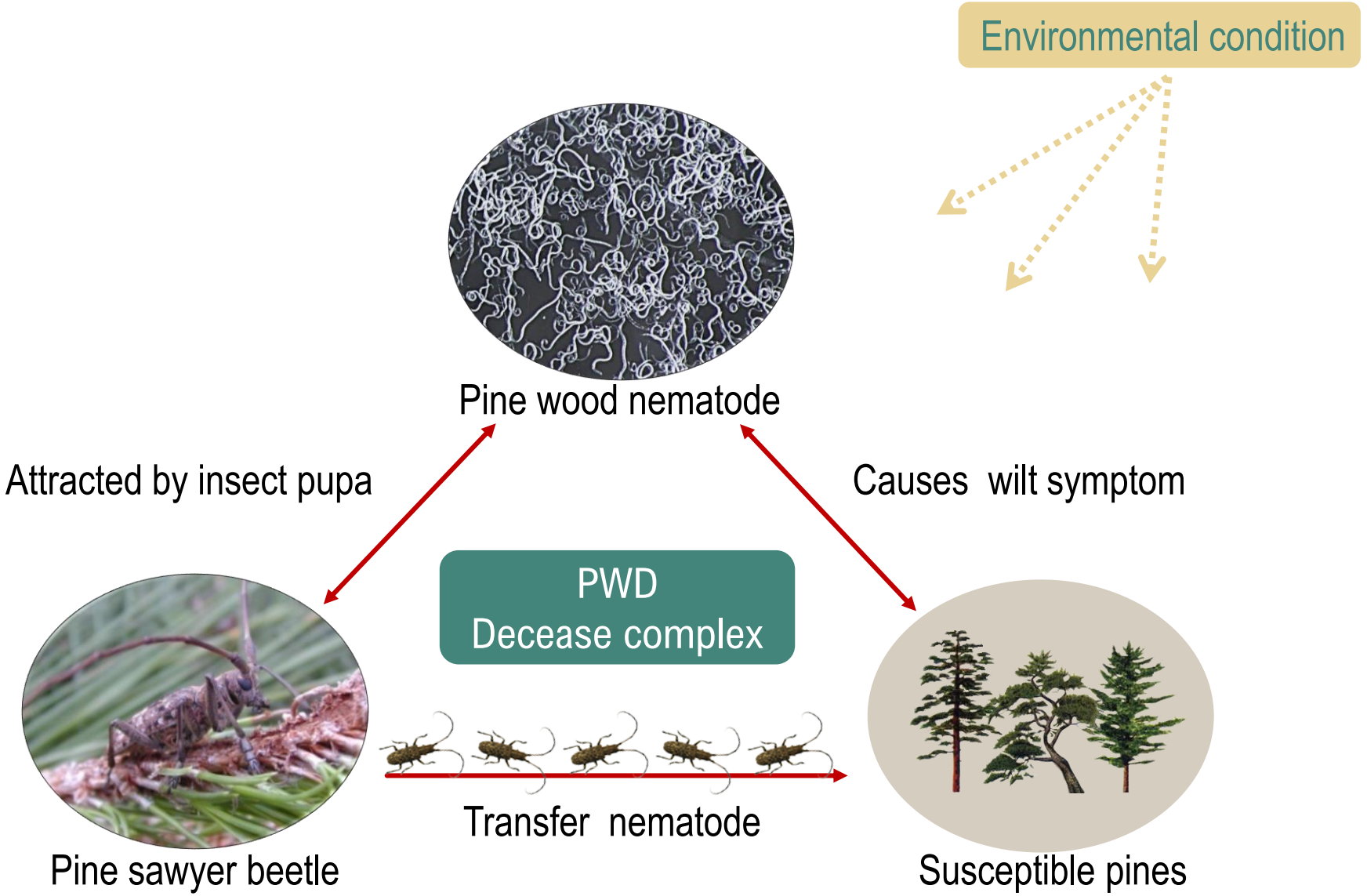
Outbreak of PWN

→ **Multiple introduction?**
Domestic movement?

Vectors in native area : *Monochamus carolinensis, M. scutellatus, M. marmorator, M. murator, M. obtusus, M. titillator*

Vectors in Rep. of Korea : *M. salturarius, M. alternatus*

→ Utilize endogenous species as vectors in introduced area


Environmental condition
Pine wood nematode
Attracted by insect pupa
Causes wilt symptom
PWD
Decease complex
Transfer nematode
Pine sawyer beetle
Susceptible pines

PINE WOOD NEMATODE

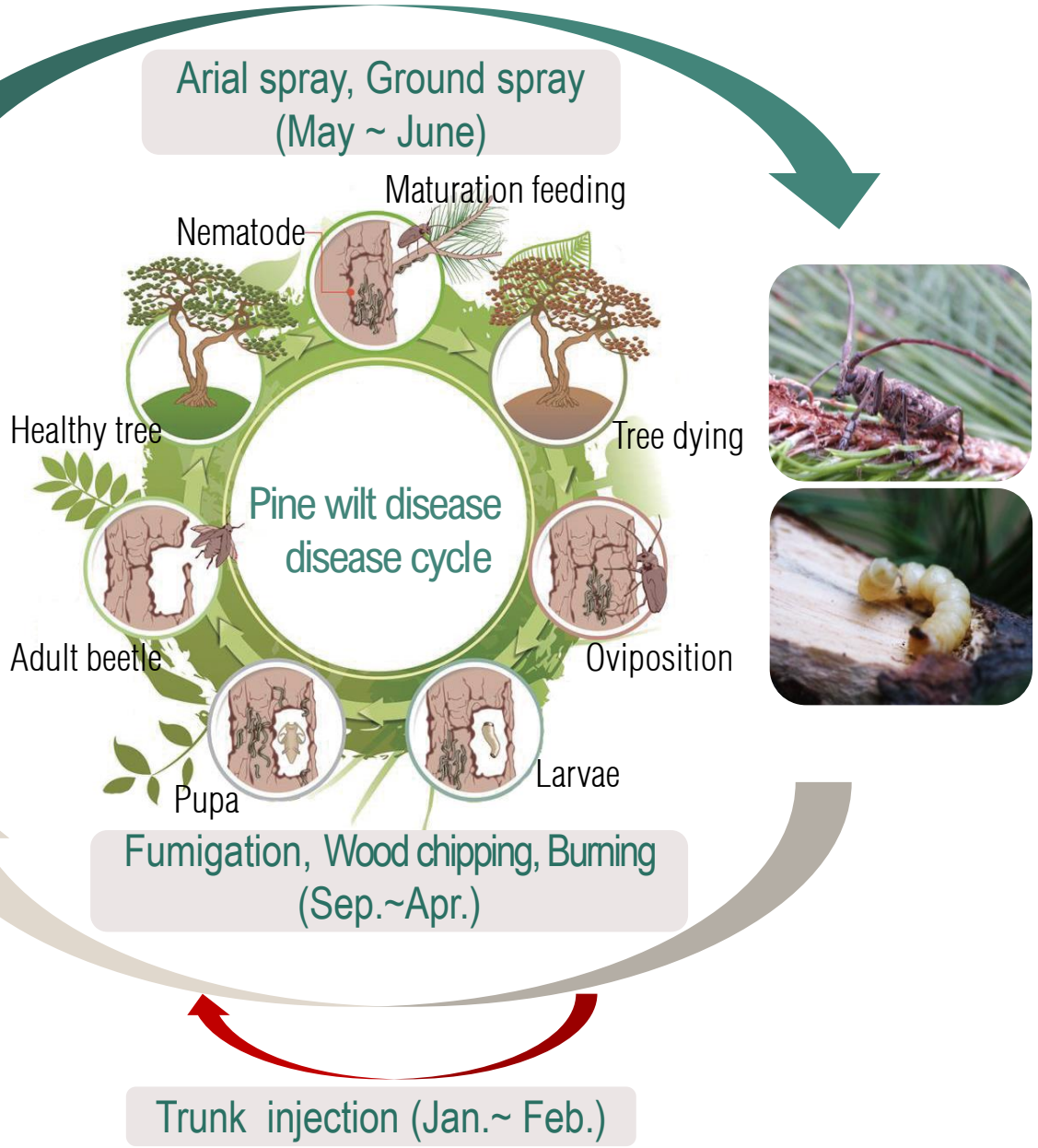
PINE SAWYER BEETLE

Official control of PWD in Korea

Special Law for Control of PWN (2005)

- Responsibility of National Government/Local Gov.
- Obligation of survey
- Obligation of report
- Capacity of diagnosis
- Order of control (felling, fumigation, incineration, prohibition of movement etc.)
- Fine and punishment etc.

Control of PWD in Korea



Felling and Chipping



- Principle : Grind logs of infected trees into sawdust or small chips(<1.5cm thickness)

  → kill the larvae and pupa of insect vector

- Advantage : Environmentally friendly method, utilization of secondary wood product

  → one of the main control measure in Korea

Felling and Burning



- Advantage : Low cost, easy, and efficient method
  ※ good for removal of small branches

- Disadvantage : restricted in dry season because of a risk of fire,
  heat damaged tree, require isolated space, air pollution

Felling and Fumigation

- Principle : volatile type of chemical kill both nematode and insect larvae

  → 1L/ m^3 (Metam sodium 25%)

- Advantage : effective and fast, on-spot treatment
- Disadvantage : laborious and expensive, safety issue, environment issue

Aerial Spray

- Principle : chemical toxic to adult pine sawyer beetle
  - → thiacloprid 10% susupentionconcentrate, Acetamiprid
- Advantage : wide area applicable, effective
- Disadvantage : expensive, environmental issue, biodiversity

Trunk injection




- Principle : injected chemical kills the nematode moves into the wood tissue
  - → Abamectin 1.8% emulsion, Emamectin benzoate 2% emulsion
- Advantage : best for prevention, effective
- Disadvantage : expensive, seasonal restriction






Mass fumigation

- Principle : volatile type of chemical kill both nematode and insect larvae
  - → 117g/ 2m^3 (Magnesium phosphide)
- Advantage : effective and fast , utilize felling timber
- Disadvantage : environmental issue, safety requirement

Ground spray

- Principle : chemical causes ingestion toxicity to insect
  - → thiacloprid 10% susupentionconcentrate
- Ground spray : high-tension spray, fog machine etc.
- Advantage : small area e.g. city park, effective
- Disadvantage : expensive, environmental issue, biodiversity

Trap logs



- Principle : attractive by adult pine sawyer
  - ⟶ induce oviposition and remove before emergence of adult
  - ⟶ decrease density of insect vector

Before and after PWD control

Survey

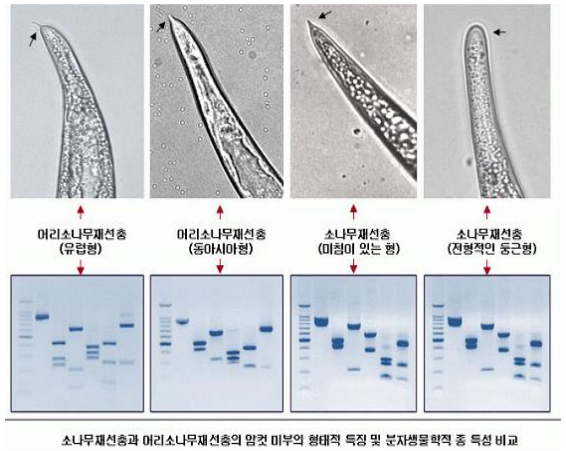
- Local government and regional forest service
  - Drone survey in dense forest (at least 20 times more efficient)
  - Research on target spray and image analysis with Drone
- Reporting from public
- Government lab for diagnosis

Research to utilize image processing for on site diagnosis and Targeted spray from Drone

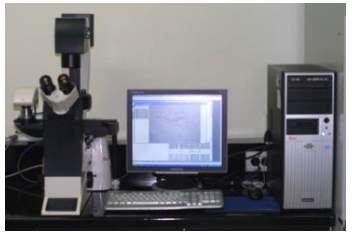
Diagnosis

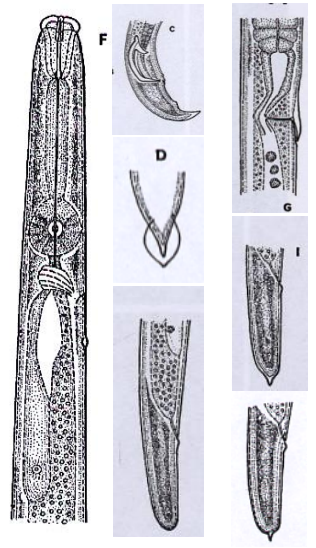
- Morphological identification
  under the microscope, PWN size 0.6~1mm
- Molecular biological identification
  genetic characteristics (e.g. ribosomal DNA, mitochondrial DNA)

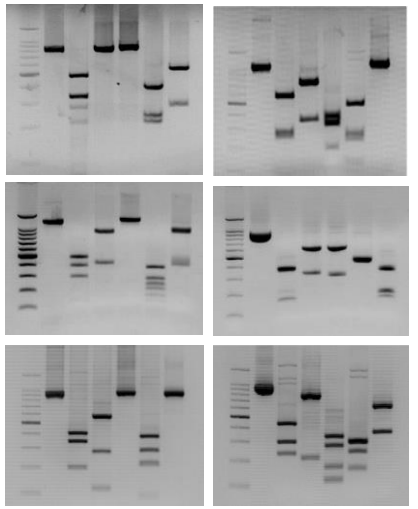
→ precise and fast identification system



소나무재선충과 어리소나무재선충의 암컷 미부의 형태적 특징 및 분자생물학적 종 특성 비교







ISPM 15 : Wood packaging material

- New pathway of plant pest introduction
- No inspection/certification
- No trace back/ Reuse

ISPM 15

History of the standard setting

- 1999 CPM added topic‘ Wood packing’
- ‘00~’01 Expert working group developed a draft
- 2001 Member consultation
- 2002 ISPM 15 adopted by CPM
- Revised in 2006, 2009, 2013, 2018

→ ISPM 15 Regulation on wood packaging material in international trade

ISPM 15

ISPM 15 (2002)

< List of most significant pests targeted by HT and MB >

Anobiidae, Bostrichidae, Buprestidae,
Cerambycidae, Curculionidae, Isoptera,
Lyctidae (with some exception for HT),
Oedemeridae, Scolytidae, Siricidae,
Bursaphelenchus xylophilus

ISPM 15

- Required phytosanitary measures for WPM
  - Debarking (commercial debarking)
  - Heat Treatment
    - 56℃ 30 min. by Conventional steam or Kiln heat chamber
    - 60℃ 1 min by dielectric heating
  - Methyl bromide treatment
  - IPPC mark

WPM management in Korea

a. ISPM 15(IPPC) 2002

b. Revision of Plant Protection Act
* Registration, Cancellation of HT service
Violation & Penalty

c. Enforcement Regulation
* How to register, registration requirement,
administrative measures, compliance

d. Quarantine Requirements of WPM (Notice, 2002)
* mark registration, monitoring, how to operate

서 화물에 사용되는 목재포장재는 국가간에 병해충을 매개체가 되고 있어, 대부분 국가들이 자연환경 및 농림산업 보호를 위하여 검역을 실시하고 있습니다.

- 목재포장재는 대부분 가공되지 않은 생목재로 제작되므로 소나무 재선충과 같은 고위험 해외병해충의 유입원이 되고 있음


검사대상이 아닌 목재포장재는?

- 접착제, 열, 압력 등을 이용하여 제조한 합판(Plywood), 베니어, 파티클보드, 배양성스트랜드보드, 직경(두께)이 6mm 이하인 목재 (대팻밥, 톱밥, Wood Tip 등) 등


Plywood


Veneer


Oriented strand board


Particle board


응집코르크


Wood wool

검사대상인 목재포장재는?

- 모든 화물에 사용된 목재포장재 중 가공되지 않은 목재로 제작한 「파렛트」, 「나무상자」, 「드럼」, 「받침목(짐깔개)」, 「목재용기」, 「지지목(버팀목)」, 「skid」, 「적재판」, 「bulk heads」, 「load boards」, 「packing blocks」, 「덮개」 등이 해당됨


Pallets


Dunnage 및 Drum


Wooden cases


Wooden cases


Wooden crates

Wooden crates


Wooden crates


Wooden crates


Wooden crates


Drum


Dunnage


Dunnage

목재포장재 검역요건은?

- 수출국에서 소독 전에 수피가 제거(Debarked)되어야 함
  - 다만, 제거 후 남아있는 수피의 허용범위는 넓이가 3cm 미만이거나 넓이가 3cm 이상인 경우는 면적이 50㎠ 미만 이어야 함


- 국제기준에 따라 수출국에서 소독 후 "소독처리마크"가 표시되어 있어야 함
  - 메칠브로마이드(MB) 또는 열처리(HT) 소독을 하였다는 "소독처리마크"가 목재포장재 2개면 이상에 표지되어 있어야 함

★ 수출화물 목재포장재의 경우는 국립식물검역원에 열처리업 또는 방제업에 등록(신고)된 업체에서 소독을 하여야 함

· "소독처리마크"는 고무인 또는 인두 등으로 지워지지 않게 표시되어야 하며, 손으로 그리거나 꼬리표 · 스티커 등은 아니 됨

- 살아 있는 해충 및 규제 병원균에 감염되어 있지 않아야 함
- 단면이 200mm를 초과하는 목재포장재는 메칠브로마이드(MB)소독처리를 해서는 아니 됨
- 소독처리마크가 표지된 목재포장재는 수선(구성요소 1/3까지 제거되고 바뀜) 또는 재제작(1/3이상 대체)되지 않는 한 재사용이 가능하며, 수선이나 재제작한 경우에는 새로 사용한 목재 또는 전체를 소독처리한 후 "소독처리마크"를 다시 표시하여야 함

★ 소독처리마크가 되어 있더라도 검역결과 소독처리가 효과적이지 않아서 병해충이 검출되면 검역처분(소독 또는 폐기)을 받습니다.


WPM regulation in Korea

Heat treatment
Providers
(702 registered)

MB treatment
Providers
(30 declared)

Implication of PWN invasion

1. Introduced pest can be more aggressive or damaging than native area
   - direct impact: loss of forest, direct control cost
   - indirect impact: indirect cost, ecology change, biodiversity, social impact, indirect environmental impact (aerial spray, burning, fumigation etc.)

2. Prevention of pest introduction is most effective and economic

3. Scope of phytosanitary measures
   - Public awareness

Implication of PWN invasion

4. Coordination between relevant authorities

5. Importance of internationally harmonized phytosanitary measures:
   pathway ISPMs to manage potential risk
   - Impact of adoption of ISPMs