

Annex 1

Examples of forest pest introductions and their impacts

Agrilus planipennis, emerald ash borer

IMPACTS

Has caused death and decline of millions of trees in Canada and the United States; predicted to ultimately kill most ash in forests, urban plantings and shelterbelts. Costs in the United States are expected to exceed US\$1 billion per year for the next 10 years. In the Russian Federation, most ash trees within 100 km of Moscow have been killed; infestation is spreading rapidly and European forests are threatened.

PATHWAYS

Movement of plants, wood and wood products in particular fuelwood, and wood packaging materials; flight and wind dispersal



BUGWOOD.ORG/PENNSYLVANIA DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES, FORESTRY ARCHIVE/5016061

Adult emerald ash borer, Agrilus planipennis



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Larval galleries

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Exit holes

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*Infested tree exhibiting root sprouts and crown dieback***MAIN HOSTS**

Fraxinus spp. (ash), *Juglans* spp. (walnut), *Pterocarya* spp. (Japanese wingnut), *Ulmus* spp. (elm)

NATIVE RANGE

China, Democratic People's Republic of Korea, Japan, Mongolia, Republic of Korea, far east of the Russian Federation

INTRODUCED RANGE

Europe: Russian Federation (Moscow and surrounding area)
North America: Canada, United States of America

SYMPTOMS AND DAMAGE

Larvae infest upper trunk and lower portions of main branches causing yellowing and thinning of foliage; dieback and death of trees normally within 3 years.

Cinara cupressivora, cypress aphid

IMPACTS

Serious damage to forests in Africa, Europe and South America. Rapidly spread through Africa after accidental introduction into Malawi in 1986. By 1990, trees worth approximately US\$44 million were lost plus US\$14.6 million per year through reductions in annual growth increment. In Kenya, it was estimated that it might kill up to 50 percent of all cypress trees during the 30-year harvest cycle.

PATHWAYS

Movement of nursery stock; flight and wind dispersal

MAIN HOSTS

Cupressus spp. (cypress), *Juniperus* spp. (juniper)

NATIVE RANGE

Europe and Near East – from eastern Greece to the Islamic Republic of Iran

INTRODUCED RANGE

Africa: Burundi, Democratic Republic of the Congo, Ethiopia, Kenya, Malawi, Mauritius, Morocco, Rwanda, South Africa, Uganda, United Republic of Tanzania, Zambia, Zimbabwe



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Cypress aphids, *Cinara cupressivora*



Damage, Kenya

Europe: France, Italy, Spain, United Kingdom

Latin America and the Caribbean: Chile, Colombia

Near East: Jordan, Syrian Arab Republic, Turkey, Yemen

SYMPTOMS AND DAMAGE

Sap sucking on terminal growth of young and old trees retards new growth and causes desiccation of stems. Progressive dieback on heavily infested trees.

Leptocybe invasa, blue-gum chalcid

IMPACTS

Major pest of young eucalypt trees and seedlings. Native to Australia, currently spreading through Africa, Asia and the Pacific, Europe, Latin America and the Near East.

PATHWAYS

Movement of nursery stock; international air traffic; flight and wind dispersal

MAIN HOSTS

Eucalyptus spp. (eucalypt)

NATIVE RANGE

Australia

INTRODUCED RANGE

Africa: Algeria, Kenya, Morocco, South Africa, United Republic of Tanzania, Uganda

Asia and the Pacific: Cambodia, India, Thailand, Viet Nam

Europe: France, Greece, Italy, Portugal, Spain

Latin America and the Caribbean: Argentina, Brazil

Near East: Iraq, Islamic Republic of Iran, Israel, Jordan, Lebanon, Syrian Arab Republic, Turkey



Ovipositing female blue-gum chalcid, *Leptocybe invasa*



G. ALLARD

Young galls on eucalypt branches and leaf petioles, United Republic of Tanzania



G. ALLARD

Leptocybe damage: older galls with exit holes on eucalypt branches and leaf petioles, United Republic of Tanzania

SYMPTOMS AND DAMAGE

Developing larvae form bump-shaped galls on leaf midribs, petioles and stems of new growth of young eucalypt trees, coppice and nursery seedlings. Severely attacked trees show leaf fall, gnarled appearance, loss of growth and vigour, stunted growth, lodging, dieback and eventually tree death.

Sirex noctilio, European woodwasp

IMPACTS

Threat to certain forests and the forest sector causing considerable damage and costs for control: New Zealand, tree losses reached 30 percent by the 1940s; Australia (Tasmania), about 40 percent of trees died in late 1950s; Australia, 5 million trees killed during 1987–1989 outbreak. A serious threat to the forest industry in South Africa, causing considerable losses in Eastern Cape and KwaZulu-Natal Provinces. In Brazil, the potential economic impacts are approximately US\$25 million annually.

PATHWAYS

Flight and wind dispersal; movement of sawnwood, untreated pine logs and wood packaging materials

MAIN HOSTS

Pinus spp. (pine)

NATIVE RANGE

Asia, Europe, northern Africa (Algeria, Morocco, Tunisia)



Adult male sirex woodwasp, Sirex noctilio

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Larval tunnelling



Damage

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INTRODUCED RANGE

Africa: South Africa

Asia and the Pacific: Australia (including Tasmania), New Zealand

Latin America and the Caribbean: Argentina, Brazil, Chile, Uruguay

North America: Canada, United States of America

SYMPTOMS AND DAMAGE

Drills into wood to lay eggs; injects toxic mucus and a fungus (*Amylostereum areolatum*) which may result in wilting and tree death; foliage turns from green to yellow to reddish-brown. Larval tunnelling damages wood; fungus causes white rot.

Cryphonectria parasitica, chestnut blight

IMPACTS

American chestnut (*Castanea dentata*) was one of the most abundant hardwoods in the eastern United States of America and is now nearly extinct because of chestnut blight – which shows how a disease can fundamentally alter an entire ecosystem. Chestnut trees are very important economically, producing durable wood (for furniture, construction) and nuts (cash crop, staple food for wildlife). The impact of chestnut blight on the forest sector in Turkey has contributed to the migration of the young workforce from rural to urban environments.

PATHWAYS

Movement of infected nursery stock, wood or bark; spread locally through poor harvesting techniques and by wind or blown rain

MAIN HOSTS

Castanea spp. (chestnut), *Quercus* spp. (oak)

NATIVE RANGE

Asia



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Symptoms of chestnut blight, *Cryphonectria parasitica* – canker and bark necrosis



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Symptoms – wilting leaves

INTRODUCED RANGE

Africa: Tunisia

Asia and the Pacific: Australia

Europe: Austria, Belgium, Bosnia and Herzegovina, Croatia, France, Georgia, Germany, Greece, Hungary, Italy, Poland, Portugal, Russian Federation, Slovakia, Slovenia, Spain, Switzerland, The Former Yugoslav Republic of Macedonia, Turkey, Ukraine

Near East: Islamic Republic of Iran

North America: Canada, United States of America

SYMPTOMS AND DAMAGE

Infects above-ground parts of trees only, creating cankers that expand, girdle and eventually kill tree branches and trunks.

Ophiostoma ulmi and *Ophiostoma novo-ulmi*, Dutch elm disease

IMPACTS

Dutch scientists first isolated the fungus in the 1920s, hence the name of this vascular wilt disease. One of the most severe diseases in the temperate world where elms are grown. Hundreds of millions of healthy mature elms lost in northern Asia, Europe and North America. Major pandemic across Northern Hemisphere from 1920s to 1940s. First reported in France, then spread through continental Europe and the United States of America, decimating elm populations. Disease declined in Europe but re-emerged when a second, more virulent species established in the United Kingdom, most of Europe, and the United States of America. Insect vectors: *Scolytus* spp. and *Hylurgopinus rufipes* (bark beetles).

PATHWAYS

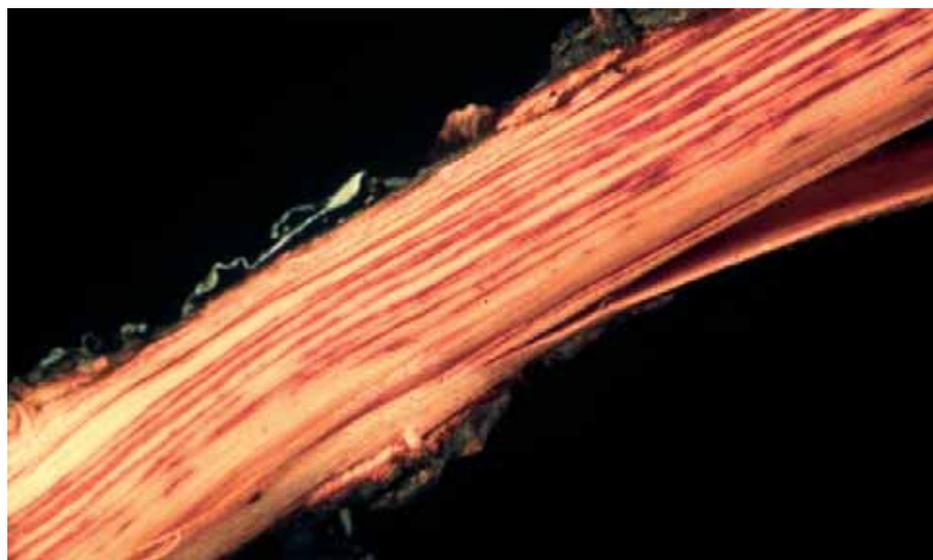
Movement of infested or infected planting material, fuelwood and logs with bark

MAIN HOSTS

Ulmus spp. (elm)

NATIVE RANGE

Asia



Symptoms of Dutch elm disease – streaking of vascular tissue



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Symptoms – wilting leaves



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Symptoms on American elm, Ulmus americana

INTRODUCED RANGE

Temperate regions. Re-introduction of more virulent species from North America to Europe (mid-1960s)

SYMPTOMS AND DAMAGE

Insect vectors carry fungus while feeding on branches; fungus spreads via tree sap throughout tree; can also spread via root grafts from tree to tree. Wilting, yellowing and browning of leaves; branches may be individually infected; brownish streaks of discolouration in branches and stems; symptoms may progress throughout a tree in a single season or take two or more years.

Phytophthora ramorum, sudden oak death, ramorum blight

IMPACTS

Attacks various nursery plants and forest trees where it has spread into forests. In the United States of America (California) millions of oak and tanoak trees have died. In the United Kingdom it has recently been found infecting Japanese larch, resulting in significant mortality. Inoculum remains viable in soil for a period of years after removal of infected trees and shrubs, thereby affecting reforestation decisions.

PATHWAYS

Movement of infected or contaminated plant material, growing media, nursery stock and soil carried on vehicles, machinery, footwear and animals

MAIN HOSTS

Quercus spp. (oak), *Lithocarpus densiflorus* (tanoak), *Larix kaempeferi* (Japanese larch), *Rhododendron* spp. (rhododendron, azalea), *Umbellularia californica* (bay laurel), and many other plant species

NATIVE RANGE

Unknown

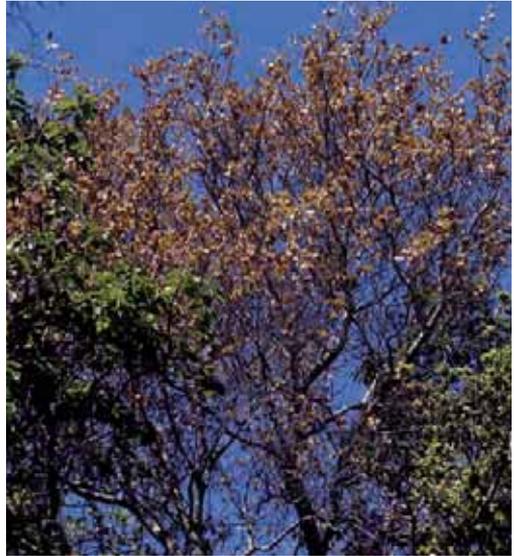


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Bleeding on coast live oak (*Quercus agrifolia*) resulting from *Phytophthora ramorum* infection



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Symptoms on *Q. agrifolia*

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Symptoms on *Q. agrifolia*

INTRODUCED RANGE

Europe: Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Lithuania, the Netherlands, Norway, Poland, Serbia, Slovenia, Spain, Switzerland, Sweden, United Kingdom

North America: United States of America

SYMPTOMS AND DAMAGE

Symptoms on oak/tanoak: stem bark lesions, bleeding basal cankers, branch cankers, crown dieback followed by death. Symptoms on other hosts: leaf lesions, small branch cankers, stem and branch dieback.

Puccinia psidii, eucalyptus rust

IMPACTS

Attacks many genera in the family Myrtaceae, with specific strains causing landscape-scale devastation on particular hosts. First described on guava, this pathogen causes substantial damage to non-native eucalypt plantations in South America.

PATHWAYS

Movement of infected or contaminated plant material, cut foliage, and any items exposed to spores, which can survive for two to three months.



Symptoms of *eucalyptus rust*, *Puccinia psidii*

MAIN HOSTS

Eucalyptus spp. (eucalypt), *Psidium* spp. (guava)

NATIVE RANGE

South and Central America

INTRODUCED RANGE

Latin America and the Caribbean: Cuba, Dominican Republic, Jamaica, Trinidad and Tobago

North America: United States of America (California, Florida, Hawaii, Puerto Rico)

SYMPTOMS AND DAMAGE

Attacks young tissues of plants and can cause deformation of leaves, heavy defoliation of branches, dieback, stunted growth and sometimes death.

Bursaphelenchus xylophilus, pinewood nematode

IMPACTS

Threat to certain pine forests; has caused extensive tree mortality in some areas where it has been introduced; millions of trees killed annually in Japan. Insect-vectors: *Monochamus* spp. (sawyer or longhorned beetles).

PATHWAYS

Flight of adult vector beetles; movement of infected and vector-infested planting material, fuelwood, timber, wood packaging materials and logs

MAIN HOSTS

Pinus spp. (pine)

NATIVE RANGE

North America

INTRODUCED RANGE

Asia and the Pacific: China, Japan, Republic of Korea
Europe: Portugal



Pinewood nematode, *Bursaphelenchus xylophilus*

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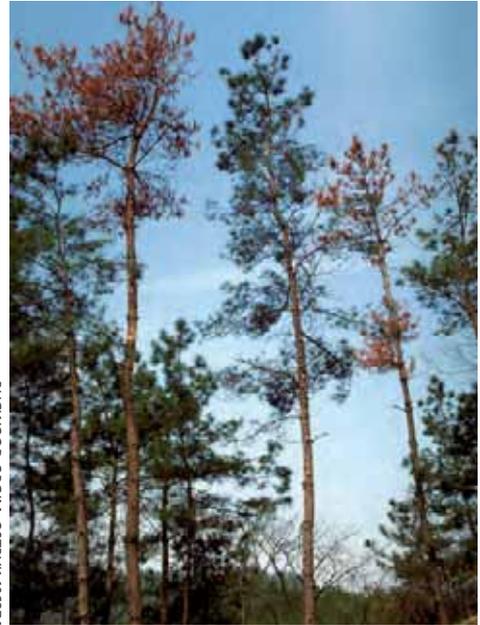
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Monochamus sp., the vector of B. xylophilus



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Needle discolouration



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Reddish crowns

SYMPTOMS AND DAMAGE

Nematode deposited when adult beetles feed or lay eggs in trees. Presence of nematodes in xylem can result in wilt and mortality; also feed on fungal tissues in dead trees or wood products.

Bursaphelenchus cocophilus, red ring nematode

IMPACTS

Significant threat to coconut and other palms; young coconut palms succumb easily; palms of various ages affected; no record of palms recovering once infected; disease not recognizable externally; losses up to 80 percent, however, the losses typically range from 10 to 15 percent on coconut and oil palms. Insect vectors: *Rhynchophorus palmarum* and *Dynamis borassi* (palm weevils); *Metamasius hemipterus* (sugarcane weevil), implicated in transmission.

PATHWAYS

Carried by insect vectors that feed on infected palms as larvae and transmit the nematode as adults; movement of infected and vector-infested wood products



D. COVNE

Damage caused by the red ring nematode, *Bursaphelenchus cocophilus*, including chlorosis and browning of the leaf tips of the oldest leaves of a coconut palm, Brazil

MAIN HOSTS

Cocos nucifera (coconut), *Elaeis guineensis* and *E. oleifera* (oil palms)

NATIVE RANGE

Latin America and the Caribbean

WORLD DISTRIBUTION

Belize, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Grenada, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Venezuela

SYMPTOMS AND DAMAGE

Nematode deposited when infected adult beetles feed or lay eggs in the crown of palms. Chlorosis occurs, first at leaf tips of older leaves, which may eventually become brown and dried. Nuts are shed prematurely; crowns of affected coconut palms often topple over (associated also with weevil damage); characteristic internal orange to brick-red coloured ring in trunk cross-section, but can be brownish in colour depending on palm species and variety.