

# The role of climate factors in association with spread of invasive forest pests with special focus on plant production

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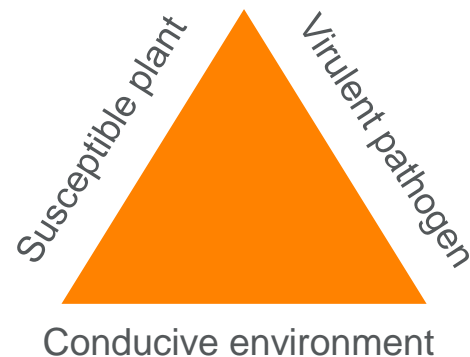
# Outline

- Plant / tree pathogens and pests
- Invasive species
- Climate change
- Plant / tree seedling production and invasive pests in changing climate



# Plant (tree) pests

- The group of plant pests contains disease inducing **pathogens**: fungi, oomycetes, bacteria, viruses, nematodes, protozoa and parasitic plants, and **insects**
- Pests affect all plants, economically most important are agriculture and forestry species
- Insects need suitable host and environmental conditions to induce damage and death
- Plant pathogens: "disease triangle":



# Non-native and invasive species

- An alien / non-native species is a species introduced **outside its normal distribution** accidentally or inadvertently **by the human actions**
- An invasive species is a non-native organism that causes **ecological or economic harm** in a new environment
- Invasive species include **all types of organisms**: animals, plants, insects, fungi, bacteria, etc.



Picture: Anne Uimari, Luke

Policeman's Helmet  
*Impatiens glandulifera*



Picture: Asko Hannukkala, Luke

Ramorum blight / Sudden oak death  
*Phytophthora ramorum* (oomycetes)



Picture: Kjetil Lenes, CC-BY-4.0

Spanish slug  
*Arion vulgaris*

# Invasive pests

- Steps of invasion:



- Main pathways for introduction are **global trade** and **increased human movement** with all accessory factors
- Establishment involves susceptible hosts and suitable environmental conditions with essential abiotic and biotic factors
- Spreading of established invasive species can be:
  - natural
    - spore dispersal with wind, water or insects, vectored spreading, moving (flying insects), etc.
  - or inadvertently aided
    - as contaminants of goods (agricultural and horticultural products), equipment and machinery, etc.

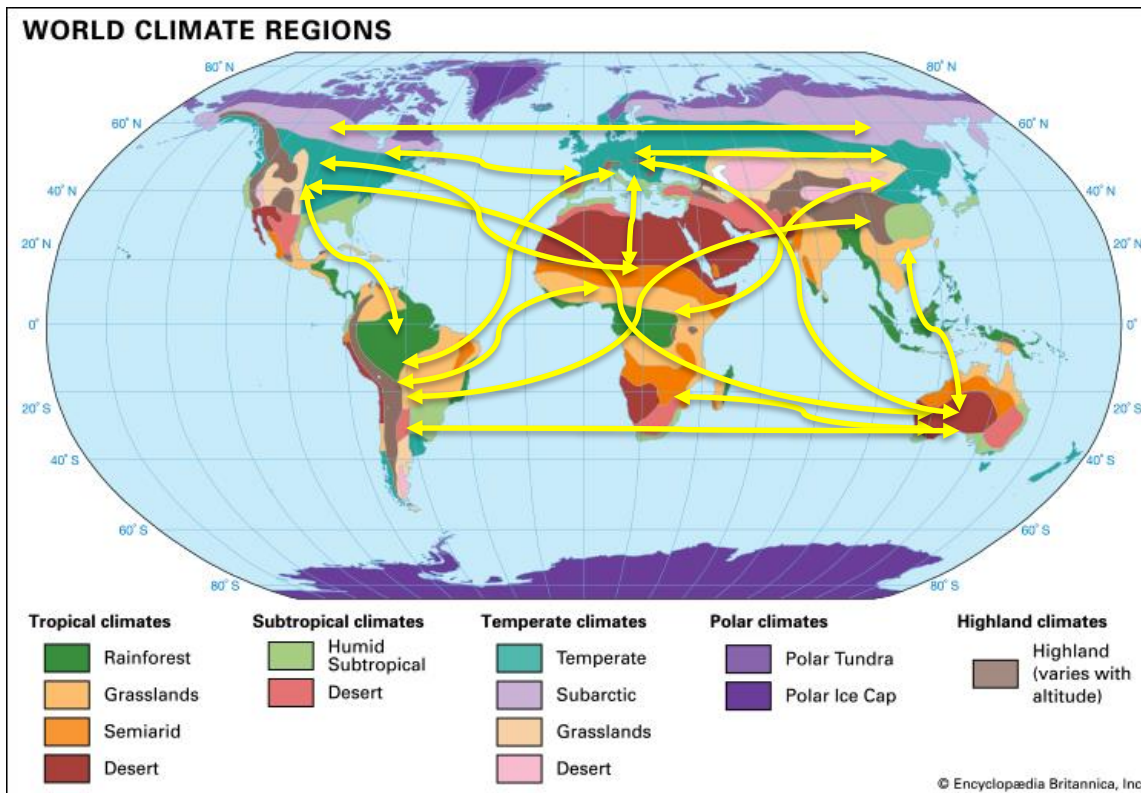
# Prevention of invasion

Invasive species are difficult to eradicate when established – **preventing the entry** the most effective strategy for managing biological invasions

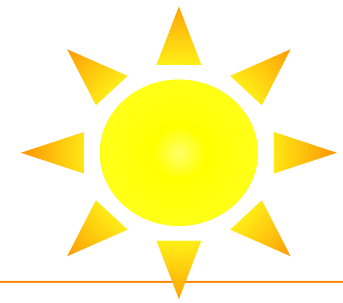
Prevention of introduction: global, regional, and national **phytosanitary measures** and **certificates** (e.g. plant passports)

Early detection / monitoring (by authorities): **surveillance** in potential entry points (e.g. harbors, timber storage, wood material import sites) and channels (e.g. plant nurseries)

Current monitoring and surveillance is not enough: **new methods and systems** and **cooperation** of authorities and the public are needed



# Climate change



- Human activity (CO<sub>2</sub> and other emissions) since 20<sup>th</sup> century has resulted the global temperature rise: the Earth's average annual temperature has increased in terrestrial (by ~ 1°C) and marine (by ~0,7°C) environments = **Climate change**
  - increased evaporation → storm-affected areas with increased precipitation and flooding, drying areas with increased risk of drought
  - glacier retreat, ice sheet shrinking, acidification of seas, decreased snow cover, etc.
  - global changes in environment and biodiversity

# Climate change and invasive pests

- Climate change can increase, decrease or has no effect on the invasive pest competities
- **Climate is critical especially for establishment and spreading** of invasive species: if no arrival (introduction) then no establishment and spreading even climate is favorable
- Pest range expansion  $\neq$  pest damage
  - Predictively climate change shifts agroclimatic zones (host availability) and phenological events of hosts and pests (phenological synchrony between the host and the pest is needed)
- Climate change and biological invasion interlink – regional and local differences

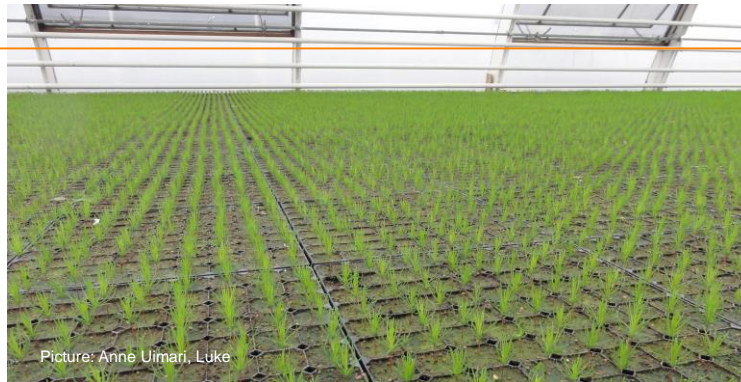


# Climate change and invasive pests

- Climate change can act synergistically with phenomena involved in species invasion
- Impact of climate change on invasive pest species
  - increased winter survival, spring revival and generation number
  - accelerated life-cycle
  - expanded host species range (genetic changes affecting pest virulence and host resistance / susceptibility)
  - range shifts (expansion, reduction) of species and environmental factors interacting with invasive species (vectors, carriers, pests, etc.)

# Plant production and invasive pests under changing climate

- Agriculture and forestry invasive pests (pathogens and insects) with economic and biodiversity impact are predicted to be most responsive to climate change
- Invasive insects and pathogens could be a multi-billion-dollar threat to global agriculture
- Invasive species acting as tree pests are a major threat to forests and nurseries worldwide
- **Insects** may be the group of invasive pests mostly benefiting from climate change



Picture: Anne Uimari, Luke

# Plant production and invasive pests under changing climate

- Extent of the risks and putative damage often difficult to predict in the new environment (climate modeling and risk assessments)
- Harmful organisms can be unknown prior establishment
  - organisms are harmless in their native region
  - plants having not evolved alongside introduced species have built up no natural resistance
  - no natural “enemies” present to control population sizes
  - organisms can expand host species range in the new environment



Picture: Anne Uimari, Luke



Picture: Anne Uimari, Luke

*Phytophthora* species are famous of their multi-host nature

# Invasive pest species in plant production

- In plant production environment:
  - Pathways for introduction and spreading include seeds, plant material, human, air (dispersal from close environment), irrigation systems, machinery and equipment, etc.
  - Invasive pests cause yield losses, plant death, infrastructure and production environment destruction (long lasting contaminations), etc.
  - Protection against pests and diseases is needed
    - chemical intervention, biological pest control, barrier methods, production methods and techniques



Picture: Anne Uimari, Luke

# Climate change and invasive pest species complicate plant protection

- New pests may be resistant against used plant protection products (PPP)
  - The range of PPPs is limited, new products and methods develop slowly
  - Climate change increases the impact of existing pests:
    - additional use of pesticides and fungicides → resistance development
    - deployment of new crop species and cultivars → host species expansion
    - modification of growing and production systems (e.g. increased irrigation) → improved conditions for invasion
- **adaption of plant production to a changing climate may alter impacts of all pests in unexpected ways**

# Conclusions

- Global temperature rise induces multiple changes in environment and biodiversity
- Agriculture and forestry invasive pests are predicted to be most responsive to climate change
- Climate is critical especially for establishment and spreading of invasive species by affecting many pest- and/or host-associated factors and phenomena
- Plant production and plant protection against all pests is complicated by the effects of climate change



Thank you!

