integrated management of forest pests addressing climate trends

FINAL CONFERENCE
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ABSTRACT of Presentations:

TITLE: International trade and climate change: the 'perfect storm' for new pest outbreaks.

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The recent spate of new pest and pathogen outbreaks in the UK and Ireland has heightened awareness of the threats posed to our woodlands by invasive organisms. Although this appears to be a relatively new phenomenon, our two island countries have been subject to pest invasions for millennia, occasionally with devastating consequences such as the virtual wiping out of elm trees because of the aggressive strain of Dutch elm disease. However, it is an unfortunate fact that a combination of vastly increased trade and the ongoing influences of climate change have created the 'perfect storm' for pests to move globally and to find suitable conditions for establishment after they arrive.

Trends in global trade indicate that there has been a 7000 fold increase since 1950, which represents an annual rate of increase of around 6% for all traded goods. Wood is often associated with these goods, even if the final product does not contain wood; pests and pathogens can often be present in and on such packaging wood and there are now strict regulations to reduce this risk. Unfortunately, the increased ability to trade has also opened the door to global movement of live plants for planting that are shipped in large quantities and very quickly, such that pests can move to new locations complete with a suitable host tree on which to live and breed. To make matters worse, these plants are often in pots with associated soil; both the plant and the soil can carry damaging organisms, many of which will not be on our lists of regulated pests.

Recent examples of concern include Asian longhorn beetle, *Anoplophora glabripennis* from SE Asia and, fortunately not yet recorded in Ireland or Wales, emerald ash borer, *Agrilus planipennis* also from SE Asia. These and other pests will be described, along with an indication of the best ways to keep our countries free of pests, both known and unknown. The team from the EU Interreg IVA project IMPACT (part funded by the ERDF Ireland-Wales programme) has been working to both assess risks and to develop potential solutions, based around biological control, for those pests that have established in Ireland and Wales or which have the potential to increase in severity with climate change. Managing 'pathways' that enable pests to move internationally is not easy, but a raised awareness by the end users of traded goods is part of the solution, both in realising that products can carry pests and also in asking where those products have come from and are they pest free?

TITLE: Using a Regional Climate Model to Assess Where and When Forest Pest Problems Intensify.

PRESENTER(s): John Sweeney + Rodney Teck, ICARUS

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Forests have a commercial lifespan which renders them vulnerable to climate change to a degree not relevant to annual crops. In particular, native pests such as the pine weevil and aphids may be rendered more viable with projected changes in temperature and precipitation. Other pests currently expanding northwards and westwards, some not currently in Ireland, such as the Horse Chestnut Leaf Miner, the Great Spruce Bark Beetle and the Oak Processionary Moth, may threaten forest productivity in future years. Many of these pests have defined thresholds for various development stages such as dormancy, egg laying, flight etc.

Output from the coupled climate model EC-Earth for the medium-high Representative Concentration Pathway of 8.5 W/m^2 was used to drive a Regional Climate Model (WRF) at a resolution of 10km^2 for a domain encompassing Britain and Ireland. The output from this RCM was tailored to known thresholds to provide preliminary estimates of where and when climate-change related threats to British and Irish forests are likely to emerge. Probable new areas of vulnerability due to intensification of existing pest problems or the spread of newly viable incomers were identified. Extension of vulnerability due to increased flight potential was particularly evident, with some pest species encroaching on northern and upland areas of Britain and Ireland where they are currently limited by existing climate conditions.

TITLE: Climate change impacts and adaptive strategies for Irish Forestry: a focus on pests and diseases

PRESENTER: Kevin Black

Keywords: Climate change, impacts, adaptation, pests and diseases

Forecasted changes in Ireland's climate will have a significant influence on the productivity of managed forests and woodlands. Given the long-term returnon investment following forest establishment and replanting, 'climate proofing' suitable provenances or genotypes is essential to ensure economic viability and sustainable forest resourceutilisation in the future. Aweb-based ecological site classification framework (CLIMADAPT) has been developed to describe species responses to climatic drivers in an effort to develop adaptive strategies. This decision support system (DSS) can potentially form the basis for assessing pest and disease impacts under future climate change. However, the development of robust adaptive tools requires good empirical data. The biology of the pest/disease-plant relationship and their combined interaction with site and climatic factors is still poorly understood. It is argued, therefore, that it may be difficult to develop a robust DSS and adaptive strategies unless the impact of climate change on forest ecosystems is better characterised. This paper focuses on some current pest and disease problems, such as green spruce aphid, fomes and pine weevil, with an emphasis on potential climate change impacts and adaptive measures using the CLIMADAPT and other forest management DSS frameworks. Examples of how climatic and practical management related factors may influence the severity and occurrence of pest and disease outbreaks are discussed.

TITLE: The work of the Ireland-Wales programme

Presenter: Simon Baily
Head of Unit, Ireland Wales Programme

Brief introduction to the Ireland Wales Programme and its work. The Programme grant aids 41 joint development projects between Ireland and Wales and this includes the IMPACT project. He will outline the context in which IMPACT operates, the Programme's achievements and give a short number of examples of other projects which the Programme funds.

TITLE: Improving biological control of the large pine weevil *Hylobius abietis*.

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IMPACT field trials in Wales carried out by Forest Research and Swansea University have focused on improving biological control of the large pine weevil *Hylobius abietis* using entomopathogenic nematodes and fungus. *H.abietis* is still the most damaging insect pest of commercial forestry in Europe, in economic terms.

Sites in Cwm Berwyn plantation in Tywi forest, an upland area known to have high populations of *H.abietis*, were chosen for the trials - These had previously been planted with Sitka spruce *Picea sitchensis* and had been clear-felled around 18 months prior to treatment. The existing biological control system used by Forestry Commission Wales (FCW), now part of Natural Resources Wales, targets the late larval and pupal stages of the pest using nematodes applied directly to the stumps in water suspension.

FCW treated the felling coupes containing the trial sites with nematodes following preliminary assessment. IMPACT trials were laid out within the area treated by FCW, with experimental treatments being applied by the IMPACT team prior to FCW operations.

Three commercially available biological control agents were trialled at Cwm Berwyn – the nematode species *Heterorhabditis bacteriophora* and *Steinernema carpocapsae* and the fungus *Metarhizium anisopliae*. Lower and higher doses of each agent, as well as lower doses of nematodes and fungus in combination, were applied to treatment stumps in June each year.

Half of the stumps in each treatment plot were assessed 4 weeks after the application of treatments, by removing the bark and checking for live and dead larvae and pupae of *H. abietis*. The remaining stumps in each plot were enclosed in emergence traps, which were checked at fortnightly intervals for emergent adult *H. abietis* surviving the treatments from August through to November. Once emergence ceased the traps were removed and stumps checked for any remaining larvae or pupae.

Analysis of the results confirms that all treatments were effective in 2011 and 2012, significantly reducing the numbers of live *H. abietis* in and emerging from stumps in comparison with an untreated control. Early indications that combined treatments of nematodes and fungus together were the most effective were not borne out in

subsequent analyses, but fungal and nematode treatments applied individually appeared to be equally effective. In 2012, the fungal treatments were significantly less effective than nematodes in the first few weeks after application, but achieved significant reductions in the numbers of adults emerging over time.

H. abietis numbers per stump were higher in 2012 than in 2011. These larger numbers improved statistical confidence in the results, and helped identify differences between treatments more clearly. Nematode treatments were significantly more effective than fungal treatments in 2012, with rates of kill greater than 90% in some cases, although fungal treatments were still effective in reducing adult emergence.

This may possibly be due to the higher host numbers, and therefore increased numbers of galleries and movement opportunities for the nematodes, although their movement would also have been assisted by the heavier rainfall that year leading to much wetter soil conditions. By contrast, the colder spring/early summer in 2012 appears to have slowed the action of the fungus.

There was little or no apparent benefit from applying the higher doses of these agents, suggesting that the current operational dose of nematodes might be reduced if biological control with fungus or nematodes or a combination of the two could be targeted more precisely. Future work is likely to focus on large-scale operational trials of reduced doses of nematodes, further investigation of fungal and combined treatments and improved monitoring of *H.abietis* to inform targeted integrated pest management.

TITLE: Environmental safety of biological pest control in a forest ecosystem

Presenter: Christine Griffin

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The large pine weevil *Hylobius abietis* is the most serious pest of reforestation in northern Europe. Weevils develop under the bark of stumps of recently felled conifers. When adult weevils emerge they feed on the bark of newly planted trees; 100% mortality of unprotected trees is not uncommon. The strategy of targetting pine weevil larvae and pupae within the stumps has potential to reduce weevil populations, and entomopathogenic (insect-killing) nematodes have been used for this purpose in Ireland and Britain. Entomopathogenic nematodes (*Heterorhabditis* and *Steinernema*) occur naturally in soil worldwide, but for pest control purposes they are mass produced and applied in large numbers ("inundatively") directly into the habitat of the pest where they are expected to knock down the pest population and

then die out. For pine weevil suppression, nematode infective juveniles are applied in aqueous suspension around each stump on a clear-fell site. They move through the soil and under the bark of the stumps, where they locate and kill the developing weevils. While entomopathogenic nematodes are generally regarded as safe, we investigated persistence and spread of nematodes applied against pine weevil, and their effects on non-target insects. No adverse effects of nematodes on numbers, diversity or community composition of non-target beetles, either wood-associated or not, were detected by comparing catches from nematode-treated and untreated stumps. Special attention was paid to two beneficial insects that occur on clear-fell sites: a longhorn beetle *Rhagium bifasciatum*, which is important in wood decomposition, and a natural enemy of pine weevils, the parasitic wasp *Bracon hylobii*. Although both are susceptible to nematodes, they escape attack by spatial and/or temporal separation from the nematodes, and impacts on populations of either insect are not expected. Intensive soil sampling indicates that nematodes do not travel far from where they were applied, and do not persist once developing pine weevils are no longer present on site. We conclude that the use of entomopathogenic nematodes against pine weevil is an environmentally sound strategy.

TITLE: Long term forest health monitoring; an Irish and European perspective.

PRESENTER: Pat Neville, Coillte.

Forest monitoring and forest health monitoring has been ongoing in Ireland for decades and across Europe for centuries. Traditional forest monitoring systems have been rigid in design; with many other monitoring systems being designed to suit a specific monitoring need, e.g. monitoring of a given pest or disease. Forest monitoring has been and remains ongoing in Ireland but visibility of this community and its outputs is often low. More recently traditional forest monitoring approaches are being challenged by new citizen science initiatives, based on emerging technologies such as smart phones and building greater public engagement into these processes. Greater synergies could exist between traditional and contemporary forest monitoring approaches.

TITLE: Classical biological control of eucalyptus pests

PRESENTER: Jan-Robert Baars
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Prominent recent introductions of new forestry pests highlight the threat posed by the day to day activities of people and movement of goods in various sectors. Concerted efforts are required to address the economic and environmental threat of forestry pests that have yet to arrive (pre-border) and have established (post-border). New arrivals need to be pre-empted, introductions need to be detected early and novel control techniques should be considered if the threat is to be managed. *Eucalyptus* forestry has often enjoyed the benefits that the genus has no taxonomically related plant species present in countries where it has been introduced and few native organisms therefore feed on these. However, the frequent movement of goods, sometimes unrelated to the industry, has led to a consistent increase in the number of insects recruiting to *Eucalyptus* growing regions in the world. Mainland Europe and Ireland are no exceptions as many new species have been introduced and few are likely to cause significant economic losses. *Eucalyptus* is grown in Ireland to supply cut-foliage but also shows considerable promise as short rotation forestry. The application of insecticides is uneconomical but classical biological control has shown good promise as a solution to insect pests in forestry. The past and present biological control programmes on *Eucalyptus* are discussed, illustrating the progress on an egg parasitoid of the leaf beetle pest *Paropsisterna selmani* (Col.: Chrysomelidae). This leaf beetle has been shown to be expanding its distribution in Ireland and is a good short and long distance disperser posing a risk of spread to UK and mainland Europe.