Forest Research

The practical issues facing management of British forests in the face of threats posed by pests, diseases and climate change-the role of forest genetic resources.

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Our forest genetic resources

Our forest genetic resources occur in different types of forests which fall between two extremes

1. Ancient natural and semi-natural woodlands
   - Major objective is conservation
   - Native species
2. Plantation forestry
   - Major objective timber production
   - Often exotic conifers

There are various intermediate forests

- Objectives are for multi-purpose forestry

- Also urban trees

Uncertainty

- Major challenges facing the policy maker and forest manager today is **uncertainty** due to:
  - **Climate change** -unidirectional over quite a long period so there may be time to adapt.
  - **Introduced pests and diseases** -no co-evolution so likely to hit harder and quicker, may be no time to adapt.
  - **Interaction** between climate change and pests and diseases.
    - Increased abiotic stress e.g. drought may make host more susceptible to disease.
    - Altered phenology of host change synchrony with current pest and diseases.
    - Altered distribution of potential host species may provide new hosts for existing/new diseases.
    - Conditions under climate change are likely to become more suitable to existing pests and pathogens.

Exotic pests and diseases - should we be worried?

Numerous examples where introduced pathogens have led to mass destruction of tree species in other countries

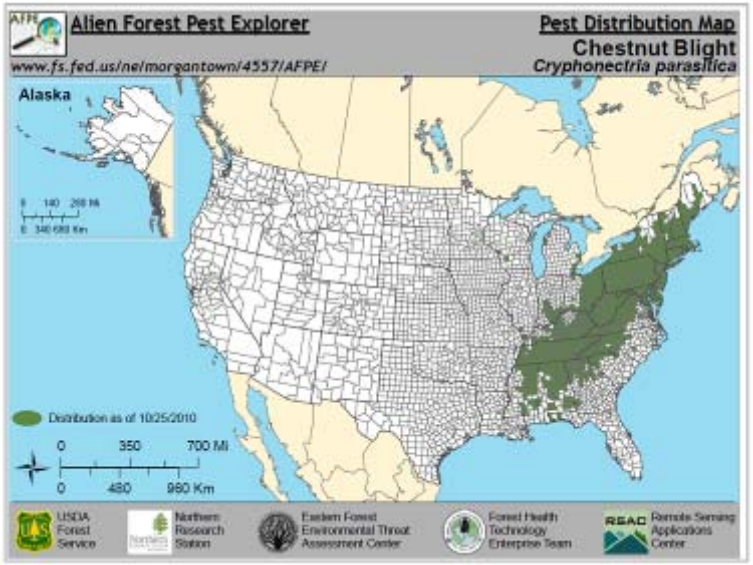
e.g.

Introduced **Chestnut Blight** largely destroyed all American chestnuts in the USA.

Introduced **White Pine Blister Rust** destroyed huge areas of white pine in the USA.

So we are right to be worried!

Good that the government has finally realised the threat posed by novel tree pests and diseases.



Practical considerations

What practical problems do these challenges present and can anything be done to deal with them?

1. Preventing importation of novel pests and pathogens

- Exotic pests and pathogens either arrive naturally e.g. natural dispersal of spores or are imported via human mediated activities.
- Without valid reasons cannot prevent free trade within Europe but can ban importation if there is a tree health hazard e.g GB finally banned importation of ash on the basis that GB did not have *Chalara* in Oct 2012
- Banning import of one species can lead to increased demand for another species and shortages of planting stock. May increase importation from abroad e.g. sycamore to replace ash planting stock.
- Millions of containers arrive at British ports and estimated that fewer than 1% are inspected by FC or FERA tree health inspectors. Impossible to prevent entry of all potential pests and diseases.
- Despite heightened awareness and vigilance forests (e.g for invasions unlikely to prevent spread of all exotic pests and pathogens

Role for Forest Genetic Resources

- If we can't prevent import of exotic pests and pathogens and the equilibrium between co-evolved native pests and pathogens is changing due to climate change what can we do?

- Forest Genetic Resources may offer a solution.

What do we know about our native British forests in terms of diversity?

The species in our native British forests

- Contain large amounts of adaptive variation, the raw material for evolution and adaptation to novel challenges.
- Exhibit local adaptation to current site conditions via the process of natural selection over many generations.
- Experience long distance geneflow (up to 100km away) which increases the adaptive potential of populations.
- Natural selection acts to fit a population to its local conditions whereas geneflow tends to counteract this process by homogenising diversity across sites by introducing genetic material adapted to very different site conditions.
- It is important not to view our native populations as static entities. We need to appreciate that they are dynamic populations whose composition both in terms of species and intra-specific diversity can evolve. We need to encourage this evolution if conditions are changing.
- Although we know that our populations show differences in adaptive variation e.g. phenology, cold hardiness we don't know if they also show differences in susceptibilities to novel pests and diseases.

Management of Forest Genetic Resources

So how should we be managing our British forests?

Native forests of high conservation value

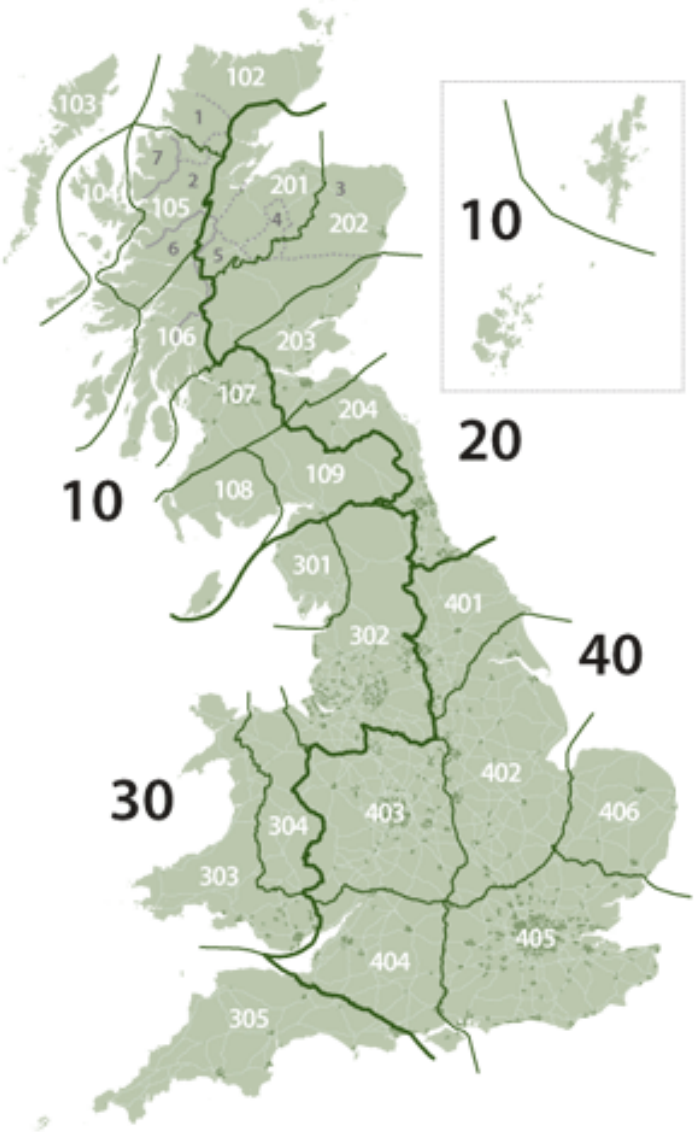
For our ancient semi-natural forests e.g. Scots pine remnants, montane willows, Atlantic oakwoods, Atlantic hazelwoods where conservation is the main objective we should:

- practice minimum intervention
- but manage to promote continued dynamic evolution by
  - encouraging natural regeneration by creation of gaps.
  - control of herbivores for regular cohorts of regeneration to be made available for natural selection to operate on under climate change.

Policy for planting stock of native species prior to climate change concerns

Prior to concerns re-climate change FC advice for native species was

- to source planting stock locally.
- planting guidance divided the country into 4 Regions of Provenance and 24 seed zones with advice to source material from at least within the same Region of Provenance.



Resources for testing local adaptation

- To explore scale and extent of local adaptation FR established provenance trials for ash and rowan based on 2 populations per seed zone at several sites across GB
- Could also provide a useful resource to examine the distribution of resistance to novel pests and diseases in our British provenances. Require regular monitoring for signs of pest or disease.
- Trials may show that some provenances may show more resistance to particular exotic pests and diseases than others.

Different strategies for the three countries

- Since this advice was issued the three GB countries have become more autonomous and anxieties regarding climate change have increased.
- Three GB countries have diverged in sourcing advice for our native species.
- This is rather counter to the EU approach which stresses the need for a collaborative, standardised international approaches to the conservation of Forest Genetic Resources.

England Recommendation

- use of planting stock with an origin up to 2^{o} latitude south of the site and up to 5^{o} south as a small component of mixed provenance stock in species of low frost sensitivity. This could mean material is brought in from Central France.

Wales Recommendation

- continuous cover strategy -plantations of native species should be managed:
  - to promote their regeneration via more stand thinning
  - to convert even aged stands to mixed age
  - to create more mixtures of broadleaves and conifers

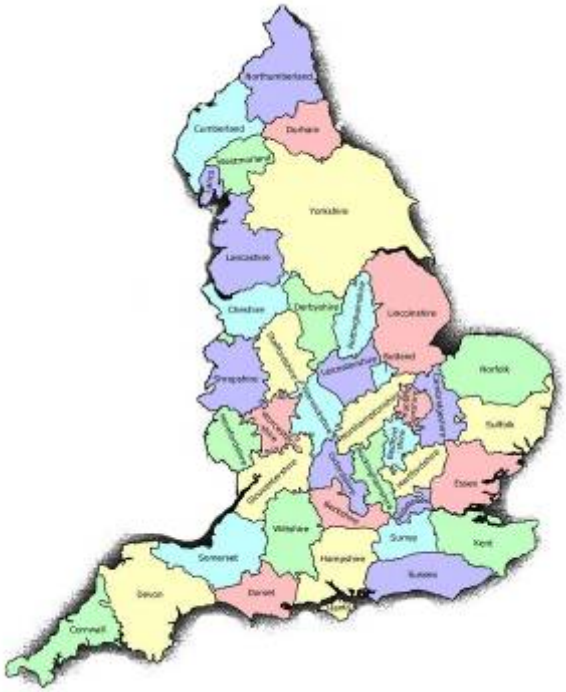
Scotland Recommendation

- Continue to use locally sourced planting material

What are the likely consequences of these different strategies?

England-

- Climate change is likely to be most severe here.
- Recommend use of more southerly provenances.
- Implicit belief that there is insufficient adaptive potential for populations to evolve and cope with climate change. This may not be true in view of high diversity within species and long distance geneflow.
- Risk of future climate matched provenances being maladapted to current British conditions. The greatest selection pressure acts at the seedling/sapling stage. This could lead to loss of planted material and also to greater susceptibility of young trees to existing/novel pests and diseases if they are already stressed.
- The planting stock will not have co-evolved with the local races of pathogens and may therefore be more at risk than the local material.
- Greater risk of introduction of pests and diseases if planting stock is sourced from abroad.



Wales

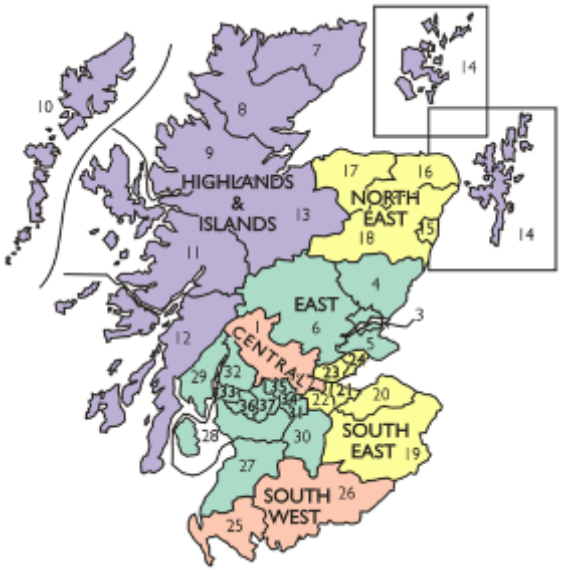
Wales

- Less severe effects of climate change predicted.
- Assumption that existing populations have sufficient genetic diversity to evolve and adapt to climate change.
- Likely to show reasonable tolerance to existing pests/pathogens via co-evolution.
- Mixed age populations will provide consistent supply of young material which via natural selection will be adapte to current conditions. There will be a gradual process of genetic adaptation to warmer, wetter climates.
- Mixed species populations will reduce the proximity of conspecific individuals may lower the disease innoculum around susceptible trees and pests may be more reluctant to move through non-host species.
- Need to consider if the natural changes in the species composition are acceptable or whether we want to maintain the current species composition to support the existing ecosystem. It may require active management to maintain things as they are-do we want to?

Scotland

Scotland

- Predicted to experience least severe effects of climate change
- Recommendation to use locally sourced material but problems of timely supply of nursery stock of the correct provenance has been a consistent problem. Fallback position should not be to use planting material from abroad.
- However, greater efforts to source local seed with the appointment of seed liaison officers tasked to
  - Identify good seed sources
  - Communicate with suppliers and planters
  - Monitor populations for good mast years
  - Advise on good management for seed production
  - Work with partners to collect seed
  - Also, longer term planning is being implemented to provide nurseries with clearer idea of future requirements.



Production conifer forests

The majority of our conifer timber production plantations are based on Sitka spruce.

The aim is to produce construction grade timber.

Sawmills much prefer a consistent product.

All the material currently planted is raised in GB much of which is the product of the breeding programme.

Sitka has been in Britain for such a long time that a British landrace has probably developed

Uniformity and quality of product

Yield and Uniformity

- Reduction in genetic diversity of improved material is accompanied by increase in yield and uniformity.

- We are on the threshold when technologies such as somatic embryogenesis and cryopreservation can make clonal forestry practically possible. Are we ready to reduce the genetic diversity of our forests at a time when diversity for adaptation to change is required? Balance between risk and improved product.

- We have to comply with sustainability guidelines that demand a minimal levels of acceptable diversity.

Number of clones	Percentage improvement over unimproved material		
	Diameter	Straight ness	Wood Density
Top 1	37	45	27
Top 10	31	37	23
Top 20	29	34	20
Top 50	26	30	17
Top 100	24	25	13

Monocultures

- Restricted or single clone plantations are accepted in poplar where ongoing breeding programmes provide clones that exhibit short term resistance. Recognised that breeding of new clones needs to keep pace with development of new races of pathogen. Should we consider such an approach for Sitka spruce?

- Good to use entirely home grown planting stock of Sitka as this reduces the risk of importation of new pests and diseases and allows continued co-evolution of landrace of Sitka adapted to GB pests and diseases.

Broader range of timber trees

- Concerns that **current range of plantation timber species is too narrow** and many are succumbing to new diseases.

However, there are risks attached to increasing the range of species.

- Host and its pathogens will encounter a different climate when translocated which may favour the pathogen e.g. *Dothostroma pini* on *Pinus radiata* in New Zealand where the wetter conditions of NZ favoured the pathogen. Much worse disease than at original location.
- New host species may be particularly susceptible to British pests and diseases as they will not have co-evolved e.g. native pine beauty moth exists in small numbers in native Scots pine stands but became a bad pest of introduced lodgepole pine plantations in the north of Scotland. A similar example in Sweden is the damage caused by *Gremmeniella*, a native pathogen on Scots pine, on introduced lodgepole pine.
- Pathogen introduced on new host species may find a highly susceptible host in one of our native tree species. Particular care needed in growing introduced species near our high conservation value forests.

Urban trees

These may be particularly vulnerable to new pests and diseases because

- their urban settings are close to ports
- often consist of a single clone i.e. little or no diversity e.g. poplars and elms. Widely planted Manchester poplar clone is very susceptible to new poplar scab disease.
- introduced pests e.g. oak processionary moth can pose a health hazard not only to trees but also to humans. The hairs on the caterpillar of this moth can be irritant and cause asthma in humans-so social implications.

- These trees are part of the British Forest Genetic Resource and need to be included in policy recommendations-e.g.
  - included when considering geneflow in the landscape,
  - can be the first to be infected by new pests e.g. oak processionary moth has now spread beyond the London parks where it was introduced on ornamental oak trees introduced from Holland westwards into Berkshire.

Lombardy poplars are a single clone

Questions

Our forests face a unpredictable future and careful consideration needs to be given to consequences of our management actions.

Challenging questions

- How can we improve port security and vigilance to prevent entry and spread of exotic pests and diseases?
- Should we aim at a pan-GB and pan-European approach to the conservation of forest genetic resources?
- For our native species, what are we trying to conserve-the resource itself or its ability to evolve to future challenges?
- How can we assess if we have sufficient diversity to cope with future challenges? Would provenance trials provide a means of doing this?
- Should we adopt clonal forestry?
- Are we correct to worry about the range of timber species and have we assessed the risks of introducing more?
- Forest genetic resources exist in many forms (native, exotic species plantations, urban trees) -how do we integrate policy for all these?