Developing a model for standardised pest and disease risk assessment of UK forests

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NERC PURE Projects

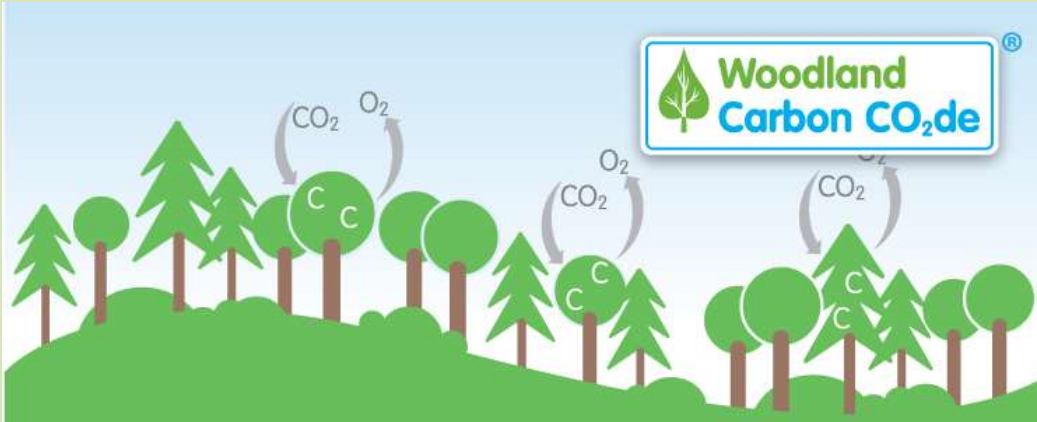
- PURE (Probability, Uncertainty and Risk in the Environment)
- New Knowledge Exchange Network funded by NERC relating to natural hazards.

- Focus of today: output of a 6 month pilot project (NERC/PA 13-021): to develop a replicable methodology and associated model to assess the pest and disease risk to UK forests: using a case study of the UK's Woodland Carbon Code. Completed in May 2014

- Received 18 months further funding (starting today!)
- Project Partners: Edinburgh University, Forestry Commission, Forest Research, ForestRe.

Woodland Carbon Code

- The standard for woodland carbon projects in the UK. Launched 2011
- Aims include:
  - Increasing private investment in woodland creation
  - Ensuring woodland is managed to a high standard
  - Ensuring carbon sequestration is robustly audited and verified
- UK quoted companies can purchase carbon units against gross emissions – voluntary reporting not for compliance obligations
- As of September 2014: 89 validated woodland projects, covering 3,200 HA, projected to sequester 1.5m tonnes of CO_2



Project Buffers

- Not all sequestered carbon sold as carbon credits
- Provisions to ensure permanence
- Each project sets aside a certain amount of credits into a pooled buffer against loss

- Must assess risk in each of the following categories
  - Legal/Social 1-2%
  - Project Management 1-3%
  - Finance 2-5%
  - Natural disturbance – Fire 2-4%
  - Natural disturbance – Weather 3-6%
  - Natural disturbance – Pest & Disease 3-10%
  - Direct climate change effects 3-10%

  SUM: Range 15-40%

- **Key question: is 3-10% an adequate buffer against pest and disease losses for WCC projects which last for up to 100 years?**

The problem

- Historical data/experience usually used to assess P&D risk (especially under carbon standard methodologies)
- HOWEVER – P&D risk often new entrants and expansion of existing ranges etc
- Pest Risk Assessments focus on individual pests
- Existing approaches focus on management i.e. control, response
- Tend to estimate average/expected loss not worst-case/catastrophic

Approach taken

- Identify all tree species constituting over 2% of the current WCC portfolio
- Identify key P&D threats to each tree species – expert interviews/literature review
- Identify key metrics for risk assessment and populate them for a sample
- Develop a scenario tool to determine the worst case loss factor - function of year of arrival, rate of spread, replanting etc.
- Determined individual risk factors for each P&D for each tree species:
  - % likelihood of arrival and establishment/expansion x worst case loss factor
- Develop model to sum these risk factors for each individual tree species
- Apply to Woodland Carbon Code projects (weighted by species)

Model

>200 P&D identified..

Pest/Disease			
LATIN name	COMMON name(s)	Type	Present in UK?
Acleris gloverana	Western black-headed budworm	Insect	N
Acleris variana	Black headed budworm, Eastern	Insect	N
Agrilus anxius	Bronze Birch Borer	Insect	N
Agrilus planipennis	Emerald Ash borer	Insect	N
Aleuroclava psidii		Insect	N
Anisogramma anomala	Blight of Hazel, Eastern filbert bli	Fungus	N
Anisogramma virgultorum		Fungus	Y
Anoplophora chinensis	Citrus longhorn beetle Black and	Insect	N
Anoplophora glabripennis	Asian Longhorn Beetle Starry Sky	Insect	N
Anthonomus quadrigibbus	Apple curculio	Insect	N
Apriona germarii	Mulberry longhorn beetle	Insect	N
Apriona japonica	Japanese mulberry longhorn bee	Insect	N
Arceuthobium americanum	Lodgepole pine dwarf mistletoe	Plant	N
Arceuthobium campylopodum	Western dwarf mistletoe	Plant	N
Arceuthobium douglasii	Douglas fir dwarf mistletoe	Plant	N
Arceuthobium laricis	Larch dwarf mistletoe	Plant	N
Arceuthobium occidentale	Digger pine dwarf mistletoe	Plant	N
Arceuthobium pusillum	Eastern dwarf mistletoe	Plant	N
Arceuthobium tsugense	Hemlock dwarf mistletoe	Plant	N
Armillaria mellea	Honey Fungus, Root Rot	Fungus	Y
Armillaria ostoyae	Dark honey Fungus, Root Rot	Fungus	Y
Arrhenodes minutus	Oak timberworm	Insect	N
Atropellis pinicola	Branch canker of pine, Trunk can	Fungus	N
Atropellis piniphila	Branch/Trunk pine canker, Twig b	Fungus	N
Botryosphaeria laricina	Shoot blight of Larch, Twig die-ba	Fungus	N
Bupalus piniarius	Pine Looper Moth	Insect	Y
Bursaphelenchus xylophilus	Pine wood nematode, Pine wilt d	Nematode	N

CRITERIA FOR EACH PEST/DISEASE

- Latin name
- Common name
- Type (e.g. Fungus, Insect etc)
- % Likelihood of entry & establishment
- Age affected
- Range:
- *Current range in UK*
- *Possible range in 100yrs if arrived today*
- *Years to 100% (if<100)*
- % Mortality (by species)
- % Loss Factor (by species)
- % Risk Factor (by species)

Scenario tool

Carbon Model	SAB
Thin/No thin	No thin
Loss %	10.0%
Years to 100	60
Minimum age	N
Maximum age	N
Years to mortality	N

		RESULTS:	ARRIVES YEAR:				
Carbon Lookup:	*Replant (SAB):*	YEAR	0	5	10	15	20
2.60	*2.60*	5	2.58	2.60	2.60	2.60	2.60
11.77	*11.77*	10	11.60	11.67	11.77	11.77	11.77
42.95	*42.95*	15	42.00	42.26	42.59	42.95	42.95
133.27	*133.27*	20	129.31	130.06	131.07	132.16	133.2
241.22	*241.22*	25	232.76	233.66	235.31	237.22	239.2
319.31	*319.31*	30	306.94	307.59	309.14	311.45	314.0
376.07	*376.07*	35	360.39	360.86	361.99	364.01	366.7
421.63	*421.63*	40	402.91	403.29	404.15	405.65	408.0
460.48	*460.48*	45	438.85	439.17	439.88	441.05	442.8
504.95	*504.95*	50	479.62	479.99	480.68	481.75	483.3
526.61	*526.61*	55	499.29	499.47	500.02	500.90	502.1
541.25	*541.25*	60	512.47	512.59	512.89	513.56	514.5
553.64	*553.64*	65	528.13	523.62	523.84	524.25	525.0
559.82	*559.82*	70	538.28	533.69	529.18	529.46	529.9
566.91	*566.91*	75	549.23	544.66	540.07	535.56	535.9
574.12	*574.12*	80	560.08	555.72	551.15	546.56	542.0
579.86	*579.86*	85	568.92	565.25	560.88	556.32	551.7
585.51	*585.51*	90	576.83	574.01	570.34	565.97	561.4
604.30	*604.30*	95	595.96	593.74	590.92	587.25	582.8
606.14	*606.14*	100	599.52	597.62	595.40	592.58	588.9
		MAX LOSS:	570.867	5.82%			

Species level risk factor..

BIRCH	*BETULA*		Risk factor	Cumulative remainder
Bronze Birch Borer	*Agrilus anxius*	*BETULA*	*3.57%*	96.43%
	Anisogramma virgultorum	*BETULA*	*0.34%*	96.10%
Citrus longhorn beetle (Black and	*Anoplophora chinensis*	*BETULA*	*2.33%*	93.86%
Asian Longhorn Beetle (Starry Sky	*Anoplophora glabripennis*	*BETULA*	*2.91%*	91.13%
Honey Fungus, Root Rot	*Armillaria mellea*		*0.29%*	90.87%

Sample outputs

- Using current WCC portfolio and a sample of P&D (just under 25%)
- *NB: preliminary sample outputs for illustration ONLY.*
- *Worst case loss: Assumes high likelihood of arrival: 1 in 20yr to 1 in 100yr and conceptually … 99% sure losses will not be worse than this..*
- *i.e. NOT a forecast*

INITIAL RESULTS (23% P&D categorised) *Latin Name*	English Name	*Risk Factor*	WCC species breakdown	*Weighted risk factors*
ACER pseudoplatanus	SYCAMORE	*5.2%*	3.42%	*0.2%*
ALNUS	ALDER	*5.2%*	3.87%	*0.2%*
BETULA	BIRCH	*9.2%*	26.89%	*2.5%*
CORYLUS	HAZEL	*5.2%*	2.39%	*0.1%*
FRAXINUS	ASH	*90.1%*	8.53%	*7.7%*
PICEA sitchensis	*SITKA SPRUCE*	*4.7%*	*5.40%*	*0.3%*
PINUS sylvestris	*SCOTS PINE*	*1.8%*	*10.86%*	*0.2%*
PRUNUS avium ssp./var. avium	*WILD CHERRY*	*2.9%*	*2.00%*	*0.1%*
QUERCUS	*OAK*	*2.2%*	*15.89%*	*0.4%*
SALIX	*WILLOW*	*5.2%*	*3.09%*	*0.2%*
SORBUS	ROWAN	*2.9%*	4.19%	*0.1%*
TOTAL:			*86.52%*	*11.8%*

- NB: Skewed by Ash *chalara.* Also Birch a pioneer species (ratio may change)
- Early days ..10% upper boundary not unreasonable assuming will reduce Ash?

Initial findings

- Need different risk assessments for e.g. timber, carbon, health
- Risks for carbon are very different
  - Consider over longer timescales: 100 year project vs timber rotation e.g. 40 yrs
  - Quality of timber not an issue e.g. oak pinhole borer stains timber but not a major killer
  - Oak processionary moth – high focus due to human health risk – again not a killer
  - If trees removed some timber can be recovered but carbon credits cancelled
- "Best" scenario for carbon – kills whilst young! E.g. Large brown pine weevil – currently widespread across UK, assume (Sitka): 25% mortality, <8yrs - RF: 0.4%
- "Worst" scenario: fast spreading P&D, high mortality, arriving late e.g. Bronze Birch Borer – 15 yrs to cover UK, resistance unknown - 90% mortality? RF: 3.57%
- Risk dominated by a few key threats with potential to cause widespread devastation to a range of species e.g. Asian/Citrus Longhorn Beetles

Other benefits …

- Identified key information missing from Pest Risk Assessments for risk assessment! Especially: % likelihoods of arrival and establishment and % mortality / % yield reduction figures in PRAs.

  (NB: overwrite values as better information becomes available)
- Confirmed that key threats are P&D arriving later in the project duration – so inform decisions on early releases from the buffer
- Highlights advantages of greater species diversification within the portfolio
- Flexible tool to support /inform discussion on the WCC P&D risk buffer
- Potential to support other purposes – broader plant health analyses, economic evaluations, insurance etc

In conclusion..

- Represents a significant step forward in the ability to understand the future threats to UK forests from P&D. A first attempt to develop a model with the potential to reduce complexity and systematically quantify the future threat from all known P&D threats and to combine this information into an overall quantitative risk assessment that can be used to support management decisions and policy.

Next phase

- Aims:
  - Assess remaining pests and diseases
  - Embed the outputs into operational procedures for WCC
  - Expand to cover timber projects
  - Develop decisions support tools
  - Pilot the development of new insurance products.

  - **Why? Because “risk measurement is NOT risk management”**

Thank you!

- Thank you to ICF for the opportunity to present our work

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