Resilience of multiple ecosystem services and biodiversity in a temperate forest (UK)

Dr Elena Cantarello

Department of Life and Environmental Science, Bournemouth University
ecantarello@bournemouth.ac.uk
Dynamics and Thresholds of Ecosystem Services in Wooded Landscapes

Dynamics of ecosystem services in forest ecosystems is a two-year (2013-2015) research project funded by the UK Natural Environment Research Council under the BESS (Biodiversity and Ecosystem Services for Sustainability) research programme.

The project aims to identify the form of the quantitative relationships between biodiversity, ecosystem functions and services at the landscape scale, and to establish whether there are critical levels of biodiversity that are required in wooded landscapes for provision of such services.

Woodlands in many parts of the world are currently at risk because of the combined effects of climate change, aerial pollution, overgrazing and the spread of pests and diseases. These factors can interact with each other, leading to the collapse of wooded ecosystems and their replacement with other plant communities. Research is needed to identify which woodland areas are at risk of such collapse occurring, so that appropriate management responses can be identified. Information is also needed on the potential impacts of such “ecosystem thresholds”, both on wildlife and on humans, through changes in the provision of ecosystem services.

This project aims to provide this information, by studying woodlands in the New Forest National Park. Research will comprise a combination of field surveys along gradients of forest dieback, resurvey of long-term plots and use of spatially explicit models of ecosystem dynamics. The project will help increase understanding of how major ecological changes occur in woodlands, and their potential ecological and societal impacts.

Read the latest project updates in the **News** page.
Meanings of resilience

Growing popularity in science, policy, practice and society (200 million hits on Google in less than a second)

Getting practical
Landis-II model structure

Landis-II Net Ecosystem Carbon and Nitrogen Succession

Cohort Biomass

Soil Carbon & Nitrogen

Spatially Interactive Landscape

Insects

Harvest

Fire

Wind

Field surveys

- 223 survey plots (0.25 ha)
- In each plot collected data on:
  - Dbh trees >10 cm
  - No of sapling
  - No of seedling
- Additional plots:
  - Soil data, ground flora, lichen, fungi, recreational and aesthetics values
New Forest resilience

1. No-disturbances
2. Browsing
3. Heathland burning
4. Fire + browsing
5. Fire + browsing + protection from herbivores by spiny shrubs

300 years simulations
Remarkably resilient as a socio-ecological system, having withstood many mega-disturbances over the past 900 years.
New Forest stands die-back
‘Pulse’ and ‘Pulse+Press’ design

Pulse: One-off disturbance applied to 0%, 20%, 40%, 60%, 80%, and 100% of the area

Pulse+Press: One-off disturbance applied to 0%, 20%, 40%, 60%, 80%, and 100% of the area, followed by press disturbance

Harvesting of beech and oak >10 cm dbh. Browsing based on current levels
Resilience properties

• **Resistance** - Measured as the magnitude of change of each variable (i.e. ecosystem service or biodiversity measure) caused by the disturbance.

• **Recovery time** - Measured as the time taken for each variable to return to the pre-disturbance value.

• **Net change** - Measured by comparing each variable at the end of the simulation with the pre-disturbance value.
Recovery

Degree of disturbance

Recovery time (years)

Disturbance type
- Pulse
- Pulse+Press
Take home messages

1. When the New Forest as a whole is considered, **woodland area is resilient** to heathland burning and browsing combined.

2. When only the woodlands are considered, the majority of **the ecosystem services and biodiversity measures are resilient to a one-off disturbance** (the black dots).

3. When only the woodlands are considered, the majority of **the ecosystem services and biodiversity measures are NOT resilient to a one-off disturbance, followed by a continuous disturbance** (the red triangles) – in other words ‘When browsing is combined with a pulse disturbance that causes tree mortality, such as a windthrow event or pathogen attack, the forest displays a threshold response - resilience of the forest declines a lot more rapidly’.
• Total carbon stock, soil nitrogen stock and tree species richness were calculated from the Century Extension of LANDIS-II, which common to all ecological models is subject to a number of limitations and assumptions.

• AGB was used as indicator for the remaining of the ecosystem services and biodiversity measures.
Implications for management

In the case study examined here, specific recommendations to enhance resilience in the short-medium term could include:

• (i) protecting tree regeneration from high herbivore pressure, which limits recruitment of trees;

• (ii) limiting the current management practice of tree cutting and heathland burning outside the woodland units, so that trees might colonise nearby grassland and heathland and adapt to the new environmental conditions.