Restoring Ecological Networks for Biodiversity and Ecosystem Services

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Implementing a resilient ecological network

“a resilient ecological network is one in which species can persist even in the face of natural perturbations and human activities”

Restoration: not just what & how, but where
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Biodiversity
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Ecosystem services – crop pollination
Restoration: not just what & how, but where

Ecosystem services – water quality
Restoration: not just what & how, but where

Optimal for biodiversity and services
Planning restoration for resilient networks
Planning restoration for resilient networks
Modelling resilient networks for biodiversity

• Structural connectivity (Euclidean distance)
• Functional connectivity (the matrix)
• Effective connectivity (+ colonisation)

Effective connectivity – simulation models

Individual-based


Mathematical

Data for models?

Dispersal/Movement

Population ecology

Modelling ecosystem services: InVEST

- **Crop Pollination**
- **Water Purification**
- **Managed Timber Production**
- **Reservoir Hydropower Production**
- **Sediment Retention**
- **Seasonal Water Yield**
- **Agricultural Production**
- **Flood Risk Mitigation**

**Terrestrial/freshwater model:** Tier 1 supporting service

**Terrestrial/freshwater model:** Tier 1 that quantifies service

**Marine model:** Tier 1 supporting service

**Marine model:** Tier 1 that quantifies service

- **Aquaculture**
- **Renewable Energy**
- **Aesthetic Quality**
- **Recreation**
- **Overlap Analysis**
- **Coastal Protection**
- **Fisheries (including recreational)**
- **Carbon Storage & Sequestration (Blue Carbon)**
- **Habitat Risk Assessment; Biodiversity**
- **Coastal Vulnerability**
- **Seasonal Water Yield**
- **Flood Risk Mitigation**
- **Managed Timber Production**
- **Agricultural Production**
- **Reservoir Hydropower Production**
- **Sediment Retention**
- **Seasonal Water Yield**

Optional model linkage, no sequencing

Required/optional model linkage, sequencing needed
Modelling pollination services: InVEST

Nesting resources
Floral resources

Crop response

Poorly validated

Floral resources

Foraging
Modelling water purification: InVEST

Validated for the UK – i.e. model matches data

Restoration & resilient ecological networks

• What is the network for: biodiversity, specific services, multiple outcomes (multi-functionality)?
• There is no one-stop shop for modelling the multiple aspects of a network
• More complex models are more accurate and/or flexible
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Model accuracy

- Several ecosystem service models tested for accuracy in sub-Saharan Africa
- e.g. carbon stocks
- Process models (e.g. LPJ) best
- Simple benefits transfer worst

Willcock ... & Bullock (in review) A continental scale validation of ecosystem service models
Restoration & resilient ecological networks

Model flexibility

- Models of habitat quality often have no/limited spatial dynamics
- e.g. InVEST Habitat Quality model
- Simple classification of land use to habitat value
- (although some mapping of threat from nearby adjacent land uses)

Restoration & resilient ecological networks

• What is the network for: biodiversity, specific services, multiple outcomes (multi-functionality)?

• There is no one-stop shop for modelling the multiple aspects of a network

• More complex models are often more accurate and/or flexible

• But (more complex) models need (more) data

• Need for concerted and integrated effort among researchers, Gov’t, NGOs, industry to:
  • Align activities
  • Plan and fund data gathering
  • Develop and use a consistent set of appropriate models
Thanks to

Collaborators: Nick Isaac, Georgina Mace, Pete Brotherton, Richard Gregory, John Redhead, Justin Travis, Steve Palmer, Simon Willcock, Felix Eigenbrod, Danny Hooftman, Steven White

Funders: CEH, NERC, ESPA, BESS, EU