

Acidification, forestry and river basin management

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Structure

- What causes environmental acidity?
- What is acidification?
- What impact can afforestation have?

- Evidence of a forest effect
- Impact models
- Management strategies





Environmental acidity

- Substance that dissociates in water to yield a solution containing H^+ having a $pH < 7$
- H^+ activity μ equivalents/litre
- pH Inverse log of H^+ concentration

- Rainfall $pH \cong 5.6$ (ideal case)
 - Regional variation pH 4.0 to pH 5.0 in UK



Natural sources of acidity

- Oceanic
 - Na^+ , Mg^{2+} , Cl^- , SO_4^{2-}
- Volcanic esp. Sulphur
- Biogenic
 - Reduction of marine algae, soils, decaying vegetation, bacteria
 - Seasonal activity, temperature dependent
 - NO and NO_2 in seawater \rightarrow Nitric acid ; ammonia
- Wind blown dust – K^+ , Ca^{2+} , also buffering effect
- Lightening N \rightarrow NO_x



Anthropogenic sources

- Watershed Sources
 - Coal mining – organic acids or oxidation of sulphide minerals
 - Afforestation – organic acids: process needs mobile anions to move H^+
 - Weathering
 - Sulphate retention
- Deposition
 - Wet deposition – sea salts
 - Dry (occult) deposition – sulphur scavenging



Acidification

- Long term processes
 - Base-poor geology & soils
 - Acidifying vegetation
- Land-use change
 - Pollen analysis (looking for land-use change)
 - Lake sediment and diatom records
- Pollution
 - Atmospheric pollutants (carbonaceous particles, fly ash, sulphur, magnetic minerals, trace metals)

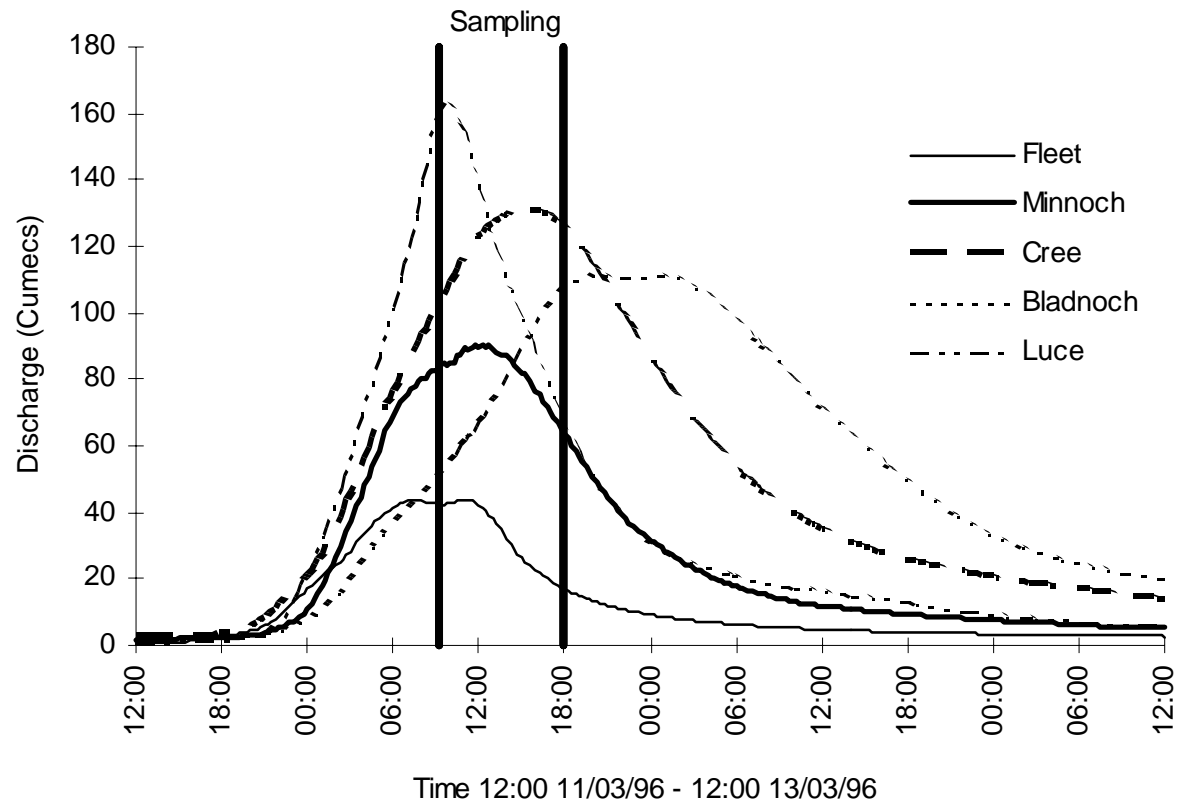


Impacts

- Aquatic biota
 - Fish deaths, Al toxicity, invertebrate populations
- Vegetation
 - especially Nitrogen & Sulphur uptake
- Soils
 - sulphate saturation and increased base cation leaching
- Carbon dioxide
 - Acts as a natural buffering agent; changes in CO₂ may affect acidification



Galloway study Puhr, et al 1999

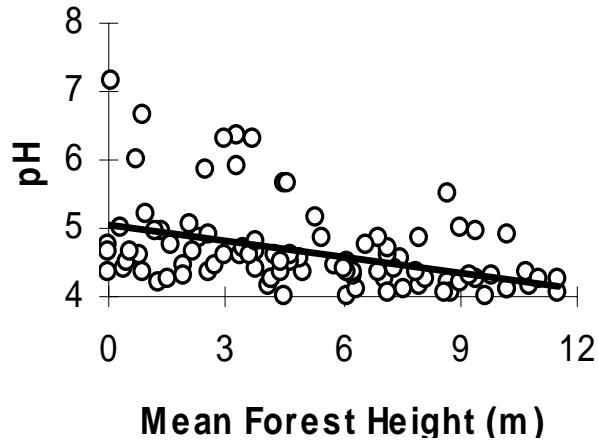




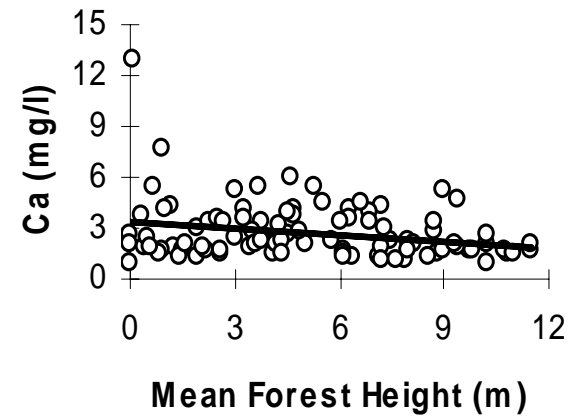


Evidence of a forest effect

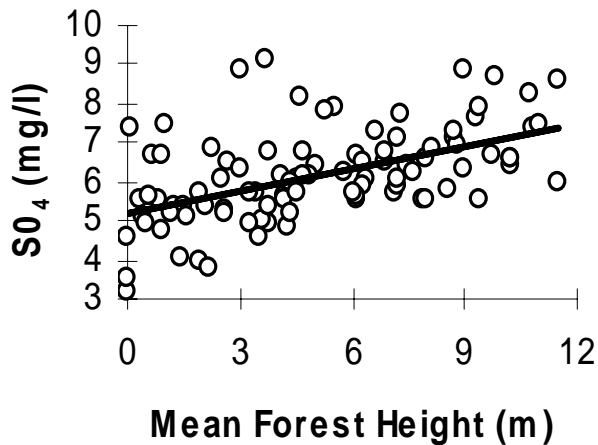
(a)



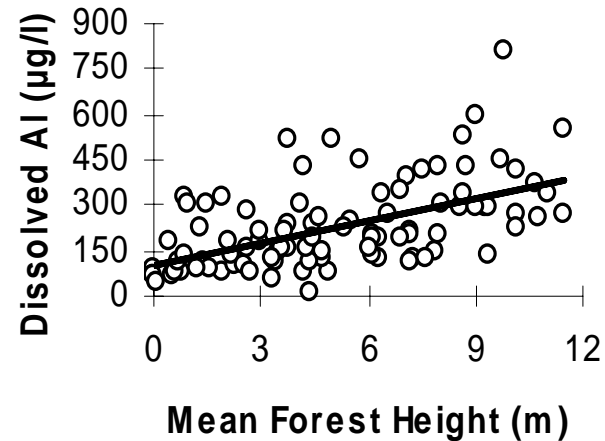
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(c)



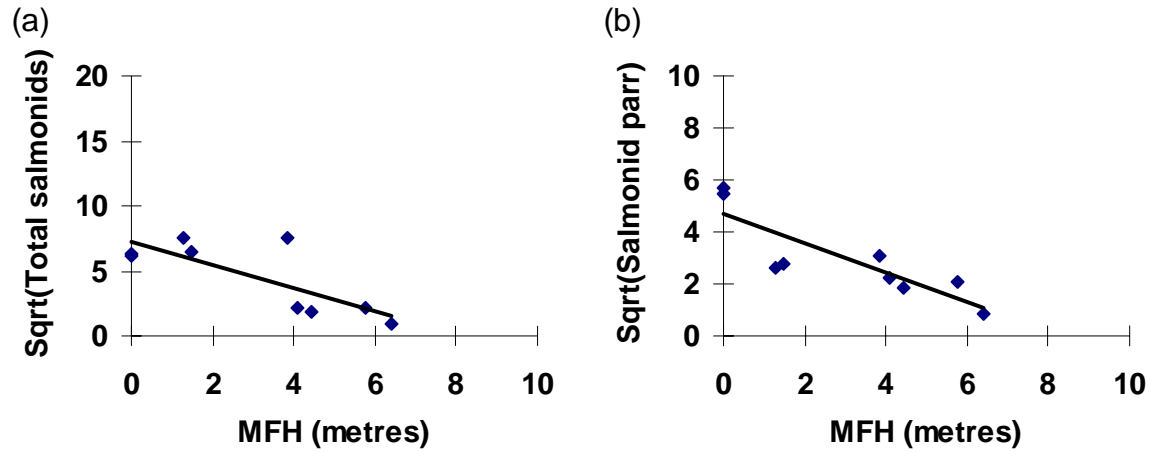
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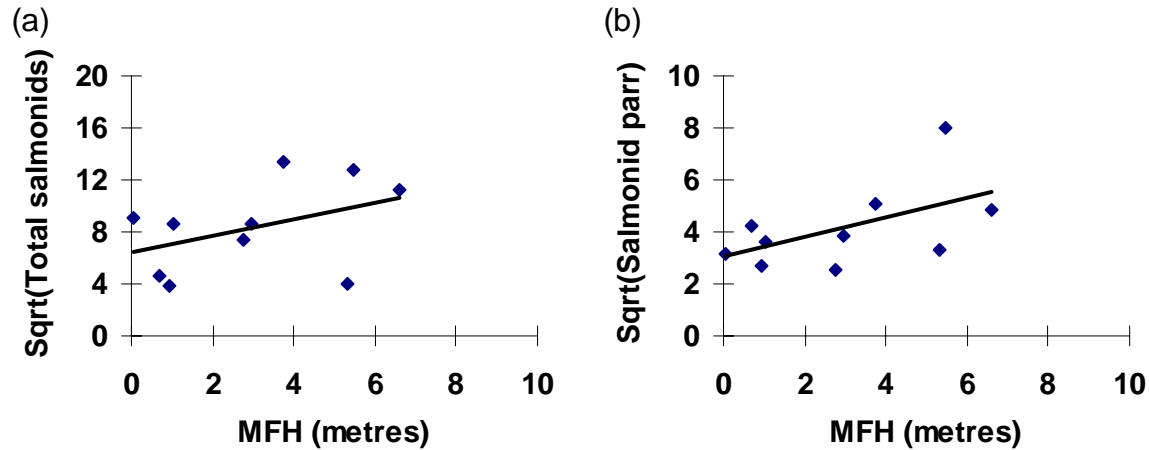




Poorly buffered geology



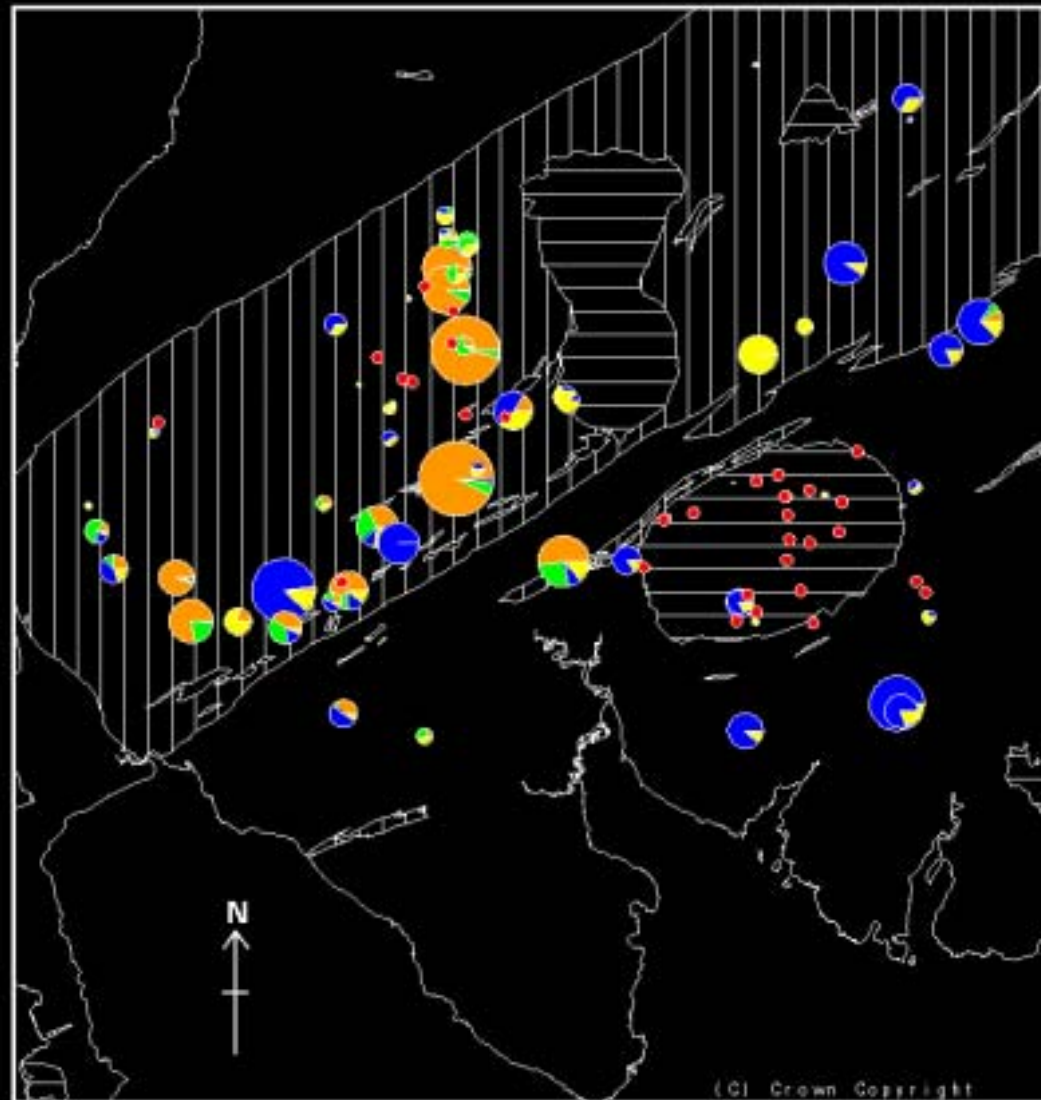
Well buffered geology



Salmonid population distribution

Minimum estimates, summer 1995

Scale 1:300,000



- Salmon age 0+
- Salmon age 1+
- Trout age 0+
- Trout age 1+
- No salmonids

- Granite
- Ordovician shales

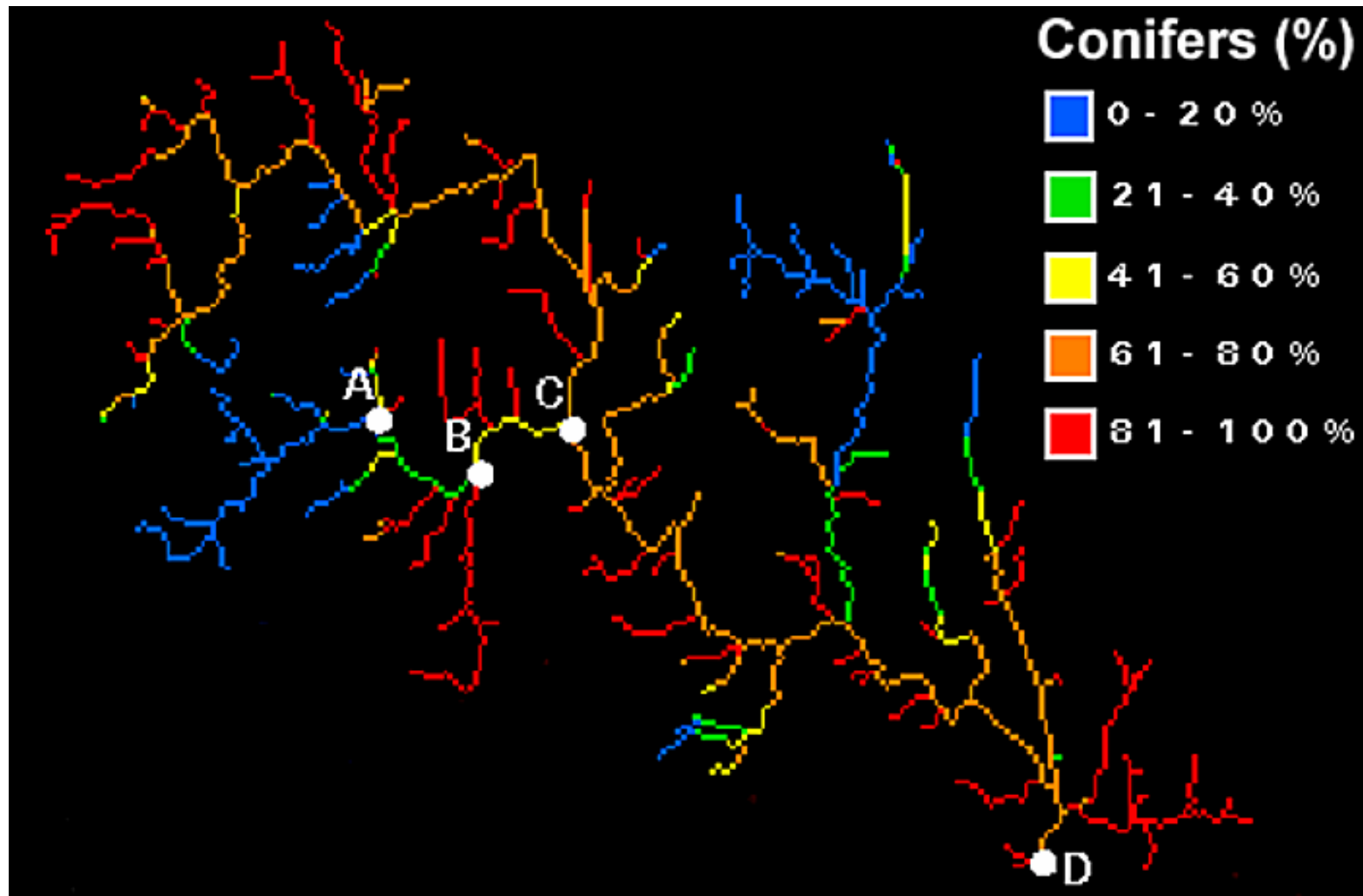


Value of Geographical Models

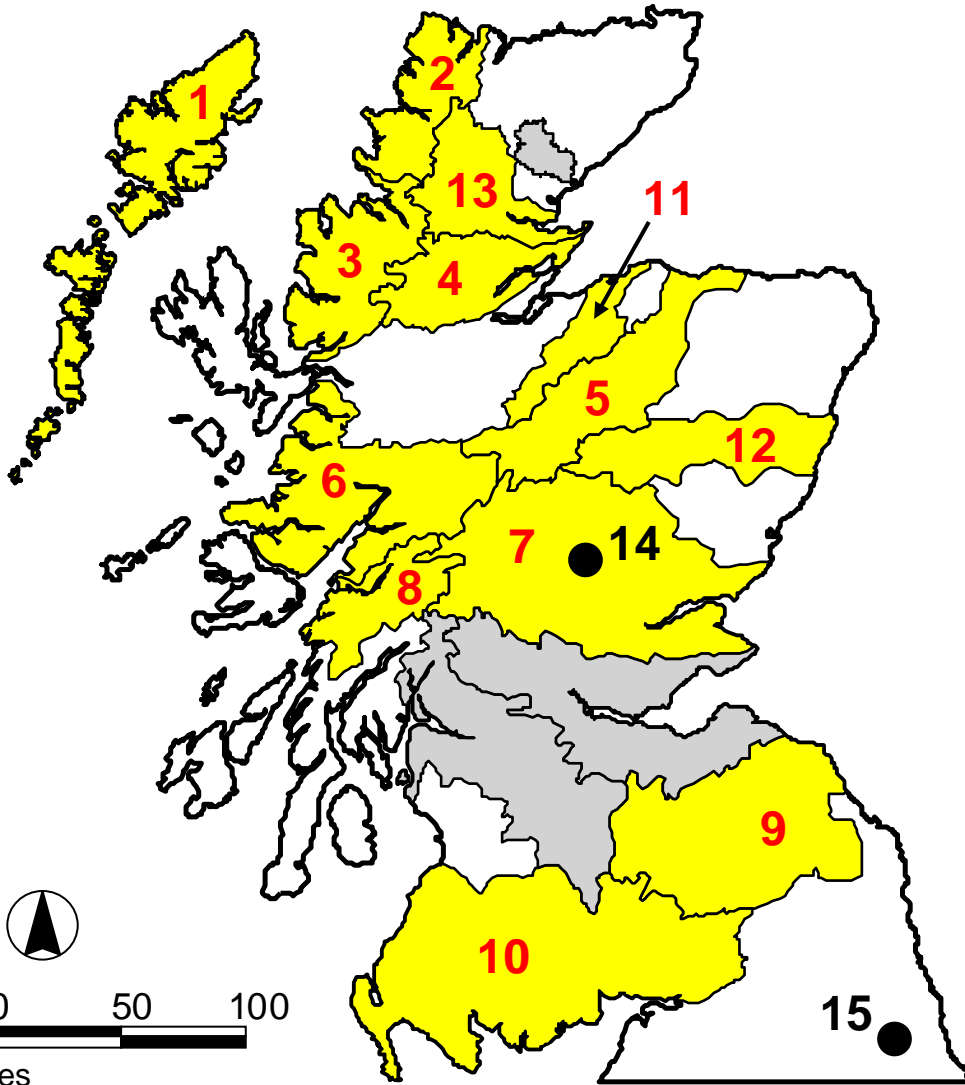
- Examine spatial patterns
- Predict future trends
- Test predictions against empirical observation
- Test competing hypotheses
- Suggest gaps in knowledge
- Feed into other environmental models



RECURSIVE CATCHMENT GENERATION



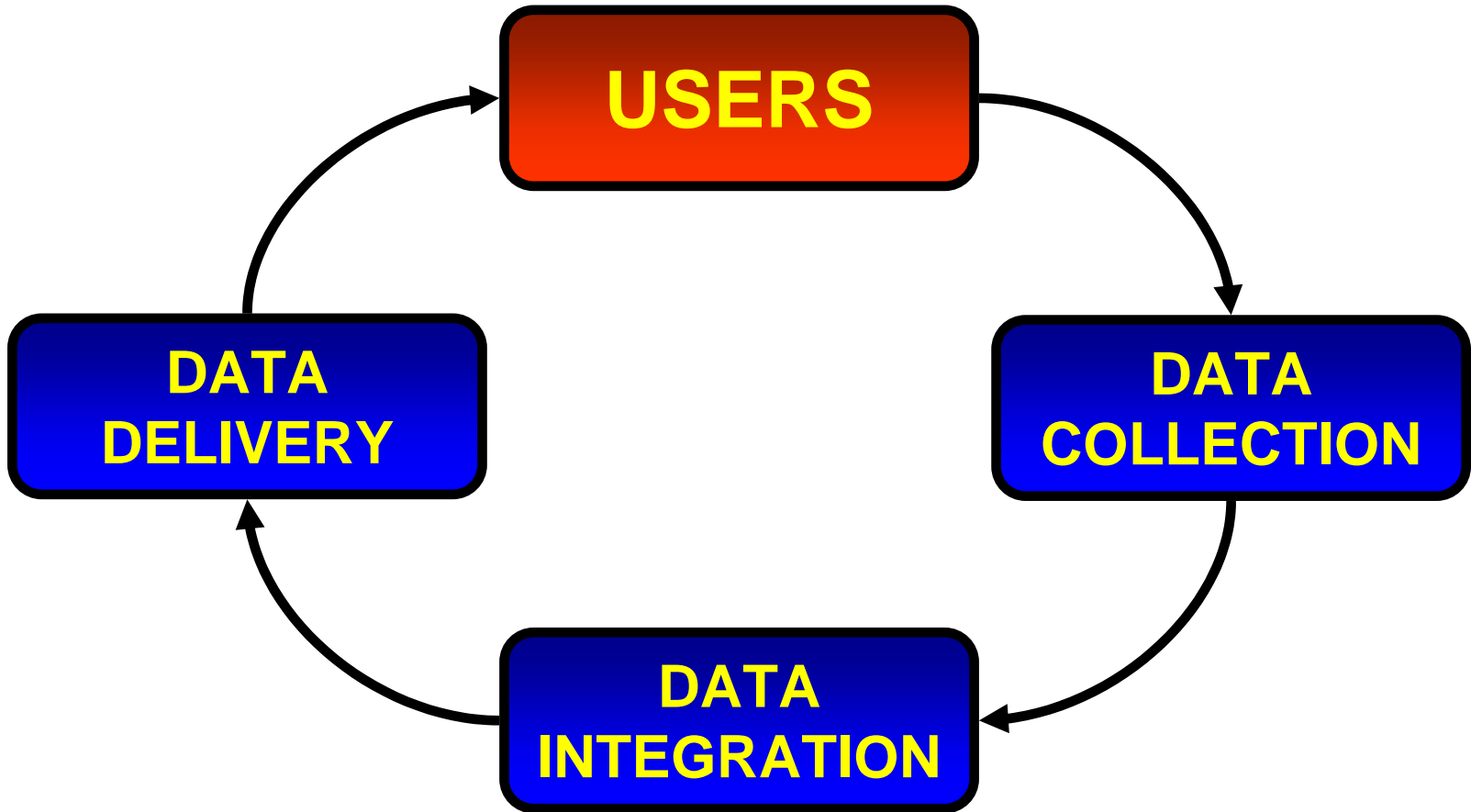
SFCC PARTNERS



1. The Western Isles Fisheries Trust
2. The West Sutherland Fisheries Trust
3. The Wester Ross Fisheries Trust
4. The Conon DSFB
5. The Spey Research Trust
6. The Lochaber and District Fisheries Trust
7. The Tay Foundation
8. The Awe Fisheries Trust
9. The Tweed Foundation
10. The West Galloway Fisheries Trust & affiliated boards
11. The Findhorn DSFB
12. The Aberdeenshire Dee DSFB
13. The Kyle of Sutherland DSFB
14. The Scottish Office (Freshwater Fisheries Laboratory)
15. The Department of Geography, University of Durham



THE SFCC





LIFE-ENVIRONMENT

- Financial Instrument of the EU in environmental protection and management
- Supports projects that set out to demonstrate new ideas, methods or technologies



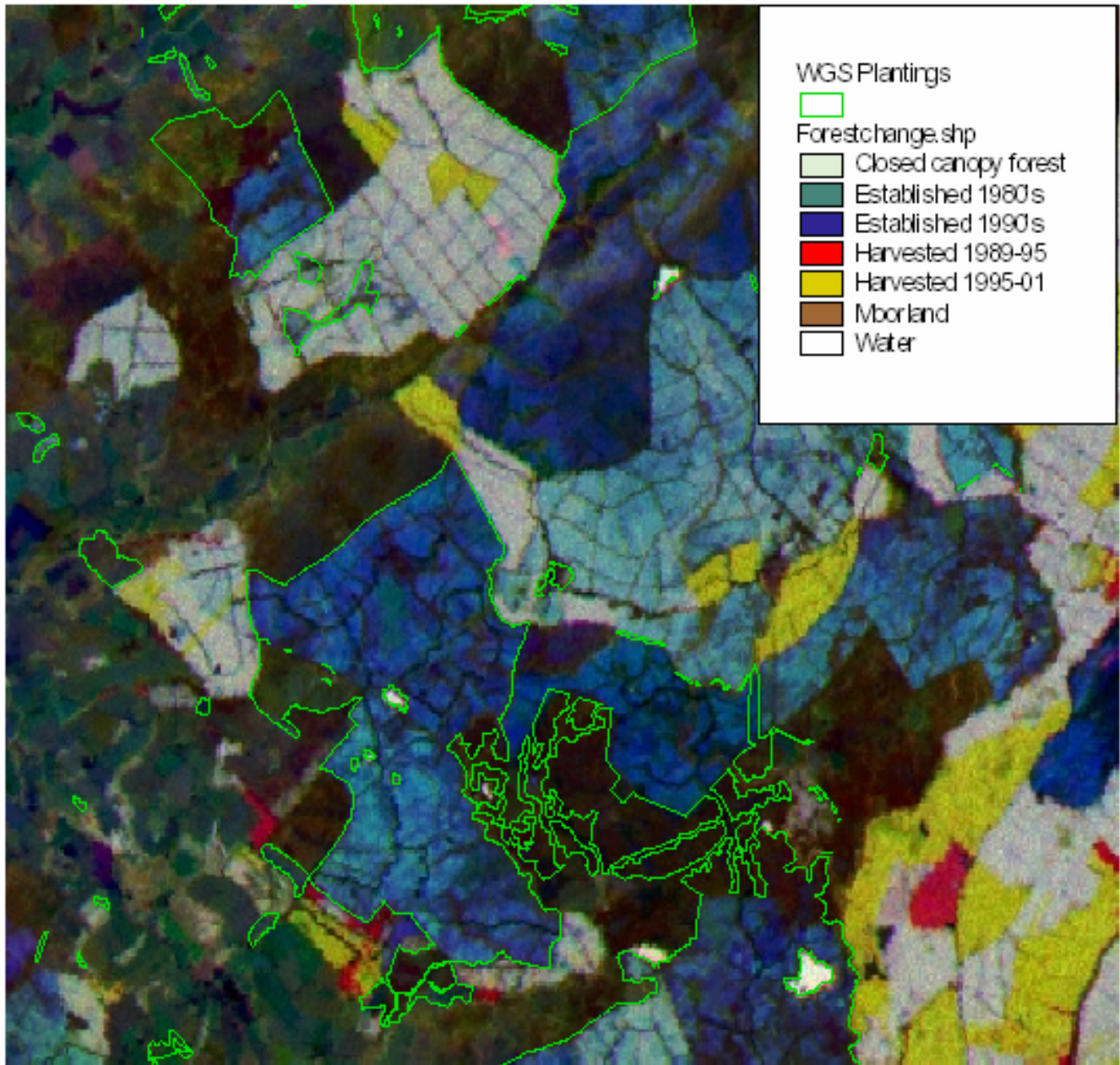
ForestSAFE & Cree Valley

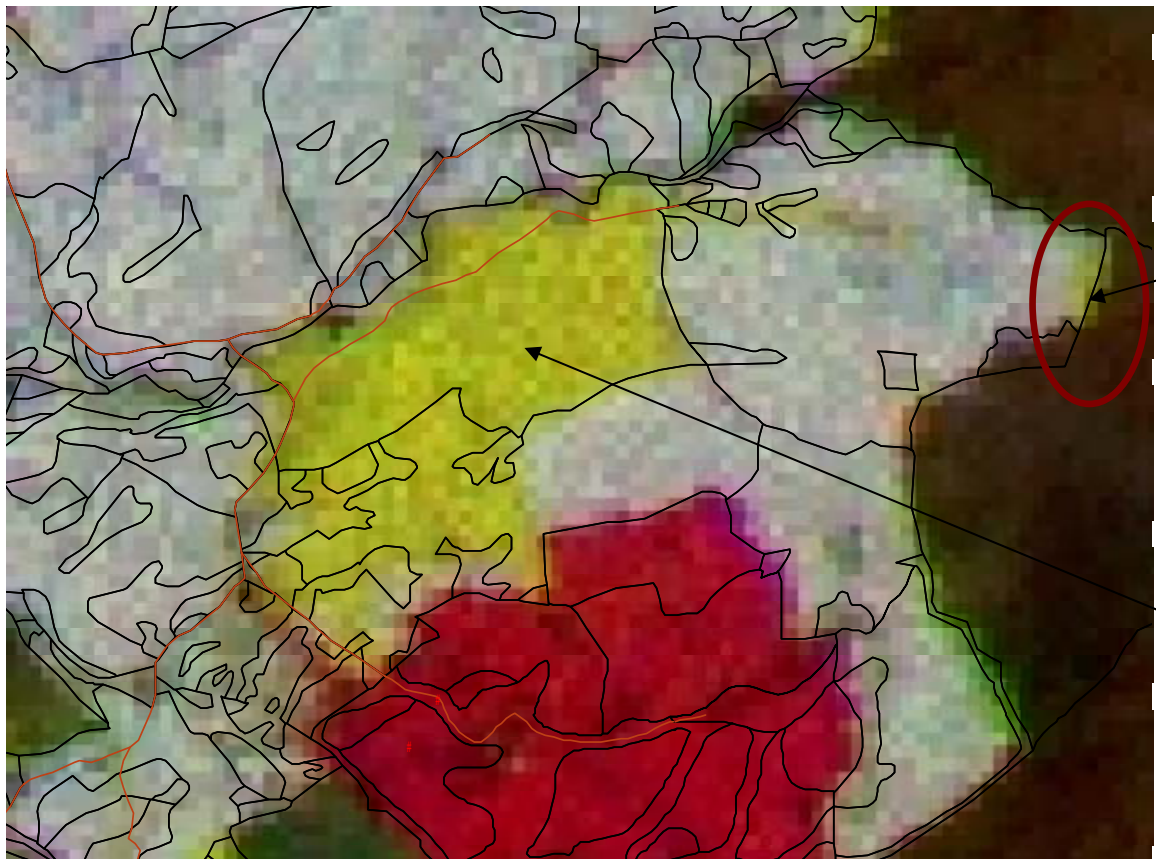
- Develop innovative scientific methods that combine satellite imagery and other ground survey data with planning and monitoring methods.
- Demonstrate how public authorities, forest companies and private forest owners can access up-to-date forestry and landscape information.



Objectives

- **Monitor** changes in the forest due to planting, harvesting and silvicultural operations
- **Identify** areas of high environmental status e.g. riparian zones with large proportion of deciduous tree species, very old forests, wetland forests
- **Estimate** growing stock, age and tree species composition at stand, local and landscape level
- **Demonstrate** methods to track stands with poor or good growth potential, identify areas of damage from wind, snow or fire.





Windthrow



Forest Harvesting



Closed canopy 1989 -95

1995 -2001



Practical Developments

- Efficient Primary Data Recording
- Data co-ordination and quality assurance
- Catchment area management plans
- Forest Management Plans
- Web based / GIS dissemination tool



FORESTSAFE: ONLINE MAPPING



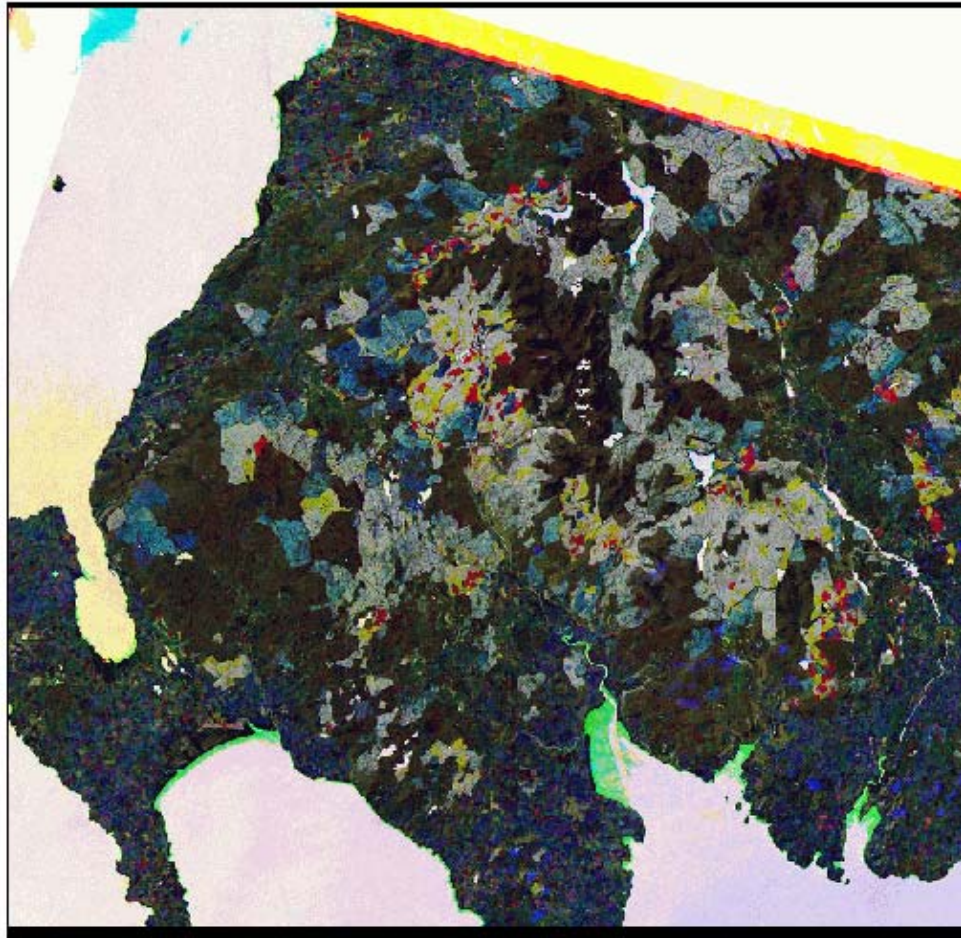
BACKGROUND IMAGE

Height Change Image 1989 - 1995 - 2001

MAP OVERLAY FILES

Settlements	<input type="checkbox"/>
Roads	<input type="checkbox"/>
Water Bodies	<input type="checkbox"/>
Woodland Grants Scheme	<input type="checkbox"/>
FC Compartments	<input type="checkbox"/>
SS Compartments	<input type="checkbox"/>

Harvested 1989-1995	
Harvested 1995-2001	
Established 1980s	
Established 1990s	
Closed Canopy	
Moorland	





FORESTS SAFE: ONLINE MAPPING



QUERY RESULTS - Microsoft Internet Ex... [min] [max] [close]

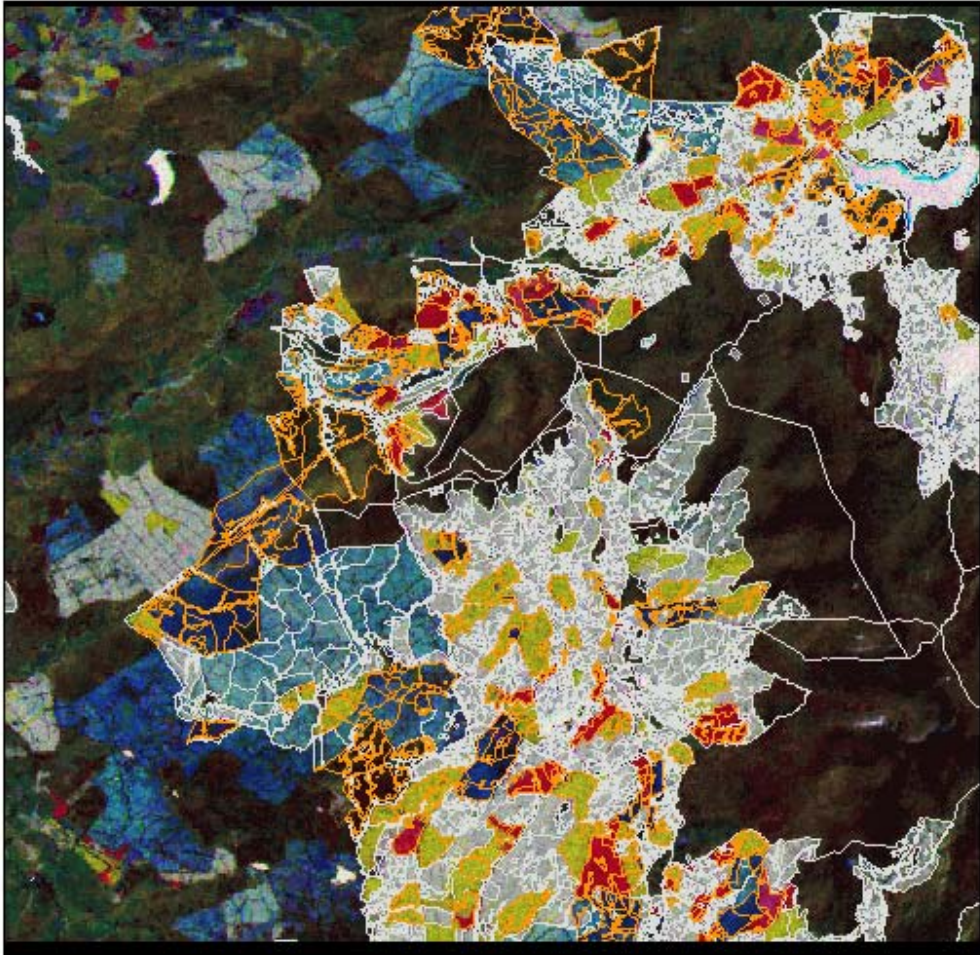
QUERY RESULTS

FC COMPARTMENT DATA

COMPT. ID: 330001187
SPECIES: SS
PYEAR: 1989

PREDICTED HEIGHT (m)

MEAN	STDEV	MIN	MAX
4.2887	1.9172	1	9



- Harvested 1989-1995
- Harvested 1995-2001
- Established 1980s
- Established 1990s
- Closed Canopy
- Moorland



Conclusions

- Geographical perspective valuable
- Benefits of new technology
 - Ability to look at regional / national problems
 - Improved quality of primary data
- Co-operative approach
 - Acidification research cuts across disciplines and lines management responsibility
 - Data costs are a significant impediment to both research and management

www.geography.dur.ac.uk/ForestSAFE

www.sfcc.co.uk

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The Scottish Fisheries Co-ordination Centre



Acidity Models

- Biological
 - Diatoms
 - Fisheries
- Steady-state water chemistry (Henriksen)
- Dynamic models
 - MAGIC



Biological Impacts

- Recruitment failure
 - Egg hatching pH limited enzyme failure
 - Al toxicity Gill damage and drowning
- Carrying capacity
 - Food availability
 - Suitable habitat
- Disruption of migration patterns
 - Chemical signature of water