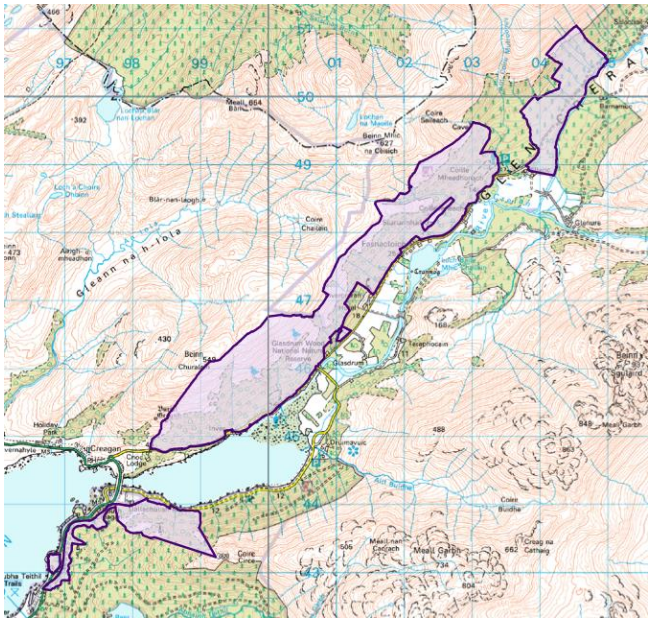
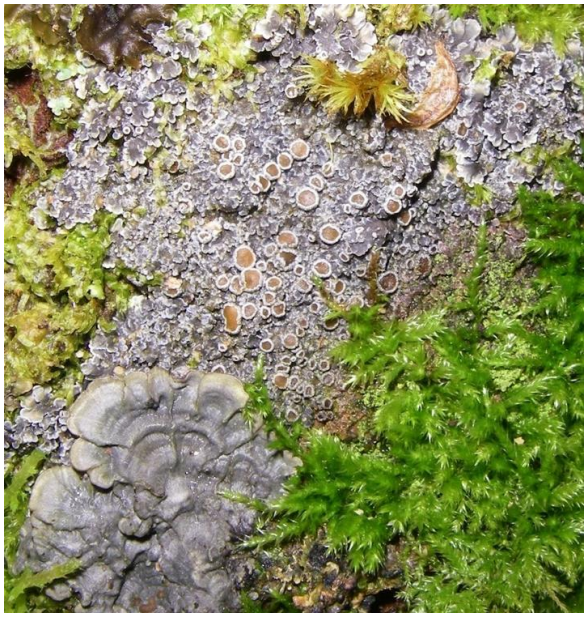
Landscape Scale Conservation of Epiphytes in Temperate Rainforests





Sally Eaton

University of Glasgow

Royal Botanic Garden Edinburgh

SCOTTISH NATURAL HERITAGE

Talk Structure

1/ Introduction:

- Landscape scale conservation
- Uncertainties
- Study system

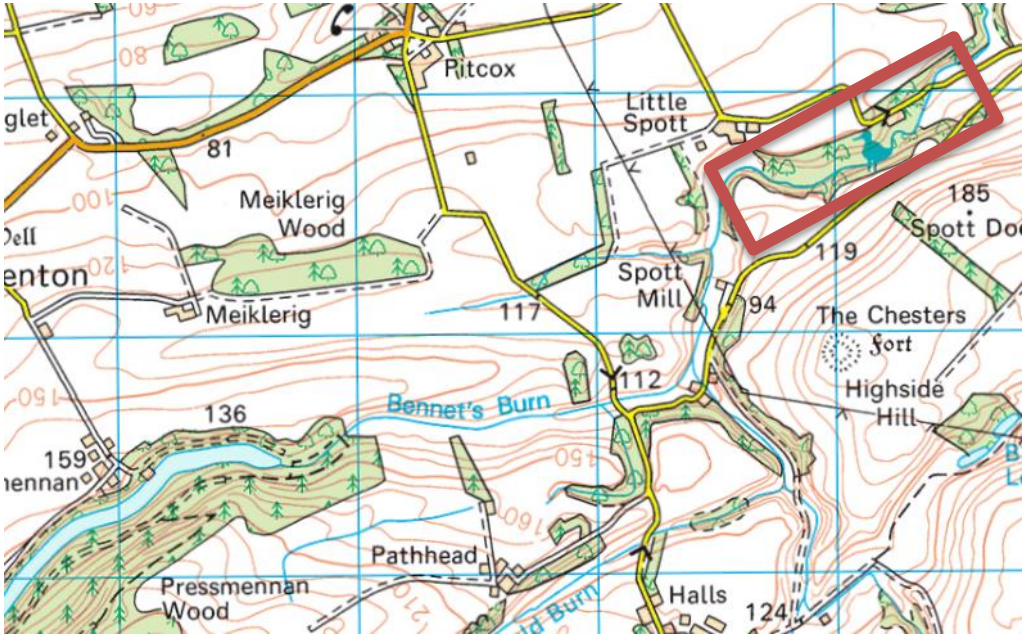
2/ Solutions:

- Habitat suitability modelling
- Dispersal patterns
- Agent based modelling

3/ A practical conservation tool

1962- Site scale conservation

“Conservation exists principally of the selection, acquisition and management of land.” Moore (1962) Journal of Ecology



1962- Site scale conservation

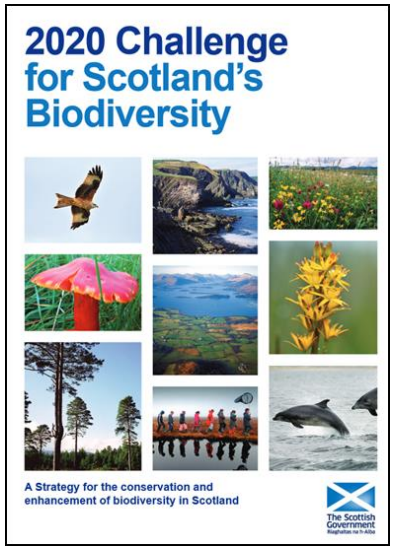
"Conservation exists principally of the selection, acquisition and management of land." Moore (1962) Journal of Ecology

2010- Landscape scale conservation

"the current system of wildlife sites does not comprise a coherent and resilient ecological network"

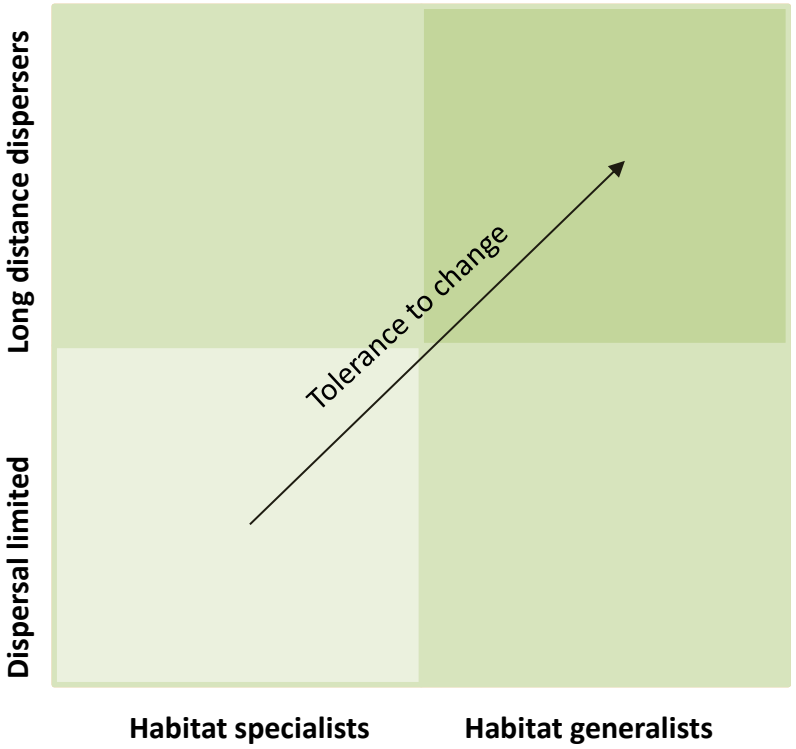
"...a step-change in our approach to wildlife conservation, from trying to hang onto what we have, to one of large-scale habitat restoration and recreation…"

Making Space for Nature - The Lawton Report (2010)(England)



Uncertainties

*"The ability of species to persist within a habitat network will depend on the **distribution** of species-specific resources and their ability to **access** these resources"* Vos et al. 2001



For individual species;

1. Do we have an understanding of habitat distribution, at an appropriate resolution, across an entire landscape?

2. Given spatial distribution, do we have an understanding of habitat connectivity?

3. Given both spatial distribution and connectivity, is it possible to test landscape scale conservation scenarios prior to implementing change?

Talk Structure

1/ Introduction:

- Landscape scale conservation
- Uncertainties
- Study system

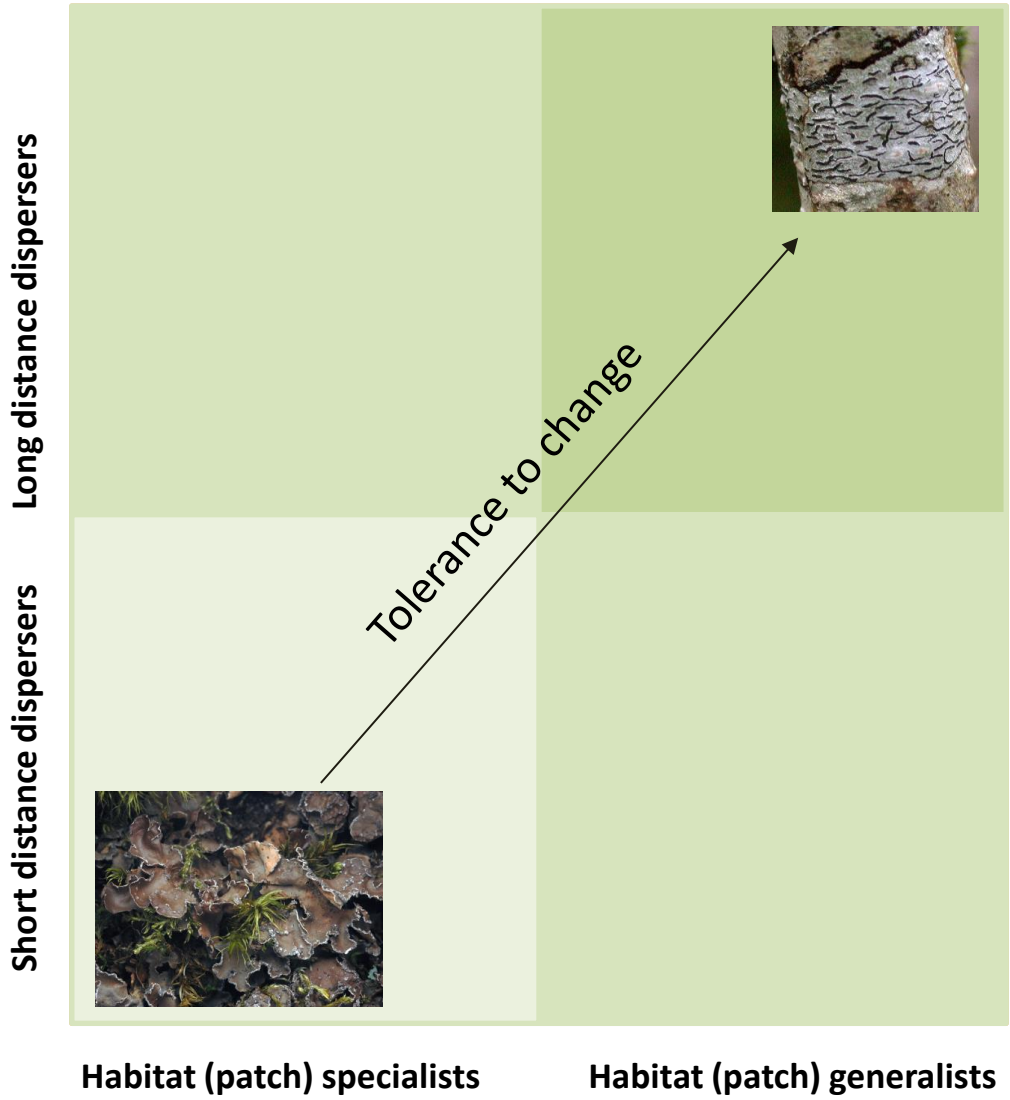
2/ Solutions:

- Habitat suitability modelling
- Dispersal patterns
- Agent based modelling

3/ A practical conservation tool

Study System

Species	Reproduction	Habitat
Graphis scripta	Sexual	Generalist
Parmelia saxatalis	Asexual	Generalist
Lobaria pulmonaria	Both	Specialist
Degelia atlantica	Asexual	Specialist
Degelia cyanaloma	Sexual	Specialist
Pannaria conoplea	Asexual	Specialist
Pannaria rubigionsa	Sexual	Specialist
Nephroma parile	Asexual	Super specialist
Nephroma laevigatum	Sexual	Super specialist



Temperate Rainforests

Map from Averis *et al.*, 2011.

“The site is outstanding, on a national and international scale, for its exceptionally rich oceanic lichen assemblage”

“The site is outstanding, on a national and international scale, for its exceptionally rich oceanic lichen assemblage”

Talk Structure

1/ Introduction:

- Landscape scale conservation
- Uncertainties
- Study system

2/ Solutions:

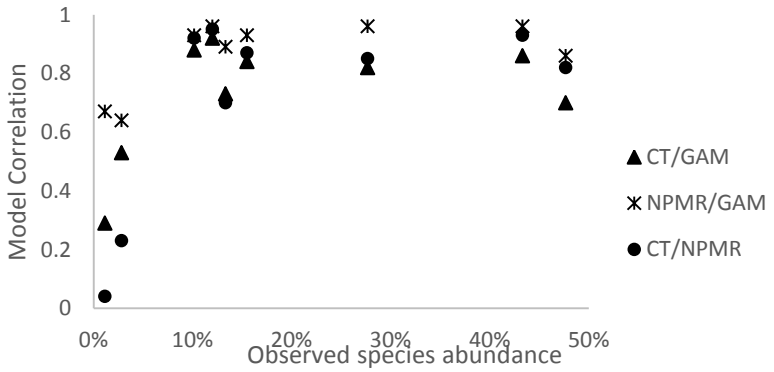
- Habitat suitability modelling
- Dispersal patterns
- Agent based modelling

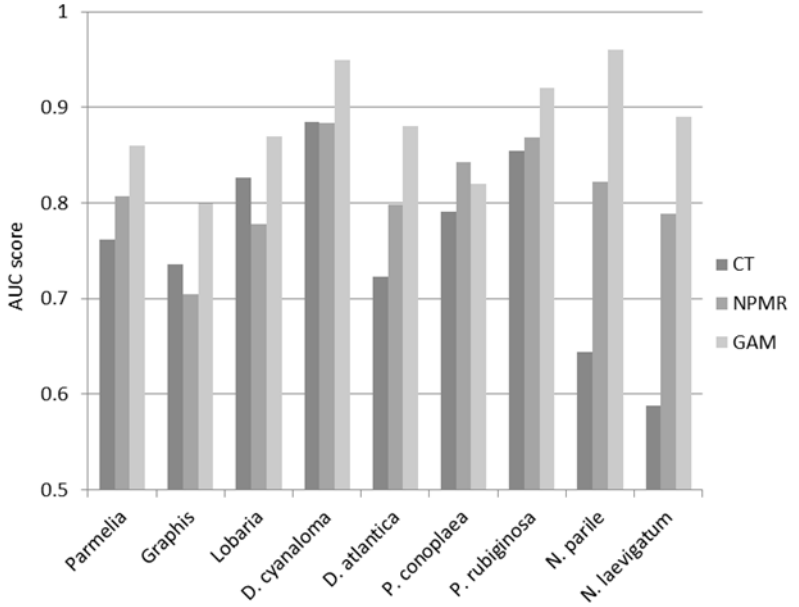
3/ A practical conservation tool

Habitat Suitability Modelling

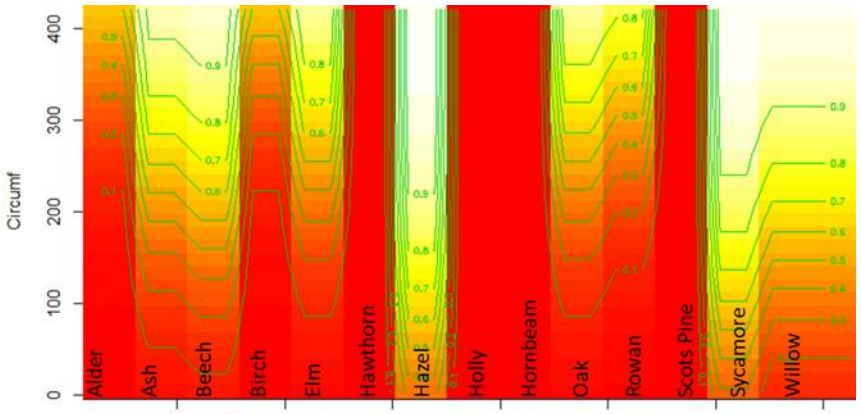
Uncertainty 1:

Do we have an understanding of habitat distribution, at an appropriate resolution, across an entire landscape?



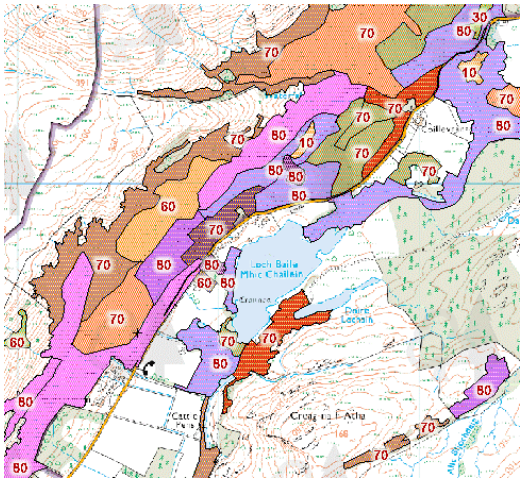


Habitat Suitability Modelling



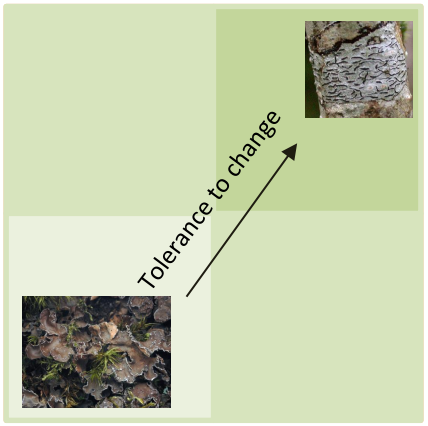
+

Native Woodland Survey Scotland (Forestry Commission)



GAM
Lobaria pulmonaria = species + s(circumference, k=3)
cvAUC 0.81

Habitat Suitability Modelling



Do we have an understanding of habitat distribution, at an appropriate resolution, across an entire landscape?
YES!

Graphis scripta

Nephroma parile

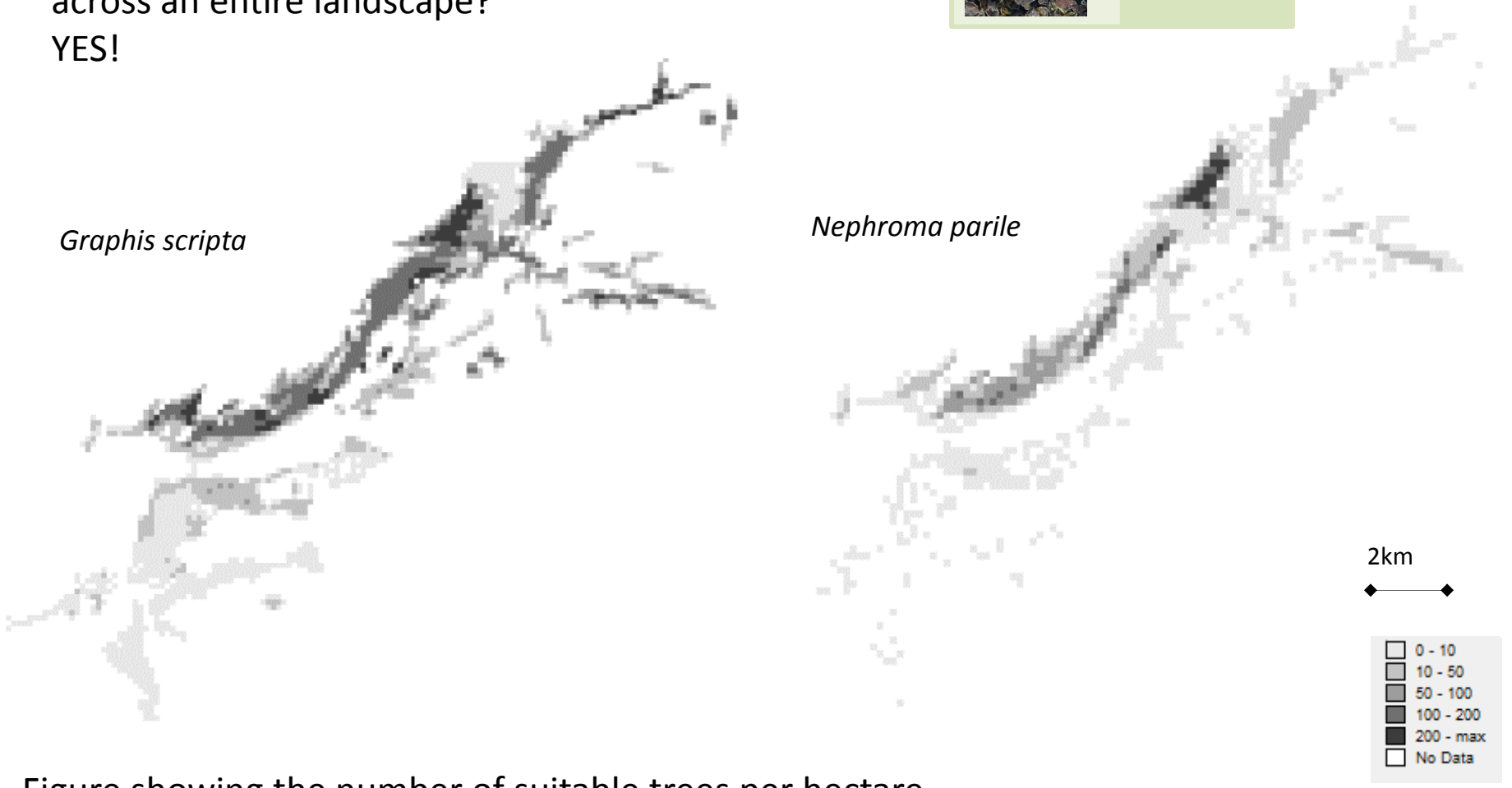


Figure showing the number of suitable trees per hectare

Dispersal

Uncertainty 2. Given spatial distribution, do we have an understanding of habitat connectivity?

Molecular Ecology (2012) 21, 3250–3265 doi: 10.1111/j.1365-294X.2012.05605.x

Genetic structure in a fragmented Northern Hemisphere rainforest: large effective sizes and high connectivity among populations of the epiphytic lichen *Lobaria pulmonaria*

OLGA HILMO,* SVERRE LUNDEMO,*† HÅKON HOLIEN,‡ KIRSTI STENGRUNDET* and HANS K. STENØIEN†
*Department of Biology, Faculty of Natural Science and Technology, Norwegian University of Science and Technology, N–7491

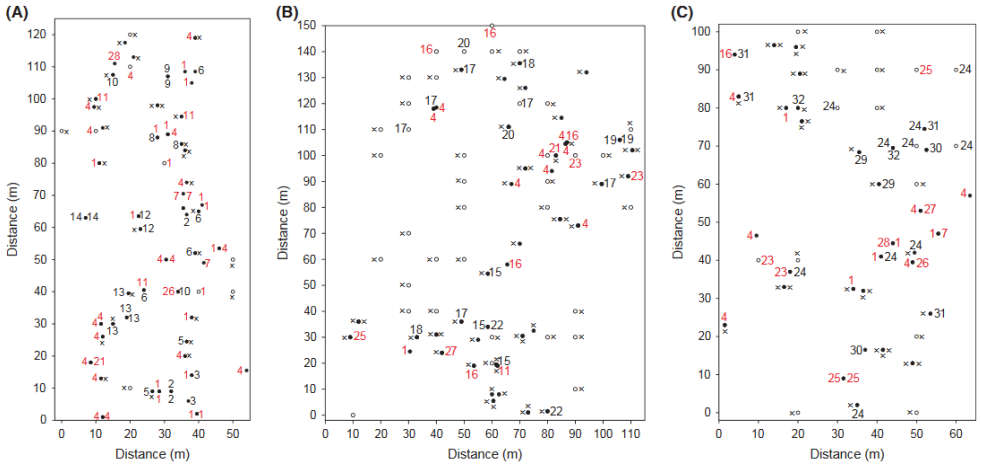


Fig. 2. Spatial distribution of genotypes in lichen thalli ($N = 225$) and snow samples ($N = 62$) at locality A: Dølaelva, B: Langdalen and C: Selnes. • = sample tree, • = snow sample, × = unique genotypes. Each number represents the ID of a repeating genotype (based on all eight loci). Numbers in red indicate genotypes occurring in more than one of the ravines. From two sample trees at Selnes, we collected three lichen individuals, instead of two.

Molecular Ecology (2001) 10, 2129–2138

Species-specific detection of *Lobaria pulmonaria* (lichenized ascomycete) diaspores in litter samples trapped in snow cover

J.-C. WALSER, S. ZOLLER,* U. BÜCHLER† and C. SCHEIDEGGER
Swiss Federal Research Institute WSL, CH-8903 Birmensdorf, Switzerland

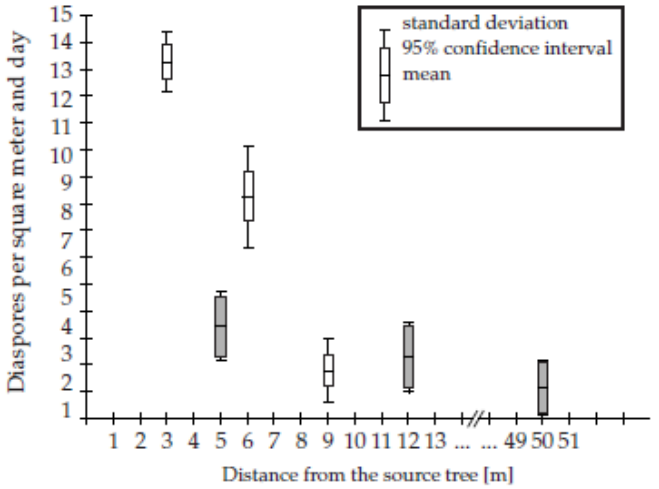
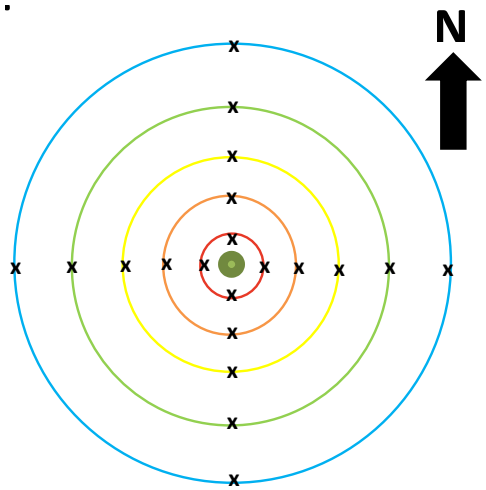
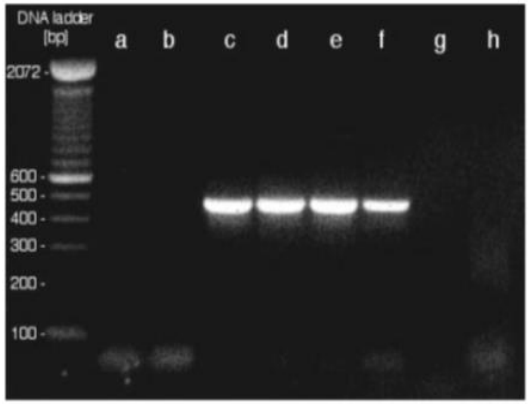


Fig. 3 Dispersal gradients of *Lobaria pulmonaria* diaspores at tree A1 (open) and B1 (shaded) with mean, standard deviation (SD), and 95% confidence interval (CI).

Dispersal



Spore traps



Genetic techniques (PCR)

Dispersal

Species	Reproduction	Habitat
Graphis scripta	Sexual	Generalist
Parmelia saxatalis	Asexual	Generalist
Lobaria pulmonaria	Both	Specialist
Degelia atlantica	Asexual	Specialist
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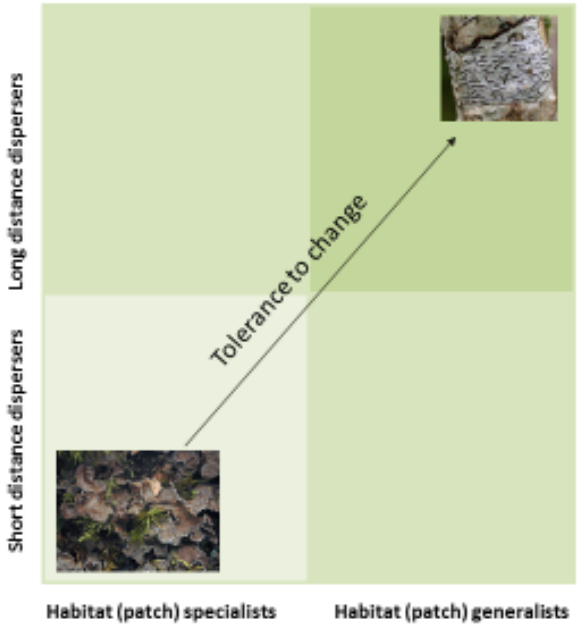
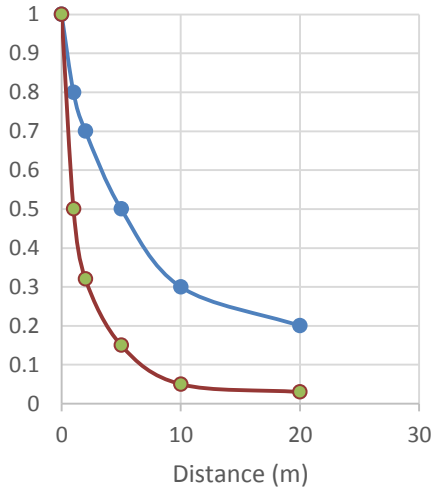
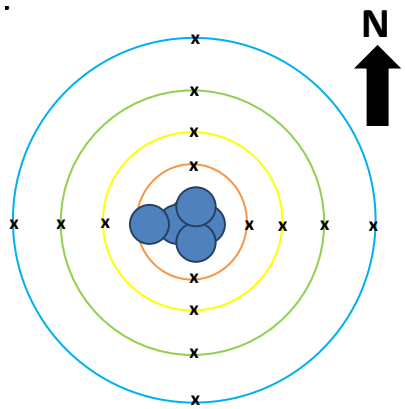




16

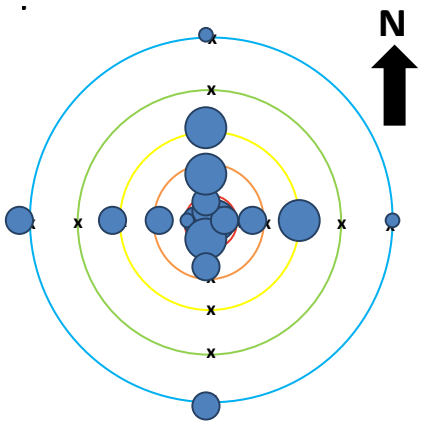
Null hypothesis: There is no difference in the dispersal kernal of sexual and asexual lichen species.

Alternative hypothesis: The dispersal kernal of sexual species has a longer tail than that of asexual species



Dispersal limited (asexual)

Nephroma parile



Dispersal unlimited (sexual)

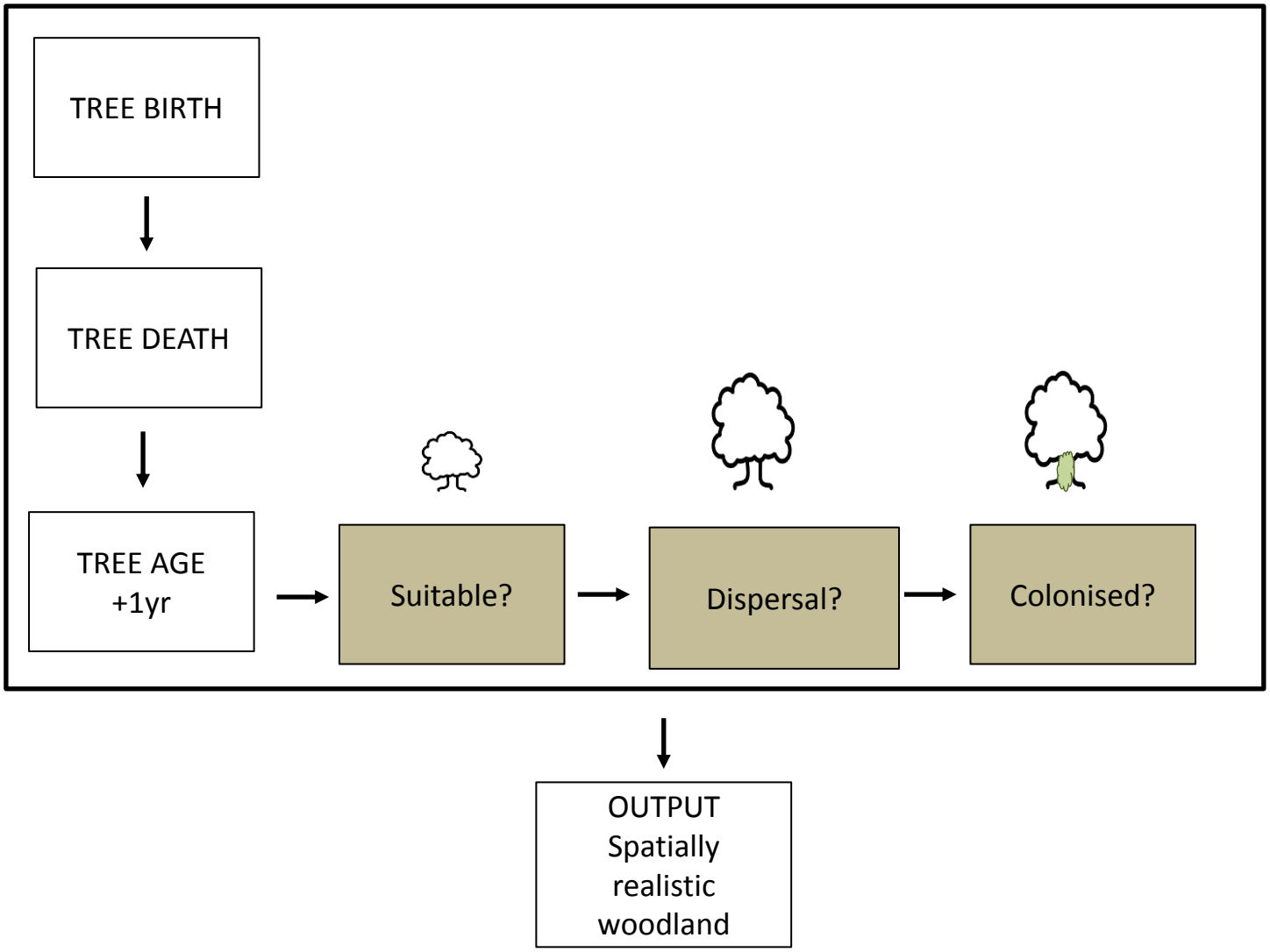
Nephroma laevigatum

Uncertainty 2. Given spatial distribution, do we have an understanding of habitat connectivity?
YES!

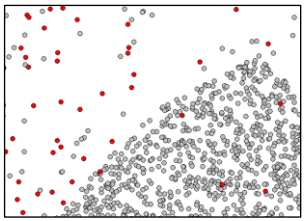
Agent based model

Uncertainty 3.

Is it possible to test landscape scale conservation scenarios prior to implementing change?



Agent based model



PER TIME STEP

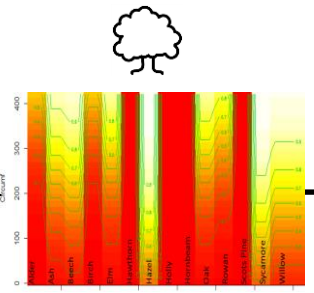
Management practices:

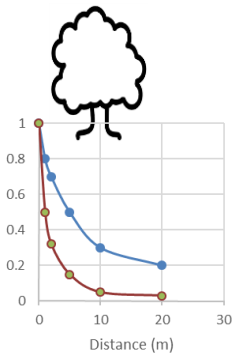
- Grazing
- Fences
- Plant trees
- Woodland creation
- Trade-off

TREE BIRTH

TREE DEATH

TREE AGE +1yr





$$C_i = \frac{1}{1+\left[\frac{y}{bS_i}\right]^2} = \frac{1}{1+\left[\frac{y'}{S_i}\right]^2}$$

OUTPUT
Spatially realistic woodland

Talk Structure

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2/ Solutions:

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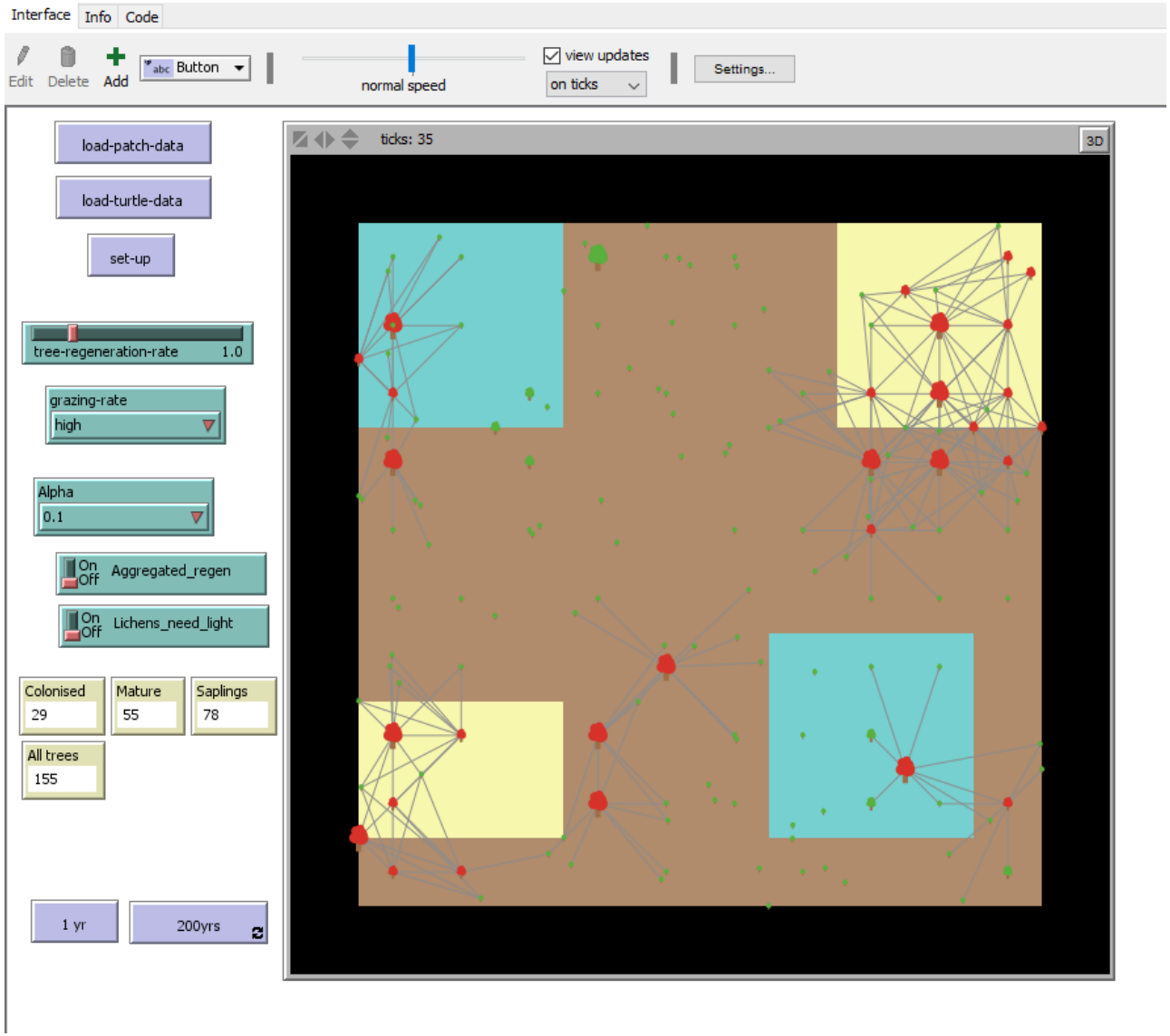
3/ A practical conservation tool


Interface
Info
Code
Edit
Delete
Add
Button
normal speed
view updates
on ticks
Settings...
load-patch-data
load-turtle-data
set-up
tree-regeneration-rate
1.0
grazing-rate
high
Alpha
0.1
On
Off
Aggregated_regen
On
Off
Lichens_need_light
Colonised
29
Mature
55
Saplings
78
All trees
155
1 yr
200yrs
ticks: 35
3D

Conclusions

1.Different species show different patterns of habitat suitability within a landscape.

2.Different species perceive habitat connectivity differently within a landscape.

3. In practice, Landscape Scale Conservation can offer a more comprehensive approach to conservation and management, however, there is much variability in species response.

Thank you

Supervisors:

Dr. Chris Ellis (RBGE), Dr. Rebecca Yahr (RBGE), Dr. Dave Genny (SNH), Prof. Daniel Haydon (UoG)


GLASDRUM
NATIONAL
NATURE RESERVE

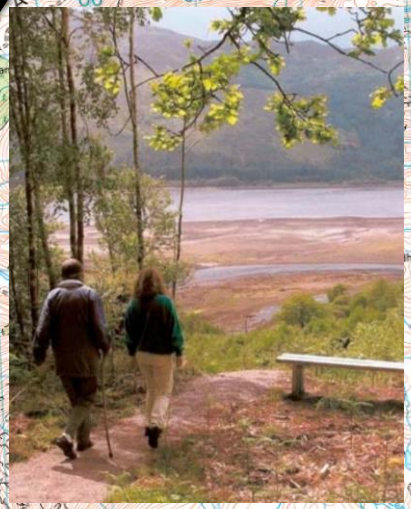
SCOTLA
GRAMPIAN
PERTH AND KIN
ARGYLL AND BUTE
STIRLING
LOCH LOMOND & THE TROSSACHS
Fort William
Ben Nevis
Kinlochleven
Ballachulish
Ben Nevis & Glen Coe
Lynn of Lorn
Oban
Taynuilt
Crianlarich
Tyndrum
Dalmally
Inveraray
Tarbet
Ben Lomond
Callander
Greenock
Dumbarton
Paisley
GLASGOW
Stirling
Mallaig
Newtonmore
Kingussie
ISLE OF MULL
JURA
ISLAY
Tobermory
GLEN CRERAN
Glasdrum Wood National Nature Reserve
Glasdrum
Creagan
Barcaldine
Elleric
Glenure
Fasnacloich
Invercreran
Loch Baile Mhic Chailein
Beinn Churalain
Meall Garbh
Beinn Sgulaird
Meall an Aodainn
Meall Lighiche
Beinn Fhionnlaidh
GLASDRUM NATIONAL NATURE RESERVE
Welcome to Glasdrum National Nature Reserve


GLASDRUM
NATIONAL
NATURE RESERVE


GLASDRUM
NATIONAL
NATURE RESERVE


GLASDRUM
NATIONAL
NATURE RESERVE


GLASDRUM
NATIONAL
NATURE RESERVE




GLASDRUM
NATIONAL
NATURE RESERVE


Ardvasar
Kinloch
Rùm
Mallaig
Small Isles
Eigg
Muck
Sound of Arisaig
Morar, Moidart & Ardnamurchan
Loch Morar
Loch Quoich
Loch Arkaig
Loch Lochy
Loch Eil
Loch Shiel
Spean Bridge
Fort William
Ben Nevis 1344m
Acharacle
Kinlochleven
Loch Leven
Tobermory
Sound of Mull
Ballachulish
Ben Nevis & Glen Coe
Loch na Keal
Lochaline
Salen
Loch Linnhe
Lynne of Lorn
Loch Tuath
Ulva
Loch na Keal
Craignure
Kerrera
ISLE OF MULL
Oban
Taynuilt
Lochbuie
Firth of Lorn
Ross of Mull
Kilninver
Dalmally
Crianlarich
Tyndrum
Killin
Lochearnhead
LOCH LOMOND & THE TROSSACHS
STIRLING
ARGYLL AND BUTE
Seil
Luing
Garvellachs
Melfort
Loch Awe
Inveraray
Scarba, Lunga & The Garvellachs
Scarba
Callander
Tarbet
Loch Lomond
Loch Katrine
Ben Lomond 974m
Aberfoyle
Thornhill
Furnace
Strachur
Kilmartin
Lochgilphead
Loch Fyne
Colonsay
Scalasaig
Oronsay
Ardlussa
JURA
Sound of Jura
Knapdale
Kyles of Bute
Tighnabruaich
Dunoon
Greenock
Collintraive
Port Glasgow
Kilmacolm
Johnstone
Paisley
GLASGOW
Dumbarton
Milngavie
Strathblane
Kilsyth
Drymen
Stirling
Helensburgh
Largs
Port
Jura
Knoydart


Cairn
Choise
663
Meall an Aodainn
678
Meall Lighiche
772

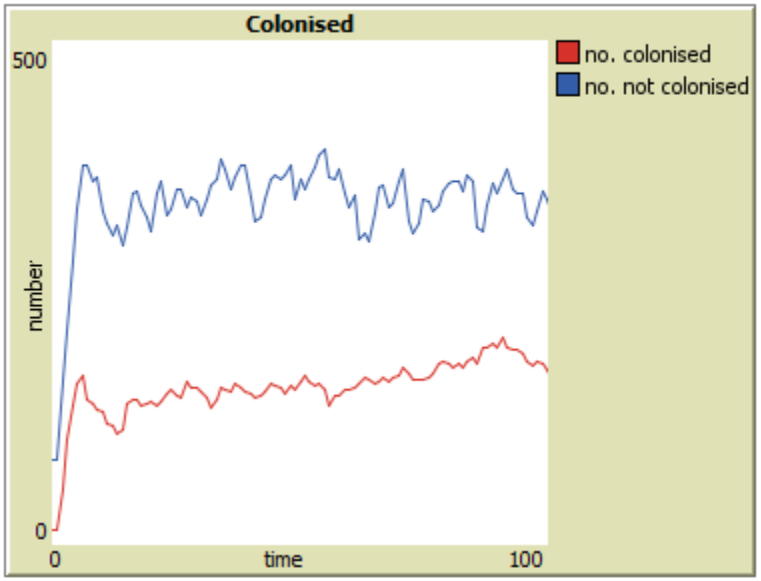

Coire Dubh
Fraochaidh
671
Cairn
Salachail
03
04
05
06
07
08
GLENCREERAN

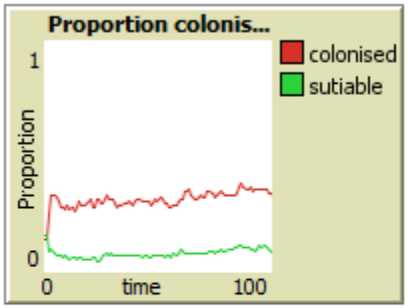

Coille Mheadhonach
Ellett
Glenure
Coire Chailein
Seanarmhail
Coilleveanoch
Fasnacloich
Creamhe
Invercreran
Tarsaichocain
168
18
25
14
47
48
49

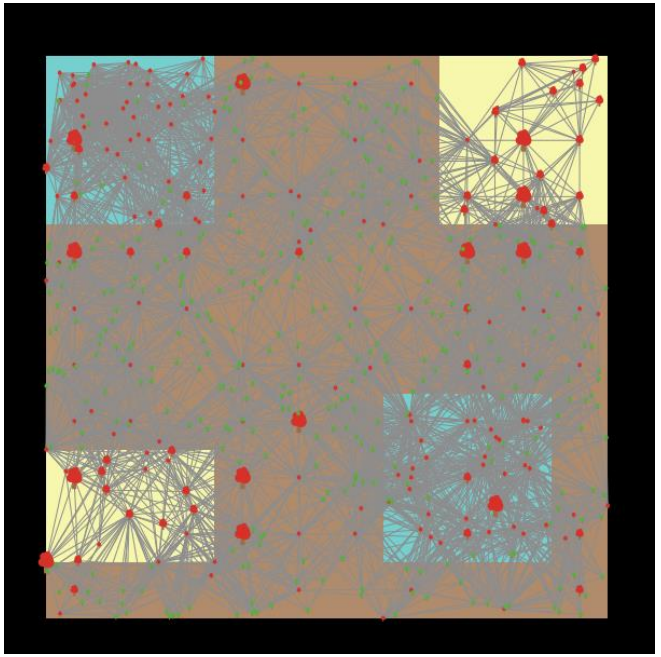

GLASDRUM
NATIONAL
NATURE RESERVE
Welcome to Glasdrum National Nature Reserve


Glasdrum Wood National Nature Reserve
Glasdrum
Beinn Churalain
549
430
Burial Ground
Holiday Park
Creagan
Invernahyle
Choc Lodge
South Creagan
Callechuilish
Coire Circe
369
Rubha Teithil
Cycle Trails
Pier
Sutherland
Resr
Meall Garbh
848
488
863
Druimavuic
44
45
46
43

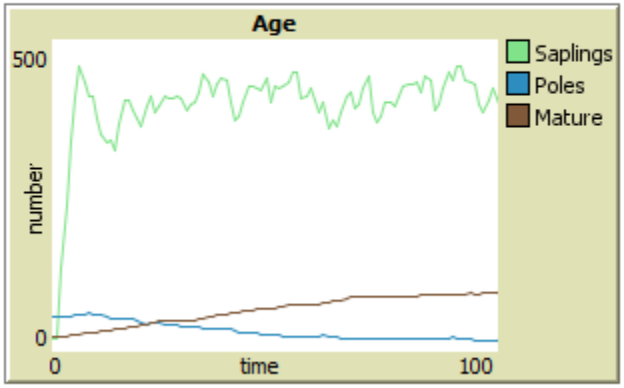
Scenario 4:
Grazing = low
Dispersal un-limited

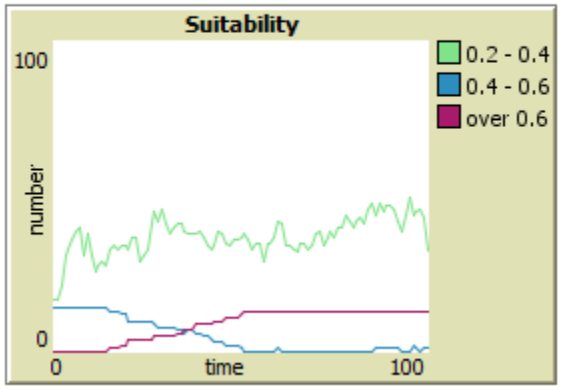






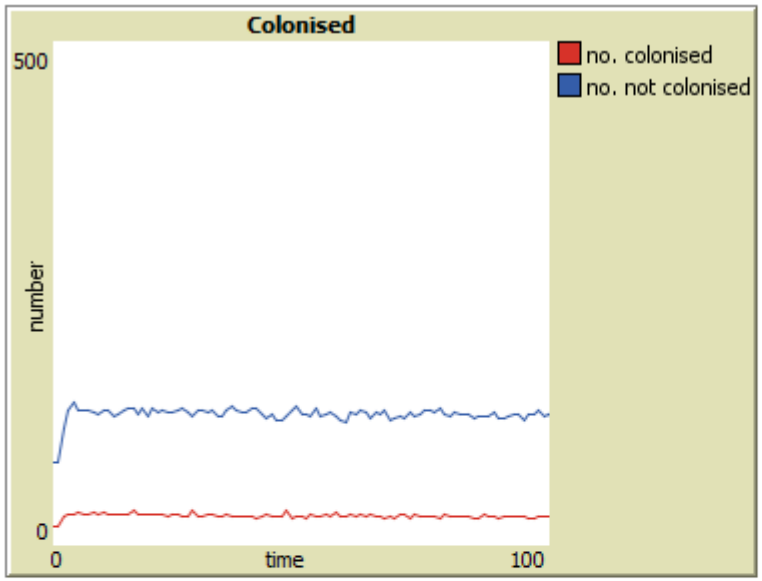
180/515 colonised (35%)

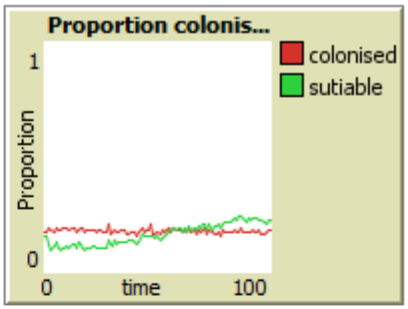


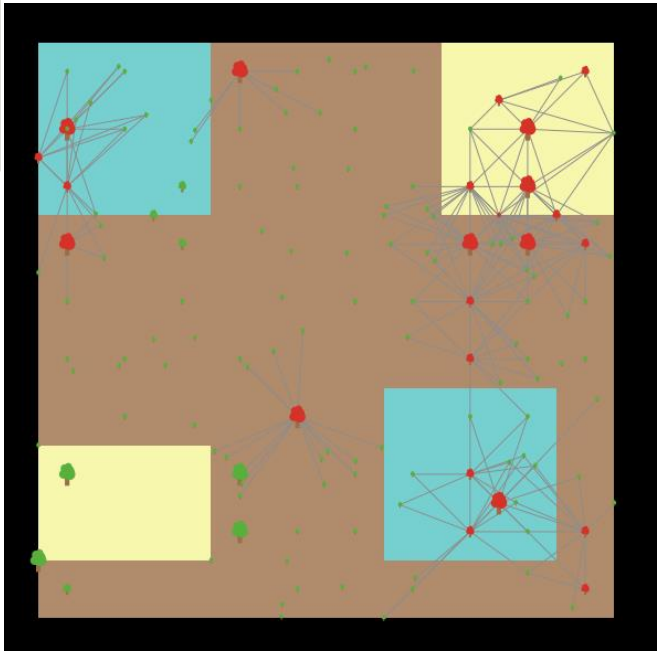


Scenario 1:
Grazing = high
Dispersal limited

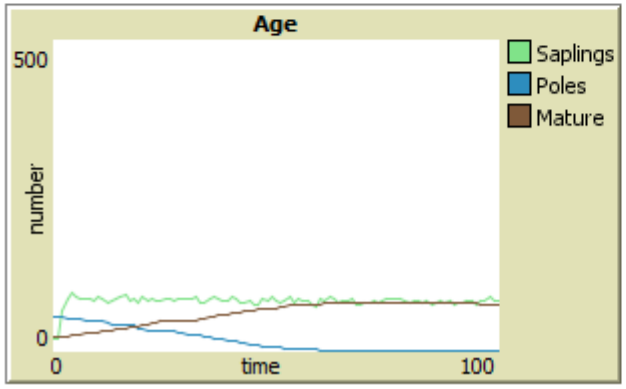
Nephroma parile

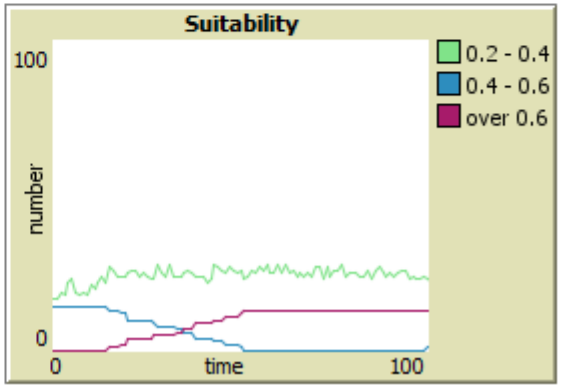




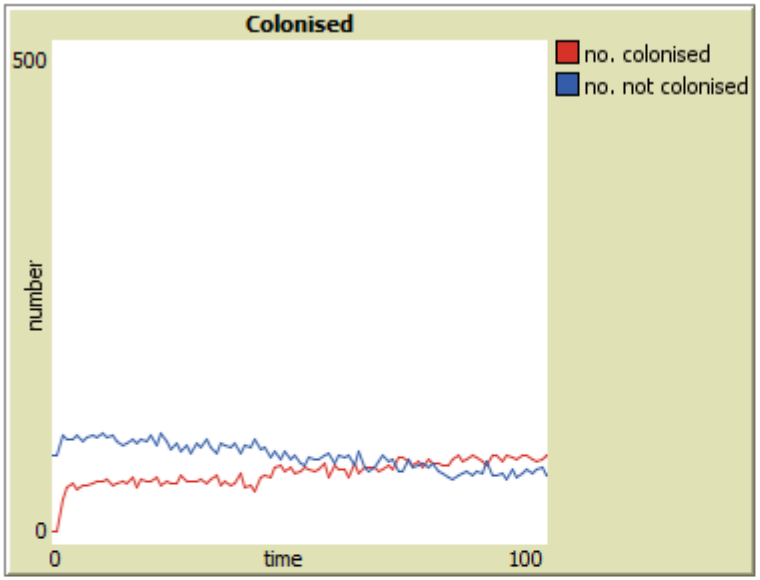


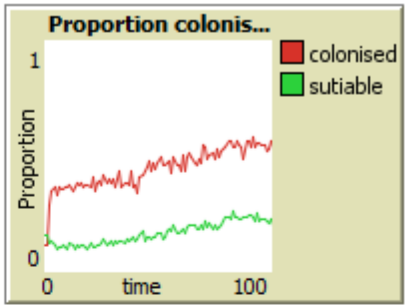
26/154 colonised (17%)

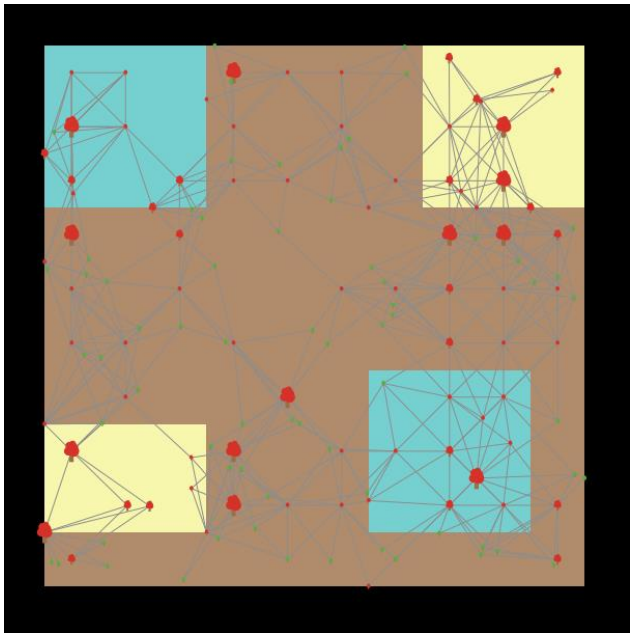




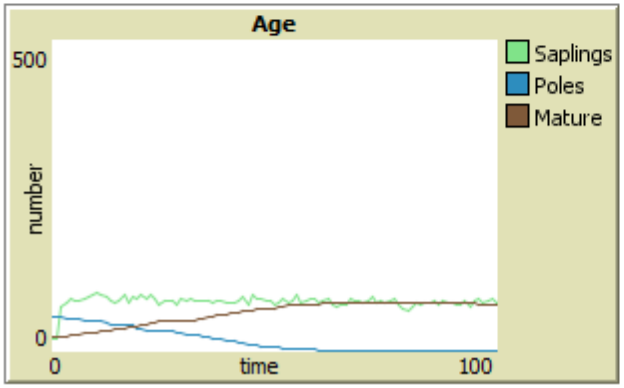
Scenario 2:
Grazing = high
Dispersal un-limited

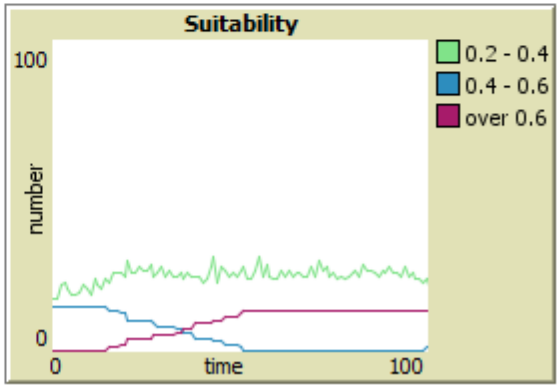




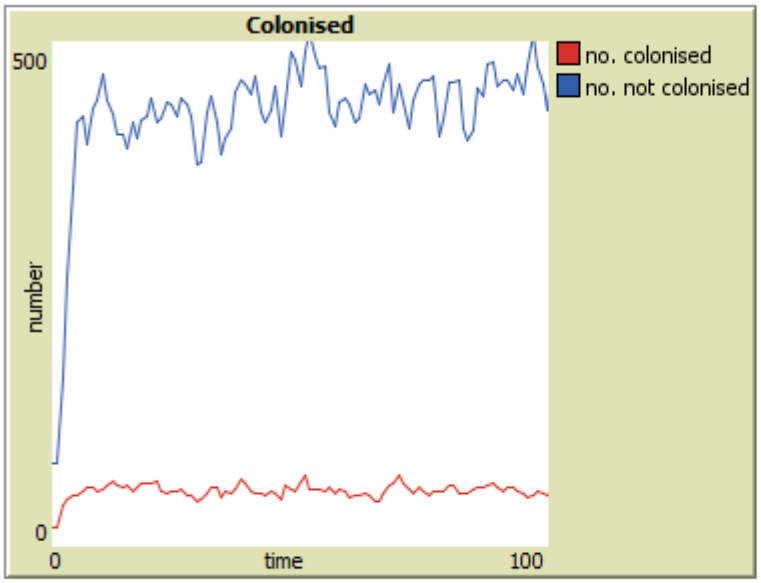


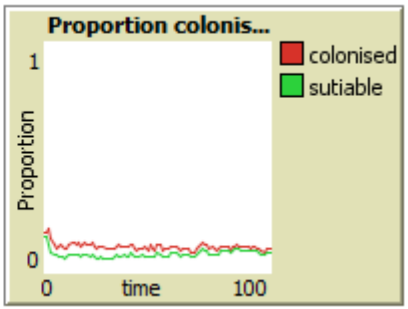
88/138 colonised (64%)

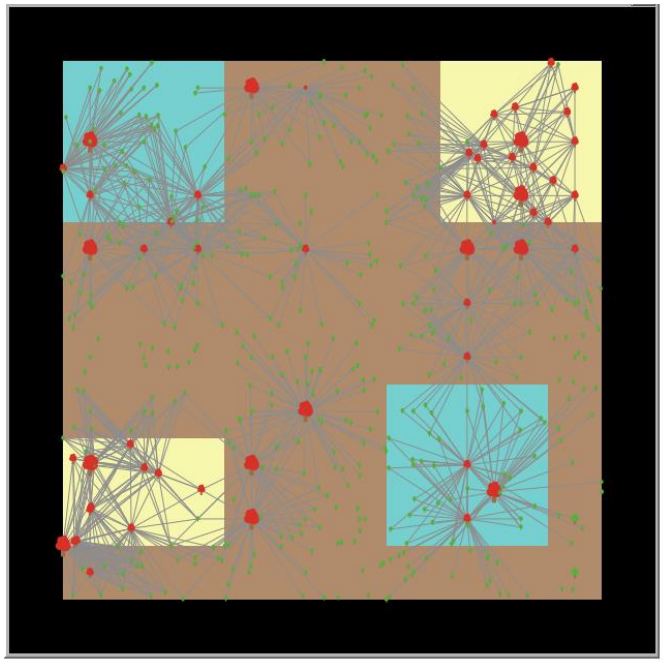




Scenario 3:
Grazing = low
Dispersal limited







39/417 colonised (9%)