Land cover data, land cover change in Scotland's National Parks, and understanding your use/needs

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SEFARI
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Scottish Government
Riaghaltas na h-Alba

The James Hutton Institute

Outline

1) Landcover data and your use of it:
-what, why important, examples and your use/needs.

2) Our assessment of regional land cover change:
-previous work, engagement, criteria, datasets and results.

Land cover data and land cover change

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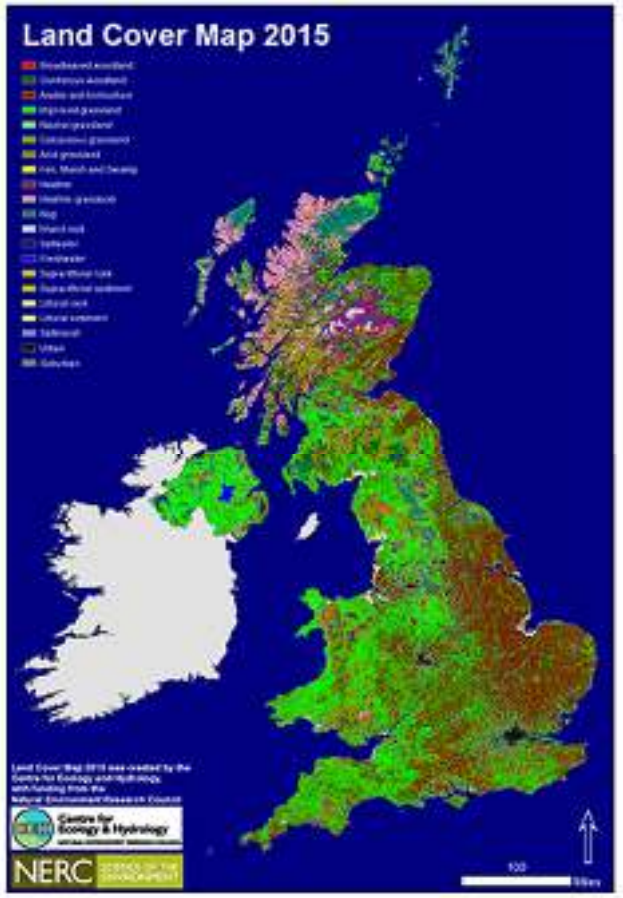
What is it?

Land cover the physical elements occupying the earth's surface.

Land use the human activity which is carried out at a particular location e.g. Integrated Administration and Control System (IACS).

Land cover change

Focus on observation and analysis of changes on the earth's surface. Natural and human driven processes.



Why important?

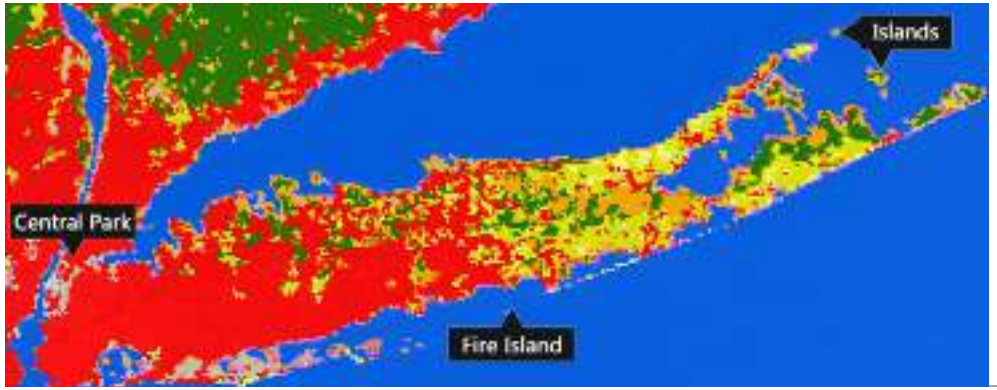
Assessing natural capital and ecosystem services or SRDP targeting.

Wide range of modelling studies.

10-60 m Sentinel 2

300 m ENVISAT MERIS sensor CCI Land Cover V2

500 m MODIS



How produced?

-sensor, purpose and steps

-diverse products

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Land Cover of Scotland (LCS88) and New Image of Scotland 1999

First-ever national medium-scale (1:25000) digital land cover map in Europe.

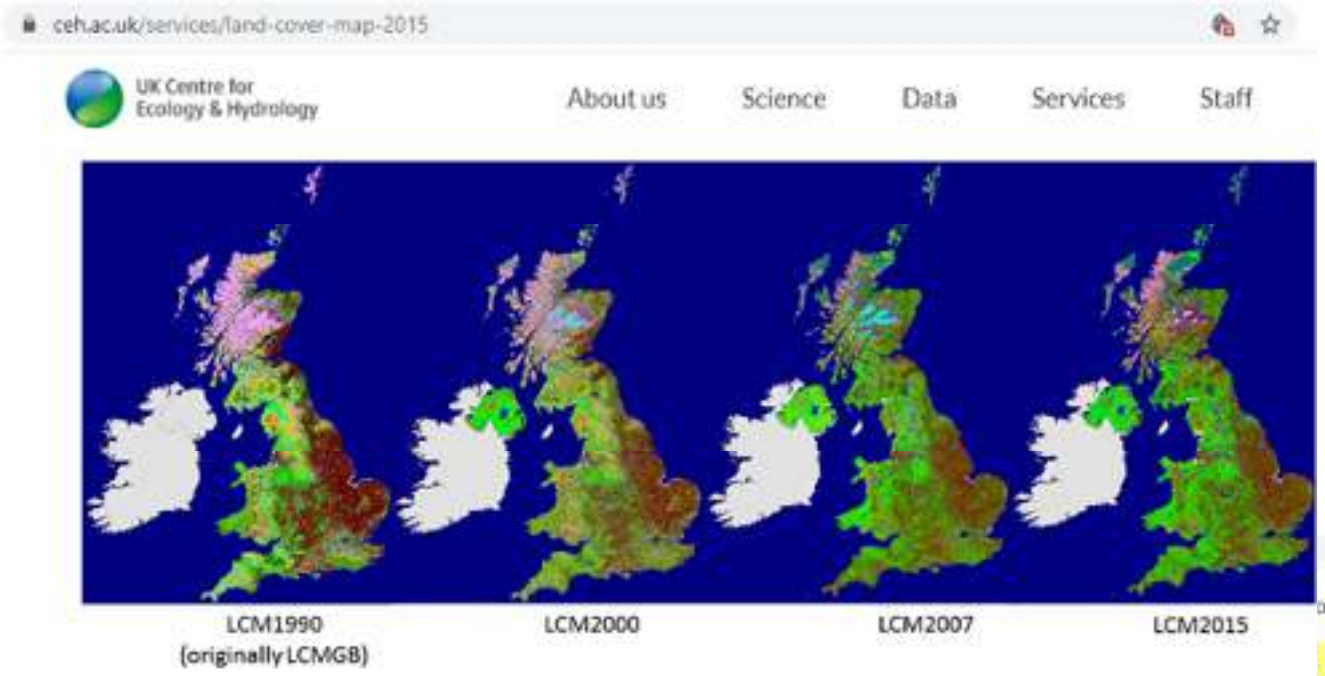
Steps

1-Aerial photography (1987-89).
2-Interpretation, extract information and digital dataset (1989-93).
3-Ground validation of the data.

Co-ordinated: Scottish Office Environment Department, The Scottish Office Agriculture and Fisheries Department, Nature Conservancy Council and Countryside Commission for Scotland (SNH) and the Forestry Commission.

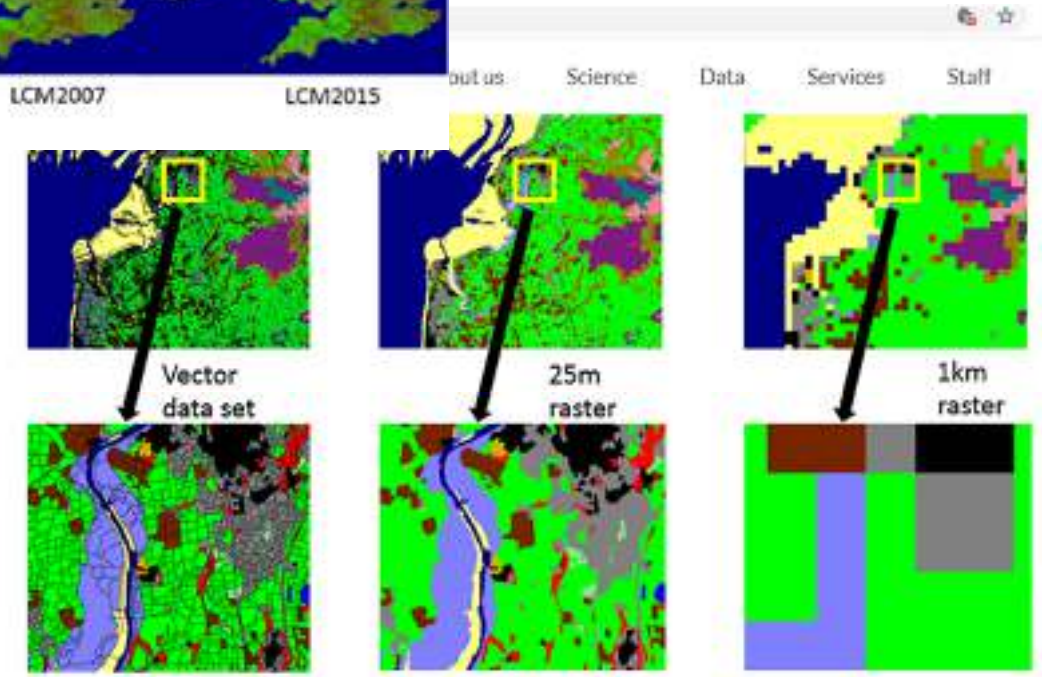
1999 New Image steering group meetings.

UK Land cover map series



Derived from satellite images and digital cartography.

Based on UK Biodiversity Action Plan Broad Habitats classes.



Comparison of the level of spatial detail in the vector product, 25m raster product and 1km dominant cover raster product for an area ~ 35km x 36km (top images) and ~ 6km x 6km (lower images) © NERC (CEH) 2017

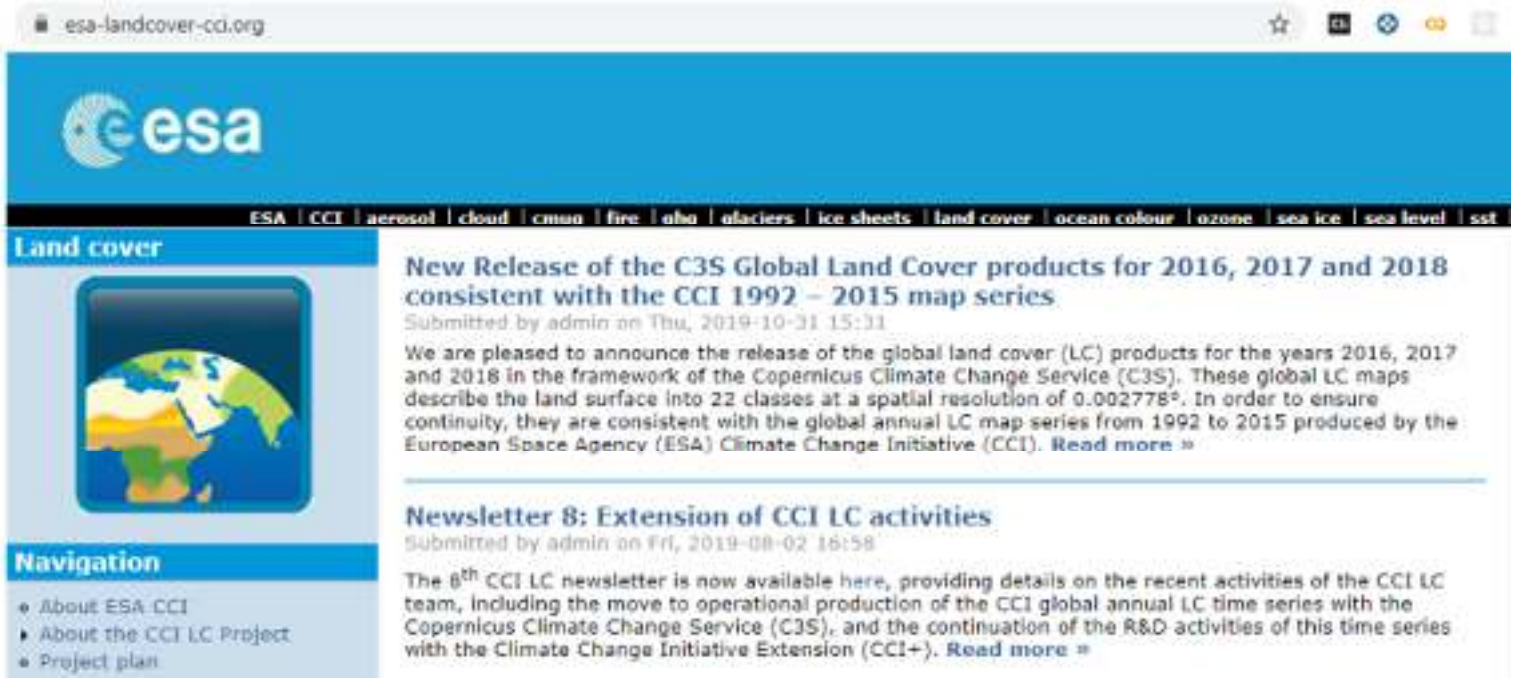
CORINE (coordination of information on the environment) land cover series

Initiated in 1985 (ref year 1990).

Inventory of land cover in 44 classes.
Minimum Mapping Unit (MMU) of 25 ha and a minimum width of 100 m.

	CLC1990	CLC2000	CLC2006	CLC2012	CLC2018
Satellite data	Landsat-5 MSS/TM single date	Landsat-7 ETM single date	SPOT-4/5 and IRS P6 LISS III dual date	IRS P6 LISS III and RapidEye dual date	Sentinel-2 and Landsat-8 for gap filling
Production time	10 years	4 years	3 years	2 years	1.5 years

ESA Climate Change Initiative Land Cover



Systematic monitoring of the global climate system.

Global coverage with a spatial resolution of 300 x 300 m.

1992- annual series.

Iarla Kibane-Dawe (Head of Φ-lab Division)

The James Hutton

Iarla Kibane-Dawe (Head of Φ-lab Division)

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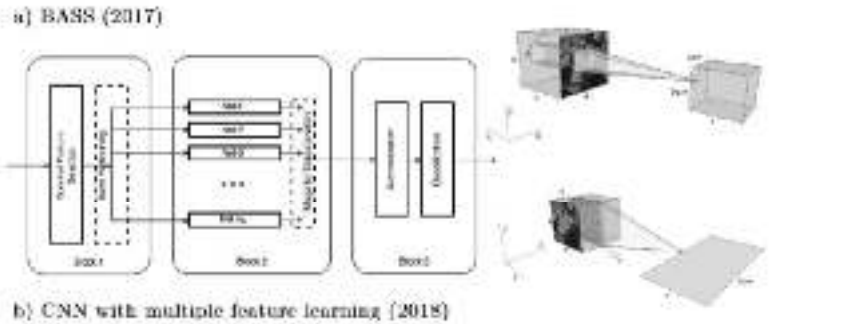
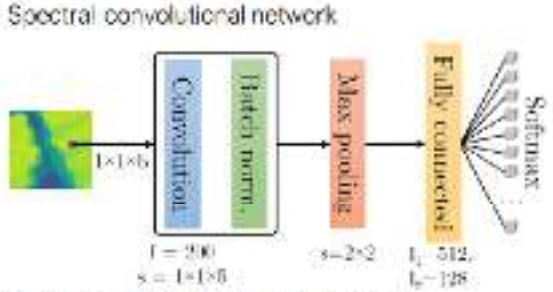
Hyperspectral image segmentation

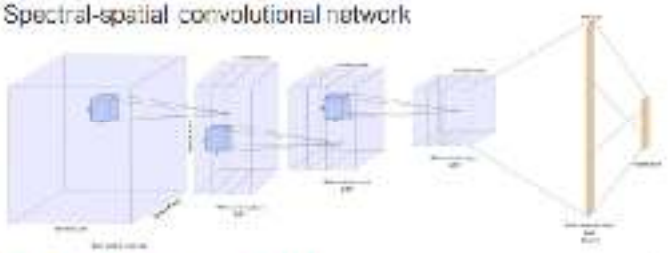
esa

We achieve the **state-of-the-art segmentation quality (TO.2)** using various deep neural network architectures (both from the literature: a-b, and ours: c-d):

- Spectral deep neural networks
- Spatial-spectral neural networks (we proposed the first „real" 3D CNN in the literature - d)







Vector tiles

- A broad collection of natural, built, and place data
- Global elevation data
- Constantly updating traffic data
- Open standard

Vector tiles make huge maps fast while offering full design flexibility. They are the vector data equivalent of image tiles for web mapping, applying the strengths of tiling — developed for caching, scaling and serving map imagery rapidly — to vector data.

How web maps work

Traditionally, maps are created from image tiles. Like for instance this PNG image tile depicting the corner of lower Manhattan with roads, building footprints, and parks:

To get the underlying vector tile data that makes up this image, you can request it specifically:

```
http://a.tiles.mapbox.com/v4/mapbox.mapbox-streets-v7/14/4823/6160.vector?access_token=<your access token>
```

ordnancesurvey.co.uk/business-government/products/open-zoomstack

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A single data file

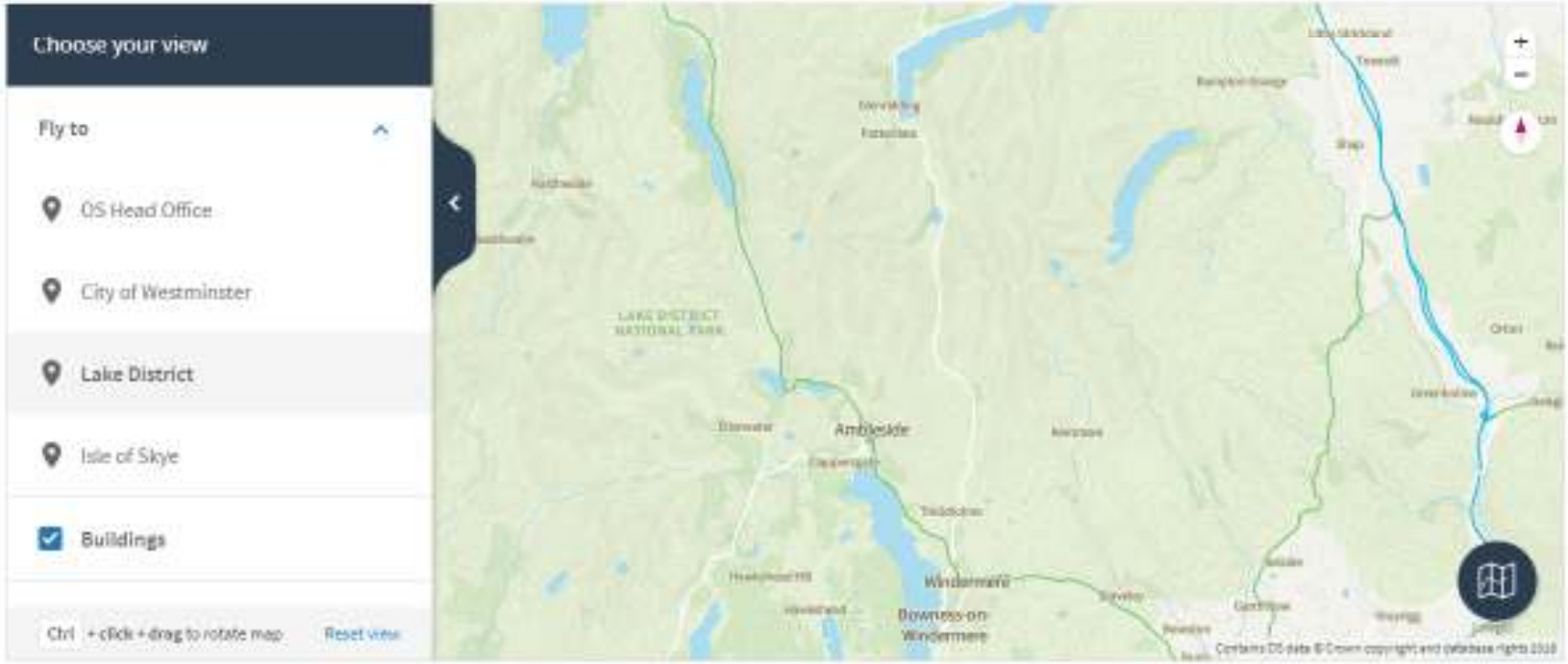
There's no need to crunch 1000's of data files – we've done it for you. The data is available in just one single file. It's provided in easy-to-use formats to help you get started quickly.

Flexible

The data is compatible with Geographic Information Systems (GIS), web, mobile and offline systems. It's highly customisable, giving you the flexibility you need.

Advanced

Vector Tiles contain actual data and not just images, which can be interrogated and analysed. The high-definition mapping also renders quickly, giving a seamless experience.



Land cover data questions

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1) Who has used land cover data in the past couple of years?
2) What land cover (or land use) data do you use and for what purposes?
3) What data model, format and how used (raster/image or vector; shapefile or geodatabase, web mapping service, web feature services or vector tile; desktop or web/mobile app)?

Macaulay Development Trust project related to vector tiles and are interested in your use or interest in them.

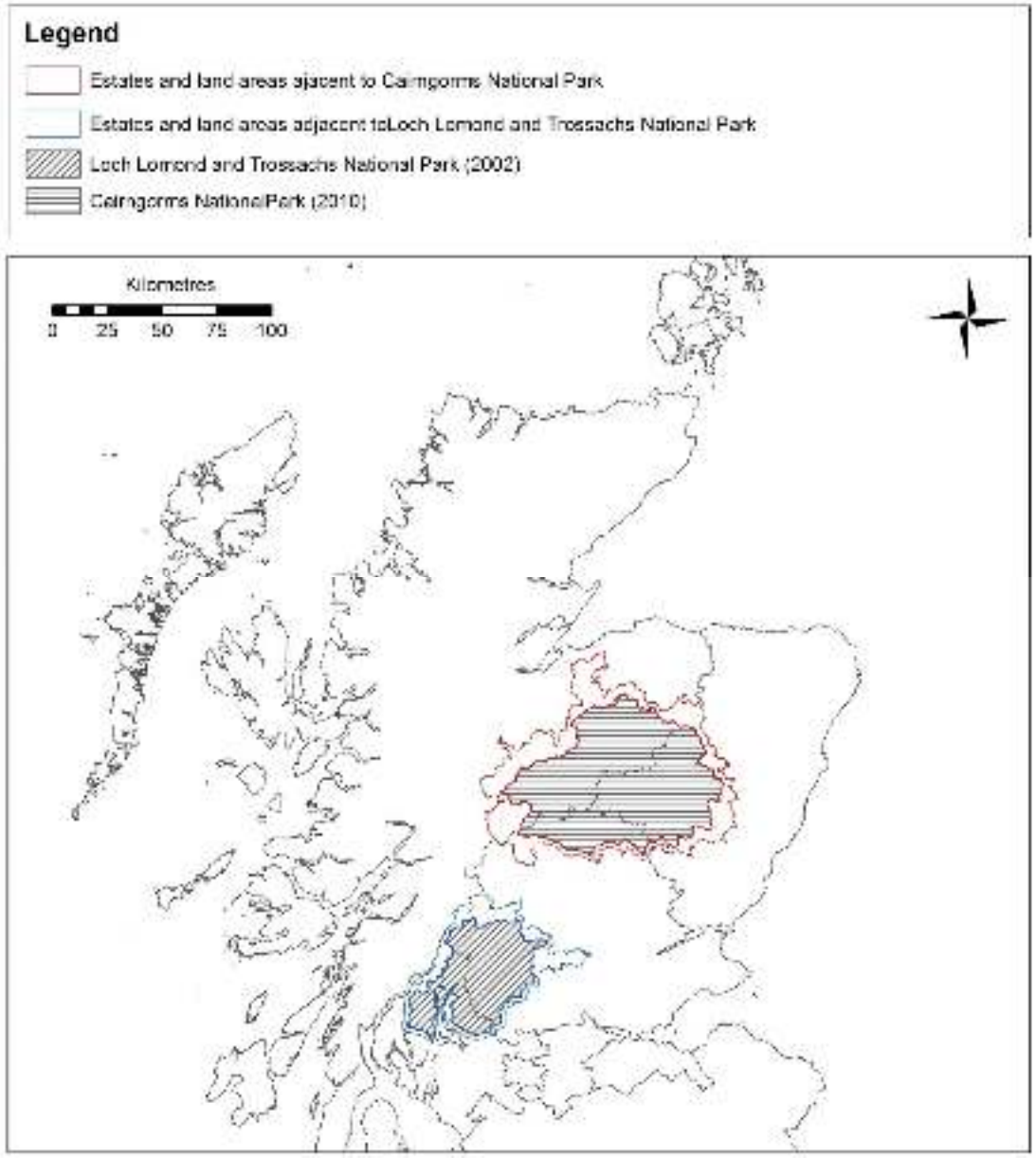
National Park land cover change

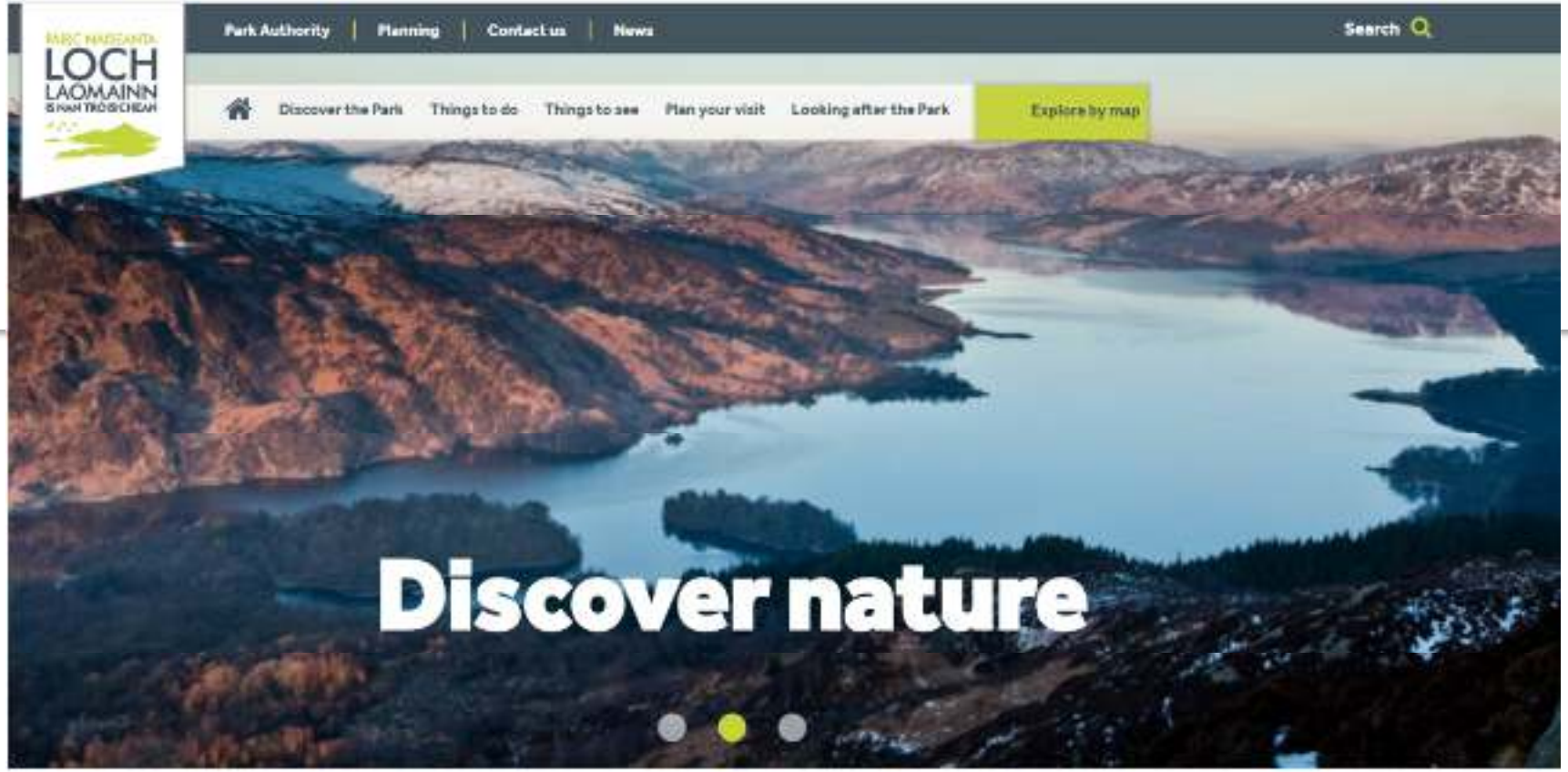
Based on ongoing conversations with National Park colleagues.

Explored previous studies.

Developed a set of criteria to evaluate existing land cover datasets.

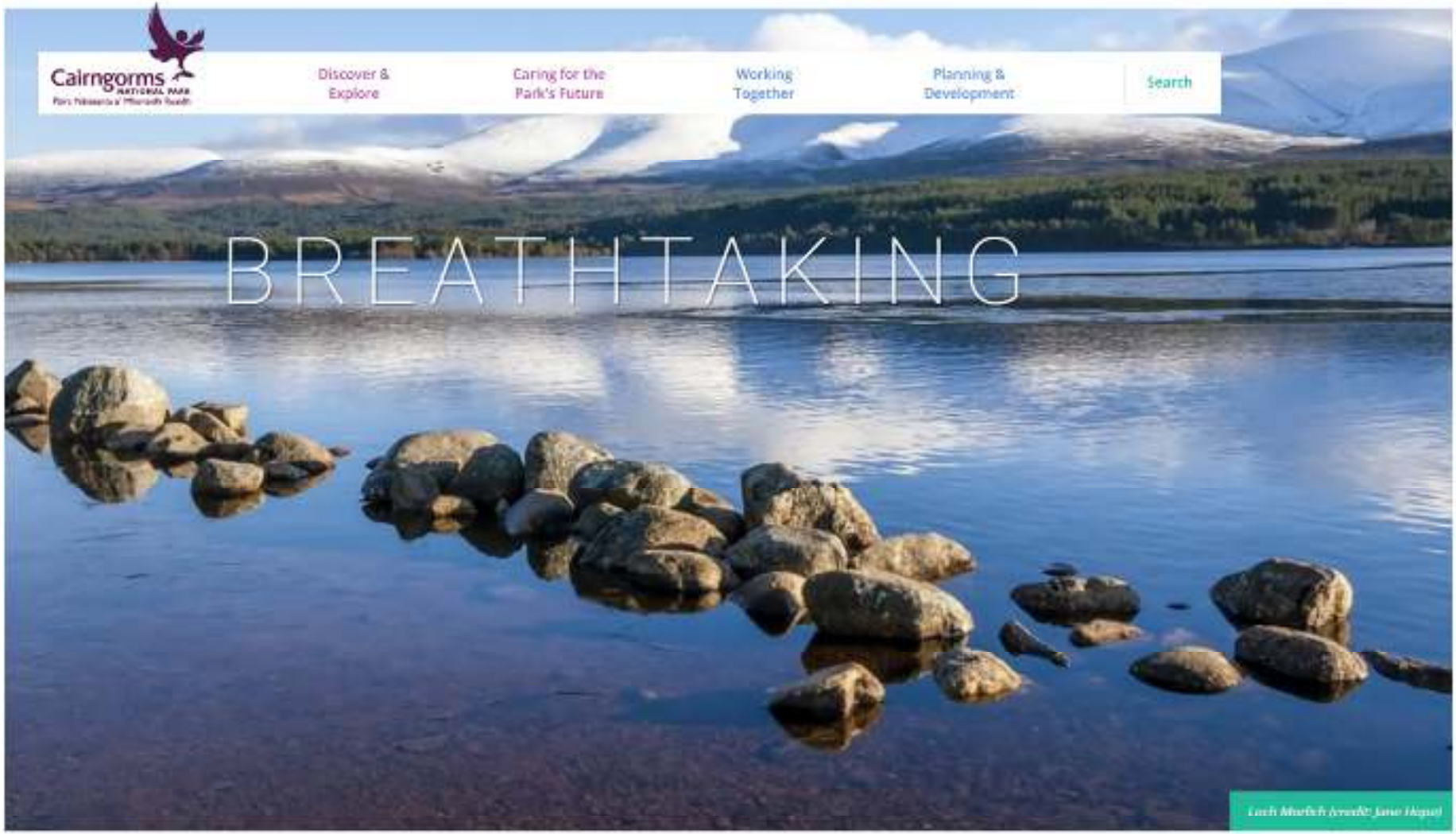
Analysed recent land cover changes in Scotland's National Parks.





Do something brilliant

Find a breathtaking view. An exhilarating ride. Or a moment on the loch shore.
Discover everything the National Park has to offer.



Safeguarding the Cairngorms National Park for Future Generations

We are helping Scotland reach 'Net Zero' carbon emissions by 2045 and here are some of the things we are already doing. However, to be successful, we will need everyone living and working in the Cairngorms to work together in one direction

Find out more here >

Cairngorms National Park: previous studies

1947-1988: significant expansion of rough grassland, plantation forest, bracken, wet ground, scattered trees, built up areas/transport corridors and bare ground; significant decreases in coniferous woodland, broadleaved woodland, managed grassland, heather moorland and blanket mire (Mackey et al 1998).

In a final note, of relevance to the current report, the authors observe that “the existing stock of change data is inadequate for today’s needs” (Mackey and Shewry 2006).

Loch Lomond & The Trossachs National Park: previous studies

Unable to identify any detailed assessment of land cover change in the recent past.

Climate Change Education Pack: Section 7 Land Use in the National Park, notes that “recent significant land use changes have included the spread of commercial forestry, the abandonment of grazing land for livestock in some areas and the growth of renewable energy production such as run of river hydro schemes in parts of the Park and wind farm developments just outside the Park boundary”.

National Park land cover change: criteria

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1) Appropriate scale (large scale/detailed maps; to ID 1-10 ha),
2) Detailed thematic classification,
3) More than one time period,
4) Dataset should include all land cover types,
5) Consistent mapping and classification methodology across dates,
6) Single integrated dataset, and
7) Accessibility.

No.	Short name	Dataset	Creator	Dates available	Scale and/or Resolution
1	LCS88	The Land Cover of Scotland 1988 (LCS88)	Macaulay Land Use Research Institute	1988	1:25,000
2	LCM	Land Cover Map (LCM) series	Centre for Ecology and Hydrology (CEH)	1990,2000, 2007 and 2015	Large scale boundary data (e.g. 1:2500 for 2007), but much smaller scale information, e.g. 120,000 for soils. See Morton et al 2011 25x25m resolution raster
3	FC	Forestry commission (FC) forestry surveys (various), e.g. Native Woodlands Survey for Scotland 2014, National Forestry Inventory for Scotland 2015, National Forest Estate Legal Boundary for Scotland 2016.	Forestry Commission	2010-15, earlier dates also may be available, e.g. National inventory of woodland and trees (1995-99)	1:10000 or larger (e.g. 1:1250, 1:2500), based on Ordnance Survey MasterMap® Minimum mapped unit 0.5 ha
4	Agcensus	Agricultural census data for Scotland (Agcensus)	Scottish Executive: SEERAD and (from 2007) Environment Directorate.	Annually from 1969	2x2km resolution (nominal scale not stated)
5	IACS simple	IACS predominant* land use 2008-15 (IACS simple)	James Hutton Institute	2008-15	From 1:5000 (lowlands) to 1:50000 (uplands). Minimum mapped unit c. 0.2ha
6	IACS extended	IACS predominant* land use, extended crops classification (IACS extended)	James Hutton Institute	2008-15	From 1:5000 (lowlands) to 1:50000 (uplands). Minimum mapped unit c. 0.2ha
7	HABMOS	Habitat Map of Scotland (HabMoS) (EUNIS Land Cover)	Scottish Natural Heritage (SNH)	Nominal date of 2015	Multiple scales
8	CLC	Coordination of Information on the Environment (CORINE) land cover (CLC).	European Environment Agency and local partners	2000, 2006,2012 and 2018	1:100,000 100x100m resolution
9	CCI-LC	Climate Change Initiative Land Cover (CCI-LC)	European Space Agency (ESA).	1992-2015	300x300m resolution

Land cover change dataset: evaluation

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Dataset	Appropriate Scale	Detailed thematic classification	More than one time period	All land cover types	Consistent mapping and classification methodology across dates	Single integrated dataset	Accessible
LCS88	✓	✓	×	✓	NA	✓	✓
LCM	✓	✓	✓	✓	×	✓	×
FC	✓	✓	✓	×	NA	✓	✓
Agcensus	×	✓	✓	✓	✓	✓	×
IACS simple	✓	×	✓	×	✓	✓	×
IACS extended	✓	✓	✓	×	✓	✓	×
HabMoS	✓	✓	×	✓	NA	×	✓
CLC	✓	✓	✓	✓	✓	✓	✓
CCI-LC	×	✓	✓	✓	✓	✓	✓

Systematic land cover change: method

Time periods: 2006-2012 and 2012-2018.

National Park and surrounding areas.

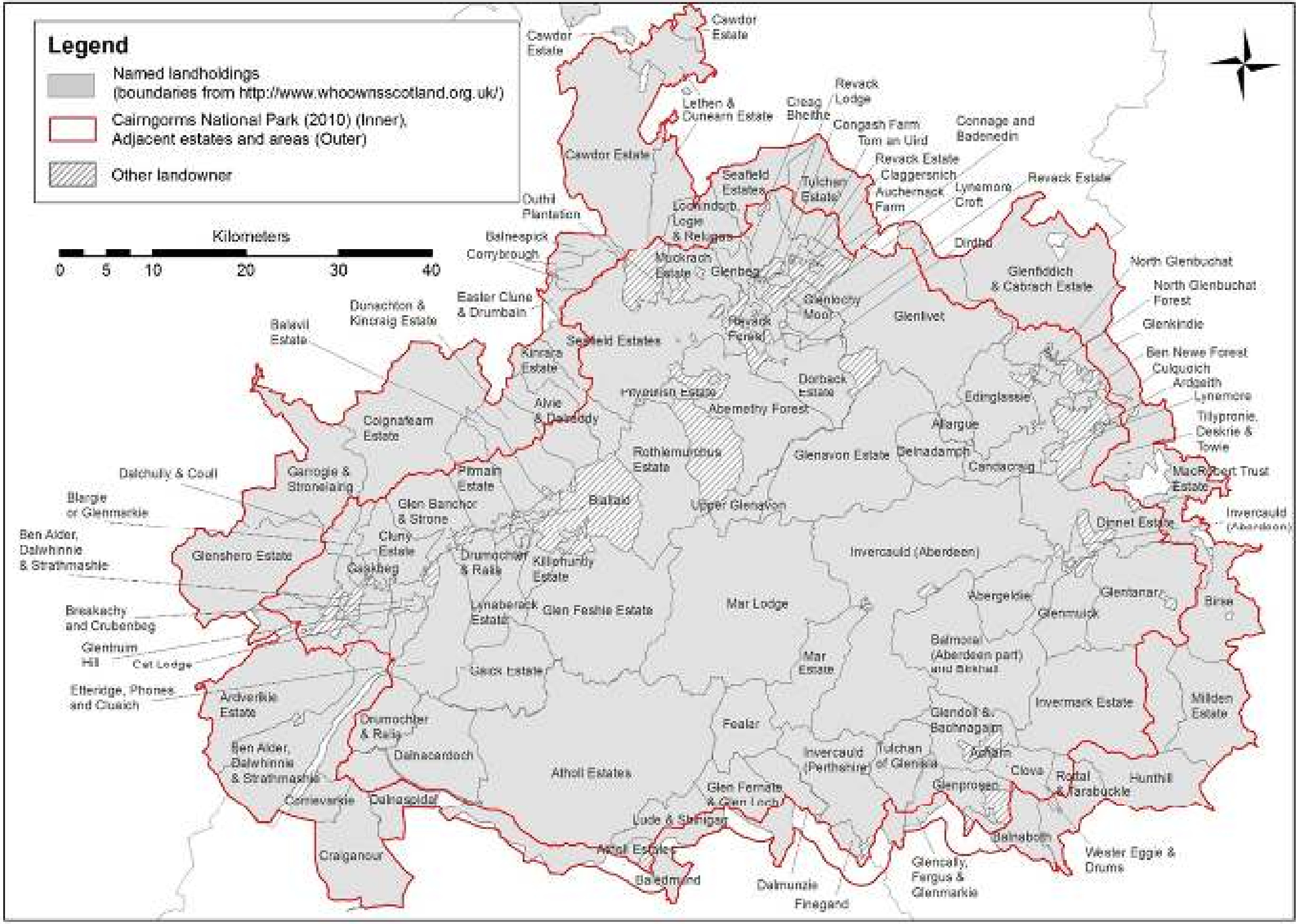
A statistical procedure (chi-square test) in which results obtained by the cross-tabulation method are compared with an "expected" results dataset in which losses and gains to each land cover class are evenly distributed to all other land cover classes according to the proportion of each land cover class.

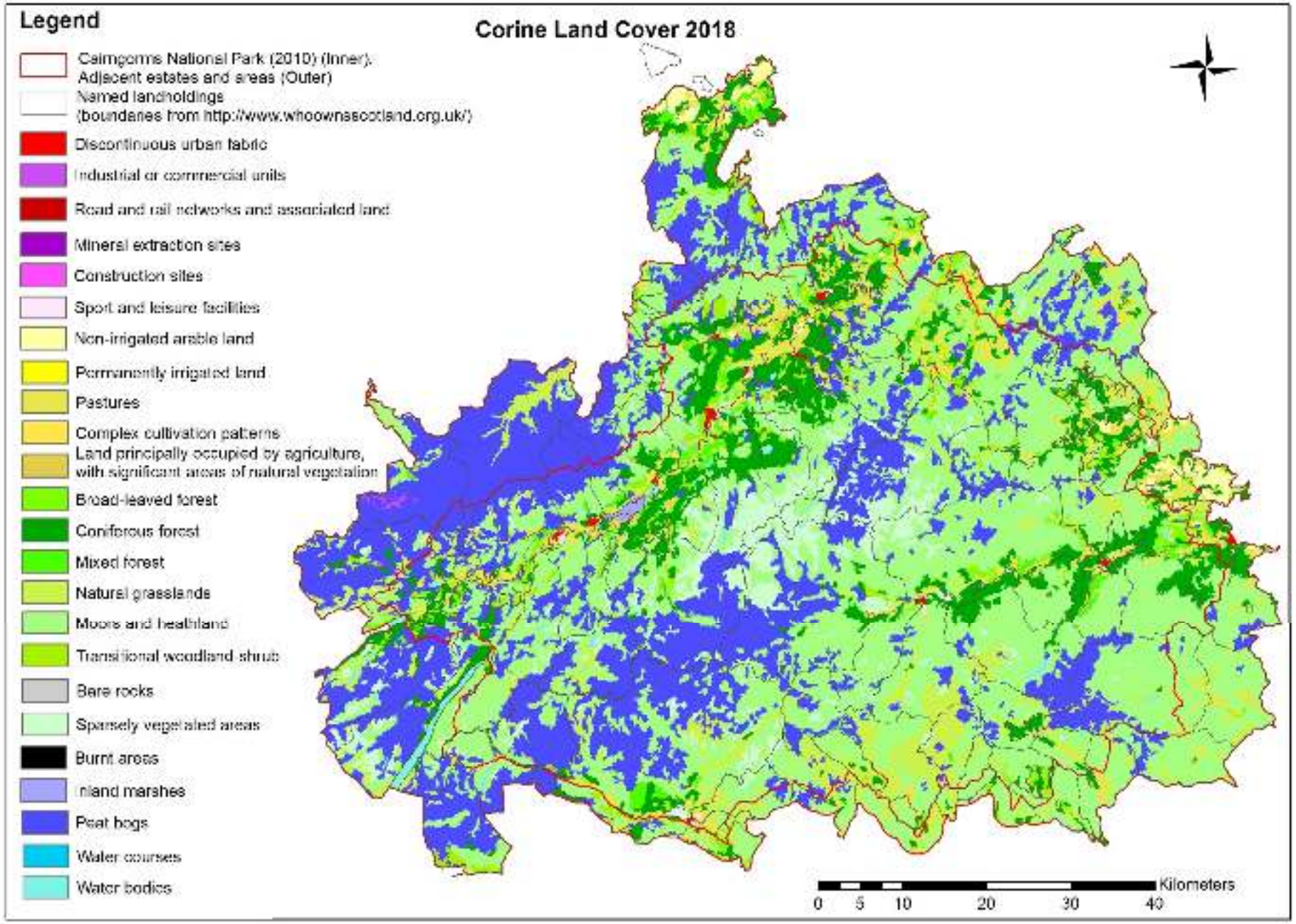
By comparing the real dataset with this random change dataset, we get an idea of the degree to which observed changes are non-random, i.e. systematic (Pontius *et al*., 2004).

National Park land cover change: results

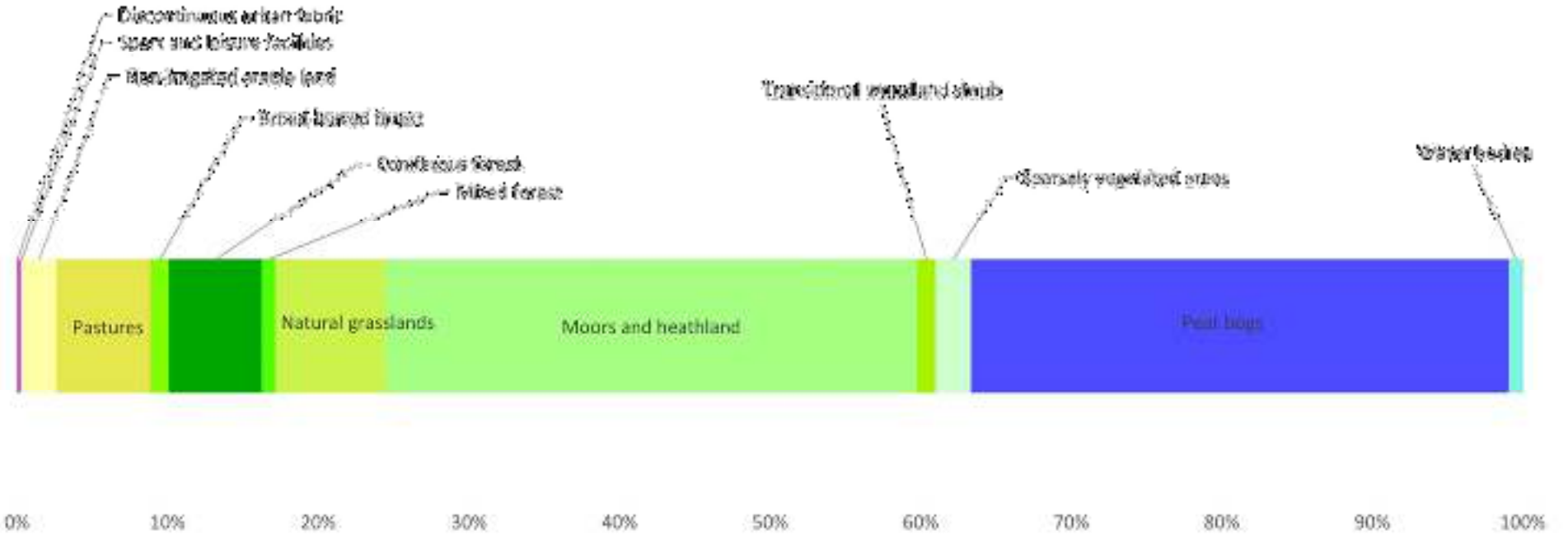
In both National Parks, more land cover change was detected in the period 2012-2018 than in 2006-2012, and

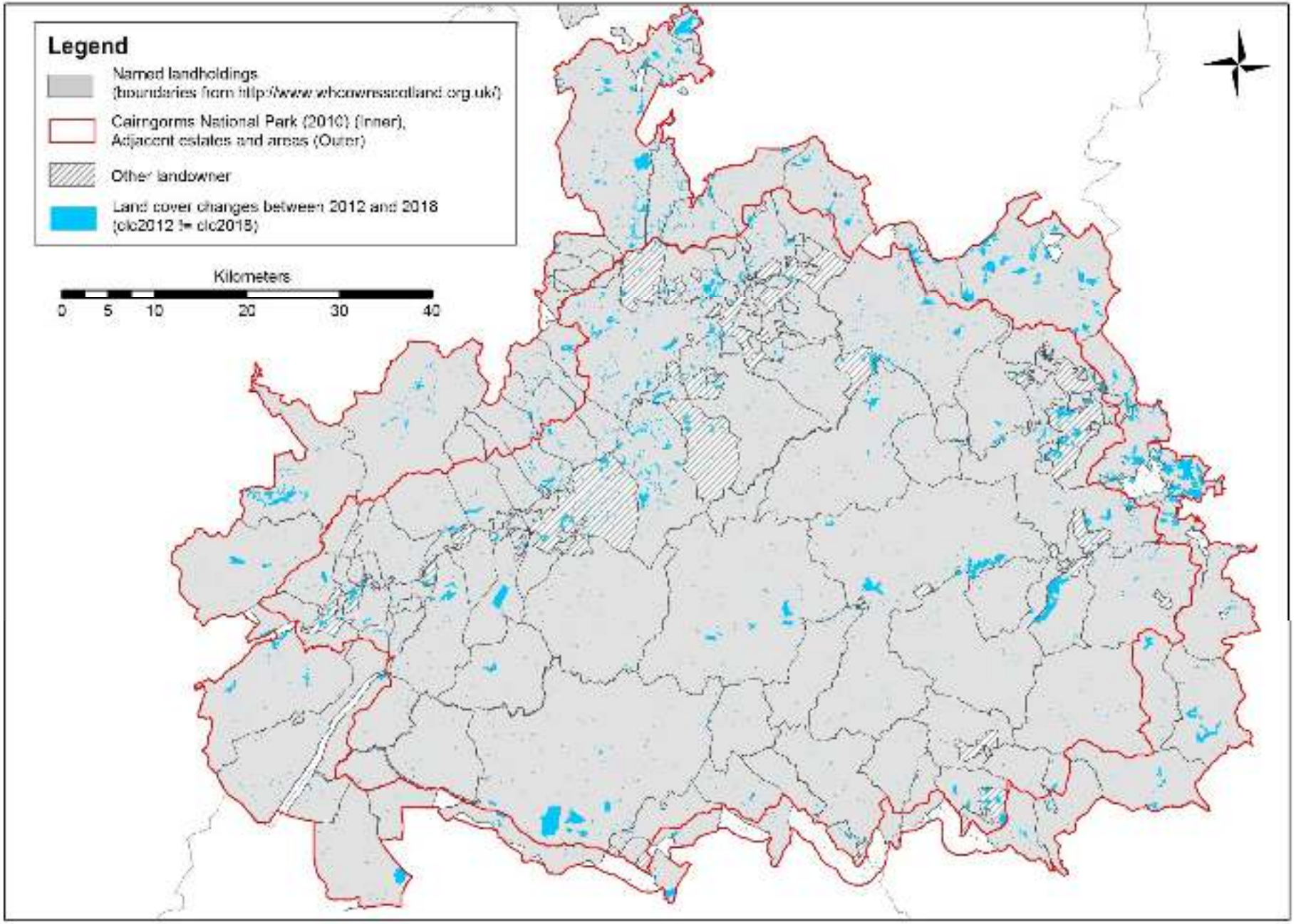
more land cover change was detected in the Loch Lomond & The Trossachs National Park and its adjacent land areas than in the Cairngorms National Park and its adjacent land areas.

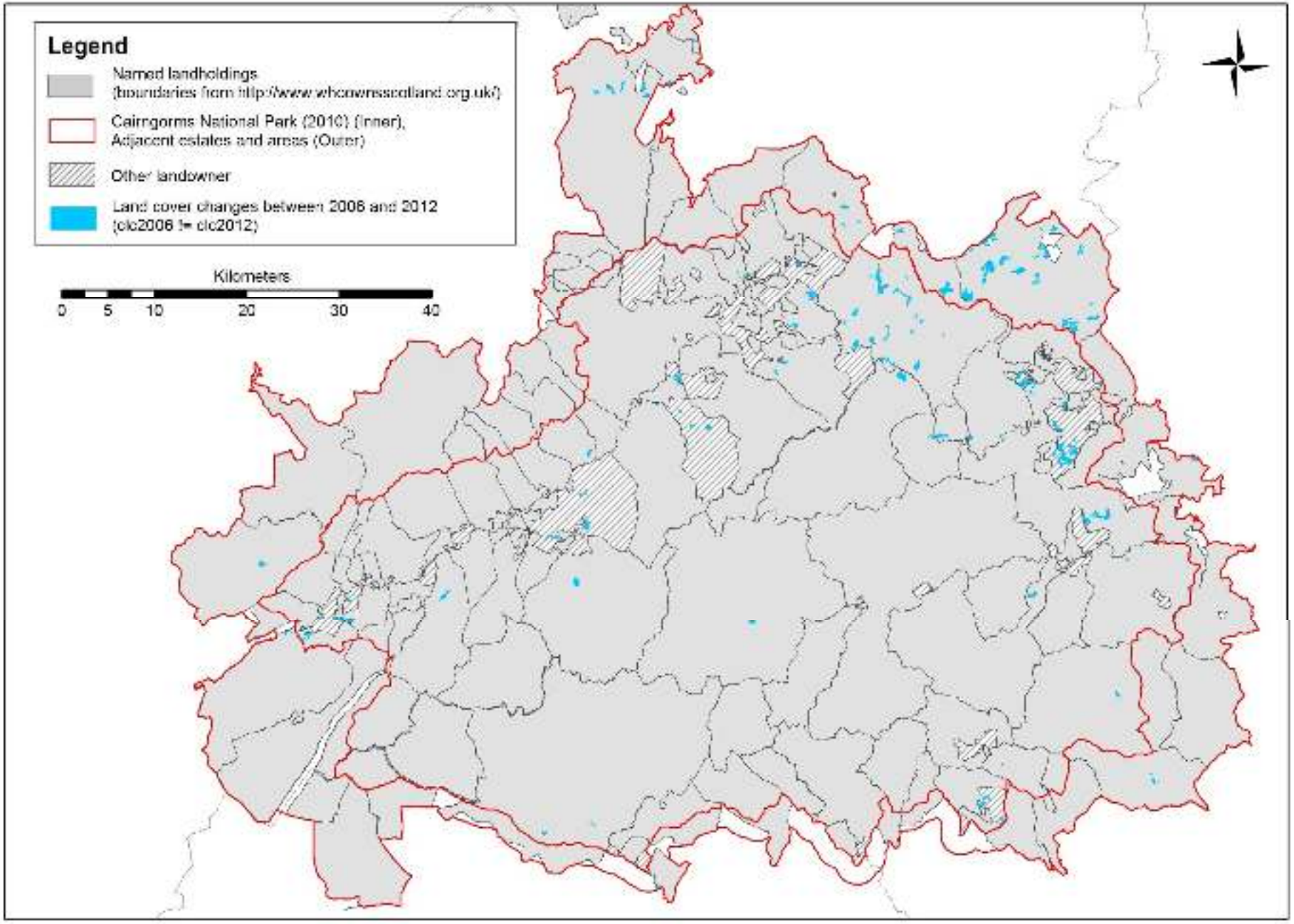

Legend
Named landholdings
(boundaries from http://www.whoownsscotland.org.uk/)
Cairngorms National Park (2010) (Inner),
Adjacent estates and areas (Outer)
Other landowner
Kilometers
0 5 10 20 30 40
Cawdor Estate
Lethen & Dunearn Estate
Creag Bheithe
Revack Lodge
Congash Farm
Tom an Uird
Connage and Badenedin
Revack Estate
Claggersnich
Auchernack Farm
Lynemore Croft
Revack Estate
Seafield Estates
Tulchan Estate
Lochindorb Lodge & Religious
Outhil Plantation
Balnespick
Corrybrough
Muckrach Estate
Glenbeg
Dirdhu
Glenfiddich & Cabrach Estate
North Glenbuchat
North Glenbuchat Forest
Glenkindie
Ben Newe Forest
Culquoich
Ardgeith
Lynemore
Tillypronie, Deskrie & Towie
MacRobert Trust Estate
Invercauld (Aberdeen)
Easter Clune & Drumbain
Dunachton & Kincraig Estate
Balavil Estate
Kinrara Estate
Glenlochy Moor
Revack Forest
Glenlivet
Dorback Estate
Alvie & Dalraddy
Abernethy Forest
Edinglassie
Allargue
Delnadamph
Candacraig
Coignafearn Estate
Rothiemurchus Estate
Glenavon Estate
Dalchully & Coull
Garrogie & Stronelairg
Pitmain Estate
Ballaid
Upper Glenavon
Blargie or Glenmarkie
Glen Banchor & Strone
Cluny Estate
Dinnet Estate
Ben Alder, Dalwhinnie & Strathmashie
Glenshero Estate
Gaskbeg
Drumochter & Ralia
Killiehuntly Estate
Invercauld (Aberdeen)
Breakachy and Crubenbeg
Lynaberack Estate
Glen Feshie Estate
Mar Lodge
Abergeldie
Glentanar
Birse
Glenmuick
Glentruim Hill
Cat Lodge
Etteridge, Phones and Cluaich
Gaick Estate
Mar Estate
Balmoral (Aberdeen part)
Ardverikie Estate
Invermark Estate
Millden Estate
Drumochter & Ralia
Dalnacardoch
Fealar
Glendoll & Bachnagairn
Ben Alder, Dalwhinnie & Strathmashie
Atholl Estates
Invercauld (Perthshire)
Tulchan of Glenisla
Clova
Rottal & Tarabuckle
Hunthill
Glen Fernate & Glen Loch
Glenprosen
Corrievarkie
Dalnaspidal
Lude & Shingar
Balnaboth
Craiganour
Atholl Estates
Wester Eggie & Drums
Baledmund
Dalmunzie
Glencally, Fergus & Glenmarkie
Fineg and

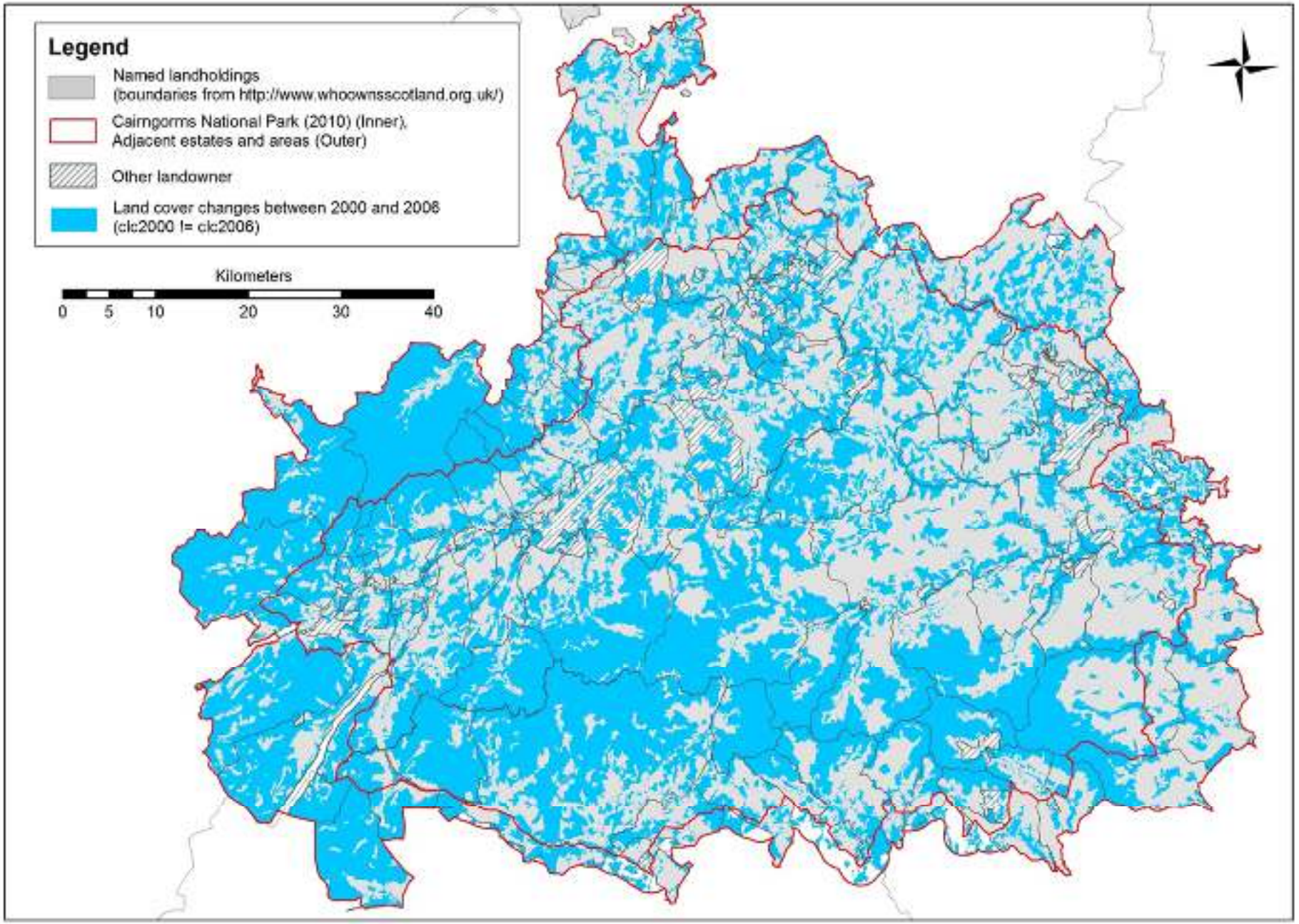

Legend
Cairngorms National Park (2010) (Inner).
Adjacent estates and areas (Outer)
Named landholdings
(boundaries from http://www.whoownsscotland.org.uk/)
Discontinuous urban fabric
Industrial or commercial units
Road and rail networks and associated land
Mineral extraction sites
Construction sites
Sport and leisure facilities
Non-irrigated arable land
Permanently irrigated land
Pastures
Complex cultivation patterns
Land principally occupied by agriculture, with significant areas of natural vegetation
Broad-leaved forest
Coniferous forest
Mixed forest
Natural grasslands
Moors and heathland
Transitional woodland shrub
Bare rocks
Sparsely vegetated areas
Burnt areas
Inland marshes
Peat bogs
Water courses
Water bodies
Corine Land Cover 2018
Kilometers
0 5 10 20 30 40

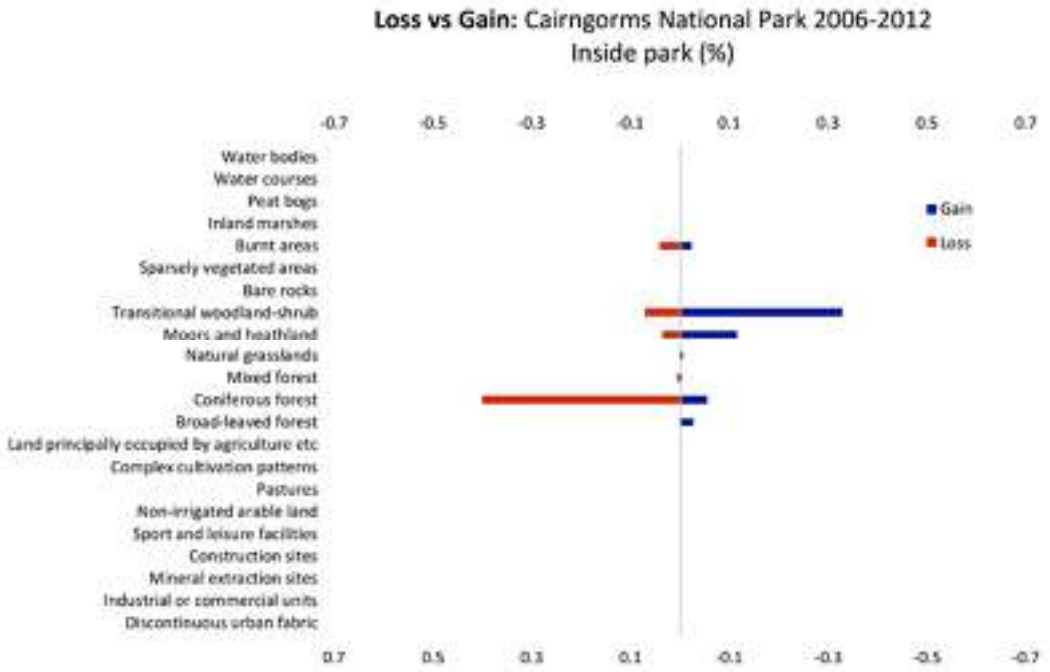

Cairngorms National Park - Land Cover 2018
Sport and leisure facilities
Broad-leaved forest
Coniferous forest
Mixed forest
Transitional woodland-shrub
Sparsely vegetated areas
Water bodies
Pastures
Natural grasslands
Moors and heathland
Peat bogs

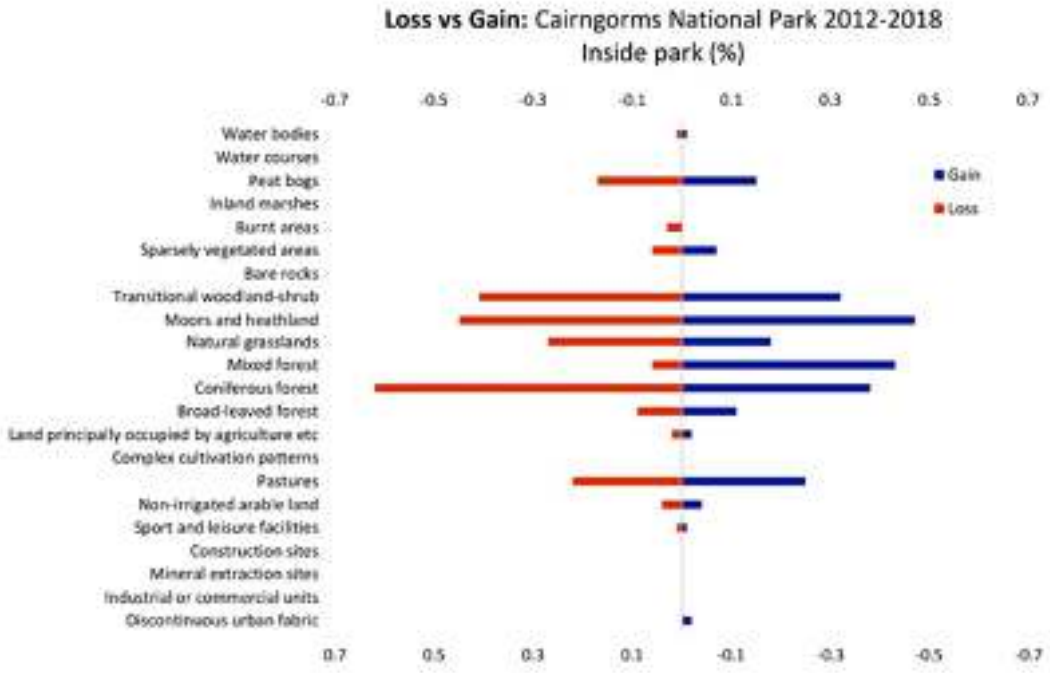

Estates and areas adjacent to Cairngorms National Park - Land Cover 2018
Pastures
Natural grasslands
Moors and heathland
Peat bogs
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%


Legend
Named landholdings
(boundaries from http://www.whoownsscotland.org.uk/)
Cairngorms National Park (2010) (Inner),
Adjacent estates and areas (Outer)
Other landowner
Land cover changes between 2012 and 2018
(clc2012 != clc2018)
Kilometers
0
5
10
20
30
40


Legend
Named landholdings
(boundaries from http://www.whoownsscotland.org.uk/)
Cairngorms National Park (2010) (inner),
Adjacent estates and areas (Outer)
Other landowner
Land cover changes between 2006 and 2012
(clc2006 != clc2012)
Kilometers
0
5
10
20
30
40


Legend
Named landholdings
(boundaries from http://www.whoownsscotland.org.uk/)
Cairngorms National Park (2010) (Inner),
Adjacent estates and areas (Outer)
Other landowner
Land cover changes between 2000 and 2008
(clc2000 != clc2006)
Kilometers
0
5
10
20
30
40





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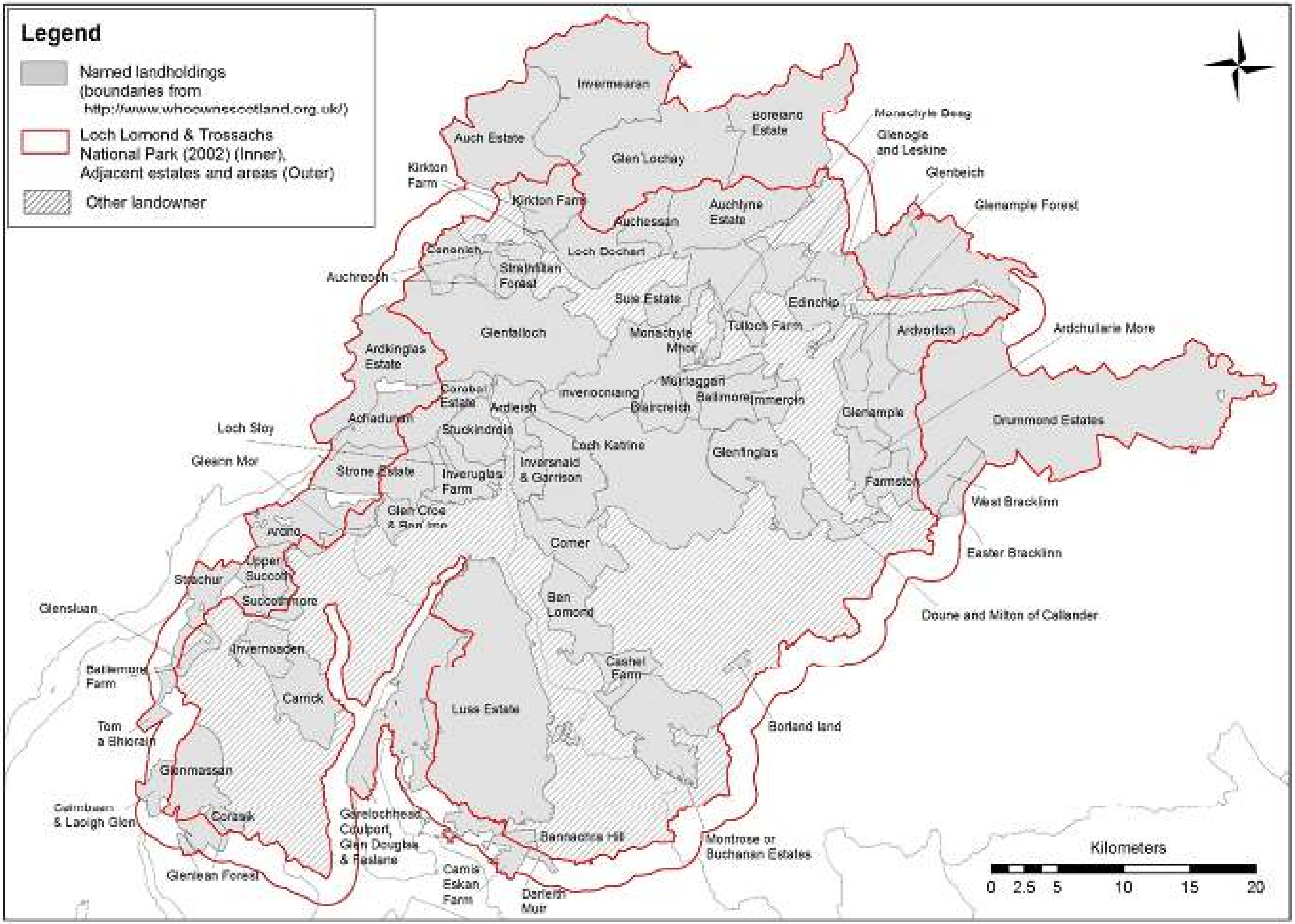
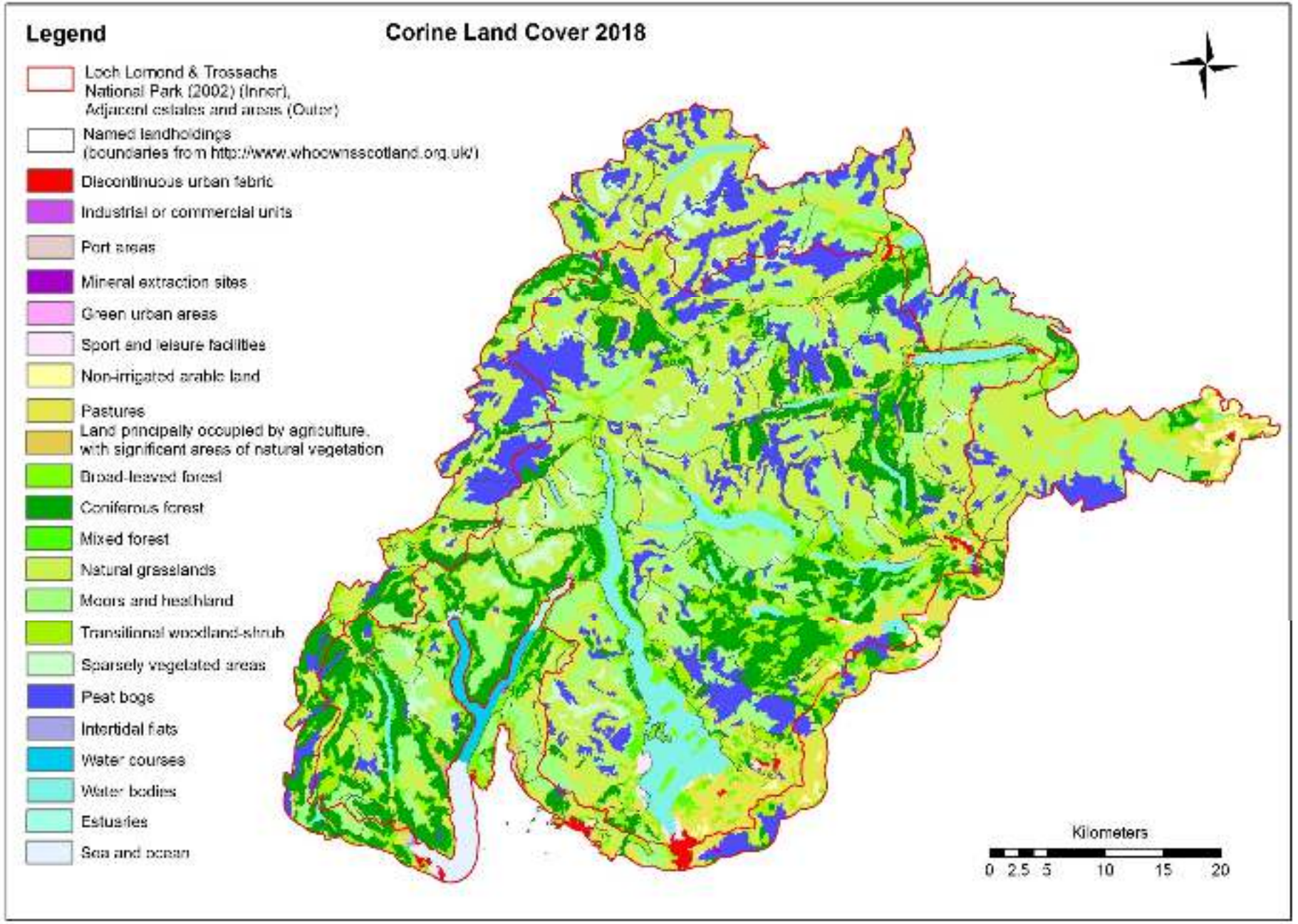
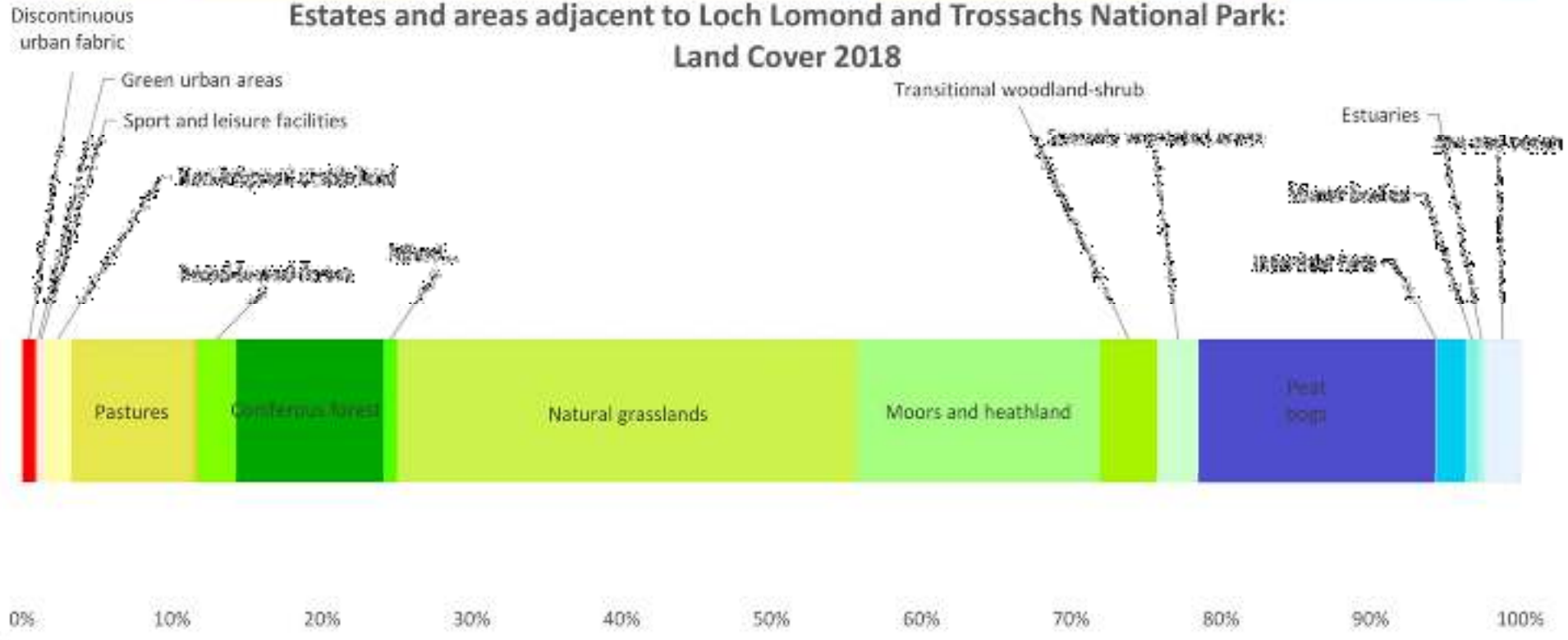
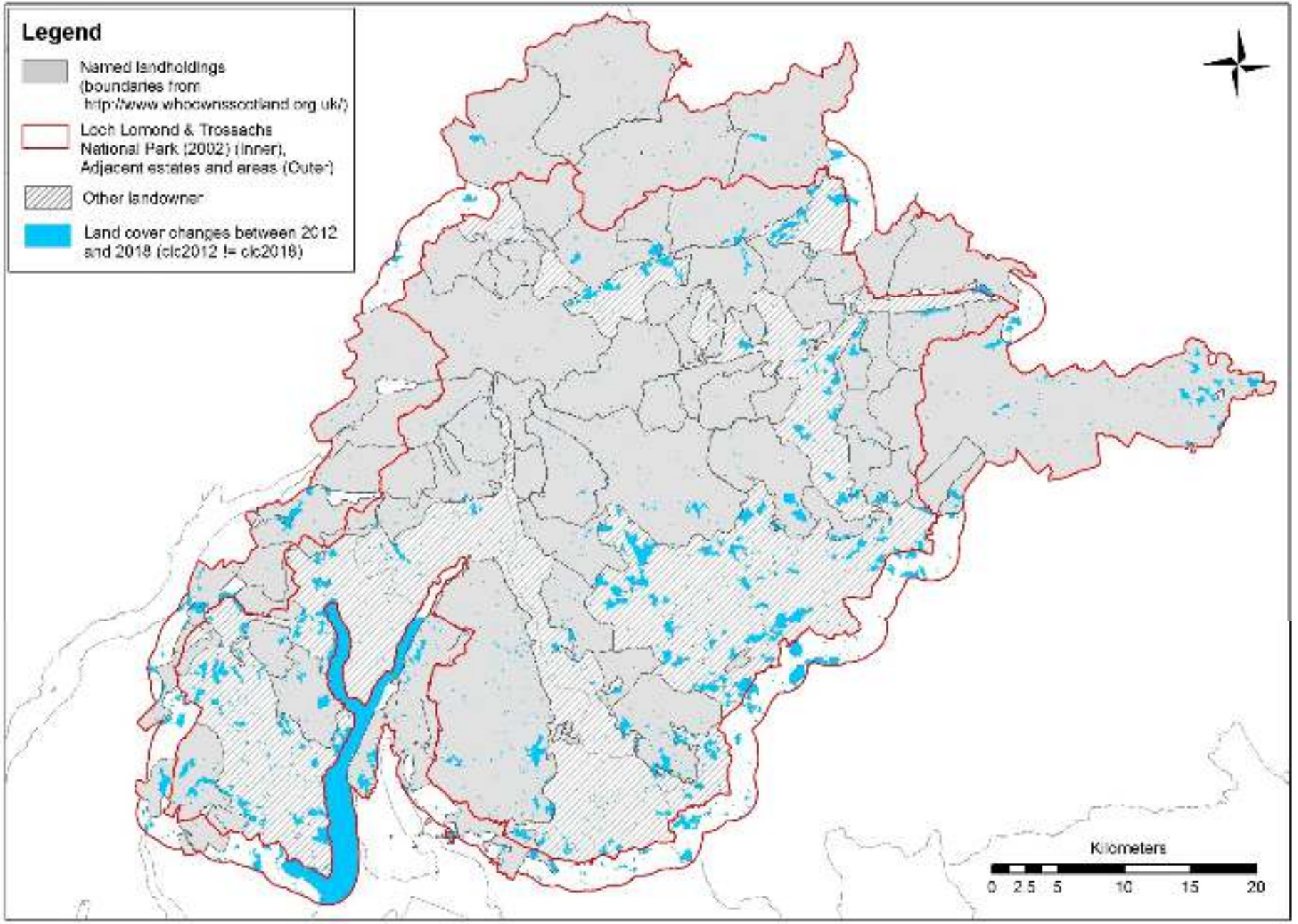
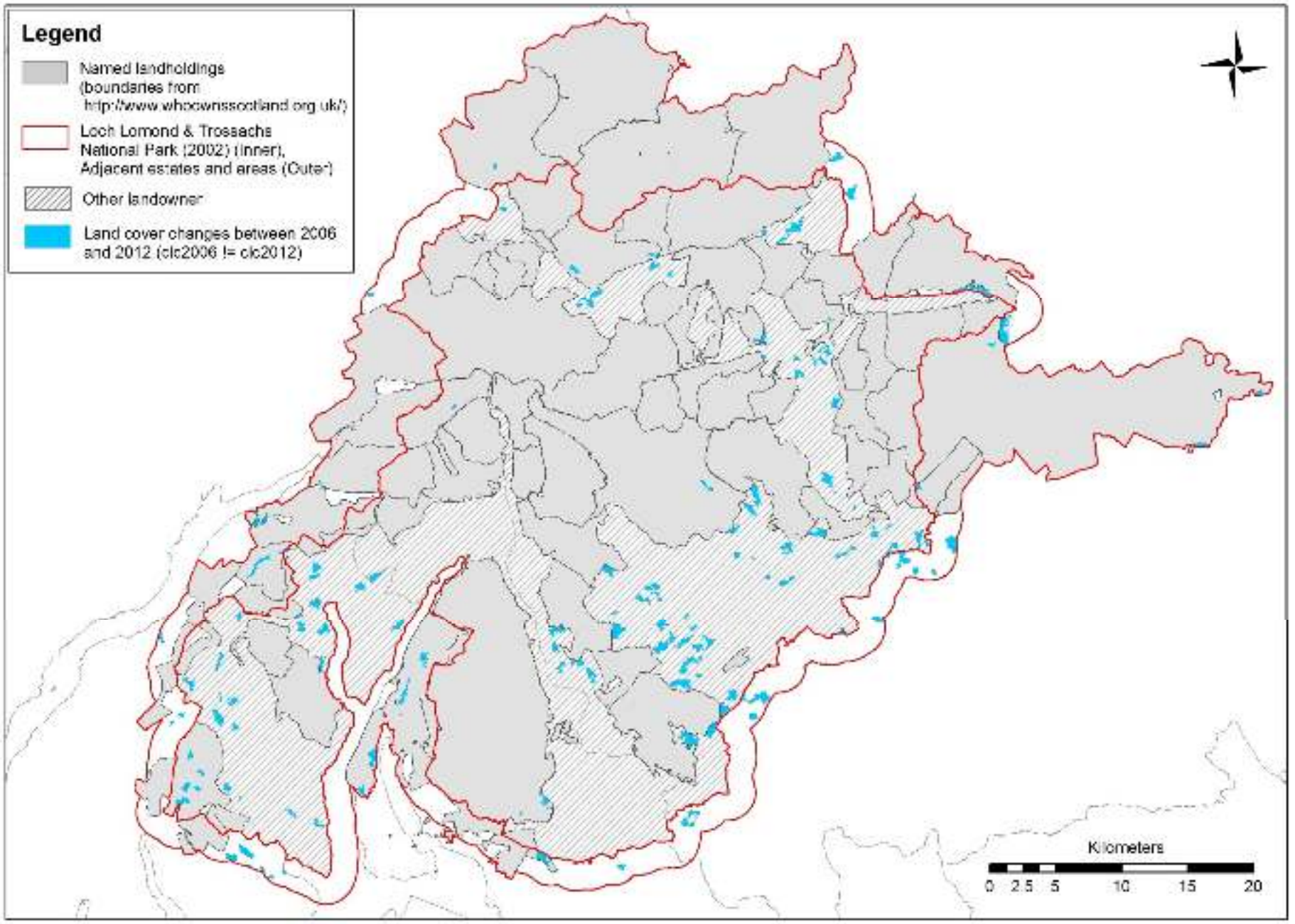

Legend
Named landholdings (boundaries from http://www.whoownsscotland.org.uk/)
Loch Lomond & Trossachs National Park (2002) (Inner), Adjacent estates and areas (Outer)
Other landowner
Invermearan
Auch Estate
Boreland Estate
Glen Lochay
Monachyle Beag
Glenogle and Leskine
Glenbeich
Kirkton Farm
Kirkton Farm
Auchessan
Auchlyne Estate
Glenample Forest
Loch Dochart
Auchreoch
Strathfillan Forest
Suie Estate
Edinchip
Glenfalloch
Monachyle Mhor
Tulloch Farm
Ardvorlich
Ardchullarie More
Ardkinglas Estate
Muirlaggan
Inversnaid
Balmore
Immeroin
Glenample
Drummond Estates
Ardleish
Blaircreich
Loch Sloy
Stuckindroin
Loch Katrine
Glenfinglas
Glen Mor
Strone Estate
Inveruglas Farm
Inversnaid & Garrison
Farmston
West Bracklinn
Glen Croe
Ardno
Comer
Easter Bracklinn
Upper Succoth
Strachur
Glensluan
Succothmore
Ben Lomond
Doune and Milton of Callander
Invernoaden
Ballemore Farm
Carrick
Cashel Farm
Luss Estate
Borland land
Tom a Bhiorain
Glenmassan
Garelochhead Coulport, Glen Douglas & Faslane
Bannachra Hill
Montrose or Buchanan Estates
Corrasik
Glenlean Forest
Camis Eskan Farm
Darleith Muir
Kilometers
0
2.5
5
10
15
20

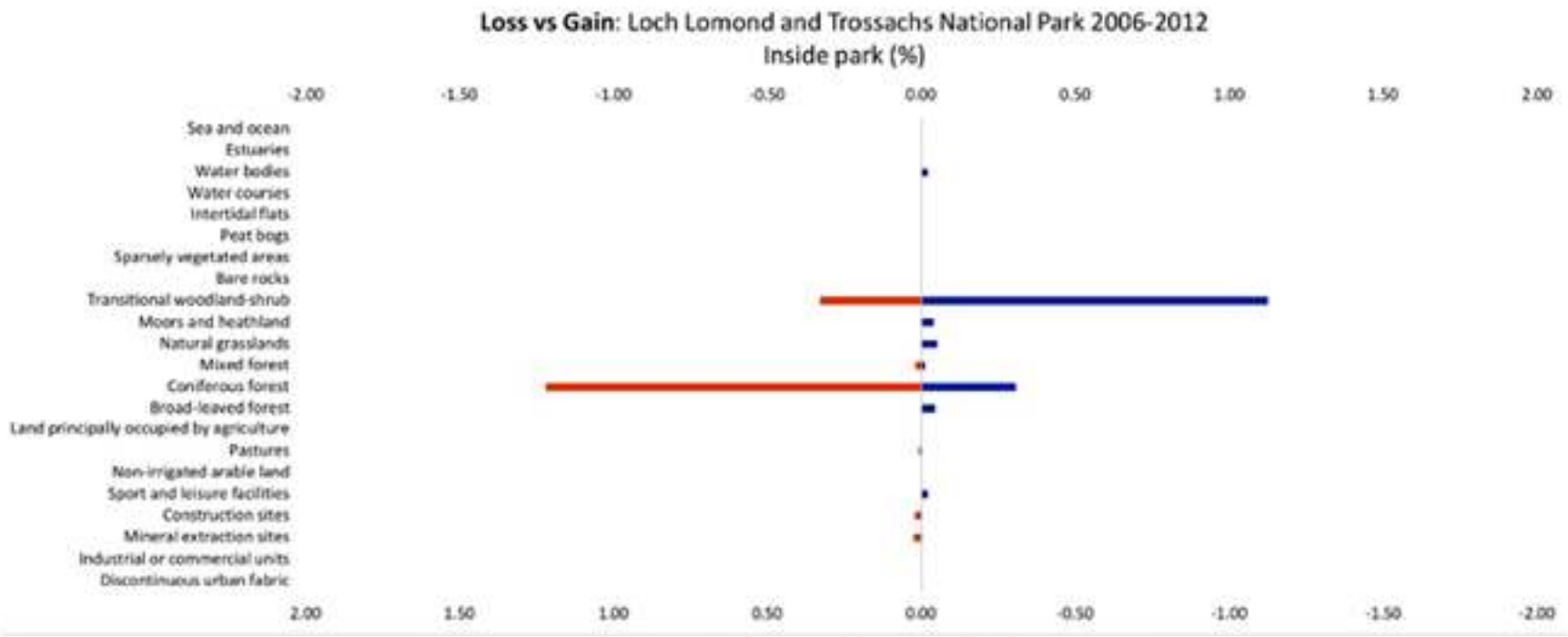

Legend
Corine Land Cover 2018
Loch Lomond & Trossachs National Park (2002) (Inner), Adjacent estates and areas (Outer)
Named landholdings (boundaries from http://www.whoownsscotland.org.uk/)
Discontinuous urban fabric
Industrial or commercial units
Port areas
Mineral extraction sites
Green urban areas
Sport and leisure facilities
Non-irrigated arable land
Pastures
Land principally occupied by agriculture, with significant areas of natural vegetation
Broad-leaved forest
Coniferous forest
Mixed forest
Natural grasslands
Moors and heathland
Transitional woodland-shrub
Sparsely vegetated areas
Peat bogs
Intertidal flats
Water courses
Water bodies
Estuaries
Sea and ocean
Kilometers
0 2.5 5 10 15 20

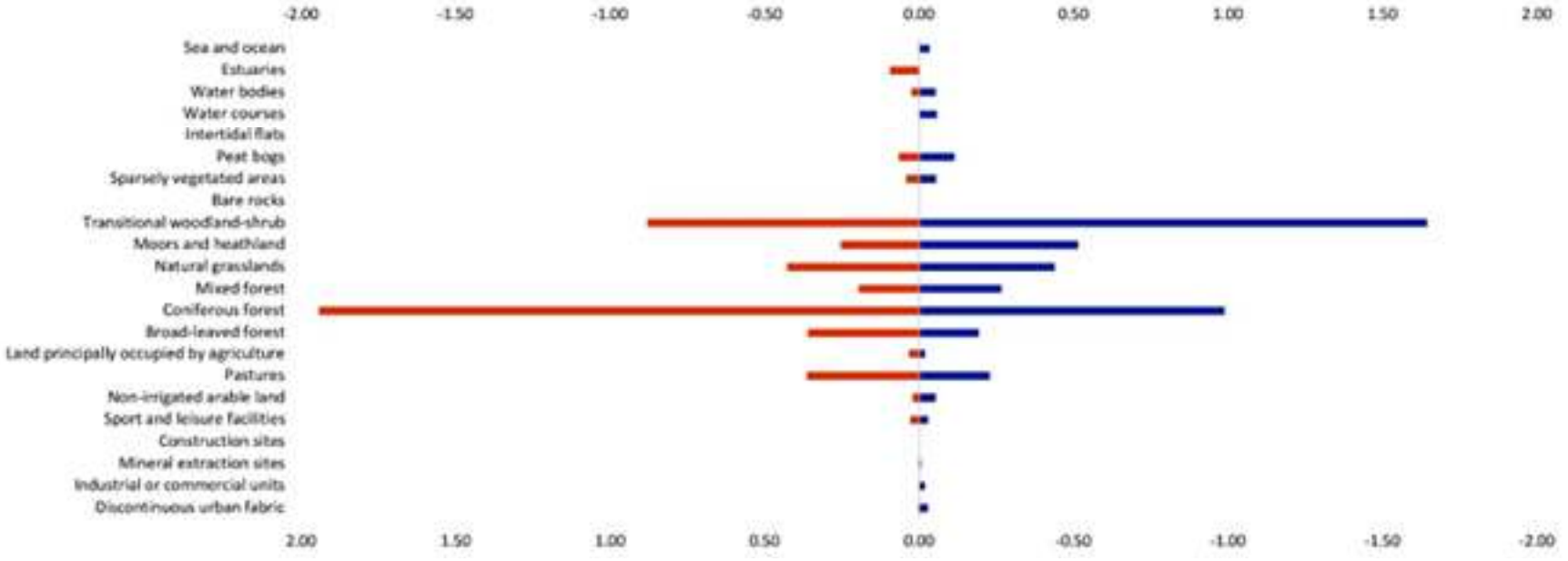

Loch Lomond and Trossachs National Park:
Land Cover 2018
Pastures
Coniferous forest
Natural grasslands
Moors and heathland
Peat bogs
Water bodies


Estates and areas adjacent to Loch Lomond and Trossachs National Park:
Land Cover 2018
Discontinuous urban fabric
Green urban areas
Sport and leisure facilities
Transitional woodland-shrub
Estuaries
Pastures
Coniferous forest
Natural grasslands
Moors and heathland
Peat bogs
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%


Legend
Named landholdings (boundaries from http://www.whoownsscotland.org.uk/)
Loch Lomond & Trossachs National Park (2002) (Inner), Adjacent estates and areas (Outer)
Other landowner
Land cover changes between 2012 and 2018 (clc2012 != clc2018)
Kilometers
0 2.5 5 10 15 20


Legend
Named landholdings (boundaries from http://www.whoownsscotland.org.uk/)
Loch Lomond & Trossachs National Park (2002) (Inner), Adjacent estates and areas (Outer)
Other landowner
Land cover changes between 2006 and 2012 (clc2006 != clc2012)
Kilometers
0 2.5 5 10 15 20





The James Hutton Institute

Questions

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