

SW Norway and the Highlands - restoration and the value of comparison

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- Ecosystem accounting
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350

Employees



800

Projects world wide



273

Scientific papers (2019)



44100000

Turnover (2020)

The Norwegian Institute for Nature Research

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Nyhets Viltren 10. november 2015

Ønsker velkommen til boklansering

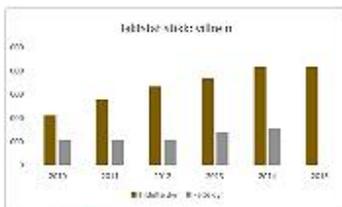
I 50 000 år har mennesker og villrein levd i tett relasjon med hverandre. Nå har vi for første gang anledning til å ta en titt inn i villreins personlige fotoalbum. [Les saken...](#)



Nyhets Viltren 09. november 2015

Hvilke etapper hadde en hjort vunnet i triathlon?

I forrige uke gikk Naturdatas viltkonferanse av stabelen. Der fikk tilhørerne nyte et variert program som tok for seg både utvidet jakttid på elg og hjortens ferdigheter i triathlon. [Les saken...](#)



Nyhets Viltren 27. oktober 2015

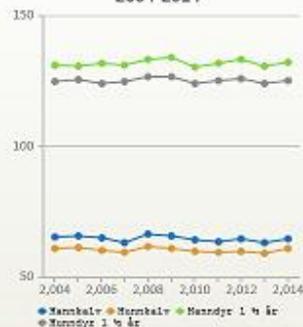
Dobling i fellingstillatelser på villrein på fem år

I 2015 ble det totalt tildelt en kvote 20 912 villrein fordelt på de 23 villreinområdene. Det er en dobling fra 2010, da tildelingen var på 10 521 dyr. [Les saken...](#)



Gå til HJORTEVILTREGISTERET

Slaktevektutvikling for elg i Norge 2004-2014



Vis større diagram

Slaktevektene for elg på landsbasis har hatt en nedadgående trend fra starten av perioden (2004) og frem til 2013. Inntil videre vil det være viktig å følge opp og på landsnivå vektene fra 2013 til kommune, besøk [Hjorteviltregisteret](#)

Kontakt oss

Har du tips til saker Hjorteviltportalen? Send en e-post til [redaksjonen](#)

Årshjul

Frister og perioder



Journal of Animal Ecology



Journal of Animal Ecology 2008, 77, 958–965

doi: 10.1111/j.1365-2656.2008.01427.x

An efficient multivariate approach for estimating preference when individual observations are dependent

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Summary

1. We discuss aspects of resource selection based on observing a given vector of resource variables for different individuals at discrete time steps. A new technique for estimating preference of habitat characteristics, applicable when there are multiple individual observations, is proposed.
2. We first show how to estimate preference on the population and individual level when only a

Peat cutting in the mid 20th Century



Gairloch



West Highlands



West Norway



West Norway

N. Uist



Jæren

(both early 20th Century)



Oslibakken near Stavanger, 1911



DSS 2075



Old peat digging with bog pine roots, west Norway, 1917



Industrial scale peat production on Fedje island near Bergen, 1903.



Peat cuttings and drying stacks in Jæren (coastal plain near Stavanger). Kitty Kielland, oil on canvas, 1900

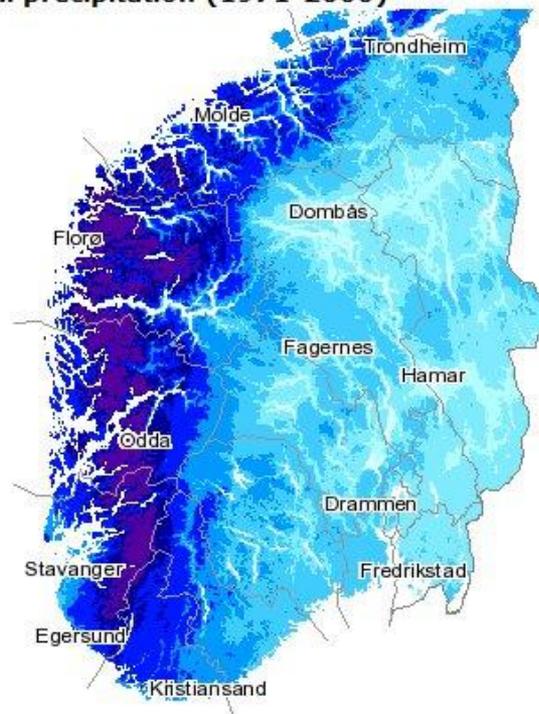
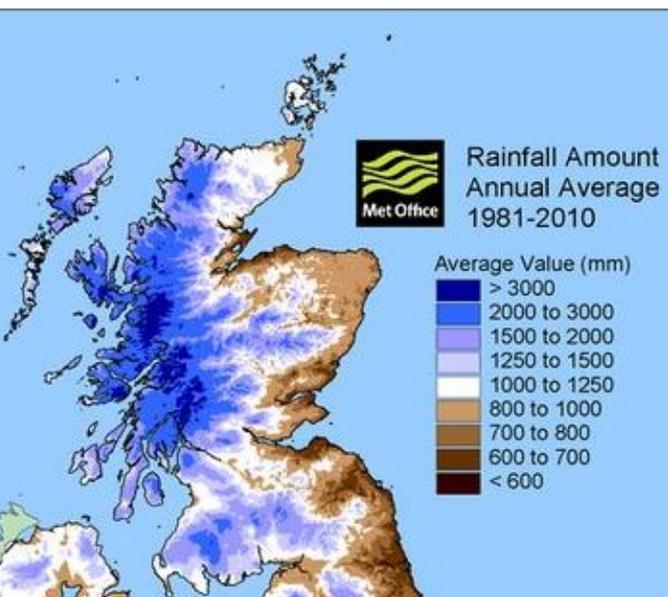
Peat was the main source of domestic fuel in coastal Norway for many centuries.

This was due to the lack of wood in the region, **conversion to open heathland being «substantially complete by the Bronze Age»**.

This open landscape was **«anthropogenic in origin»**, due primarily to the effects of grazing and associated activities such as muirburn and use for firewood (Prøschedanielsen & Simonsen 2000).

Normal annual precipitation (1971-2000)

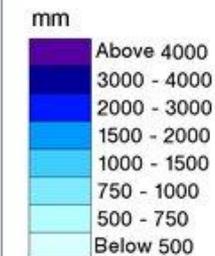
Climate comparisons



Theme information

Map shows normal annual precipitation (in mm) for normal period 1971-2000.

Colour legend



Map legend

- Oslo** Placename
- National boundary
- County boundary
- Lake

Presented on seNorge.no

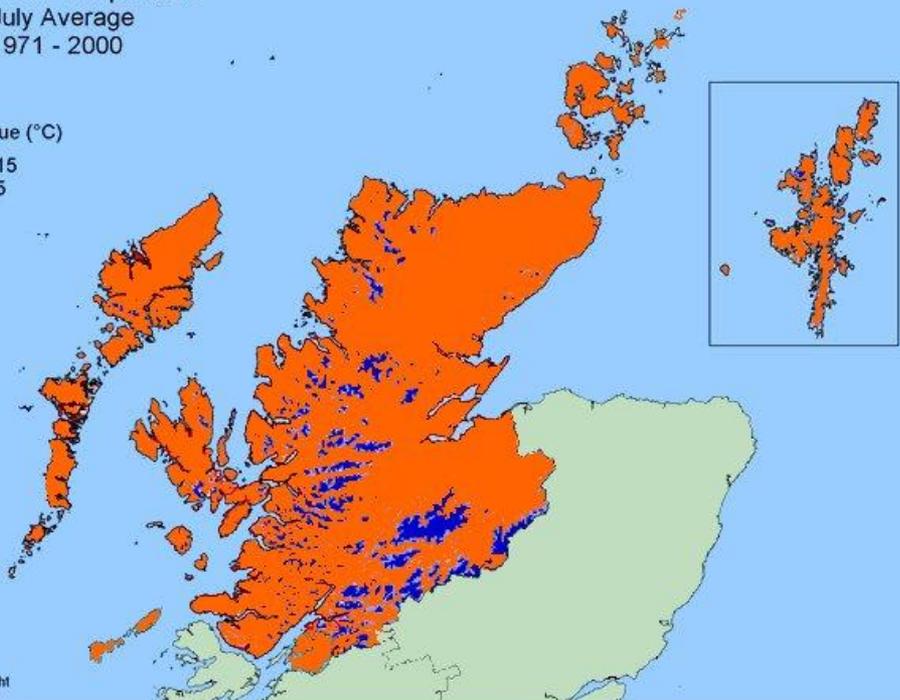
(maps to scale and in correct relative positions)



Mean Temperature
July Average
1971 - 2000

Average Value (°C)

- 10.5 - 15
- 6 - 10.5

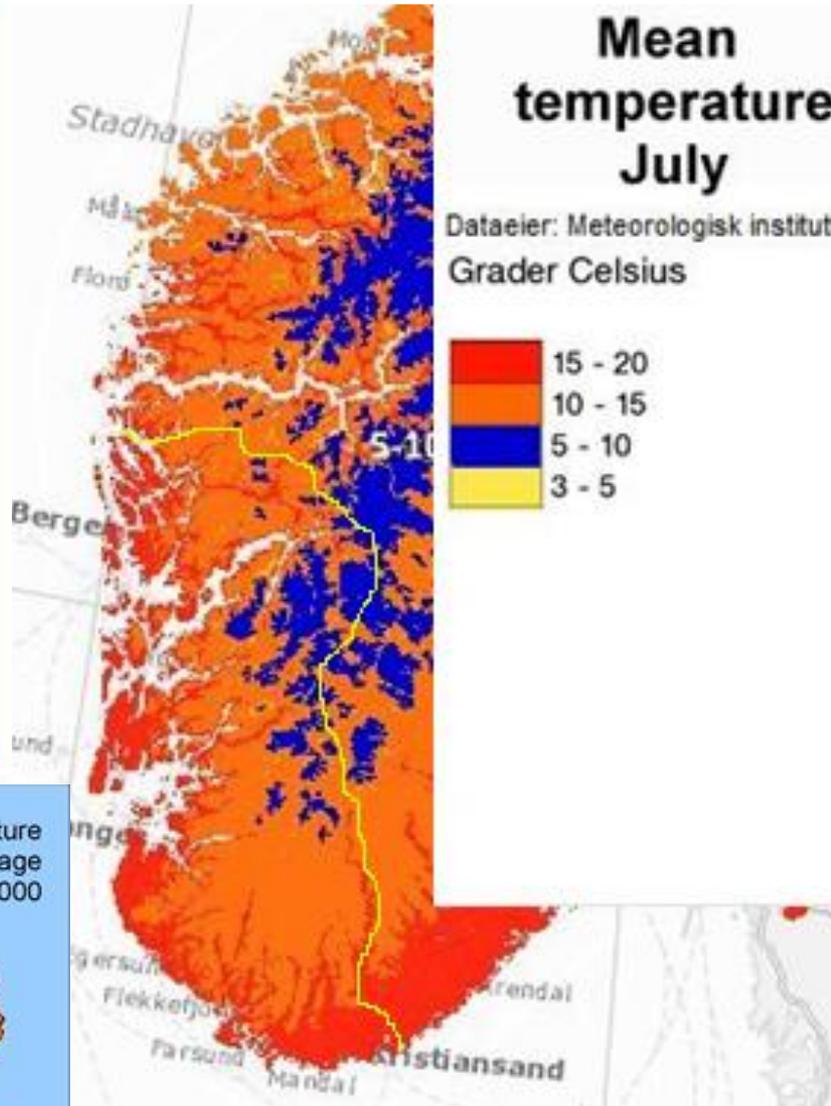


© Crown copyright

Mean temperature July

Dataaier: Meteorologisk institutt
Grader Celsius

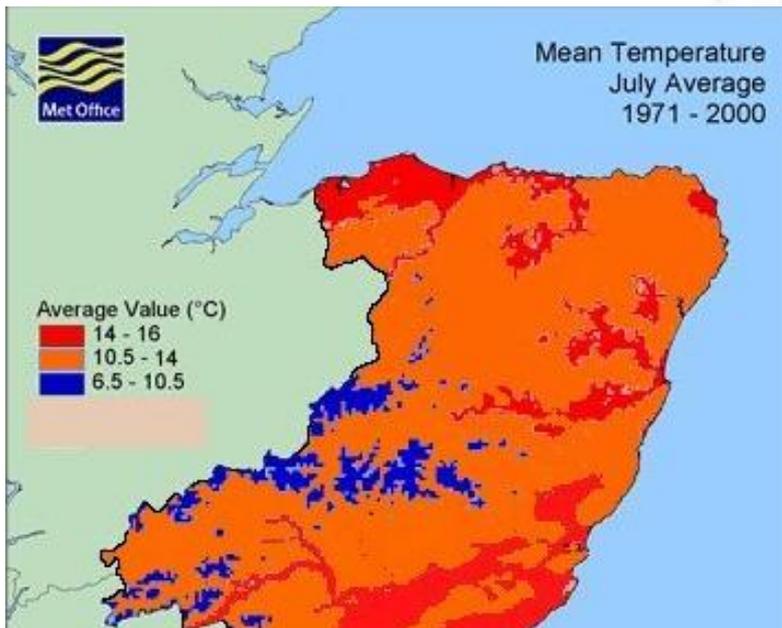
- 15 - 20
- 10 - 15
- 5 - 10
- 3 - 5



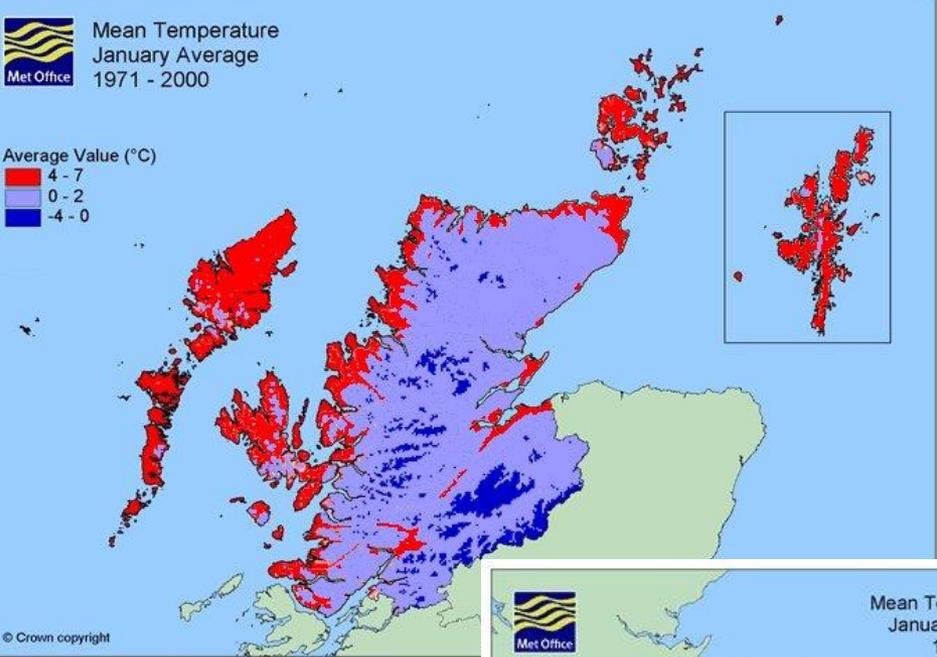
Mean Temperature
July Average
1971 - 2000

Average Value (°C)

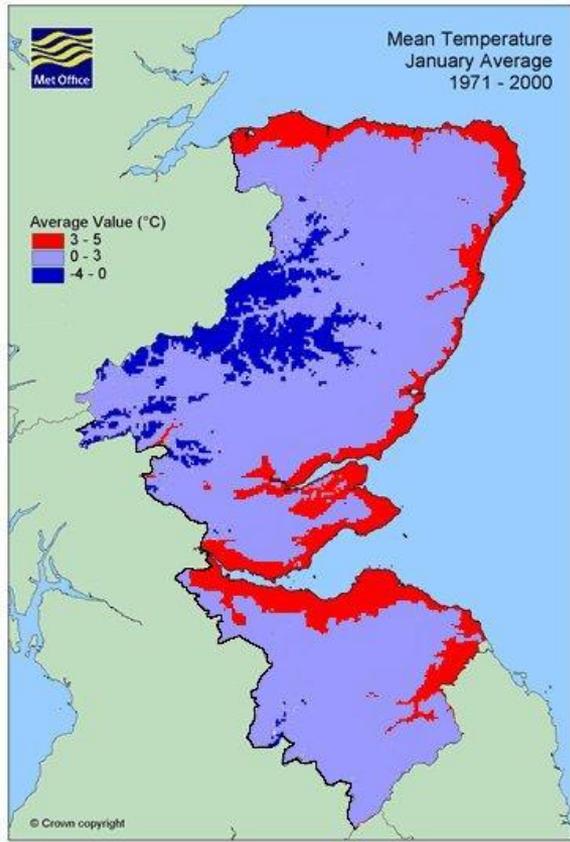
- 14 - 16
- 10.5 - 14
- 6.5 - 10.5



Average Value (°C)
 4 - 7
 0 - 2
 -4 - 0



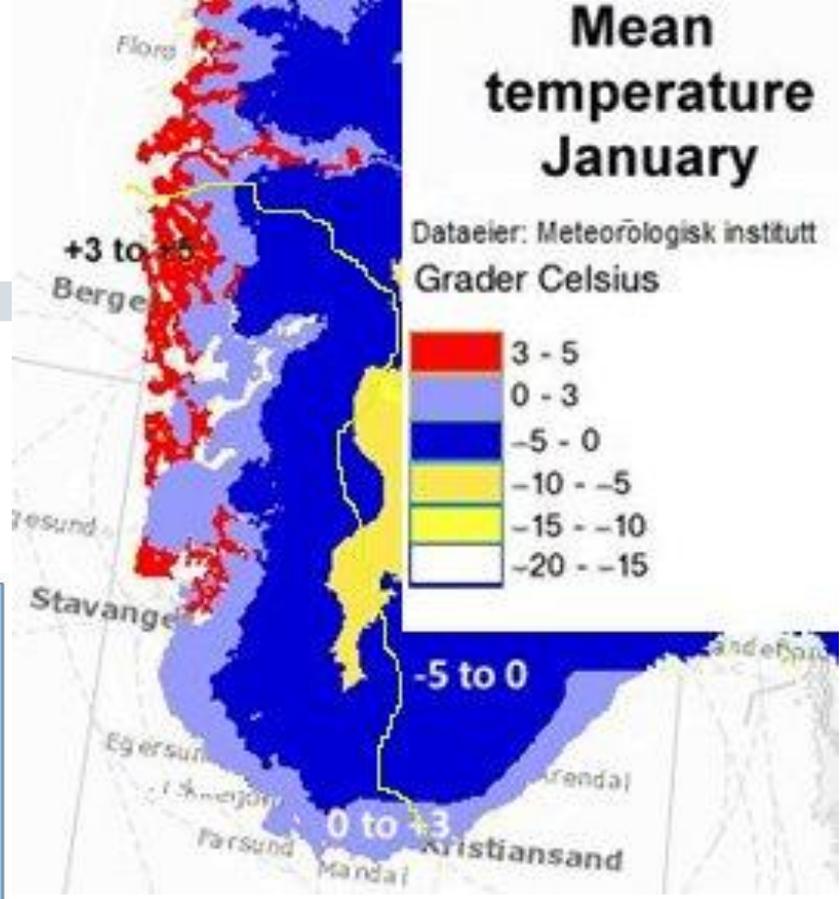
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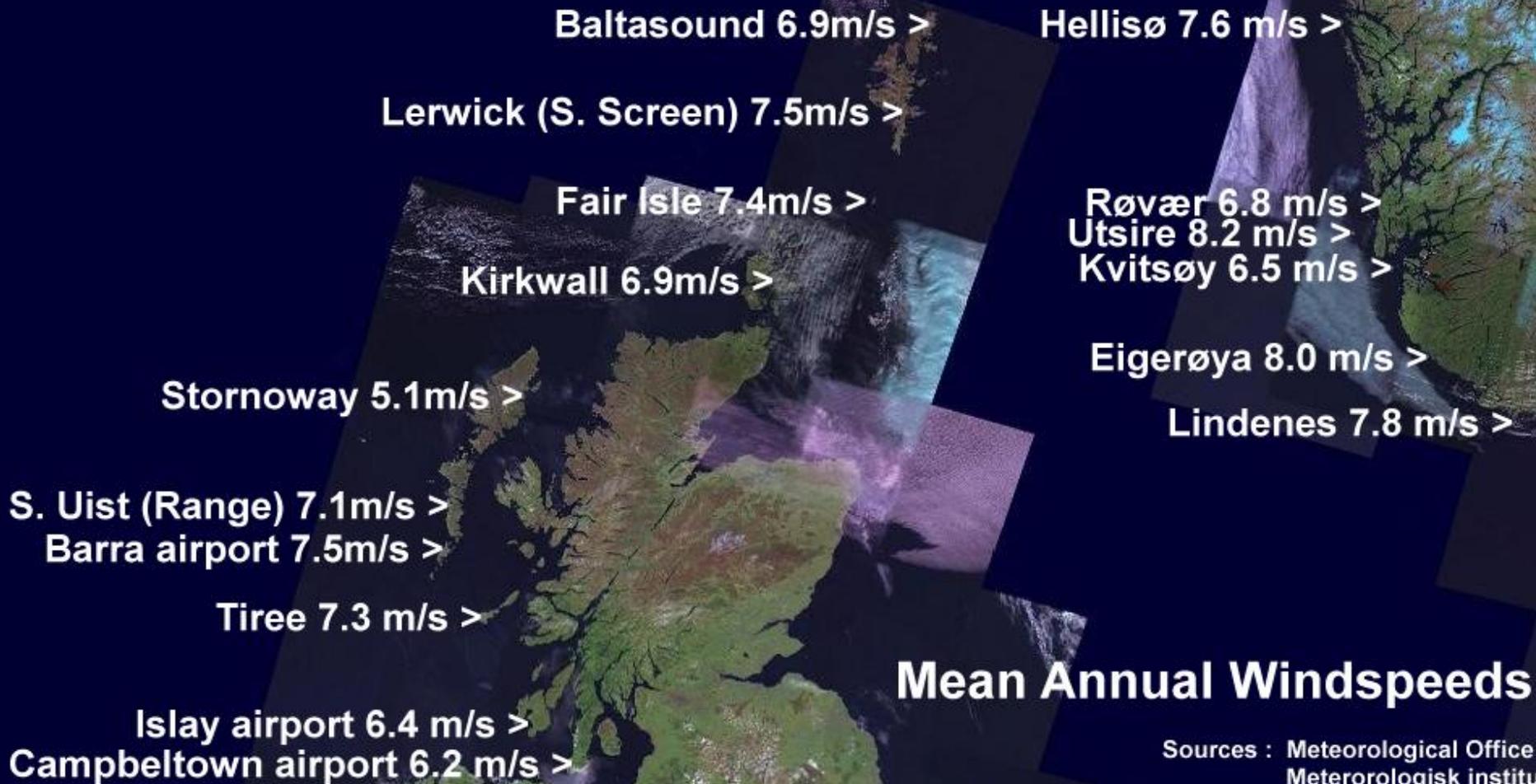


Mean temperature January

Dataaier: Meteorologisk institutt
 Grader Celsius

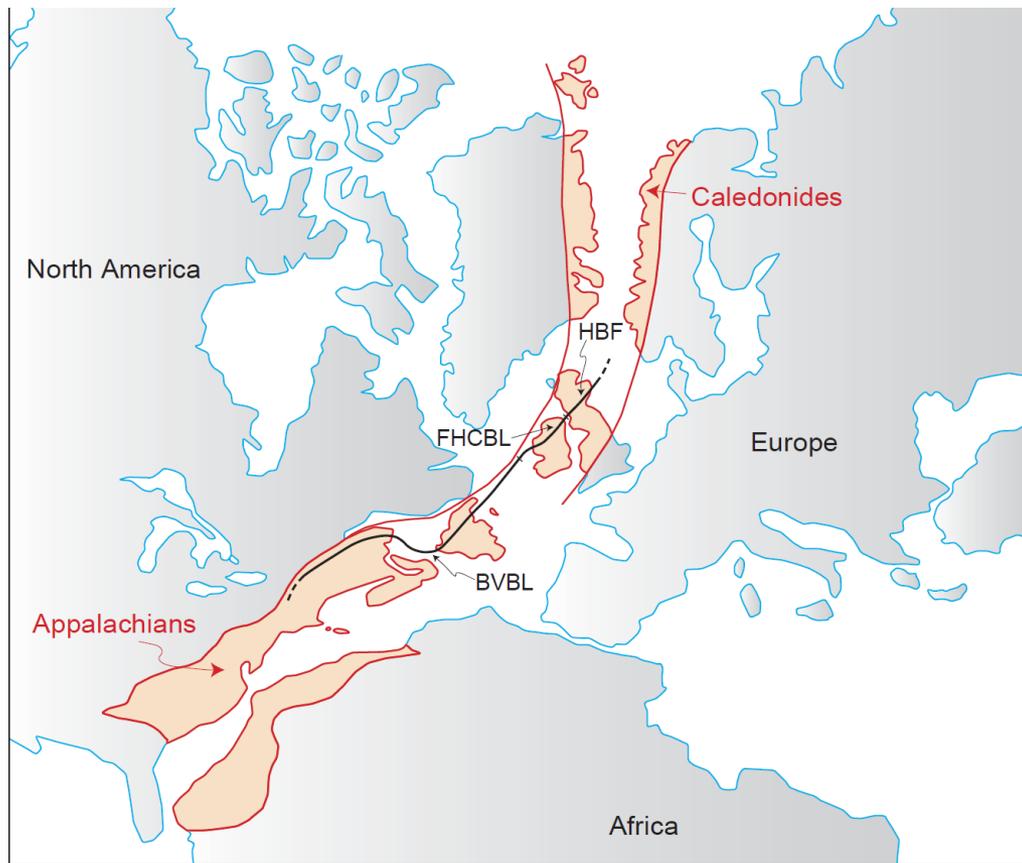
3 - 5
 0 - 3
 -5 - 0
 -10 - -5
 -15 - -10
 -20 - -15





Sources : Meteorological Office
 Meterorologisk institutt

Geology



Caledonian orogeny

Figure 1. Schematic plate reconstruction at the end of the Caledonian orogeny, c. 390myBP (Chew 2005)



Fidjadalen



Fidjadalen 2015



<http://jarenfri.no/no/steder/friluftsgarden-man/>





X=approximate point of shot 1911 photograph

Photo: Erlend Tøssebro

Fonnes, Hordaland 1971



Pines planted 1907 >

Fonnes >

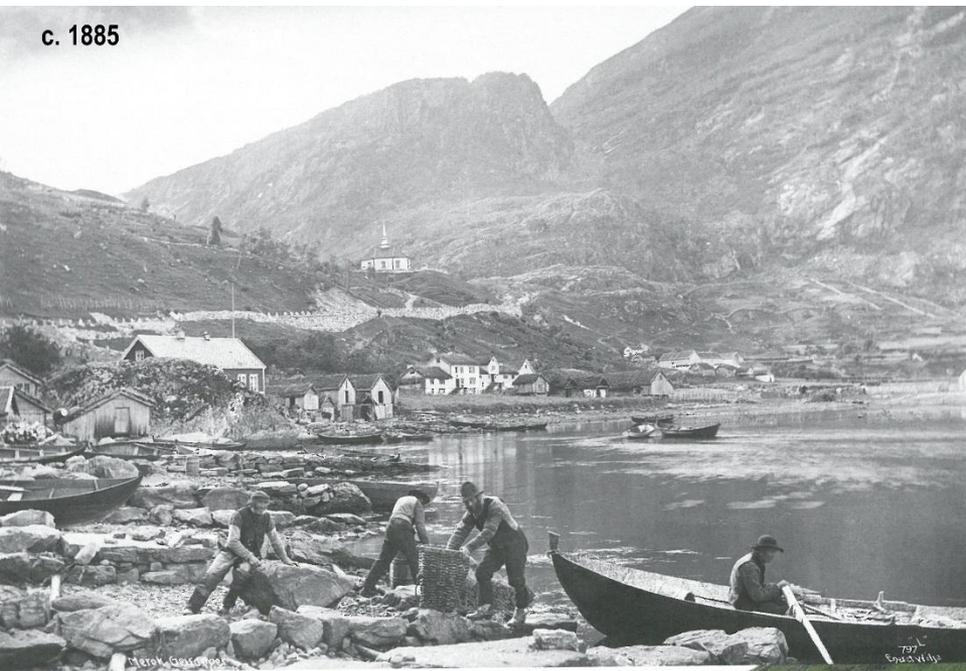


Fonnes, Hordaland 2005

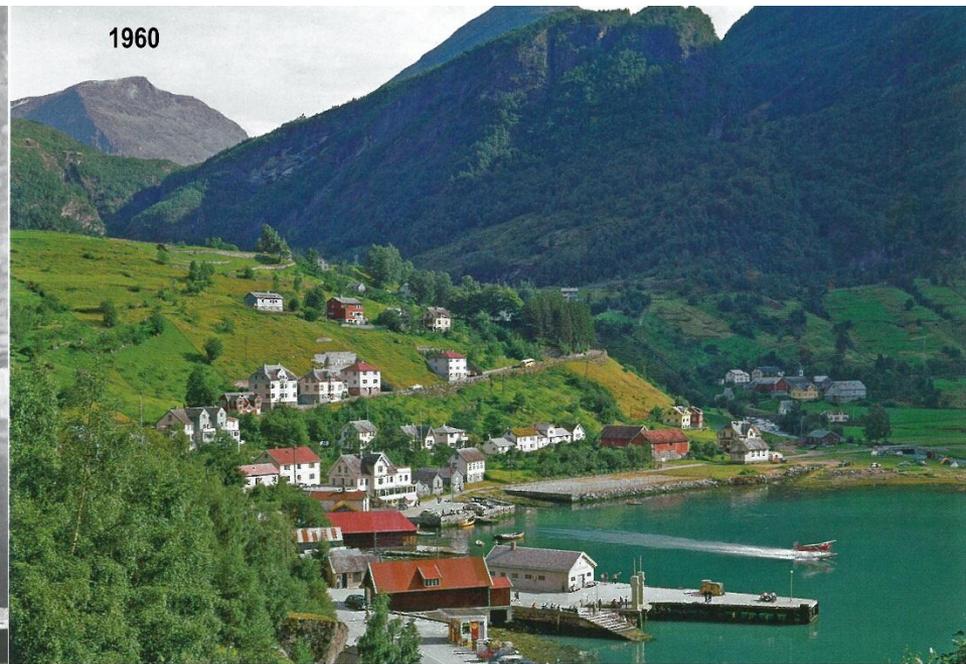


Grazing pressure reduced from 1975

c. 1885



1960



2004



Geiranger
(west Norway)

www.tilbakeblikk.no



5km

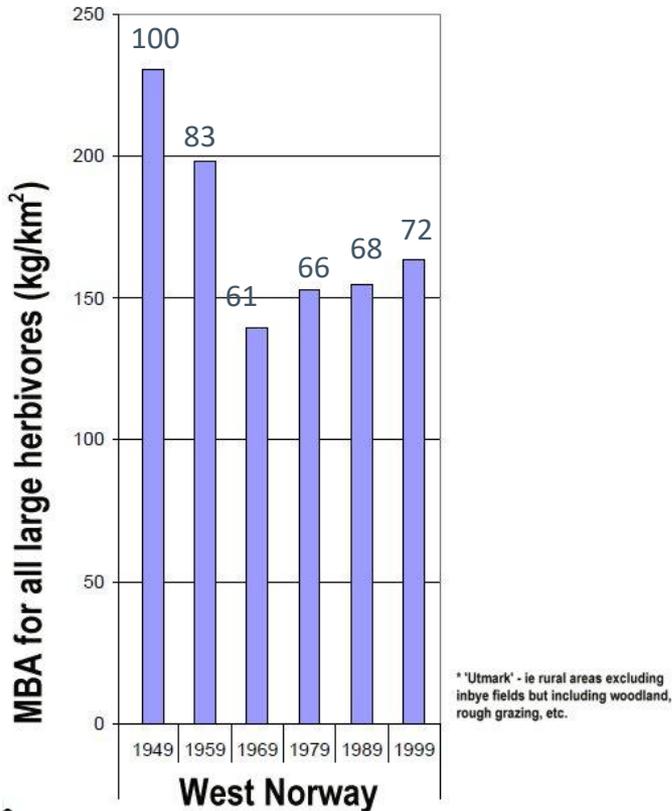
Rogaland/Vest Agder 58°25'N



Images: Google Earth Compilation: duncan.halley@nina.no

Wester Ross 57°50'N

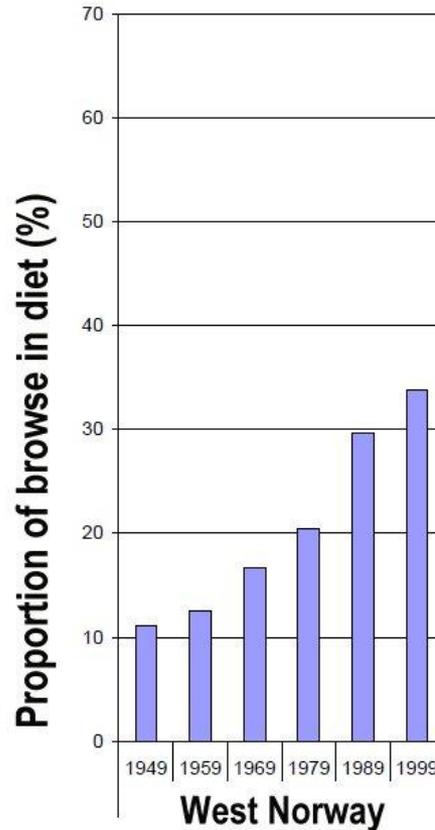
**Metabolic biomass per sq km
all large herbivores.*
West Norway 1949-1999**



Source: Austrheim et al 2008

NB: earliest quantified data from 1949. Pressures were higher in the 19th and early 20th centuries, and earlier.

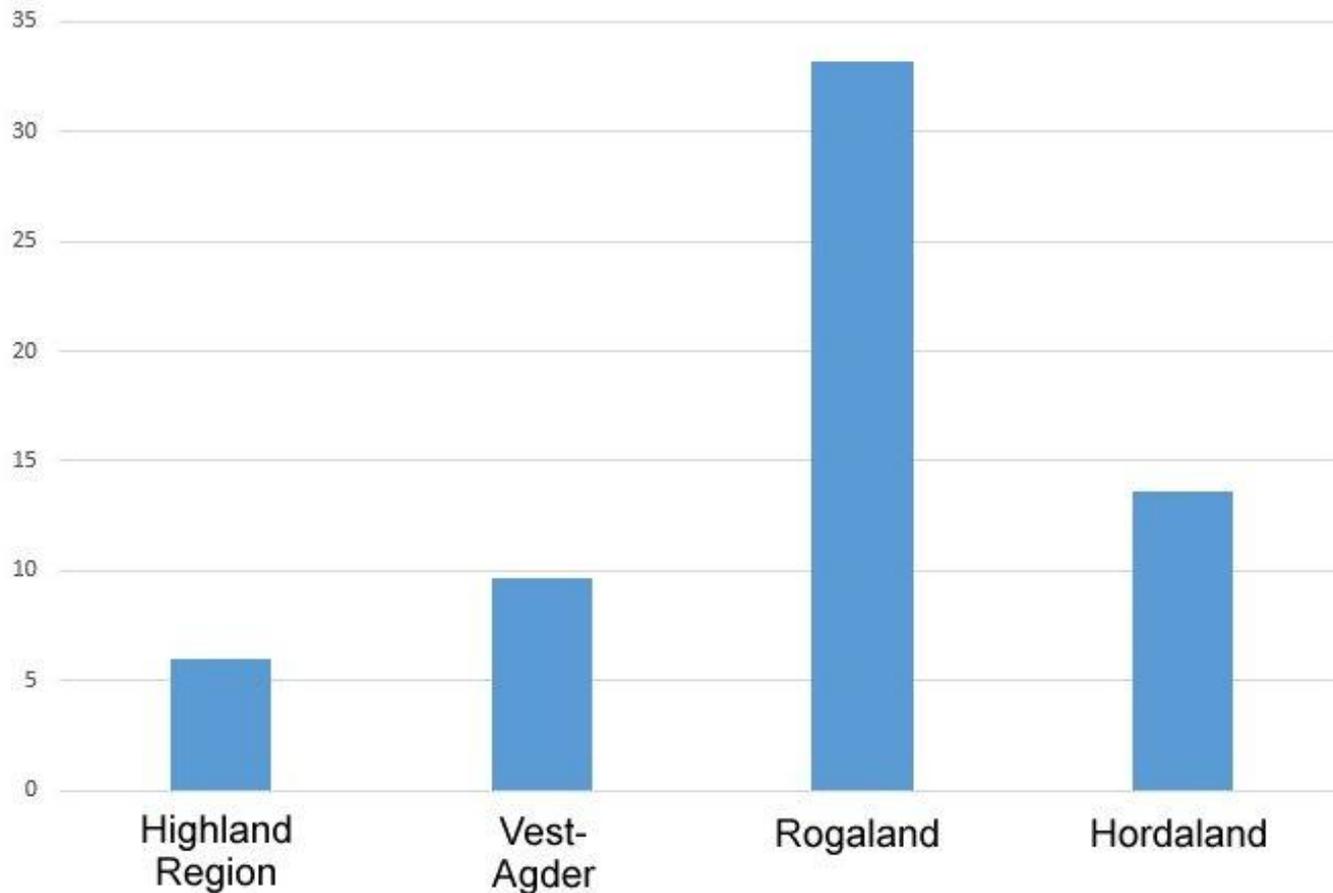
**Proportion of browse in diet
all large herbivores,
West Norway, 1949-1999**



Source: Austrheim et al 2008

- 1949 levels sufficient to inhibit woodland regeneration
- 1969 levels allowed woodland to regenerate from an unwooded state
- Later increases in metabolic biomass of herbivores were not sufficient to inhibit woodland regeneration over time
- Even though proportion of browse in overall herbivore diet increased
- This appears to have been due to increased levels of regeneration (ie, more seedlings), plus soil development (ground more fertile)
- NB minimum pressures 1969, but rate of woodland spread apparently peaking 2000-2010s. Lag probably related to availability of seed source, plus soil development effects .
- However, detailed research would be useful.

Population densities (residents/km²) Highland Region and the provinces of SW Norway, excluding main urban settlements



Inverness,
Kristiansand,
Stavanger
(including Sola
kommune),
Bergen
excluded

View from Hovdenuten (1119m)



- SW Norway is closely similar in the basic conditions of life (climate, landforms, geology) to Highland Scotland- as comprehensive data demonstrates.
- Landscape history, including the pattern of landscape use and of deforestation, was closely similar from the Mesolithic until the mid 18th century.
- SW Norway has reforested, largely through natural regeneration, since the late 19th century, and especially since the 1950s.
- Research demonstrates that this been a result of reductions in grazing intensities and associated land uses (e.g. muirburn, fuelwood).
- Natural reforestation is continuing at a rapid rate.
- It was and is a working cultural landscape.
- The human population density in rural SW Norway is much higher than in Highland Scotland

Some comparative approach insights for restoration in the Highlands



1) Where do species *really* want to live?

(aka, the 'refugee habitat' problem)

- Alpine blue sow-thistle *Cicerbita alpina* is critically endangered in Britain. It is confined to four rock ledges in the extreme SE of CNP (Angus glens & Lochnagar). A fifth patch went extinct in 1977.
- The plants are highly impoverished genetically. They rarely produce seeds.
- Management publications on the species in Britain correctly identify that it is highly palatable to grazing animals, and this is the major factor in its rarity.
- But they have until recently included statements like:

"As the species has a continental distribution, this would suggest optimum conditions of hot summers and cold winters."

"In western Norway, *Cicerbita alpina* seems to avoid the extreme oceanic areas and tends to be found in the more continental inner fjord areas. It avoids the west coast; like many boreal species, it tolerates or even needs high summer temperatures, occurs in areas of cold winters and tends to be absent from areas with mild winters"

"As a consistent feature of its European habitats, winter snow cover protects plants from winter frosts and provides additional moisture in early summer"

- All of the three statements above are false, but lead to the first of the 'key factors' identified as "limiting the current and future distribution of *C. alpina*" as being:

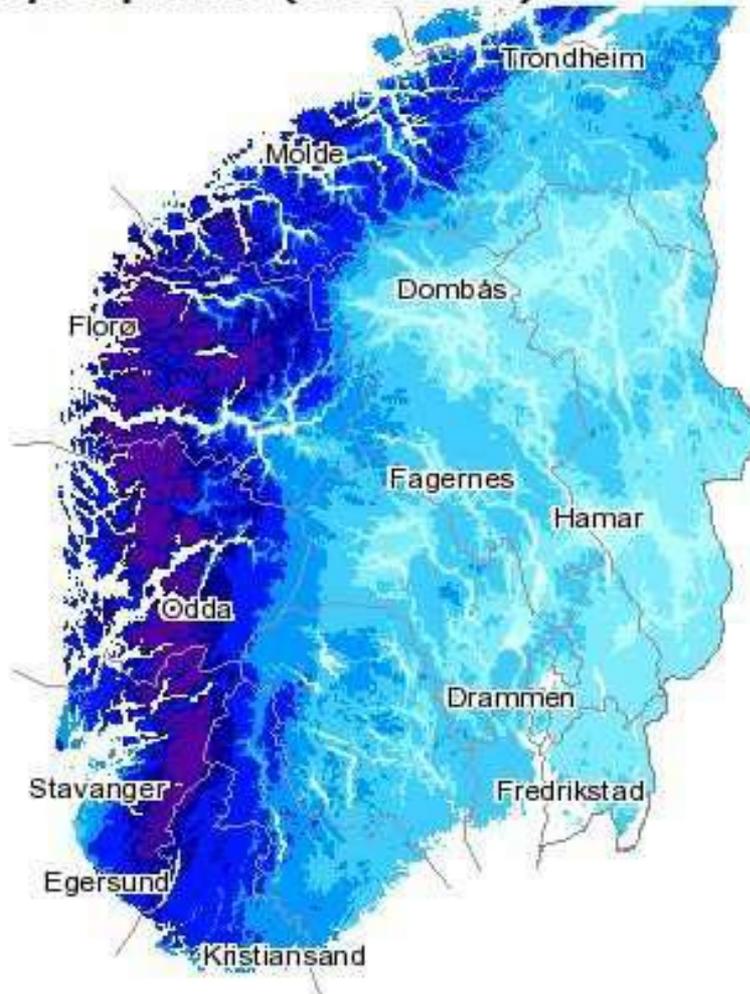
"*C. alpina* appears to be at the western limit of its climatic tolerance in Scotland..."



Cicerbita alpina distribution, Norway

Source: www.artsdatabanken.no

Normal annual precipitation (1971-2000)

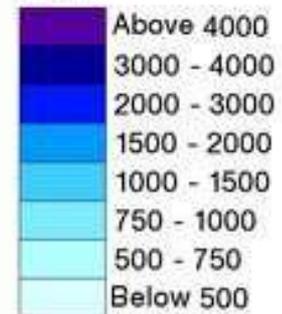


Theme information

Map shows normal annual precipitation (in mm) for normal period 1971-2000.

Colour legend

mm



Comparisons: annual precipitation

Ben Nevis (summit) 4350mm

Ben Cruachan (summit) 3600mm

Ben Lawers 1430mm

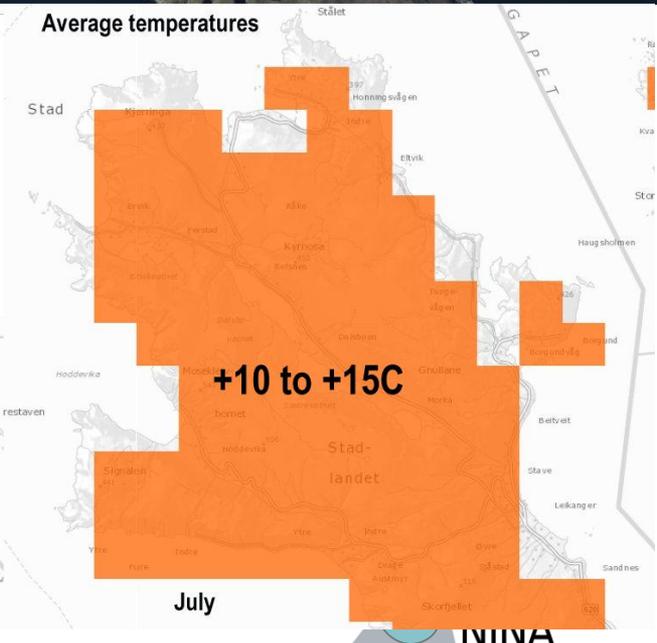
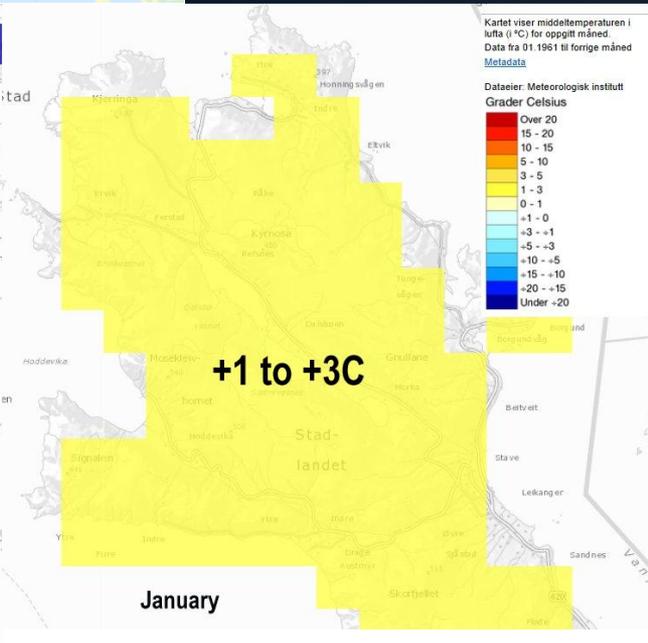
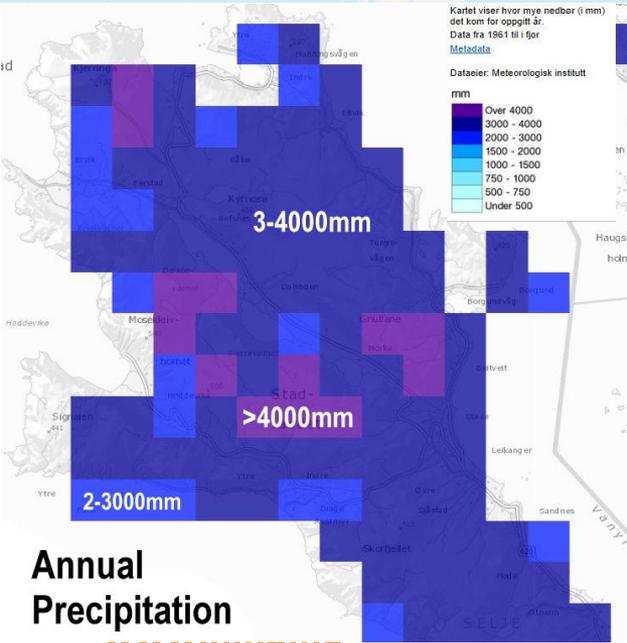
Creag Meagaidh (plateau) 1250mm

Cairngorm (plateau) 1100mm

[Theme from met.no](http://www.met.no)

Presented on seNorge.no

C. alpina recorded **Jan Mayen**
 in every decade since
 the 1950s on Stad by
 university botanists
 (UiO, NTNU, NMB)

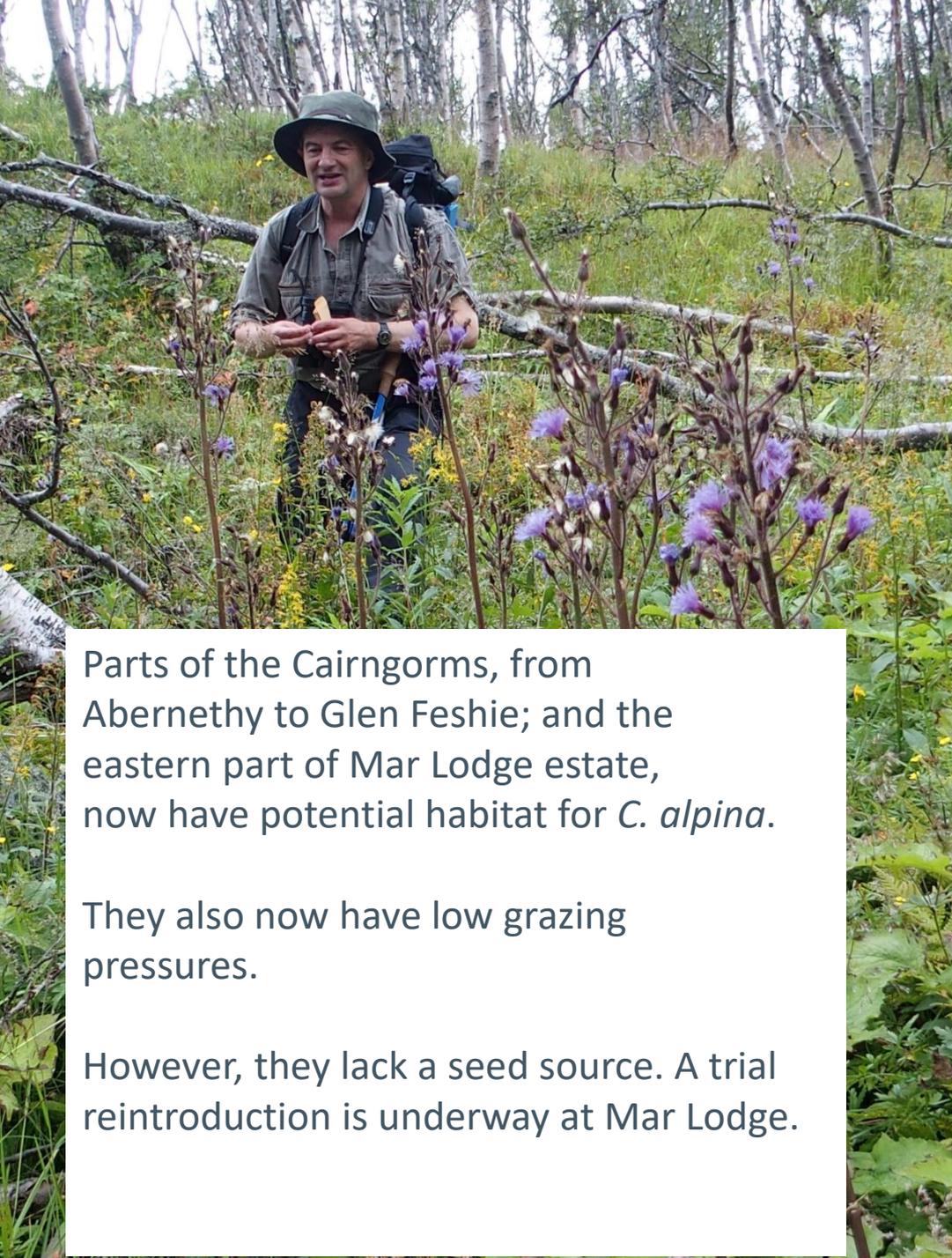




‘Highly prized browse for many animals... In our (*i.e.*, coastal SW Norway) mountains it (*C. alpina*) must seek refuge in inaccessible places to avoid being eaten by sheep’

Bakkeveig, S. (1983). Botany for mountain lovers. Stavanger Hiker’s Association, Stavanger

- Rogaland (‘Stavanger county’) sheep population, summer 2014: ~510 000 sheep or 59.4/km²; ca. 20% of all sheep in Norway (data: Statistics Norway)
- Rogaland is 2.8% of Norway’s land area; sheep grazing intensity for the county taken as a whole is thus c. 14x the Norwegian average. Most sheep graze on the coast and on the foothills behind the coast



Parts of the Cairngorms, from Abernethy to Glen Feshie; and the eastern part of Mar Lodge estate, now have potential habitat for *C. alpina*.

They also now have low grazing pressures.

However, they lack a seed source. A trial reintroduction is underway at Mar Lodge.

Natural *C. alpina* habitat: the understory of damp, open, montane woodland. Slåttlian in Berdal, which has a climate similar to the Cairngorms, at 750m asl.

The site in the photo was treeless moorland for many centuries, but montane woodland has now regenerated, restoring habitat for this and other species.



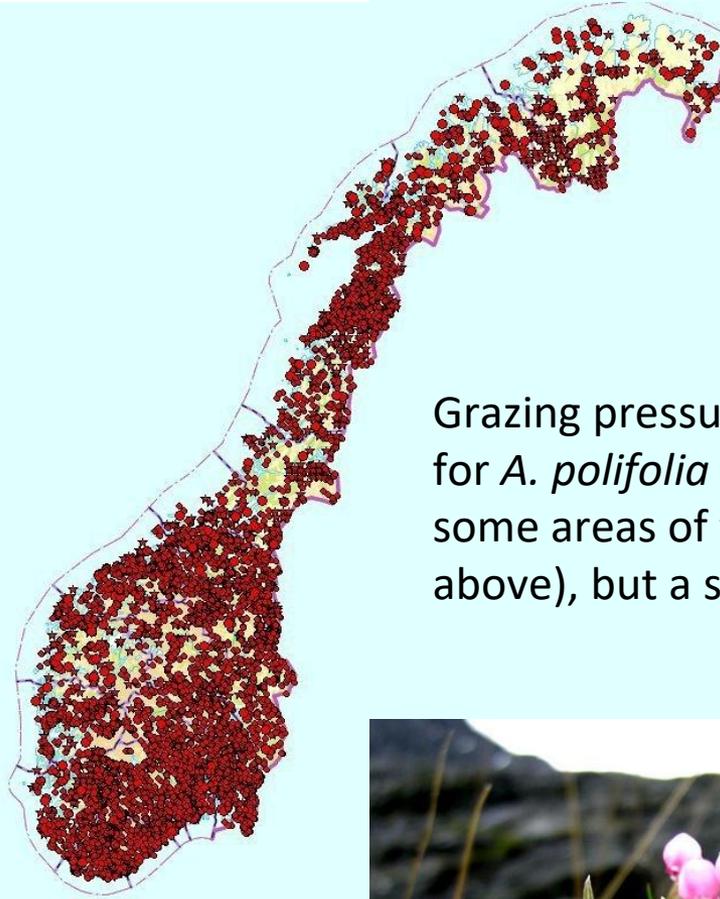
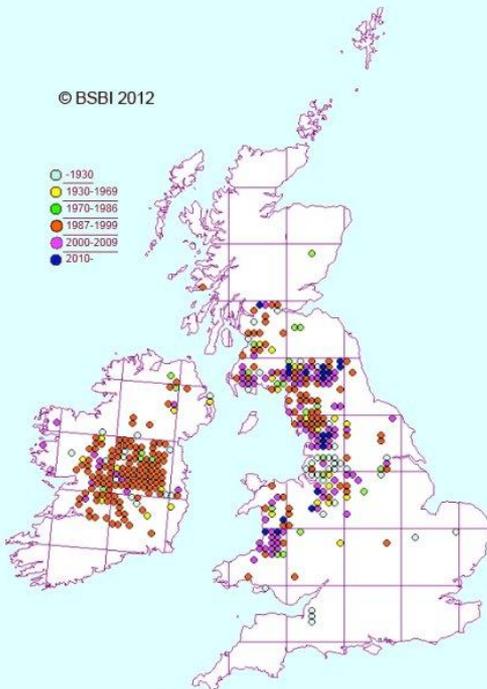
Photo: Aline Finger, Royal Botanic Garden Edinburgh

Inbreeding/genetic bottlenecking effects(?) Growth of Scottish and Norwegian seeds of *C. alpina*, sown at the same time and grown under identical conditions.



Andromeda polifolia (Bog rosemary)

www.artsdatabanken.no
www.bsbimaps.org.uk/atlas/main.php

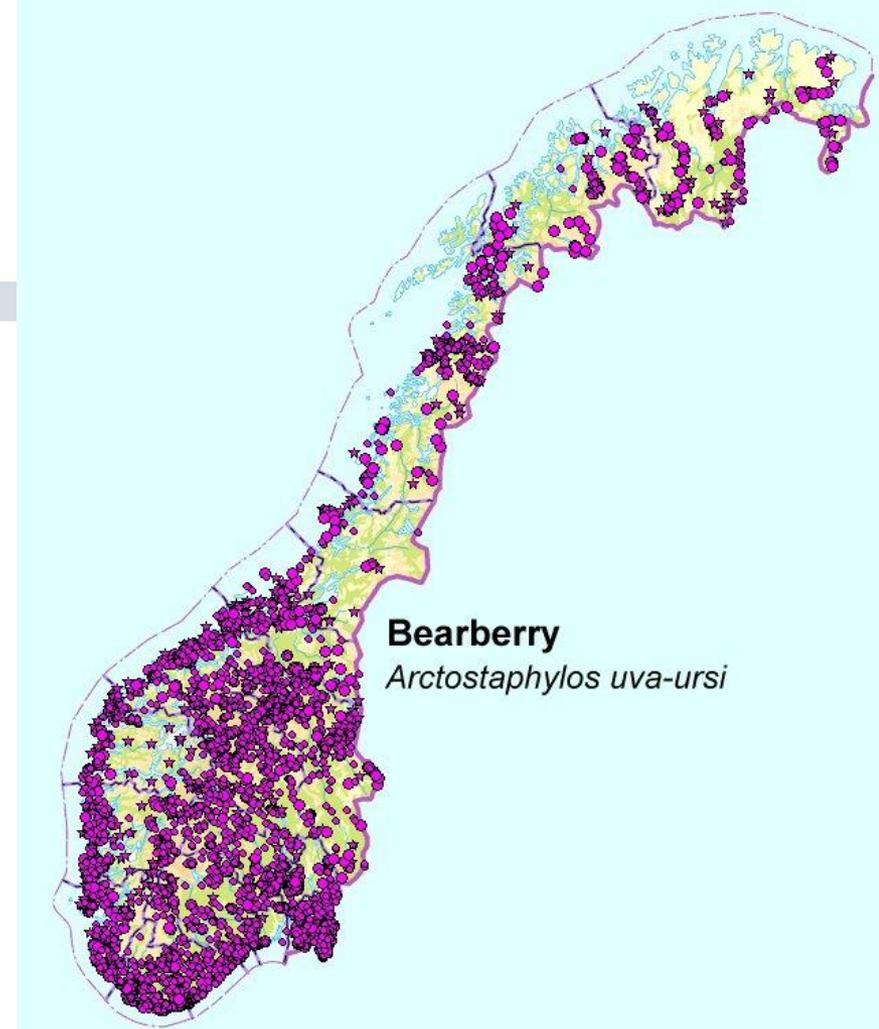


Grazing pressure is now low enough for *A. polifolia* to reestablish in some areas of the Highlands (see above), but a seed source is lacking.





- In Scotland (including CNP), SACs with 'bearberry heath' have been cleared of naturally regenerating pine to 'protect' the 'bearberry heath', and in particular the bearberries.
- In Norway, the species is LC status and abundant from sea level to the low alpine zone, largely as an [open woodland understory plant](#).
- Its usual habitat is described as "[Bearberry grows in drier woodlands, most usually Scots pine woods](#), and drier heaths. It is common in the whole country up to the firn snow level. Bearberry can grow both on acidic and alkaline soils." [Source](#)
- It is certain that treeless habitats are *not* a requirement for *Arctostaphylos* (among others).
- Especially not a recent 'survivor assemblage' dating only to the late 19th century, and which is dependent on frequent rotational burning by humans.
- Comparison with similar climates and geologies outside Scotland can help avoid the assumption that current 'refugee habitat' is what a particular species needs or wants – sometimes seriously compromising restoration work.





Netted mountain moth *Macaria carbonaria* is an upland bog species (the common Norwegian name, 'myrbuemåler', translates as 'bog inchworm'), also sometimes found on moorland. It is common in Norway (LC), and as a caterpillar feeds primarily on bog rosemary (currently extinct in the Highlands); but can also eat bearberry.

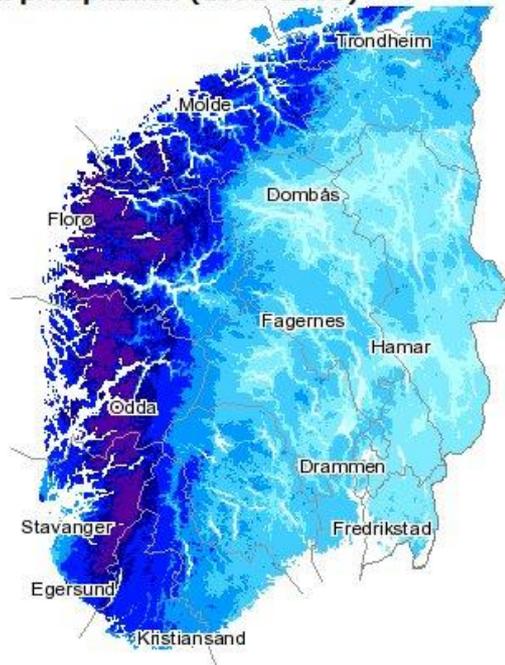
In the Highlands, where it is rare and a 'UK Biodiversity Action Plan Priority species', publically available 'conservation guidance' is still to burn moorland regularly, to preserve 'bearberry heath' for *M. carbonaria* (e.g. [Butterfly Conservation Scotland/SNH](#))

But the evidence is that *M. carbonaria* is, in the Highlands, restricted to a secondary food plant growing in a recent 'refugee' assemblage quite unlike its real core habitat. Its rarity is a function of this.

It is likely that addressing the food plant issue, as an element of wider restoration of healthier landscapes, would be more productive in conserving this species than freezing in place a recent, species-poor refugee assemblage - which bearberry, *M. carbonaria*'s secondary food plant, is not in fact dependent on.



Normal annual precipitation (1971-2000)



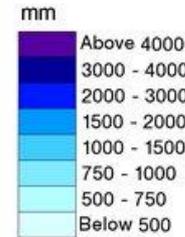
Theme from met.no

Presented on seNorge.no

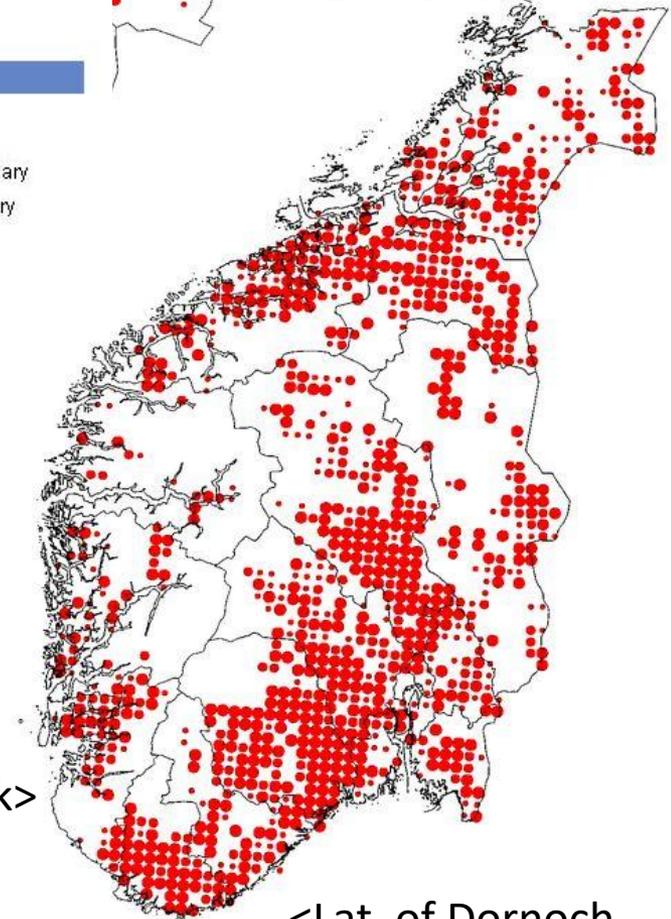
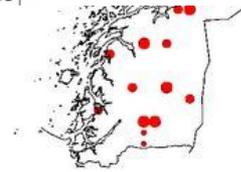
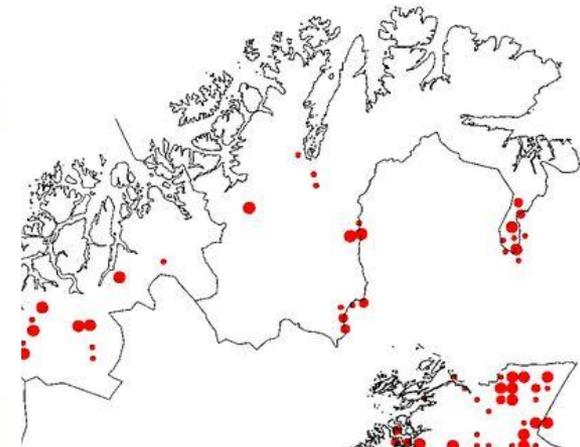
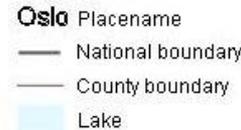
Theme information

Map shows normal annual precipitation (in mm) for normal period 1971-2000.

Colour legend



Map legend



Lat. Of Wick >

< Lat. of Dornoch

NORSK FUGLEATLAS
Norsk Ornitologisk Forening 1994

- Capercaillie are declining and red listed in Scotland
- They are stable, 'LC' status, in Norway
- A hypothesis in Scotland is that they dislike oceanic climates and this is a factor in decline
- However, in SW Norway they occur in mild, 'hyeroceanic' areas of very high rainfall
- (and in Norway, all capercaillie predator populations are at levels set by the environment)
- Suggesting comparative research might be illuminating

www.nina.no

Scotland: ring ouzel habitat stated to be “*open* heather clad moorland and mountains with only very sparse or stunted tree cover” (Rollie 2007).

An SPA review for the species in Scotland stated: “Key conservation requirements: Maintain good moorland management and *open* moorland/ pasture interface” (my italics).

Norway: “Prefers hilly areas with rocky terrain and mixed grass and shrub vegetation... It especially likes steep slopes with lots of rocks and plenty of juniper bushes, where at the same time there are mixed in more open areas with grass. It does not like barren areas with little vegetation, either on the coast or in the mountains” (Pedersen 1994).

Montane shrub mosaic associations as described above, the core habitat for the species, are functionally extinct as habitats in Scotland. *The ‘key conservation requirement’, if implemented as an SPA, would have prevented reestablishment of these associations.*



Ring ouzel

Turdus torquatus torquatus

Britain: the species' range contracted by 43% between 1968-72 and 2008-11 (Balmer et al 2013). Populations declined 58% between 1988-91 and 1999, and then 29% between 1999 and 2012 (Wotton et al 2016). Red listed and a priority species in the UK biodiversity action plan.

Norway: appears to be slowly increasing (Pedersen 1994). Common, Red list status ‘LC’ (*Least concern*)

The same subspecies breeds in both countries and they appear to winter in the same regions of Morocco.

SPA status considered for current Scottish habitat (rejected only for technical reasons).

2010 UK BAP revision: “Encourage comparative breeding-season studies in Norway/Sweden, where the population is apparently stable”.

Golden eagle

“the golden eagle breeds in hill forest and mountain tracts over most of the country...The golden eagle is first and foremost associated with open montane woodland (*fjellskog*)...it can also breed in open coniferous forests a long way from the open fell”

Gjershaug et al. (eds.) (1994). Norwegian Bird Atlas.



Hen harrier

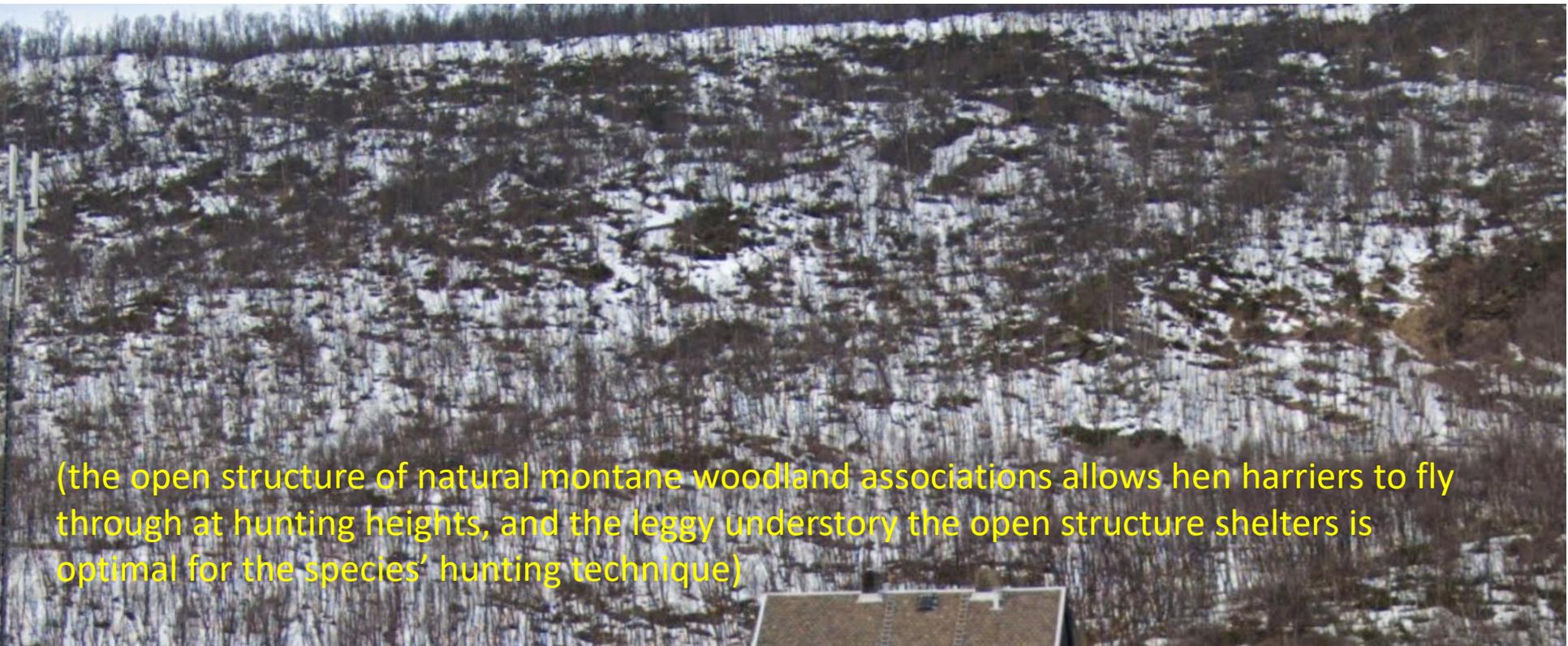


- Some native woodland planting schemes in upland Scotland have recently (2024) been refused because hen harriers nest in the area
- This seems to be because in Scotland the species usually nests on open heather moorland and it's assumed that is what it must have
- However, that is a man-made habitat; what do the birds like *naturally*?
- In Norway, core breeding habitat is «associated with montane willow-covered bog and heath areas in the mountains, together with open montane woodlands (*åpen fjellskog*)...The hen harrier places its nest on the ground, usually between tall willow bushes» (Gjershaug et al 1994)

Hen harrier natural summer habitat - Fokstumyra



Hen harrier natural summer habitat - Kongsvoll



(the open structure of natural montane woodland associations allows hen harriers to fly through at hunting heights, and the leggy understory the open structure shelters is optimal for the species' hunting technique)





<https://vimeo.com/620043121>





Some other bird species with significantly different habitat preferences to those Scottish conservation planning often assumes (based on what is available to them, in Scotland, now.)

www.nina.no





...and some that would probably colonise/become much more common as breeding birds if their montane woodland habitats (in Cairngorms climates, c. 600-900m asl; currently functionally extinct as habitats throughout Scotland), were restored.



2. Peat erosion (Scotland):
It's not 'natural'!



Blanket peat in Norway.

Better developed & biodiverse ground layer with trees on drier patches and by watercourses; peat haggling absent





3. Scree formed in the period of deforestation throughout SW Norway, in climates closely similar to Scotland, is now very widely in the process of recolonisation, initially by birch and aspen - forming new soils, sequestering carbon, and reducing erosion

(it's not 'natural' either, at least below the alpine zone)



4. Effects of mutual shelter: wind-bent 'granny pines' scattered among straight young-adult pines, naturally regenerated since the 1930s following reduction in grazing pressures. (Songli, coastal Trøndelag, 300m asl).

<https://www.nina.no/english/Sustainable-society/Restoration-Ecology>

5. Montane habitat restoration in Norway







Restoration of ammunition testing ground in Cairngorms plateau climates to montane willow associations

20th August 2019





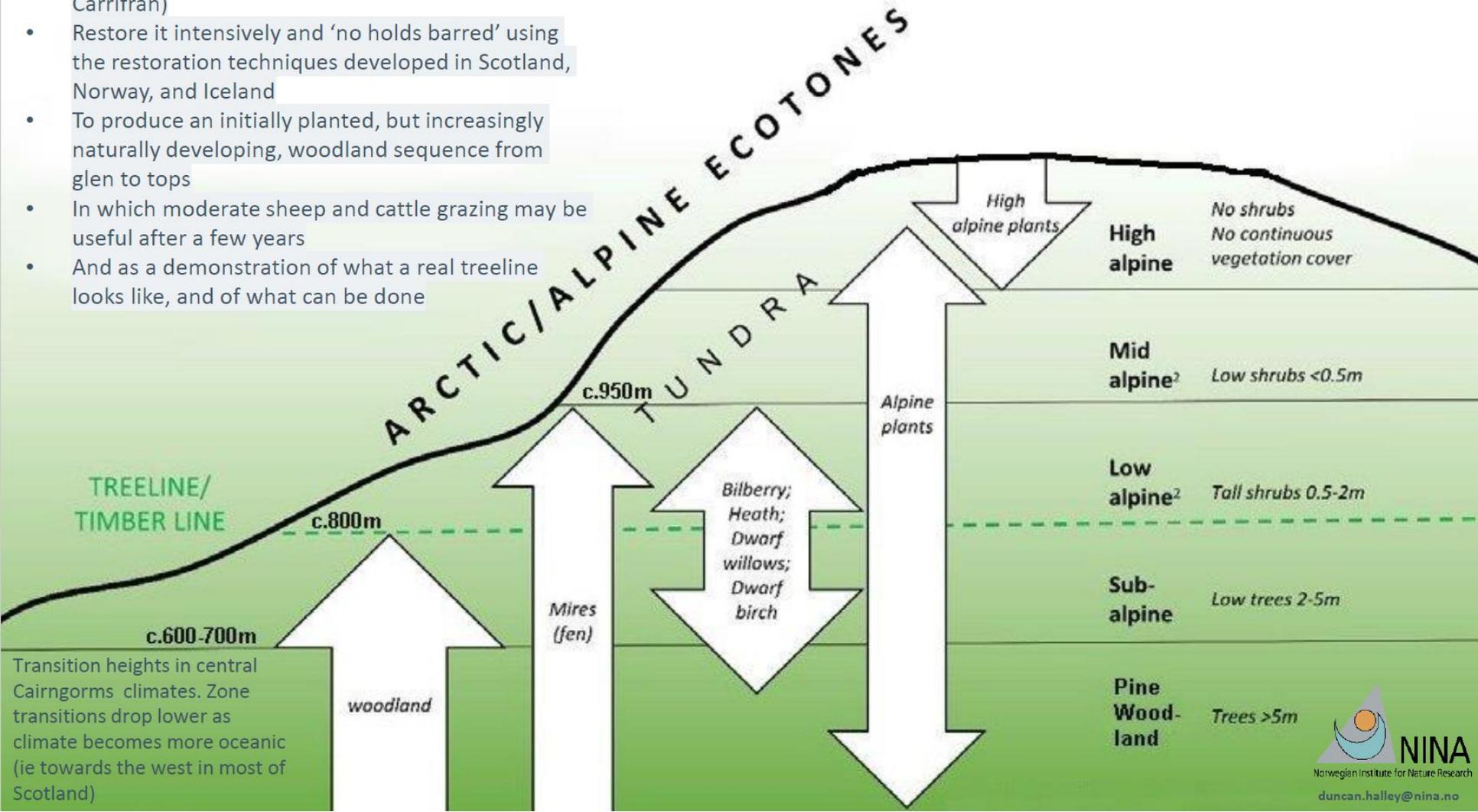
RESTORATION PROJECTS

- | | | |
|--|---|--|
| <p>Hjerkinn shooting range ></p> <p>From battlefield to national park</p> | <p>RESCAP ></p> <p>How can restoration be scaled up in practice?</p> | <p>Hermit beetle ></p> <p>Can species restoration ensure that the hermit survives in Norway in the long term?</p> |
| <p>Transforest ></p> <p>The pine forest in Norway has been greatly reduced, and there is a great need for restoration.</p> | <p>The breeding program for arctic foxes ></p> <p>The breeding program has developed methods for breeding in captivity and releasing arctic fox pups.</p> | <p>Newt Hotel ></p> <p>Artificial hibernation sites are a good alternative to the greater salamander's hibernation sites</p> |
| <p>Vulnerability assessments ></p> <p>Handbook for vulnerability assessments in Norwegian protected areas</p> | <p>Restoration rate ></p> <p>Nature restoration is one of NINA's strategic initiatives</p> | <p>White-tailed eagle to Europe ></p> <p>The Norwegian sea eagle is helping to re-establish sea eagles in Europe</p> |
| <p>Forest restoration ></p> <p>Important for value creation, climate and natural diversity</p> | <p>TEAM#UP ></p> <p>Team-up knowledge on ecological restoration</p> | <p>The Svea project ></p> <p>Restoring arctic wilderness in Svea on Svalbard</p> |
| <p>SYNFOREST ></p> <p>How can forest management and wood product production be adapted to more oak in Norwegian forests?</p> | | |

'Worst First' – restoration of a natural treeline sequence in Scotland

- a 'modest proposal'

- Find a whole mountain of little economic or conservation value – no designations – e.g. chronically overgrazed sheepwalk
- Fence it off or keep deer levels very low by shooting (e.g. as at Glenfeshie, Mar Lodge, Carrifran)
- Restore it intensively and 'no holds barred' using the restoration techniques developed in Scotland, Norway, and Iceland
- To produce an initially planted, but increasingly naturally developing, woodland sequence from glen to tops
- In which moderate sheep and cattle grazing may be useful after a few years
- And as a demonstration of what a real treeline looks like, and of what can be done



Cairngorms comparative: Byklehei

- In the Byklehei region of SW Norway, seasonal climates and landforms are closely similar to the central Cairngorms. The geology is granite.
- There are no biophysical differences of significance for the conditions of plant and animal life
- However, landuse history is significantly different, especially since the mid-18th century



Alpine zone

Willow Region

Birch Belt

Pine woodland



Pine zone – montane woodland transition, Byklehei

Montane birch woodland on Hovdenut

Hartevatnet 759m



View WSW from shoulder of Jarekollen at c. 900m

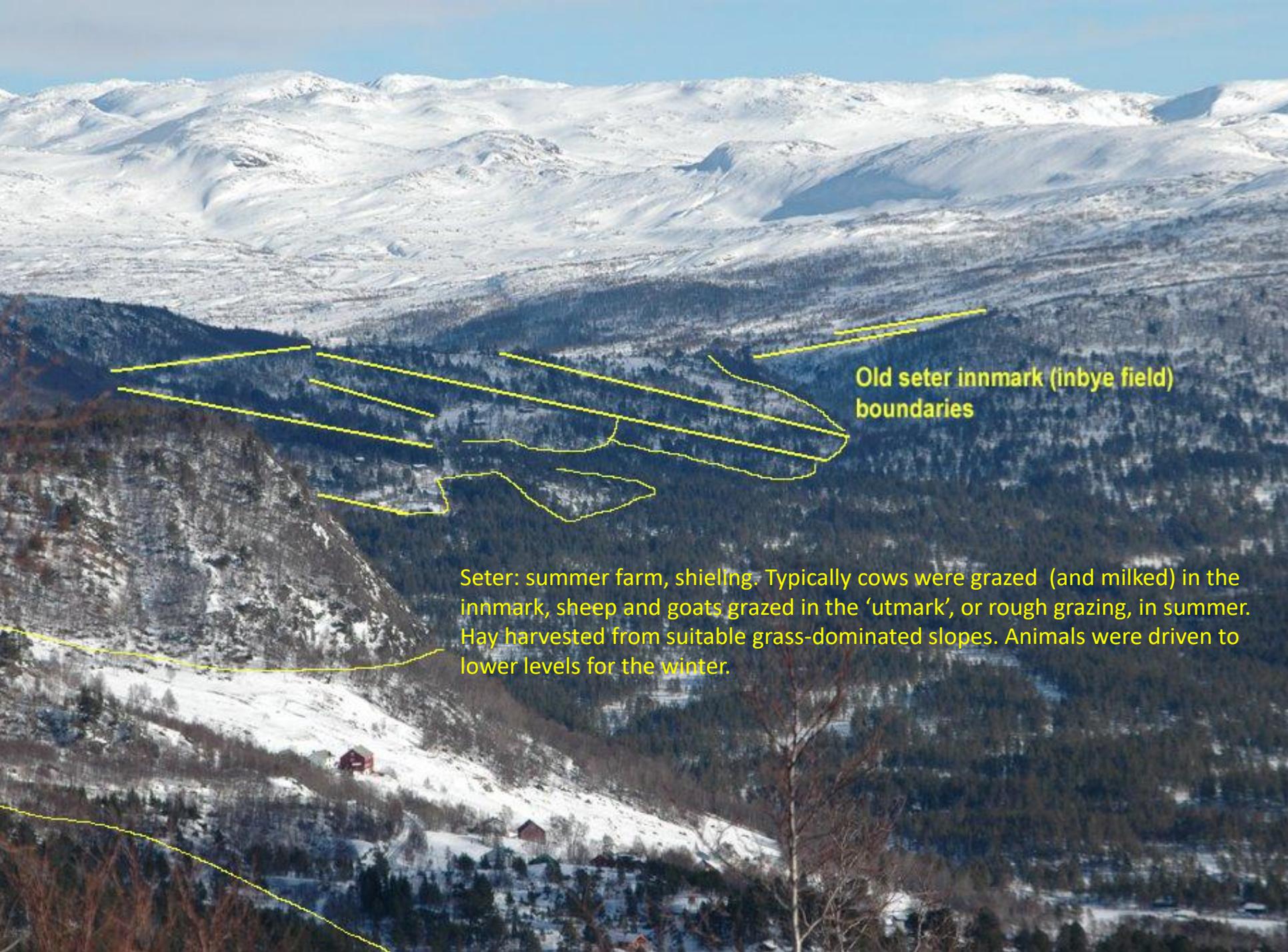
Voilenuten 1343m

Bosvatn 551m

Foreground is typical 'rabbe' vegetation - found on ridges, etc. where snow normally blows off in winter. Willow is typically found in more sheltered locations with snow lie.

Bygdeheii 1306m





Old seter innmark (inbye field) boundaries

Seter: summer farm, shieling. Typically cows were grazed (and milked) in the innmark, sheep and goats grazed in the 'utmark', or rough grazing, in summer. Hay harvested from suitable grass-dominated slopes. Animals were driven to lower levels for the winter.

Hovden alpine ski area, Bykle



Nos 1183

Hovdenuten 1119

Hovden Skisenter

Breivevatn

759m



Willow region c. 950m

(Typical 'willow region' vegetation. The term means the zone where montane willows are common; *not* that the zone is all willow, or even dominated by willows (which is rare). Birch, rowan, juniper and aspen are typically common as well; with krummhölz pine in some places, all interspersed with more open patches of grasses and forbs.

This area was open moor 50 years ago; regeneration has followed decline in grazing pressures. Cows and sheep are still grazed at this site in summer at moderate densities; wild browsers include moose and reindeer)

Sloaros 1045m





Berdalsbu (980m asl) & Berdalen, Byklehei

Lairig Ghru & Glen Geusachan, Cairngorms



But – why not see for yourself?

Photo: ut.no



GBP – British Pound

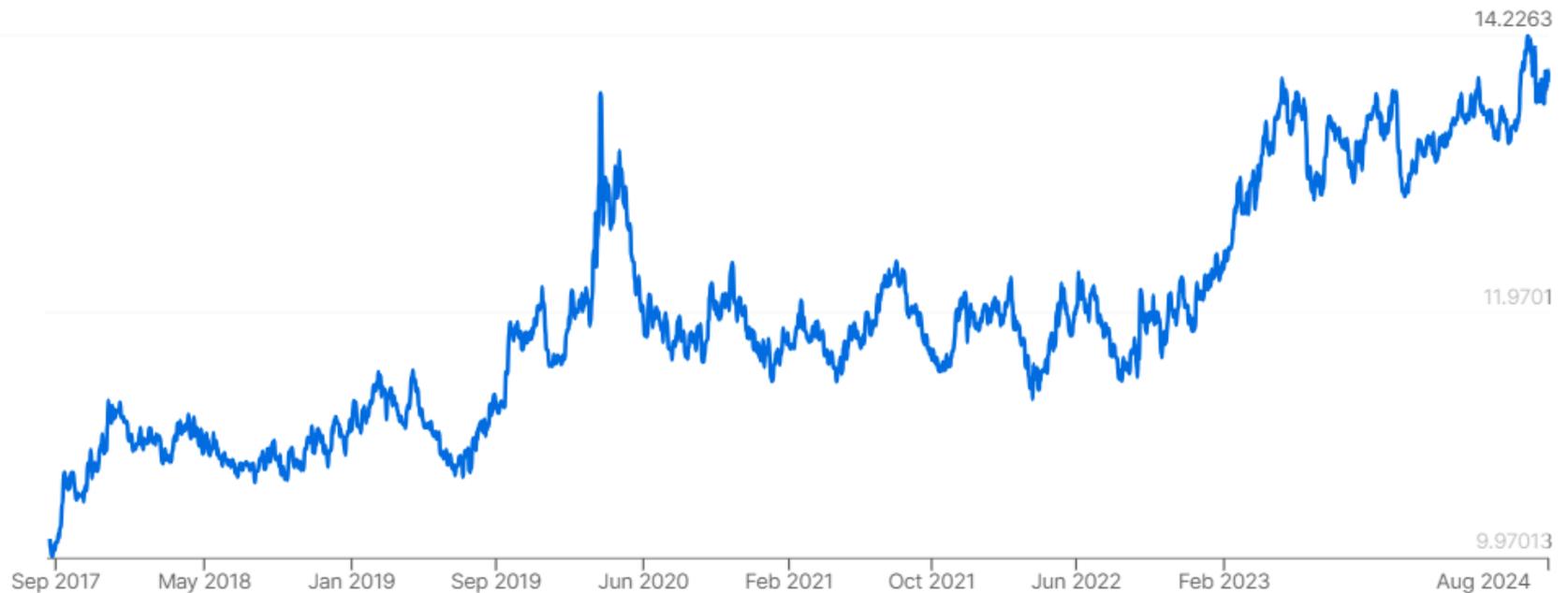


NOK – Norwegian Krone

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British Pound to Norwegian Krone



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