Opportunities and problems with introduced tree species in the Danish forests – in a historical perspective

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What is an exotic / introduced / foreign versus a native species?


Google earth


Google earth


Google earth

Typically a nationalistic approach…

… the randomness of borders

… the randomness of borders

Sorbus intermedia

Cotoneaster niger

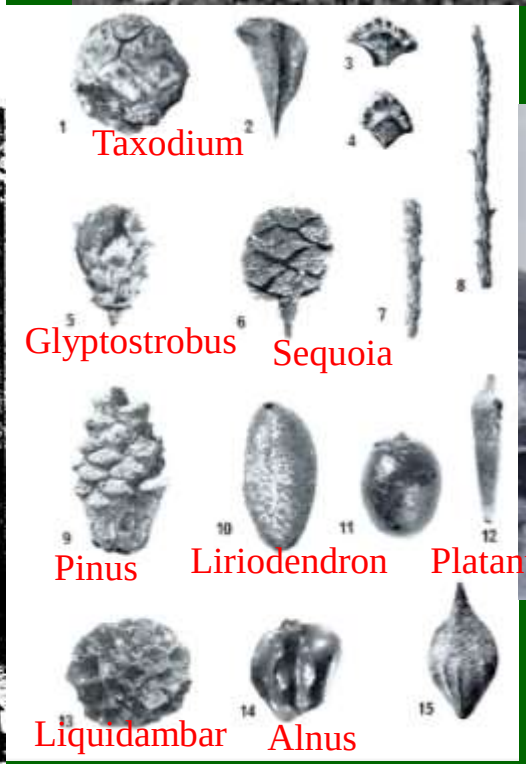
Sorbus rupicola

Cotoneaster integerrimus

Sorbus hybrida

The long time perspective

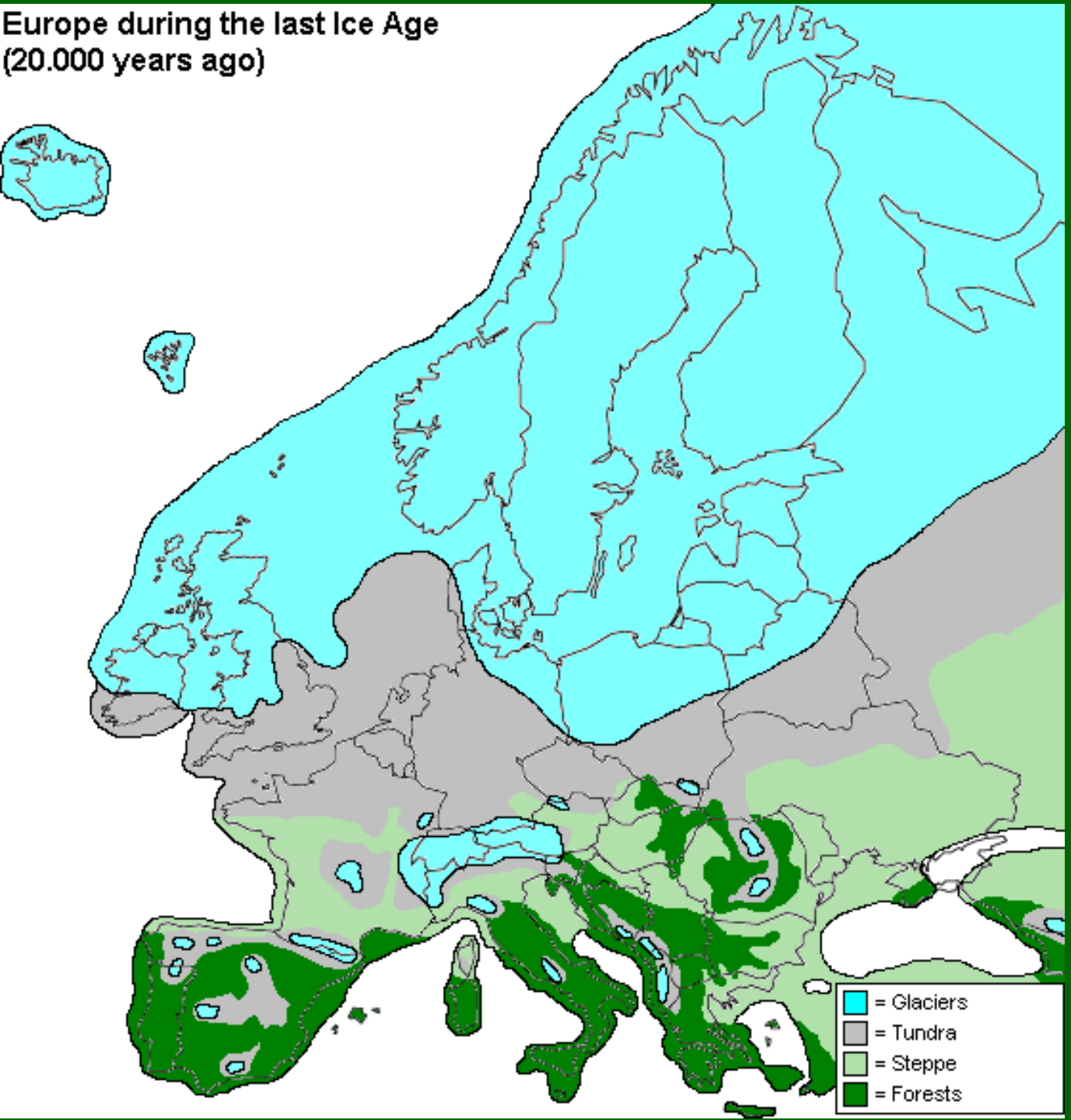
Brown coal from freshwater deposits Miocene (ca. 18-13 mio. years)



Sequoia
Troldhede Brunkulsleje 1919

Conifers in ‘Denmark’ during the last million years

	Holocene **Interglacial?** **Since 12.500 BP**	**Brørup** **Interstadial** **ca. 60.000**	**Eemian** **Interglacial** **120.000-90.000**	**Holstenian** **Interglacial** **240.000**	**Cromer** **Interglacial** **650.000**
Tree species/genus					
Juniper, *Juniperus*	x	x	x	x	x
(Scots)Pine, *Pinus*	x	x	x	x	x
Spruce, *Picea*	-	x	x	x	x
‘Serbian’ spruce, *P. omorikoides*	-	x			
Yew, *Taxus*	x	-	x	x	x
Larch, *Larix*	-	x	-	-	-
Fir, *Abies*	-	-	-	x	-
Cauc. Wingnut, *Pterocarya*	-	-	-	x	-


Europe during the last Ice Age
(20.000 years ago)
= Glaciers
= Tundra
= Steppe
= Forests

Conifers in ‘Denmark’ during the last million years

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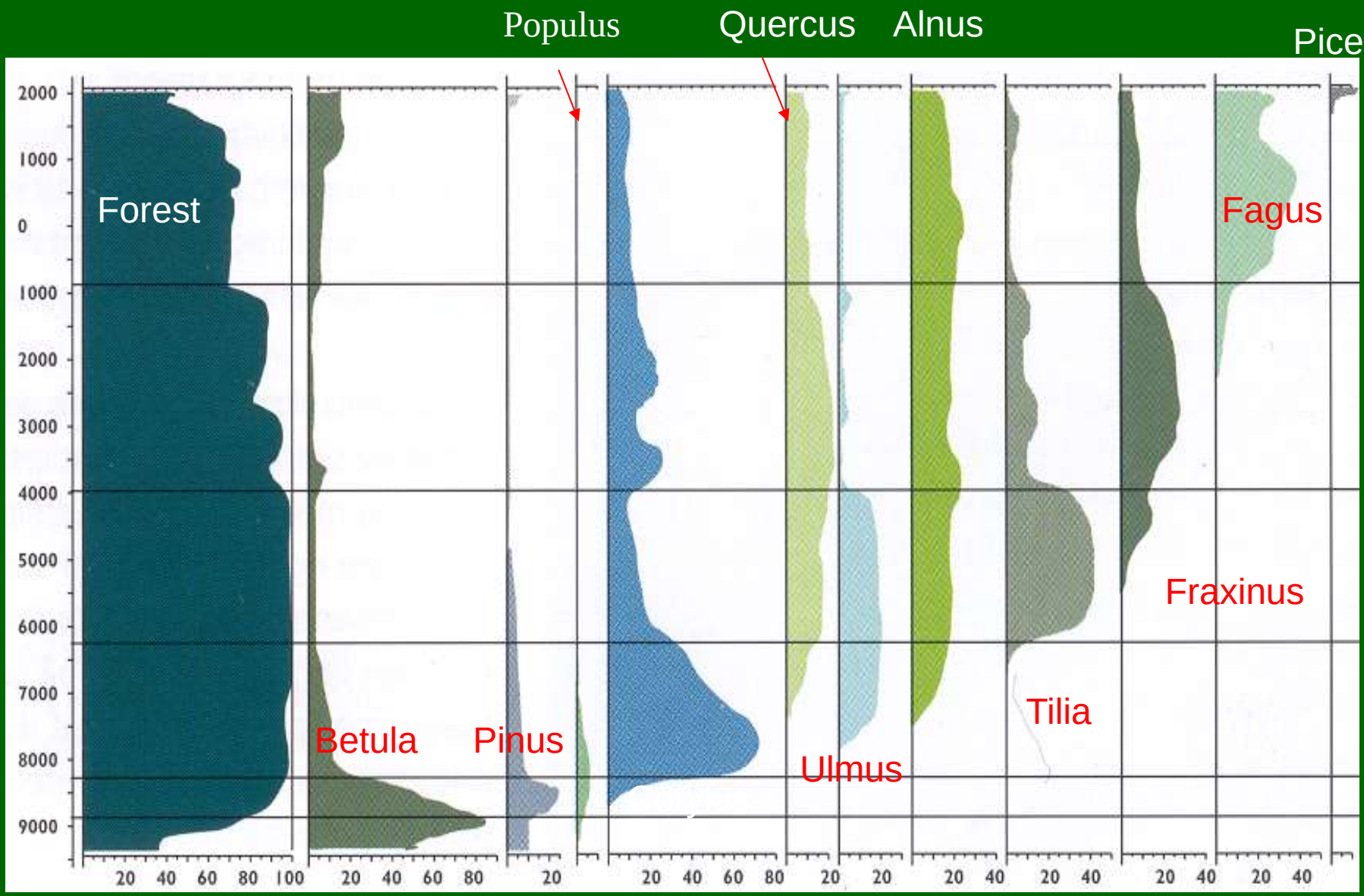
Yew, *Taxus*	x	-	x	x	x
Larch, *Larix*	-	x	-	-	-
Fir, *Abies*	-	-	-	x	-
Cauc. Wingnut, *Pterocarya*	-	-	-	x	-

Native norway spruce *(Picea abies)* in Denmark (Emmerlev Klev, SW Jutland)

Eemian Interglacial
130-110.000 BP

Exhibited at Danish Museum of Hunting and Forestry (Dansk Jagt- og Skovbrugsmuseum)



Holocene forest development on fertile soils in East Denmark

source: B. Odgaard GEUS / AaU

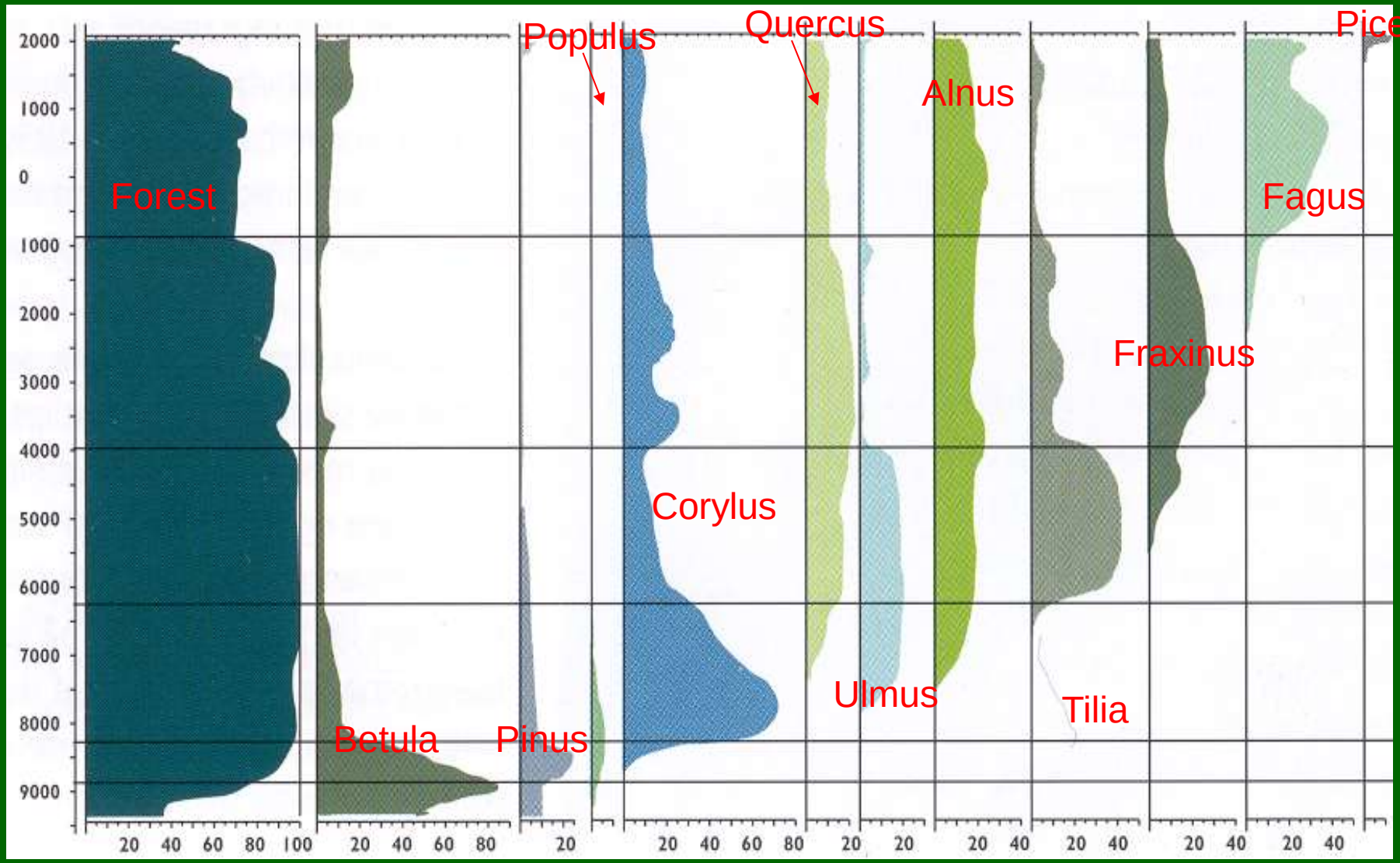
Beech forests

Only three native conifers in Denmark in the Holocene:

Juniper
Juniperus communis

Scots pine
Pinus sylvestris

Yew
Taxus baccata



Holocene forest development on fertile soils in East Denmark

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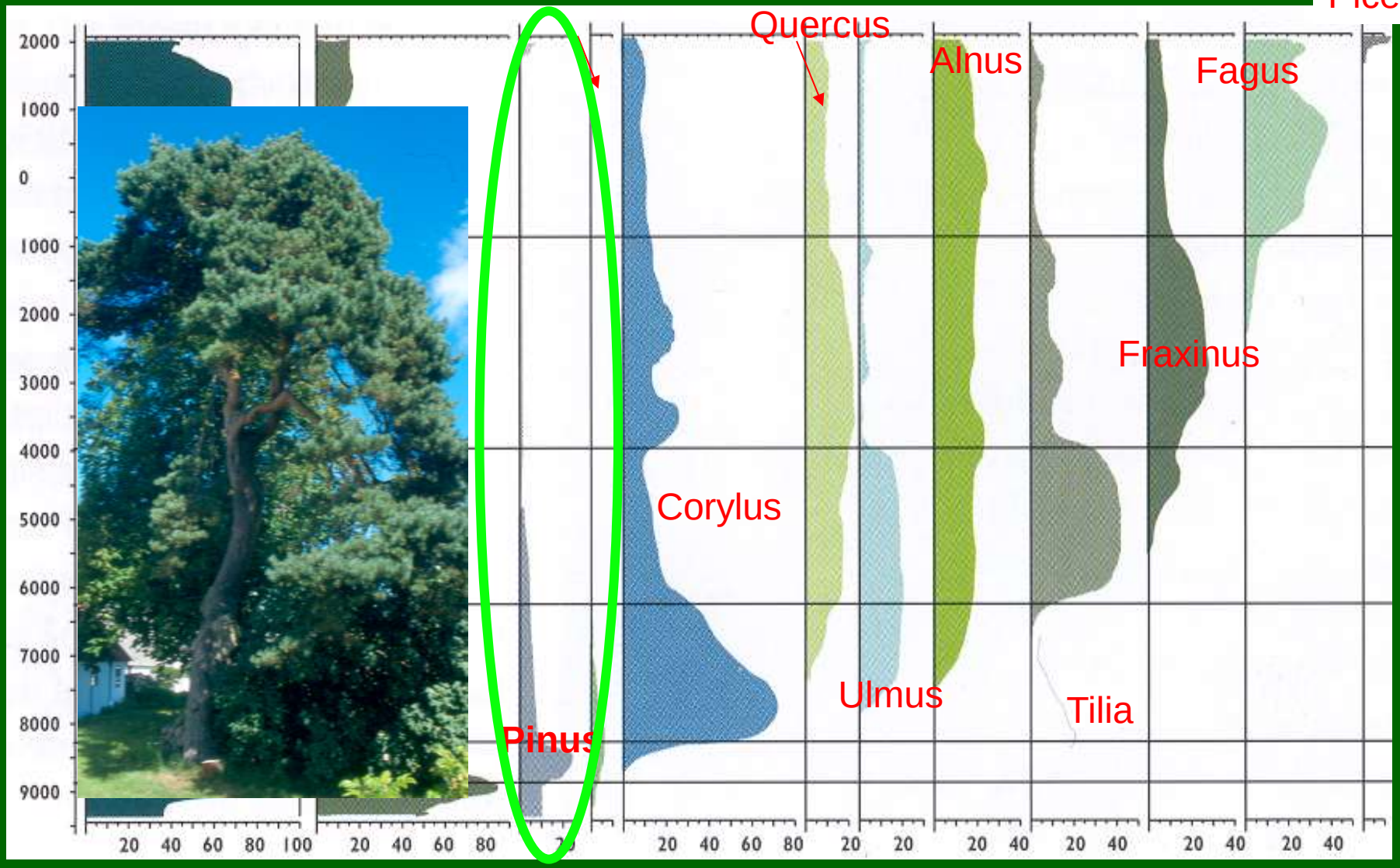

Holocene forest development on fertile soils in East Denmark

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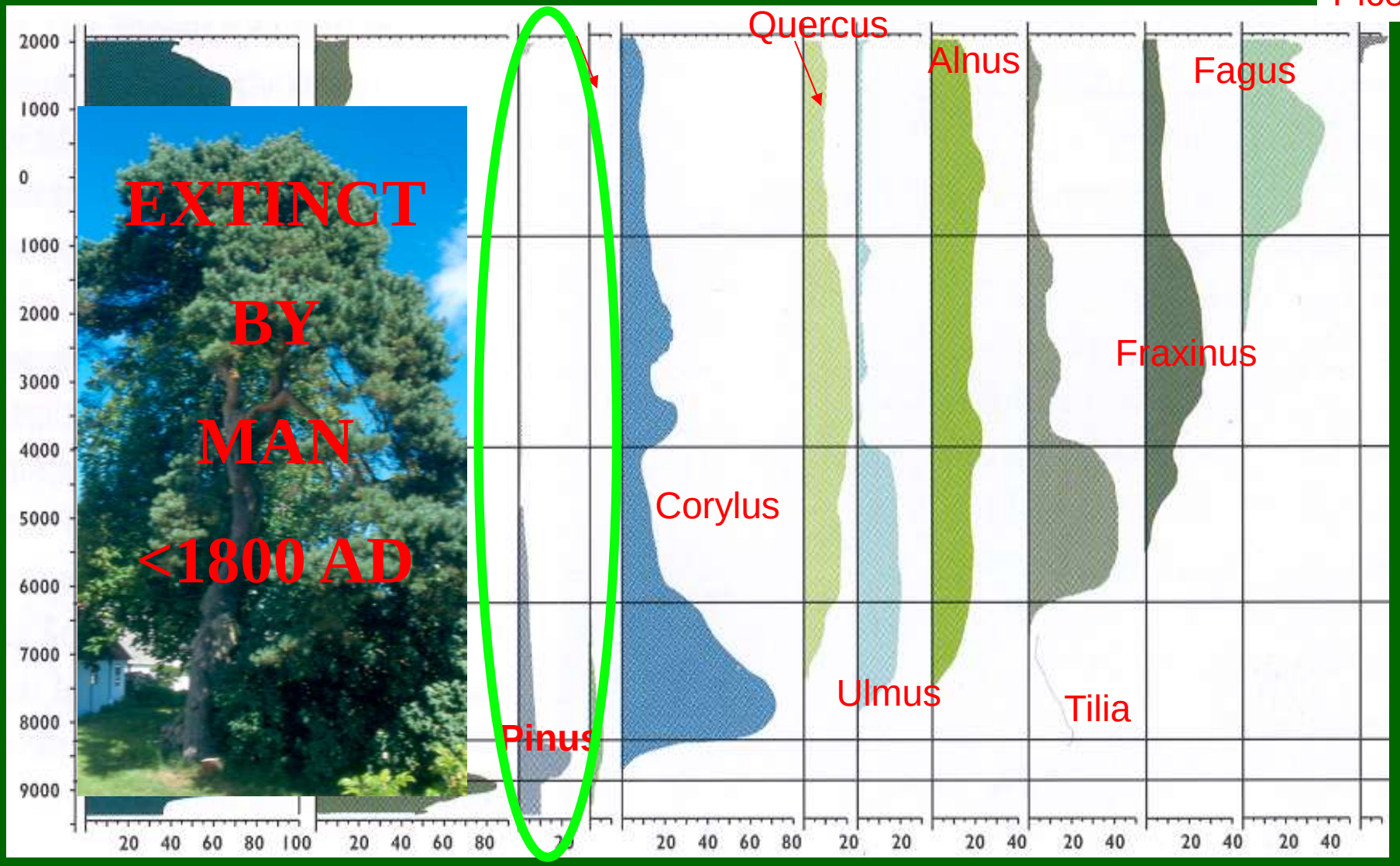

Holocene forest development on fertile soils in East Denmark

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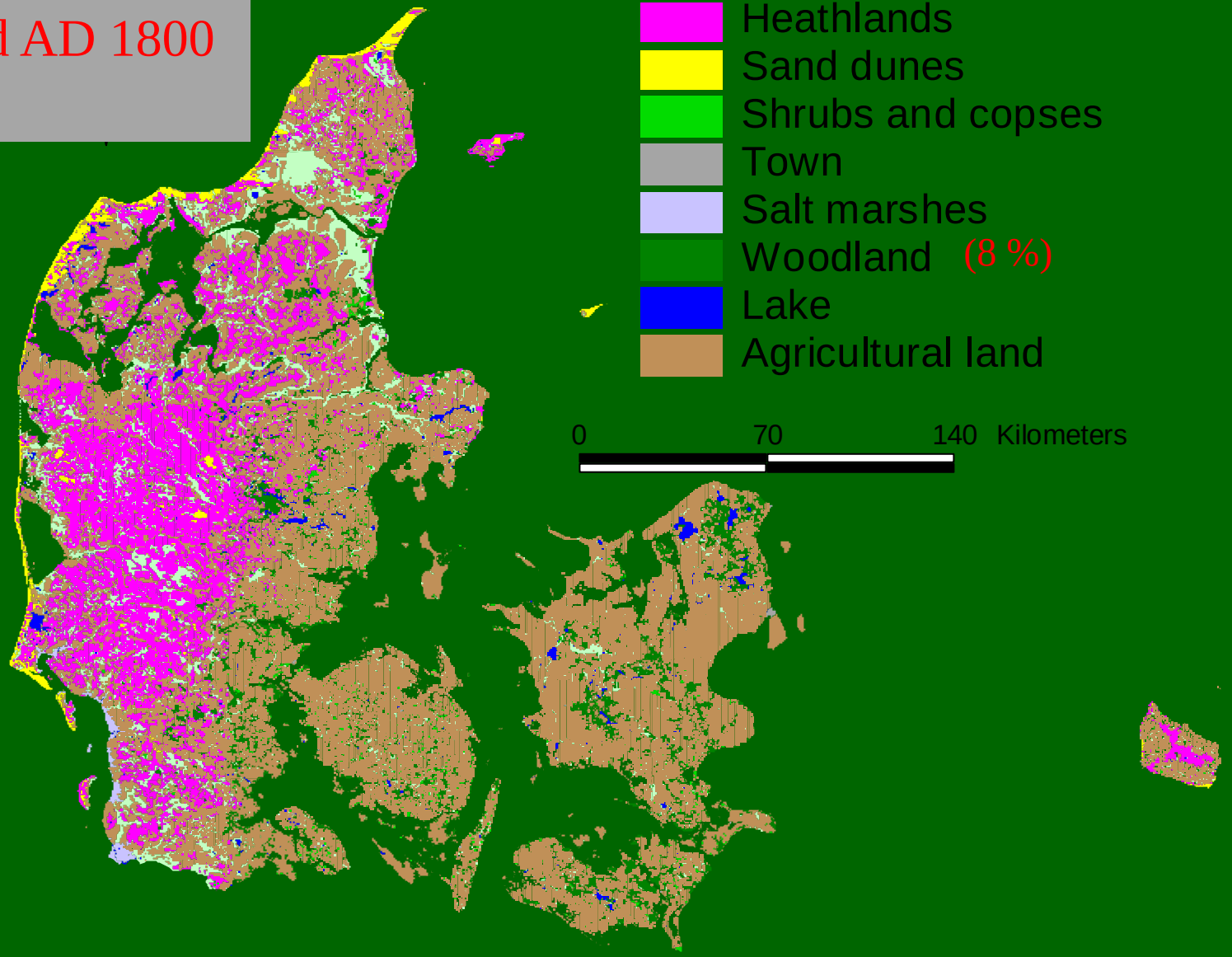
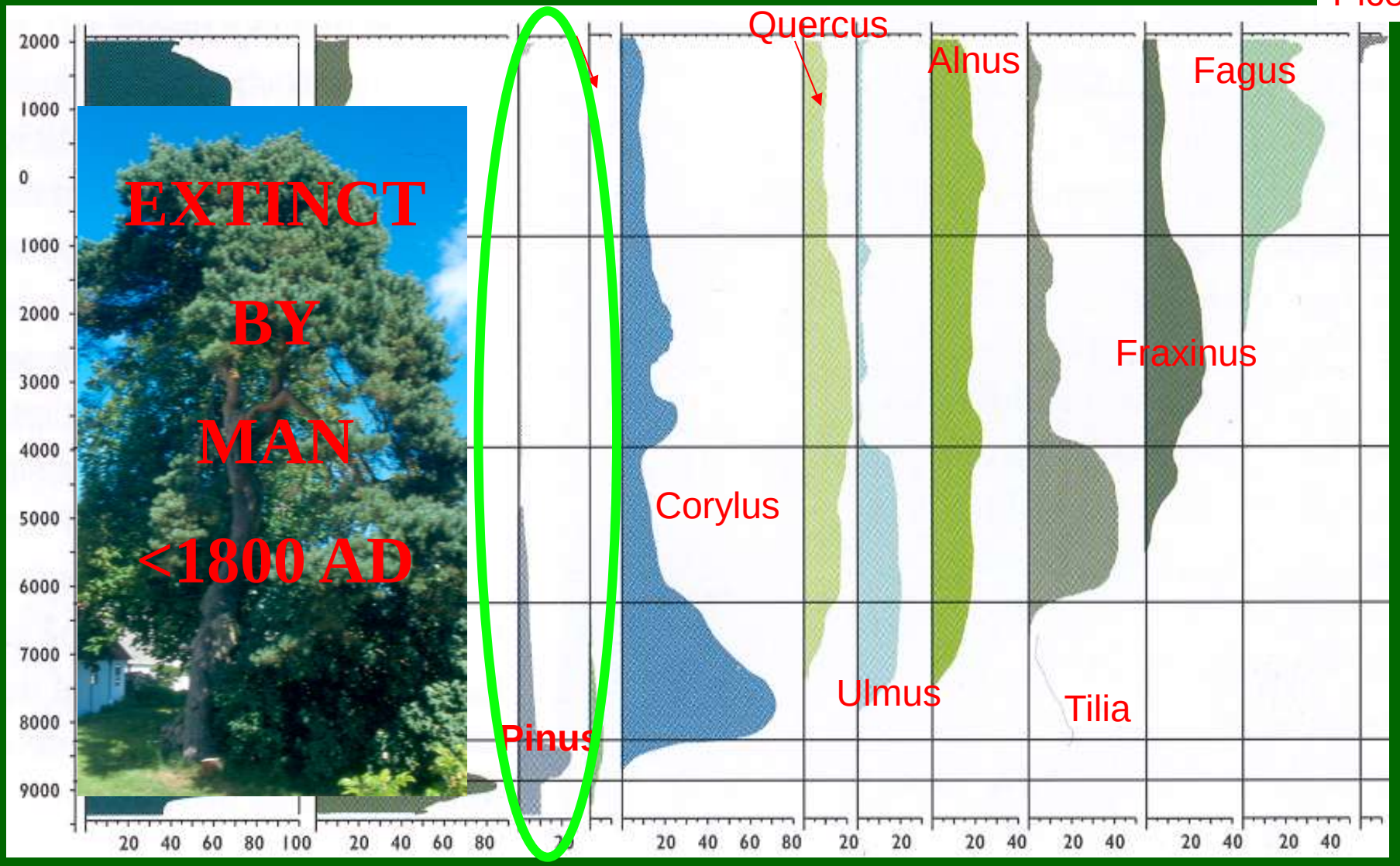
Land use in Denmark Around AD 1800



Based on maps made by Videnskabernes Selskab 1768-1805.



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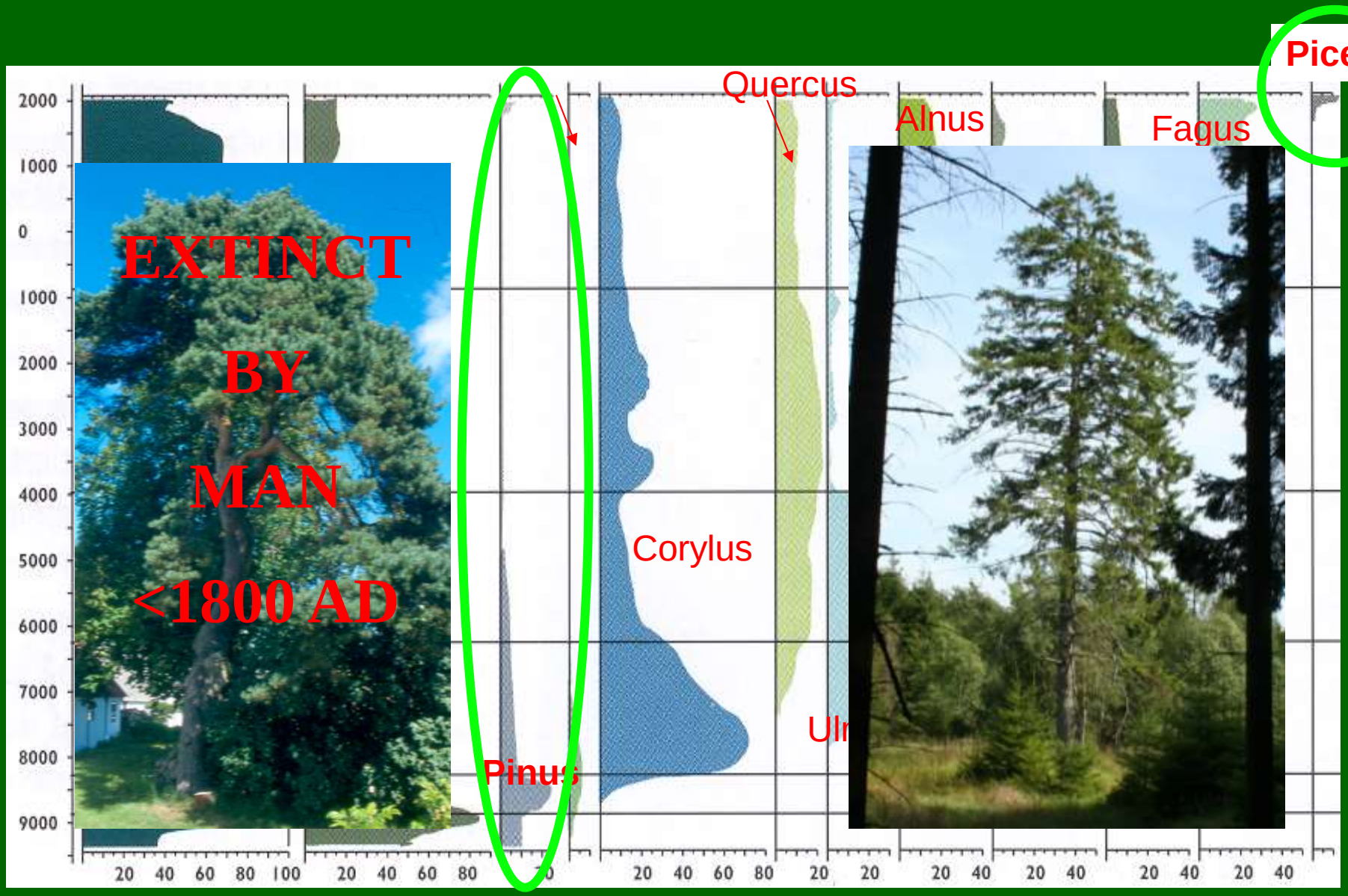

Holocene forest development on fertile soils in East Denmark

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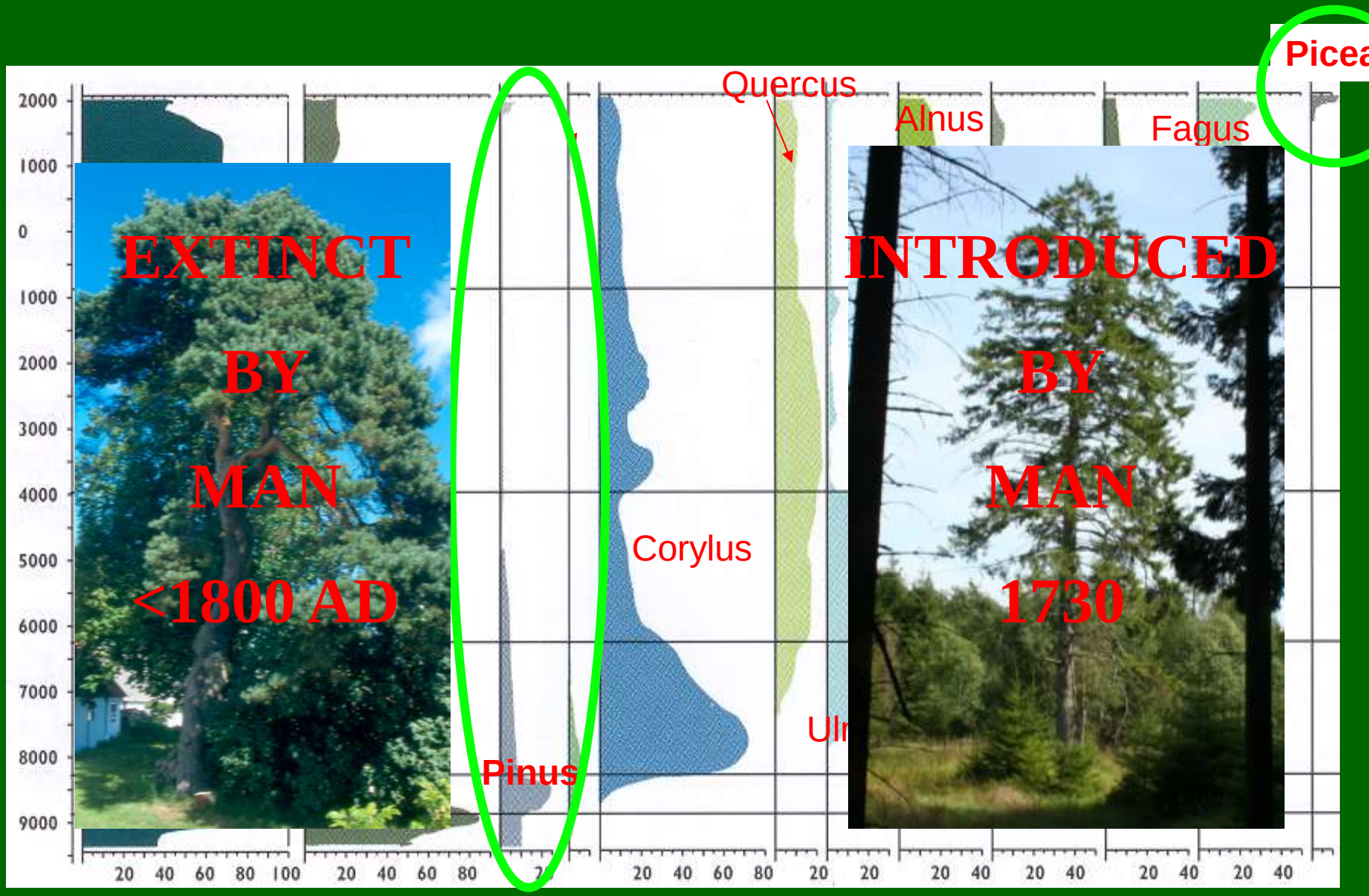
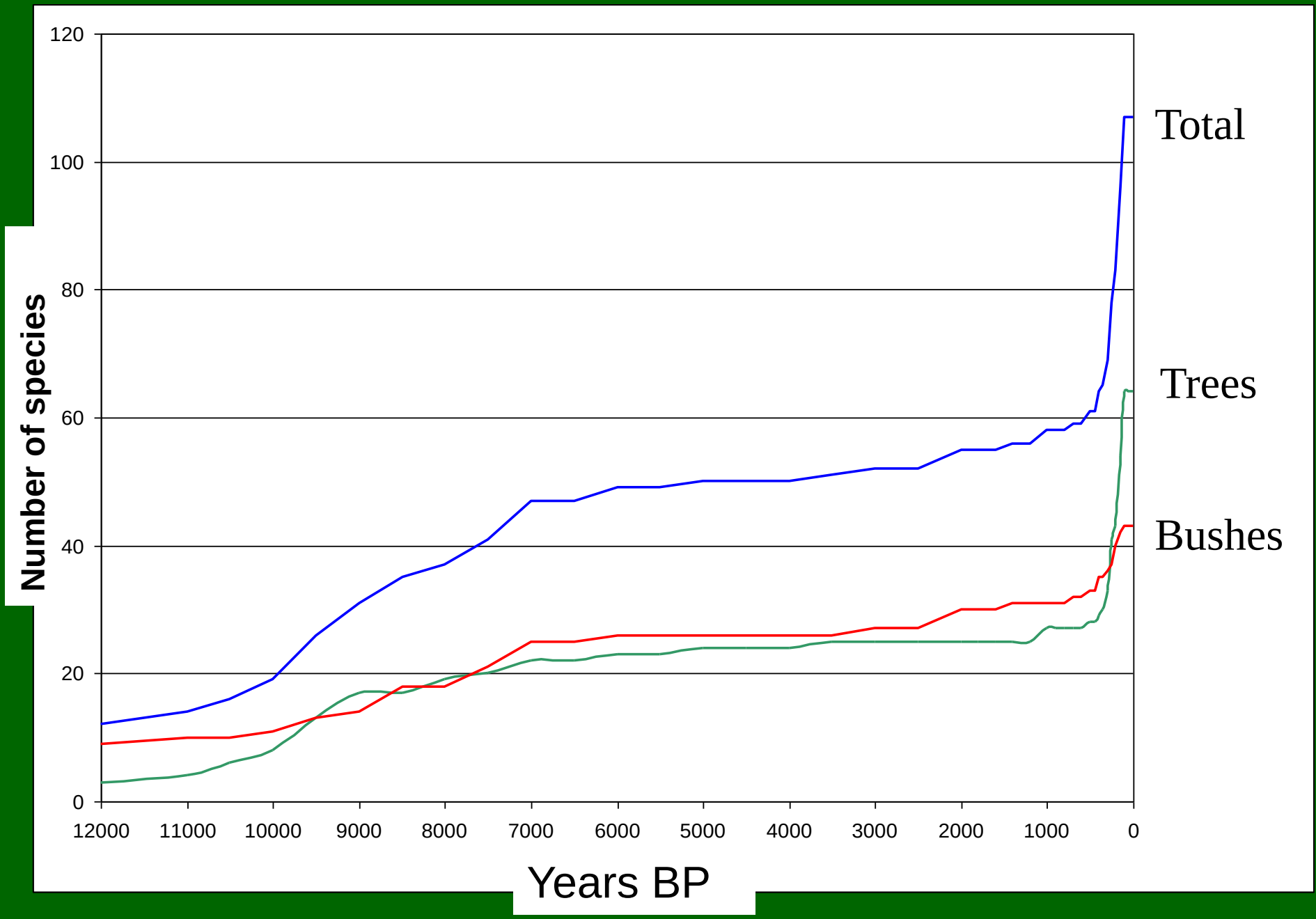
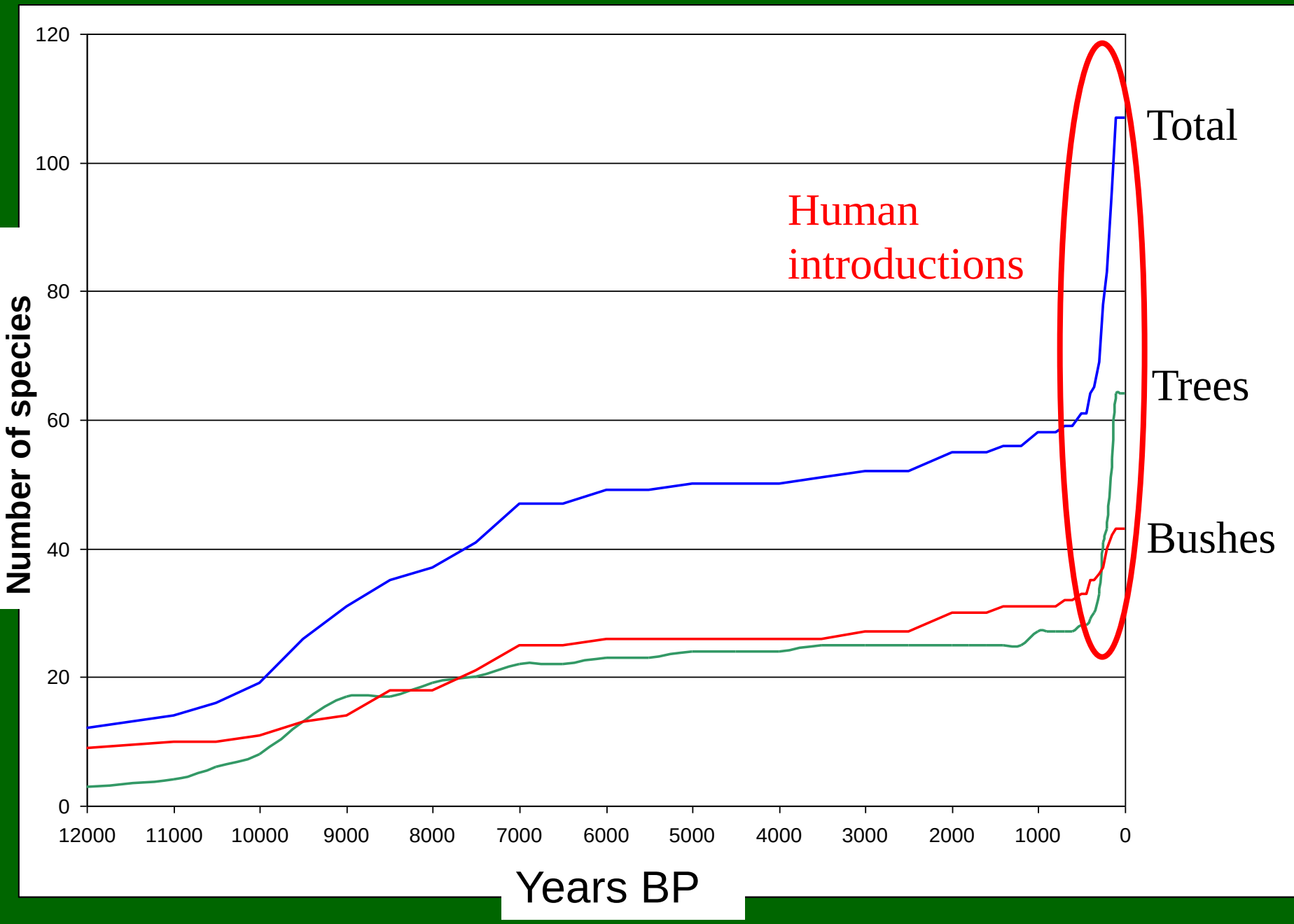


Holocene forest development on fertile soils in East Denmark

source: B. Odgaard GEUS / AaU

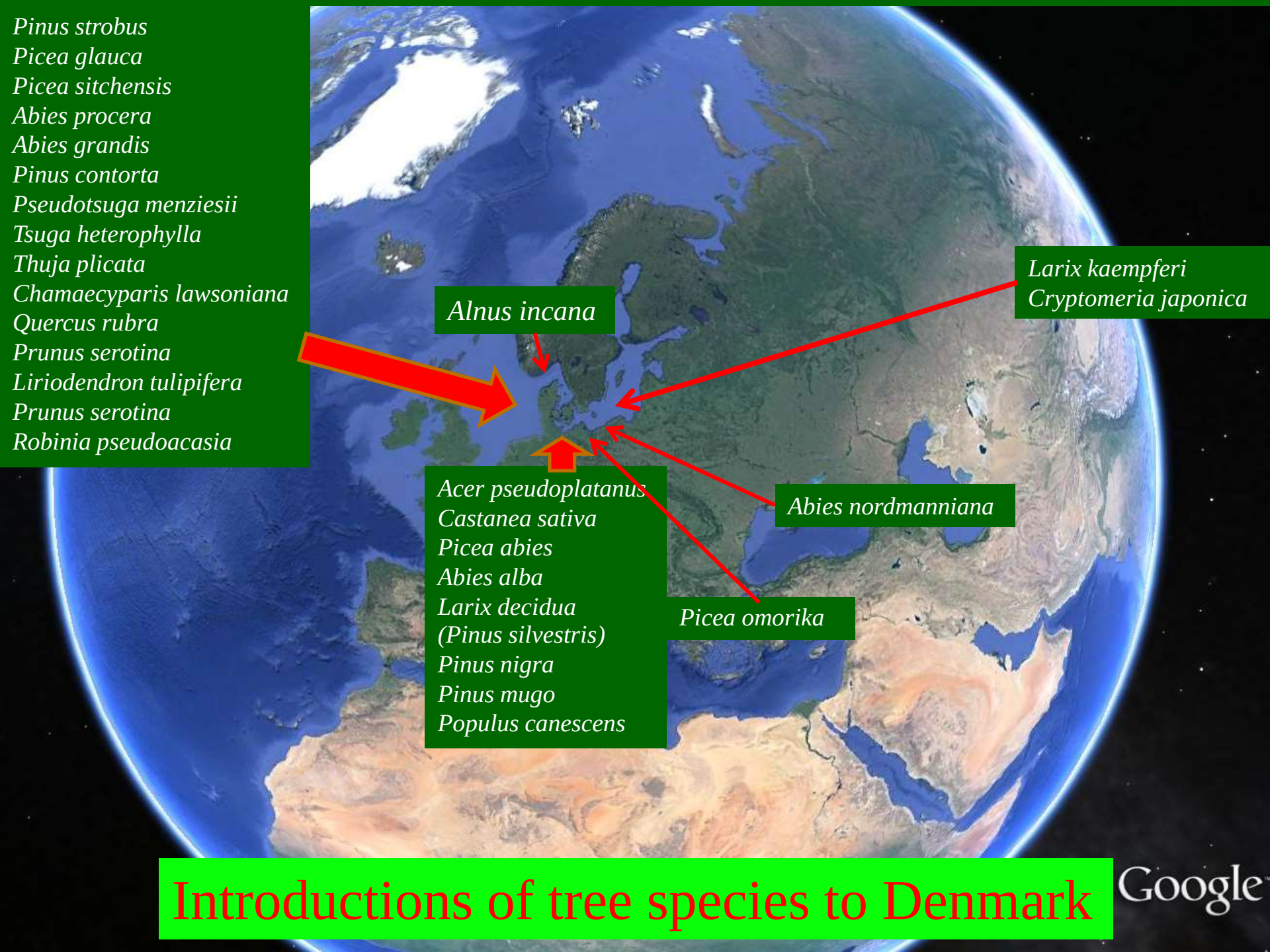


Number of woody species in the Danish woodlands during the Holocene



Number of woody species in the Danish woodlands during the Holocene

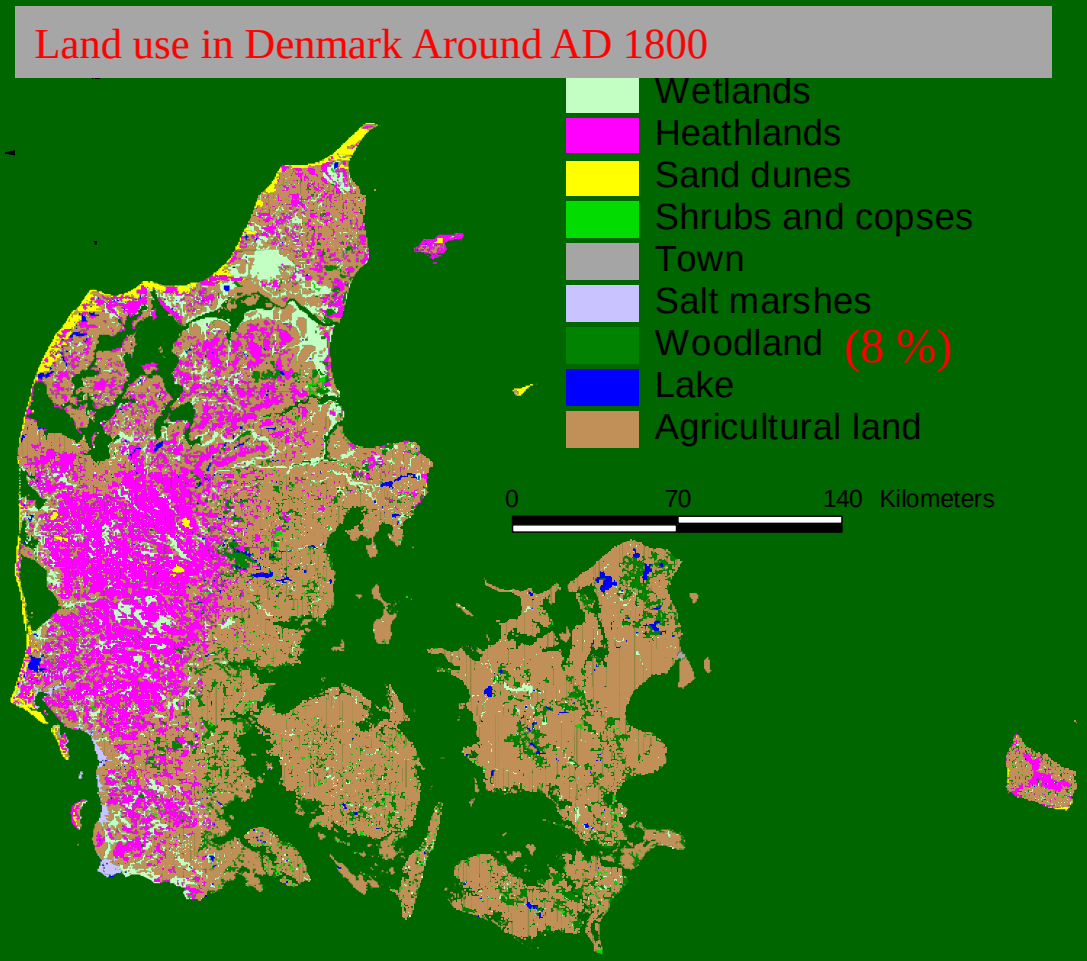

Introductions of tree species to Denmark
Google


Pinus strobus
Picea glauca
Picea sitchensis
Abies procera
Abies grandis
Pinus contorta
Pseudotsuga menziesii
Tsuga heterophylla
Thuja plicata
Chamaecyparis lawsoniana
Quercus rubra
Prunus serotina
Liriodendron tulipifera
Prunus serotina
Robinia pseudoacasia
Alnus incana
Larix kaempferi
Cryptomeria japonica
Acer pseudoplatanus
Castanea sativa
Picea abies
Abies alba
Larix decidua
(Pinus silvestris)
Pinus nigra
Pinus mugo
Populus canescens
Abies nordmanniana
Picea omorika
Introductions of tree species to Denmark
Google

Time from introduction to use in the landscape/ the woods

Species	**Latin name**	**Origin**	**Introduced to Denmark**	
			Parks, botanical gardens, arboretums etc.	Forestry
European silver fir	Abies alba	Europe	1660 (?)/1740	1765
Mountain pine	Pinus mugo	Europe	1798	1820
Austrian pine	Pinus nigra	Europe	1829	1837
Douglas fir	Pseudotsuga menziesii	NW America	1849	1866
Lawson cypress	Chamaecyparis lawsoniana	NWAmerica	1855	1870
Sitka spuce	Picea sitchensis	NW America	1854/1860	1873
Caucasian fir	Abies nordmanniana	Caucasus	1848	1874
Western hemlock	Tsuga heterophylla	NW America	1877	1877
Western red cedar	Thuja plicata	NW America	1850	1880
Noble fir	Abies procera	NW America	1855	ca. 1890
Grand fir	Abies grandis	NW America	1855	ca. 1890
Lodgepole pine	Pinus contorta	NW America	<1871	1890
Japanese larch	Larix kaempferi	Japan	1889	<1920
Serbian spruce	Picea omorika	SE Europe	1891	<1940
Japanese cedar	Cryptomeria japonica	Japan	1849	<1950

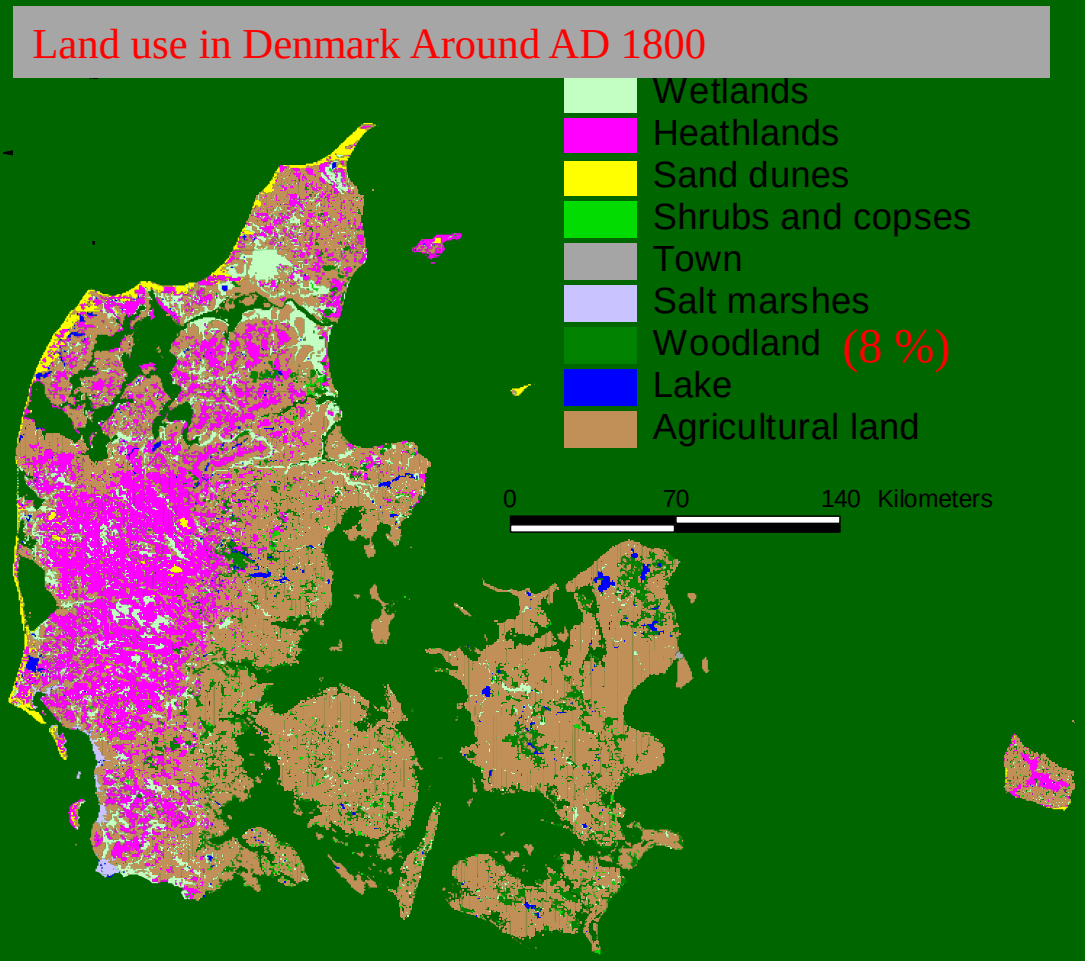
Reasons for use of ‘exotics’



Based on maps made by Videnskabernes Selskab 1768-1805.

Reasons for use of ‘exotics’

- Need for timber



Based on maps made by Videnskabernes Selskab 1768-1805.

Oak wood / shrub in Western Jutland

European silver fir
Abies alba

Nørreskov

1765

H = 46 m

D = 1½ m

European larch
Larix decidua

Tinghus

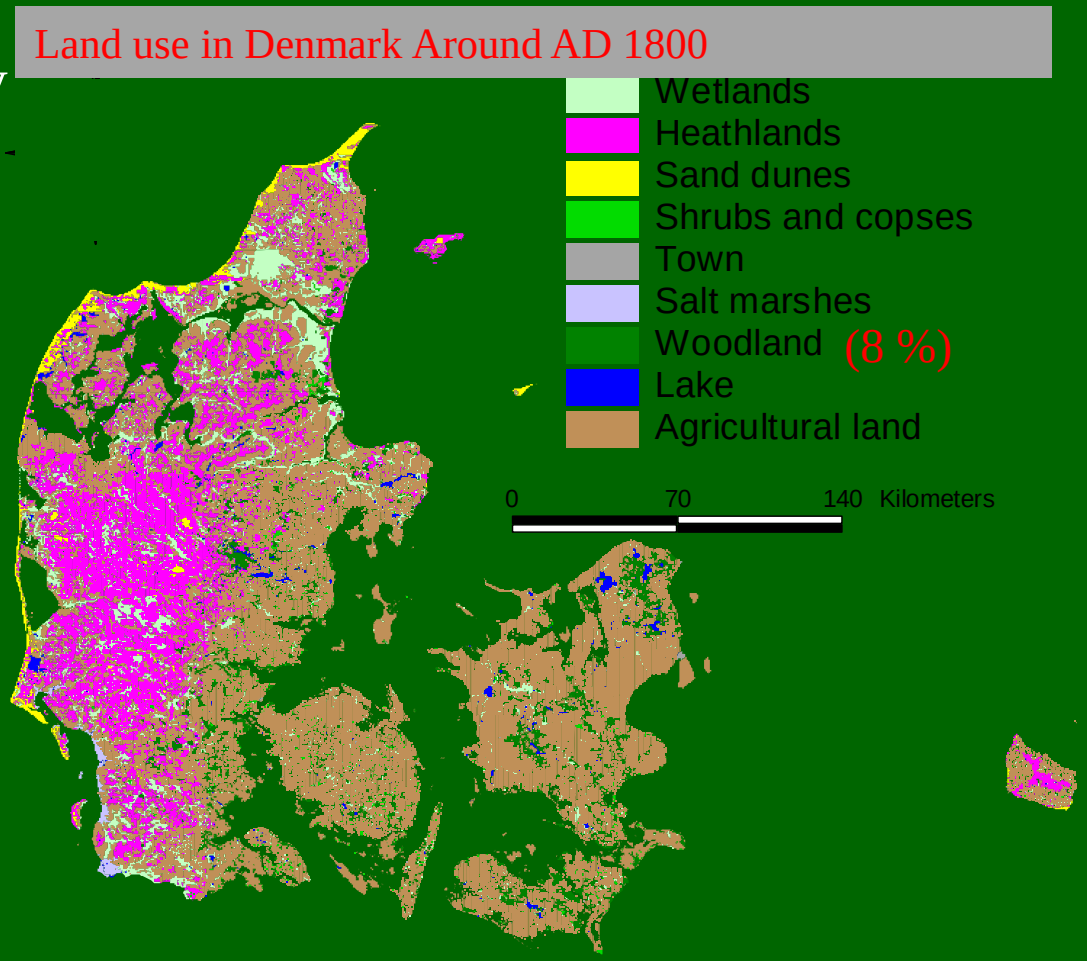
1776

Norway spruce
Picea abies

50 years old

Reasons for use of ‘exotics’

- Need for timber
- Need for firewood/energy



Based on maps made by Videnskabernes Selskab 1768-1805.

Beech for firewood. Bognæs, Sealand 1931

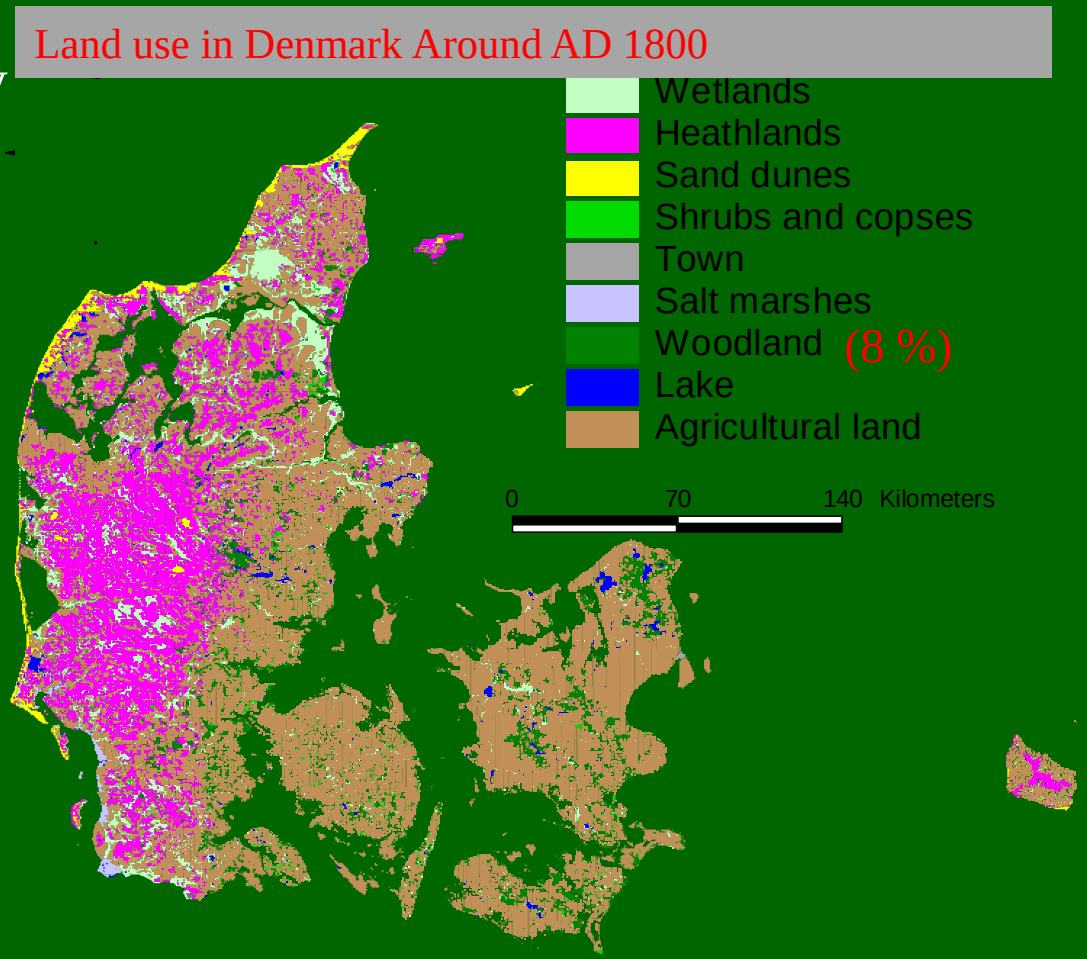
Lejre Lokalhistoriske Arkiv

1765 Farum Nørreskov

Sycamore (Great maple)
Acer pseudoplatanus

Reasons for use of ‘exotics’

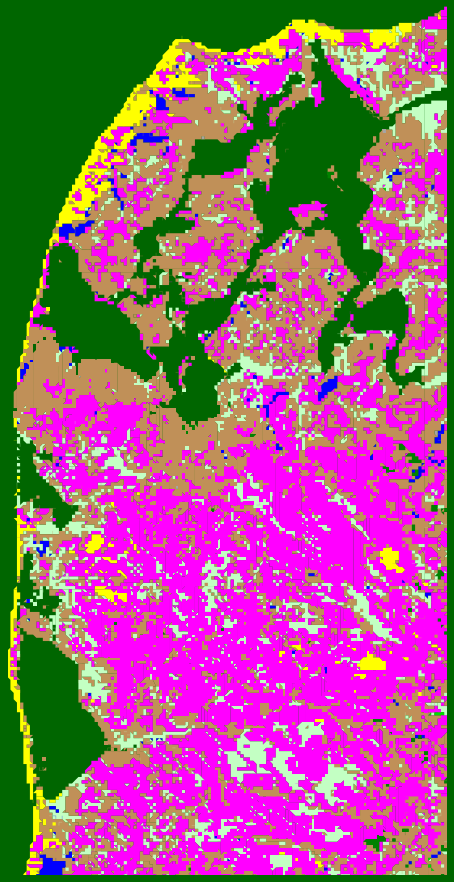
- Need for timber
- Need for firewood/energy
- Need of pioneer species for afforestation on dunes and heathland



Based on maps made by Videnskabernes Selskab 1768-1805.

Challenges / problems

Heathlands
Sand dunes



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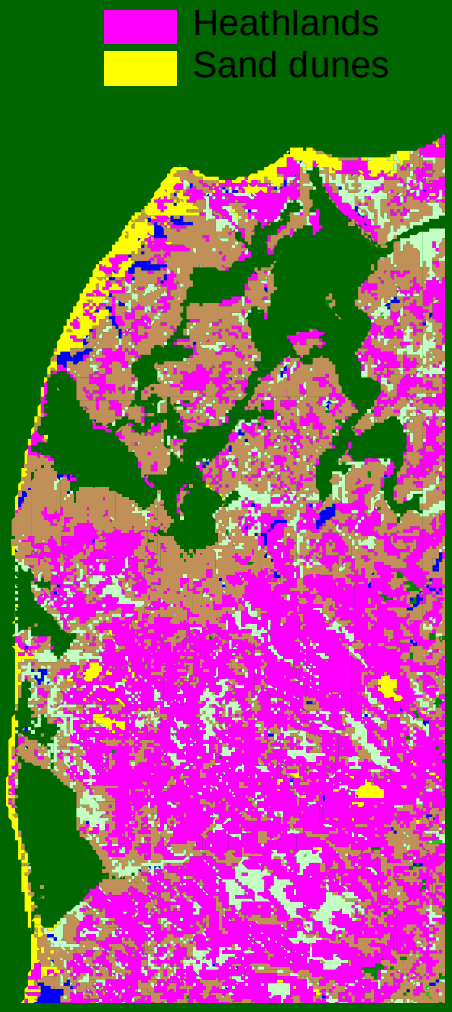
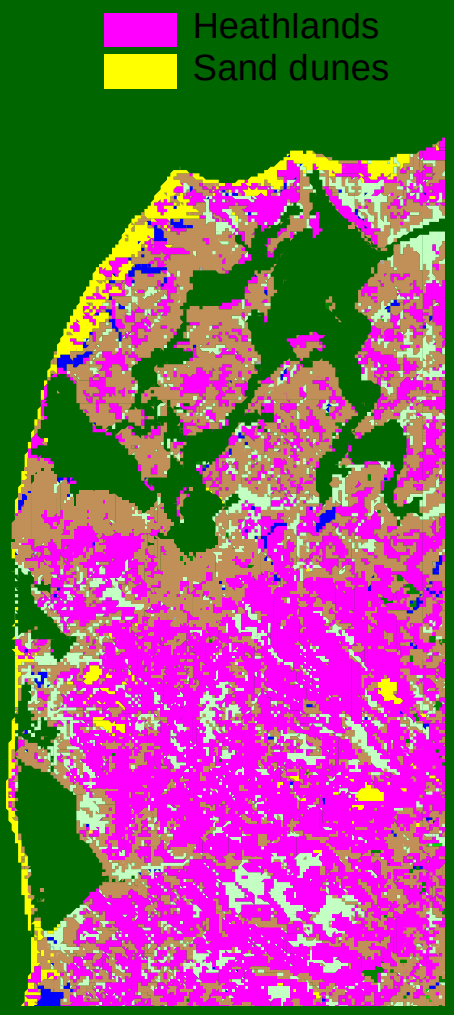
Challenges / problems



- Sanddrift

Based on maps made by Videnskabernes Selskab 1768-1805.

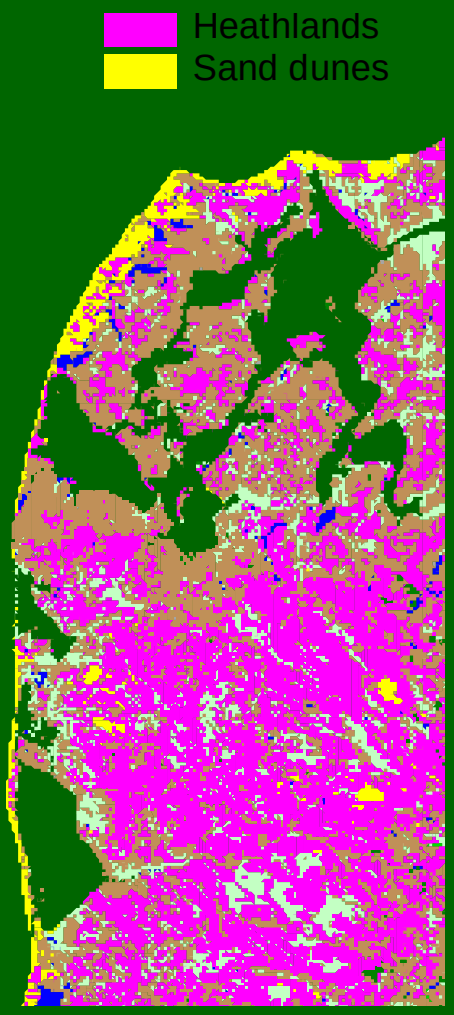
Challenges / problems



- Sanddrift
- Lack of shelter

Based on maps made by Videnskabernes Selskab 1768-1805.

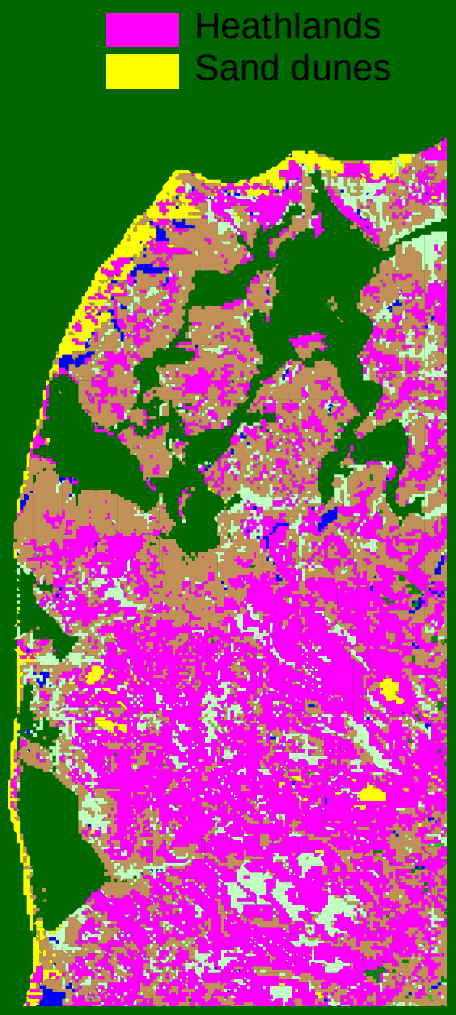
Challenges / problems



- Sanddrift
- Lack of shelter
- Soil conditions

Based on maps made by Videnskabernes Selskab 1768-1805.

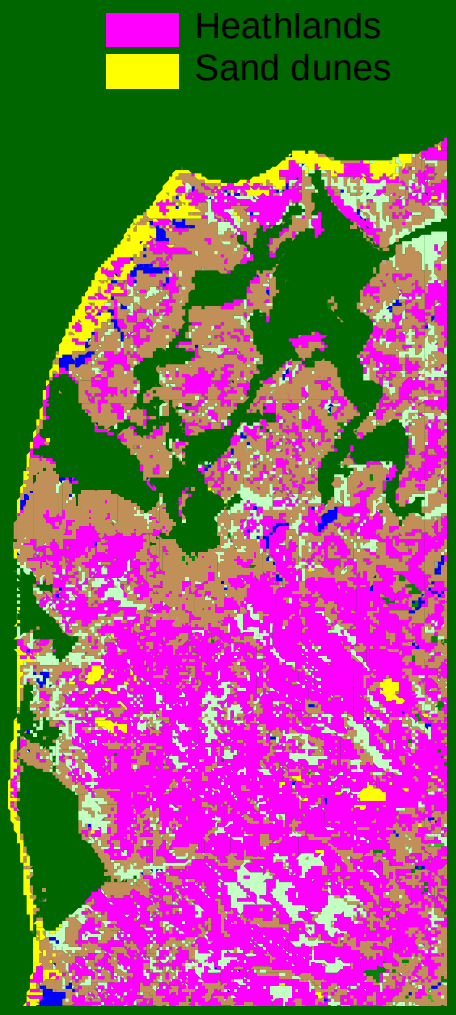
Challenges / problems



- Sanddrift
- Lack of shelter
- Soil conditions
- Low nutrient content

Based on maps made by Videnskabernes Selskab 1768-1805.

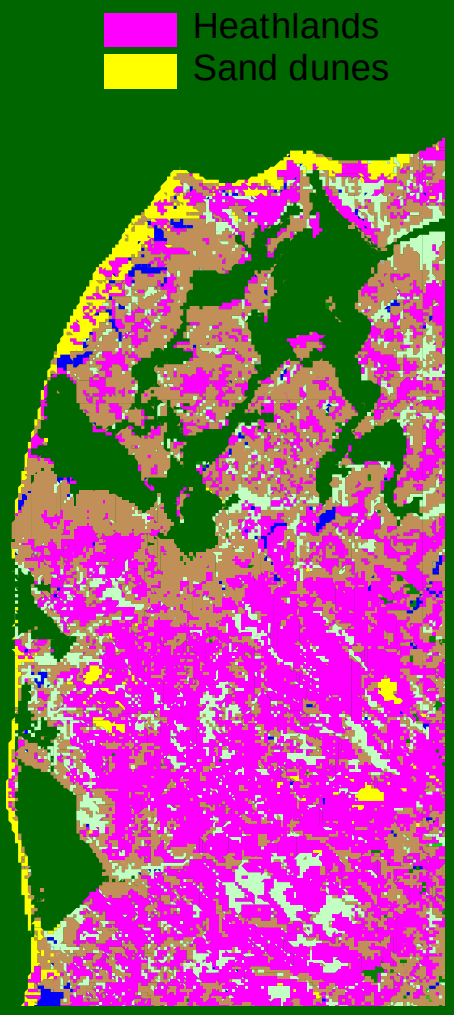
Challenges / problems



- Sanddrift
- Lack of shelter
- Soil conditions
- Low nutrient content
- Competition from heather

Based on maps made by Videnskabernes Selskab 1768-1805.

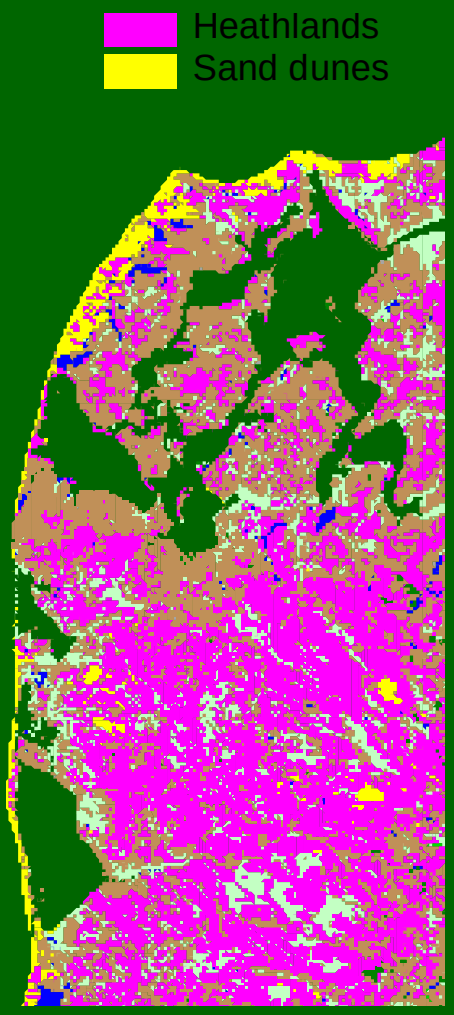
Challenges / problems



- Sanddrift
- Lack of shelter
- Soil conditions
- Low nutrient content
- Competition from heather
- Lack of experience

Based on maps made by Videnskabernes Selskab 1768-1805.

Challenges / problems



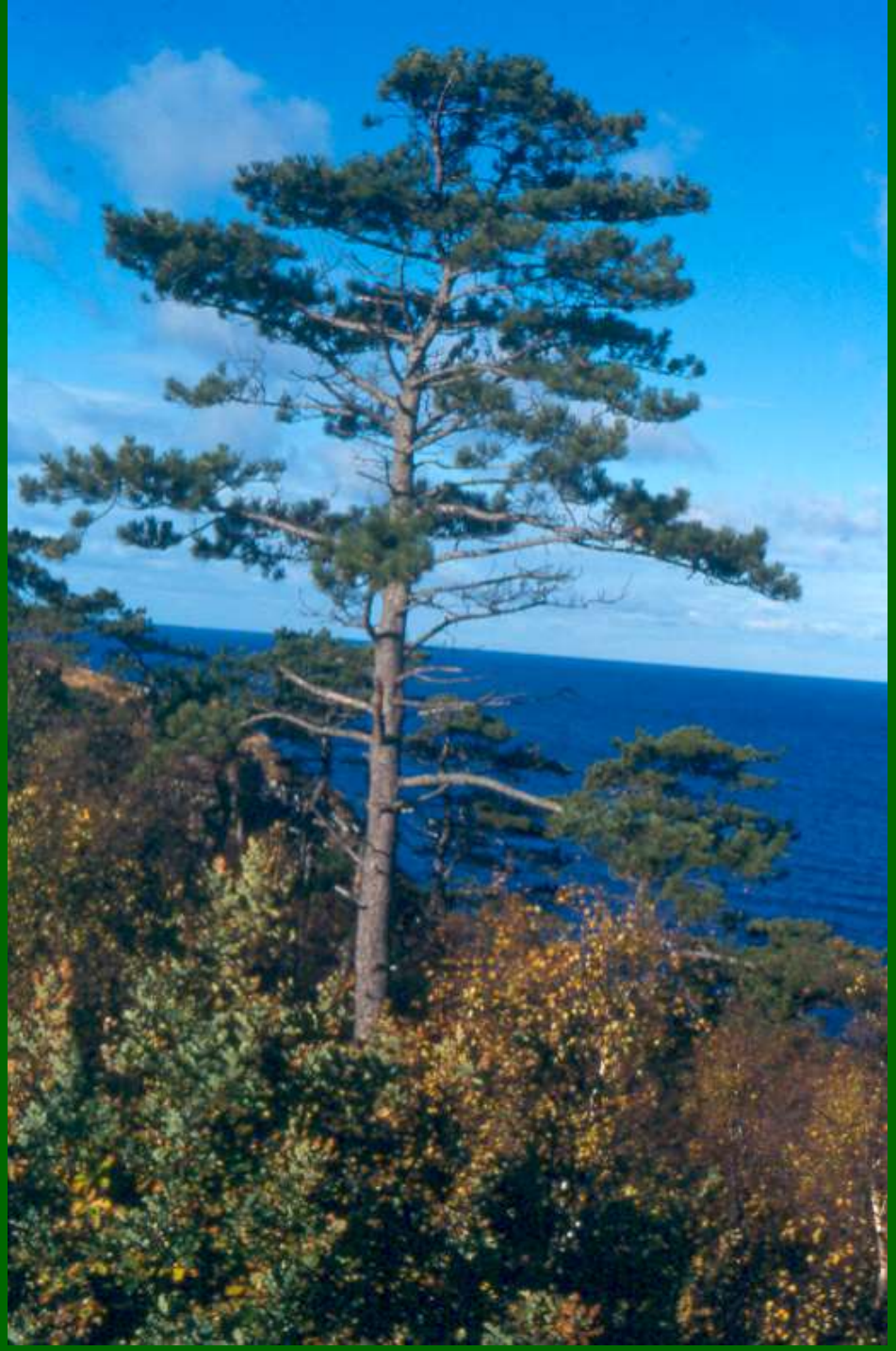
- Sanddrift
- Lack of shelter
- Soil conditions
- Low nutrient content
- Competition from heather
- Lack of experience
- Economy

Based on maps made by Videnskabernes Selskab 1768-1805.

Introduced 1798, used from 1820

Mountain pine, *Pinus mugo*

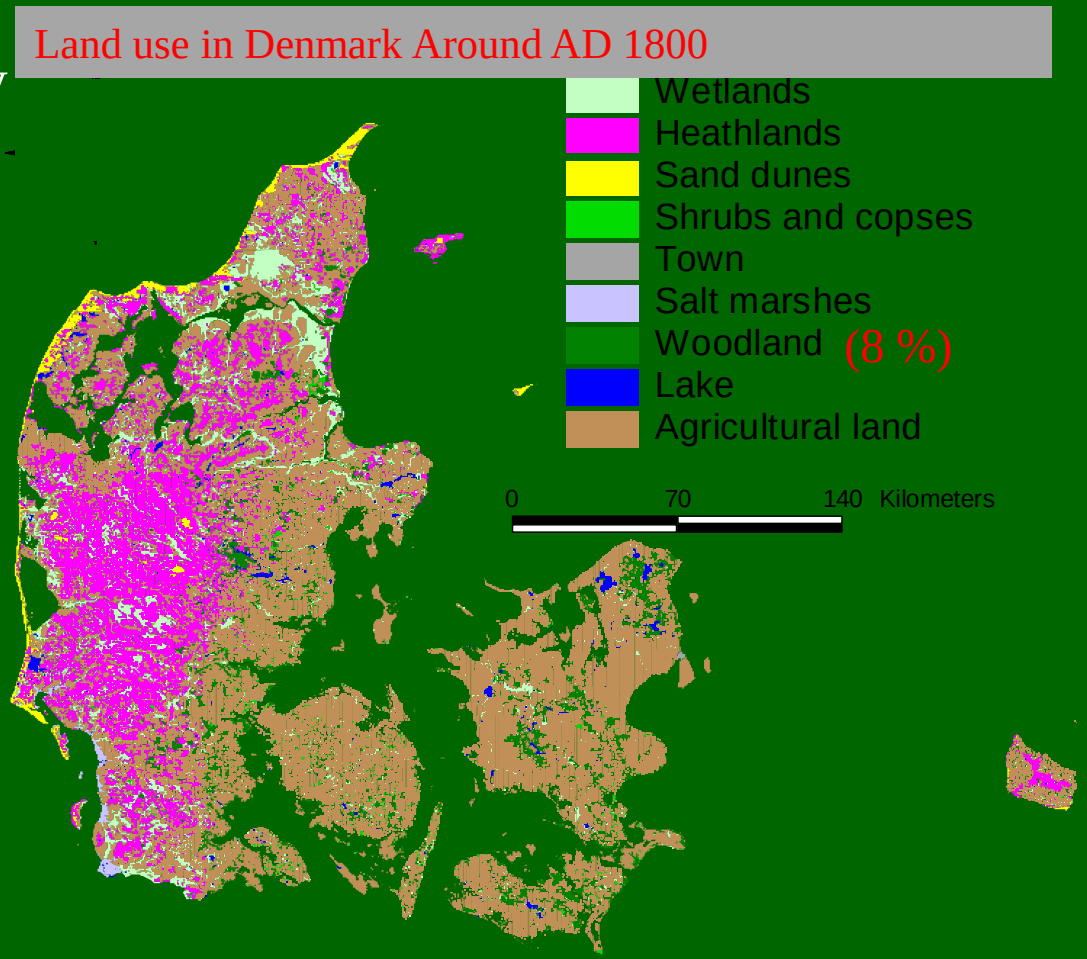
Introduced 1829
Used since 1837



Austrian pine
Pinus nigra

Reasons for use of ‘exotics’

- Need for timber
- Need for firewood/energy
- Need of pioneer species for afforestation on dunes and heathland
- Utiliarism



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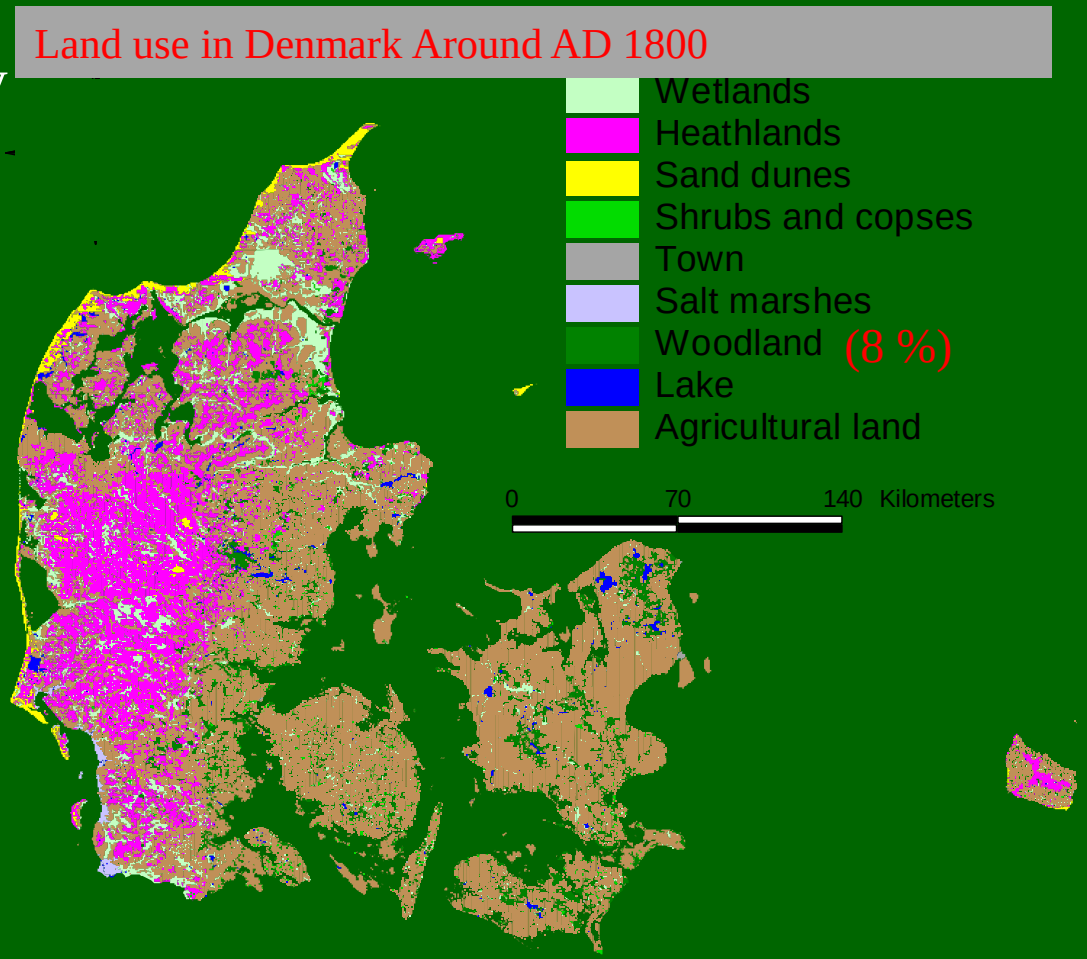
Reasons for use of ‘exotics’

- Need for timber
- Need for firewood/energy
- Need of pioneer species for afforestation on dunes and heathland
- Utiliarism
- Curiosity



Based on maps made by Videnskabernes Selskab 1768-1805.

Douglas fir

Pseudotsuga menziesii

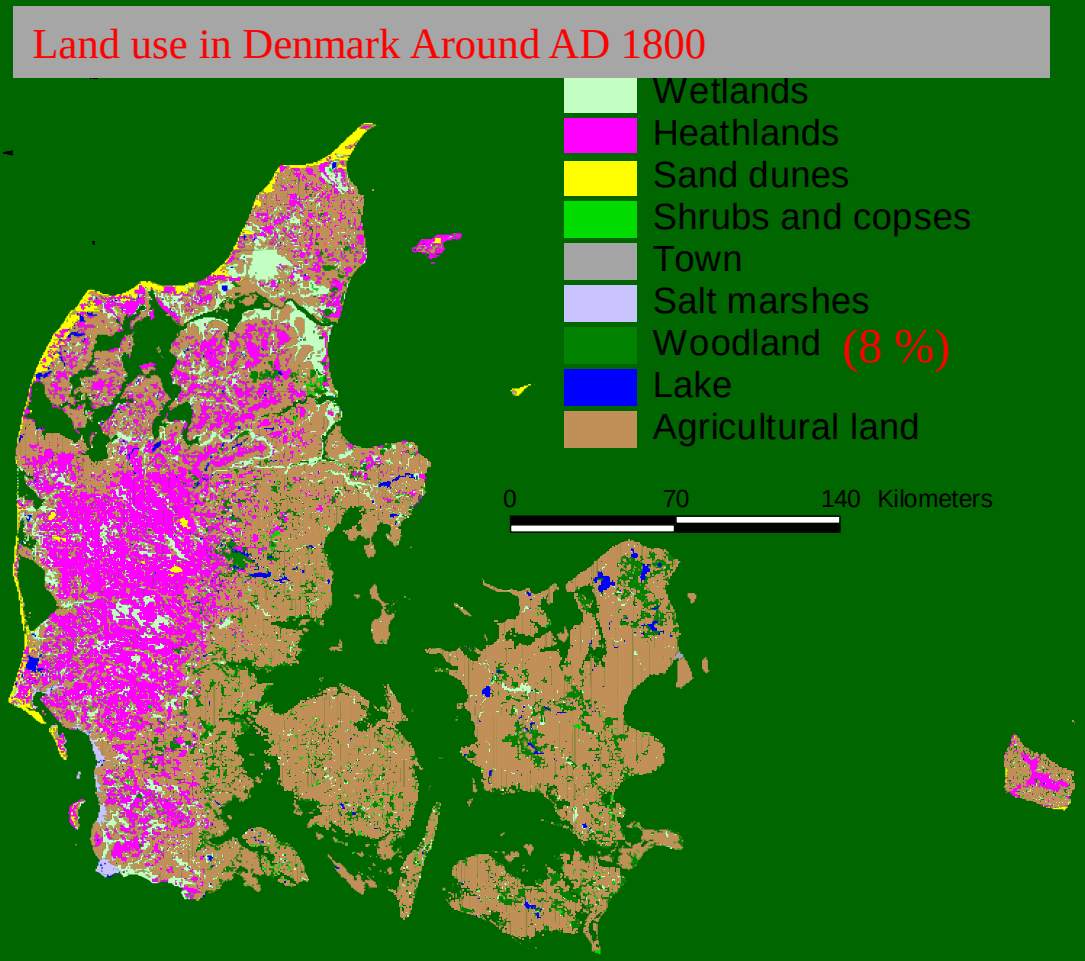
Noble fir, *Abies procera*

Production of christmas trees and greenery
Since +/- 1955

Abies nordmanniana

Abies procera

Examples



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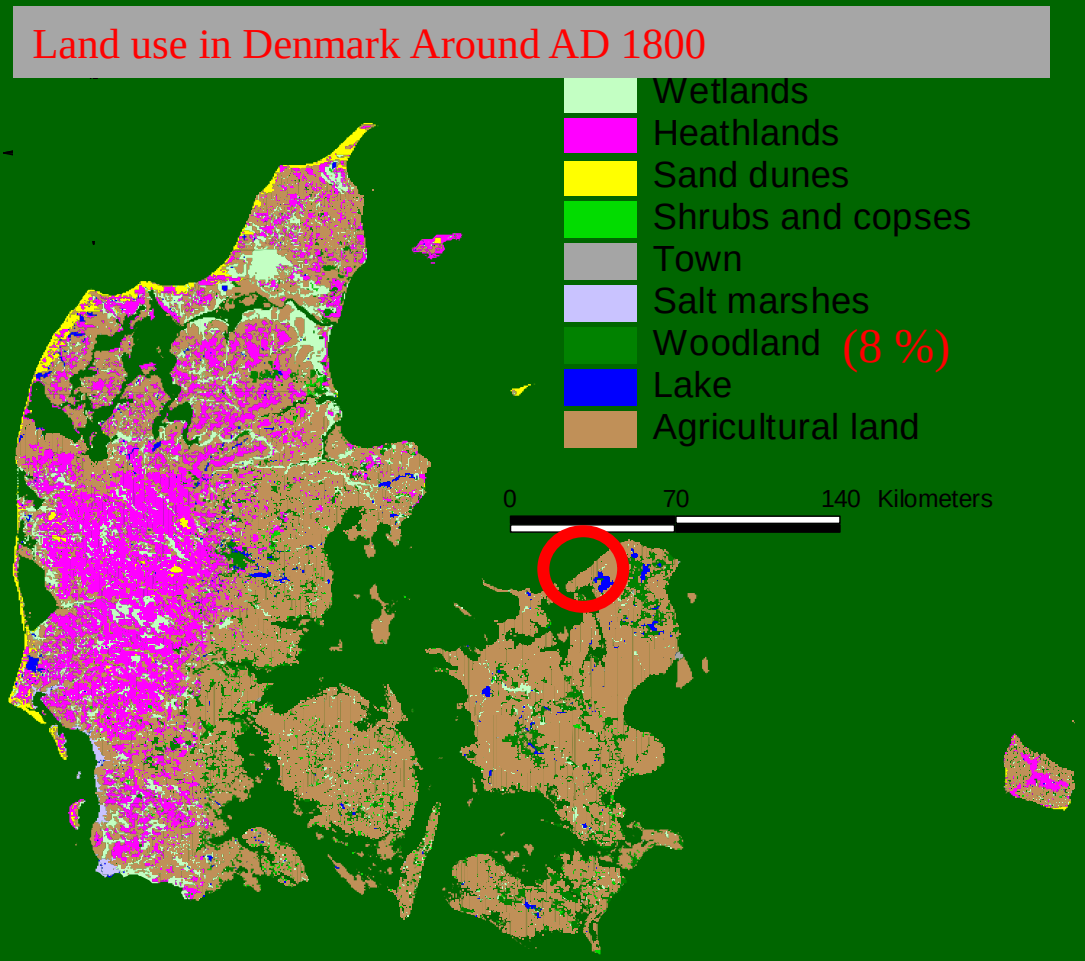
Examples



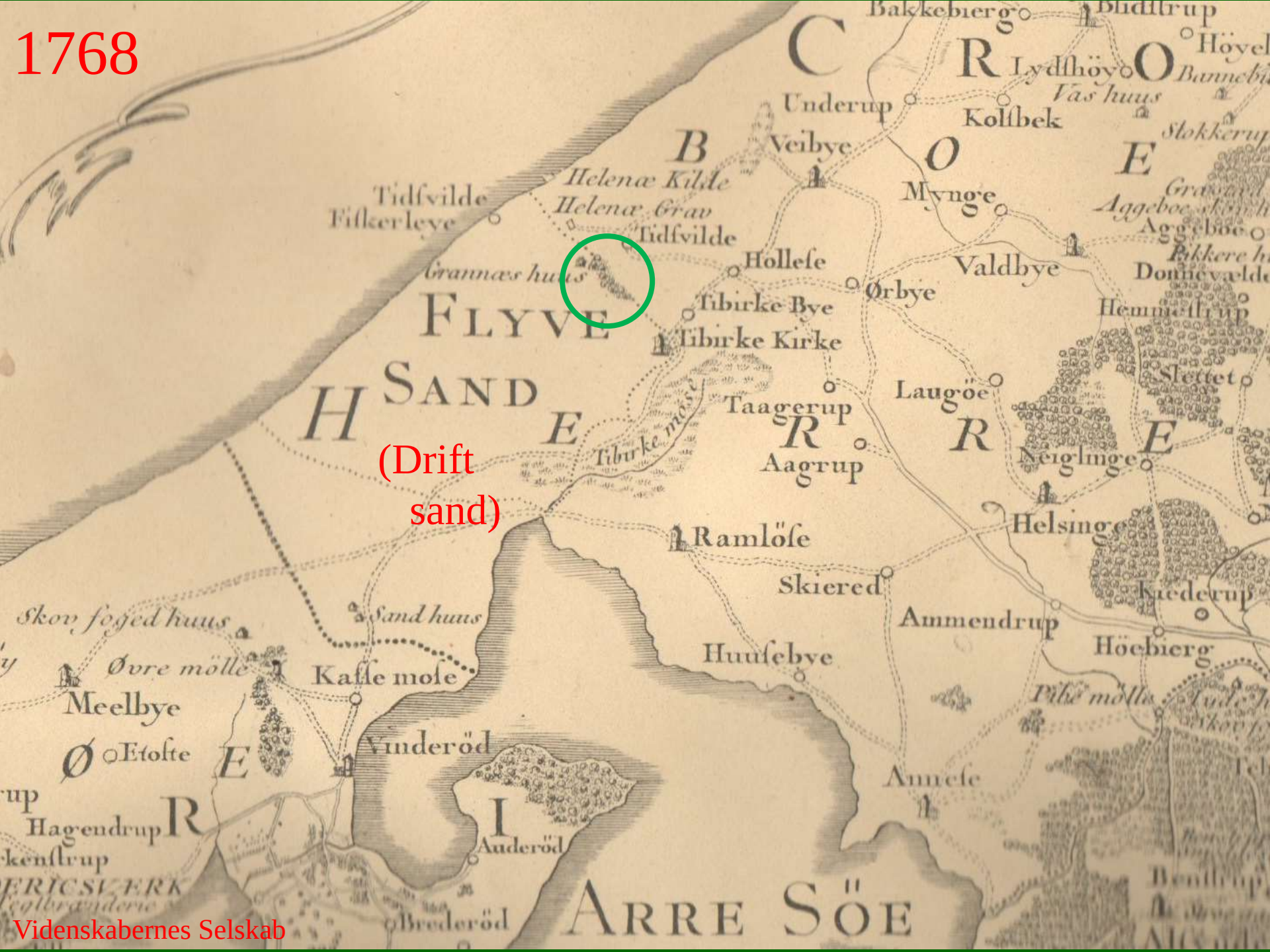
Based on maps made by Videnskabernes Selskab 1768-1805.


1768
Bakkebierg
Underup
Kolſbek
Veibye
Helenæ Kilde
Helenæ Grav
Tidſvilde
Fiſkerleye
Tidſvilde
Myngе
Valdbye
Hollefe
Ørbye
Grannæs huus
Tibirke Bye
Tibirke Kirke
FLYVE
SAND
Taagerup
Laugöe
Aagrup
Tiburke mose
Helsinge
Ramlöſe
Skiered
Ammendrup
Höebierg
Skov foged huus
Sand huus
Øvre mölle
Kaſſe moſe
Meelbye
Huuſebye
Etolſte
Vinderöd
Annefe
Hagendrup
Auderöd
Brederöd
ARRE SÖE
Videnskabernes Selskab


1768
Bakkebierg
Blidstrup
Höyel
Lydshöy
Bannebi
Vas huus
Underup
Kolsbek
Slokkerup
Veibye
Helenæ Kilde
Helenæ Grav
Tidsvilde Fiskerleye
Tidsvilde
Mynge
Aggeboe
Hollese
Ørbye
Valdbye
Grannæs huus
Tibirke Bye
Tibirke Kirke
FLYVE SAND
HERRED
Taagerup
Laugöe
Tiburke mose
Aagrup
Neiglinge
(Drift sand)
Helsinge
Ramlöse
Skiered
Ammendrup
Höebierg
Skov foged huus
Sand huus
Øvre mölle
Meelbye
Kasse mose
Huusebye
Vinderöd
Etolste
Hagendrup
Annese
Auderöd
Brederöd
ARRE SÖE
Videnskabernes Selskab

Coastnear dune plantation Tisvilde Hegn 22.09.2012

Coastnear dune plantation Tisvilde Hegn 22.09.2012


1768
Bakkebierg
Blidstrup
Høyel
C
R
Lydshöy
O
Bammebi
Vas huus
Underup
Kolsbek
Stokkerup
B
Veibye
O
E
Helenæ Kilde
Helenæ Grav
Tidsvilde
Fiskerleye
Myngе
Gravsted
Aggeboe skandse
Tidsvilde
Aggebоe
Bikkere hu
Hollese
Valdbye
Donnevælde
Grannæs huus
Ørbye
Tibirke Bye
Hemmestrup
FLYVE
Tibirke Kirke
SAND
Slettet
H
E
Laugöe
Taagerup
Tibirke mose
R
R
E
Aagrup
Neiglinge
(Drift
sand)
Helsingе
Ramlöse
Skiered
Kiedrup
Skov foged huus
Sand huus
Ammendrup
Höebierg
Huusebye
Øvre mölle
Kalle mose
Meelbye
Pile mölle
Ø
Etofte
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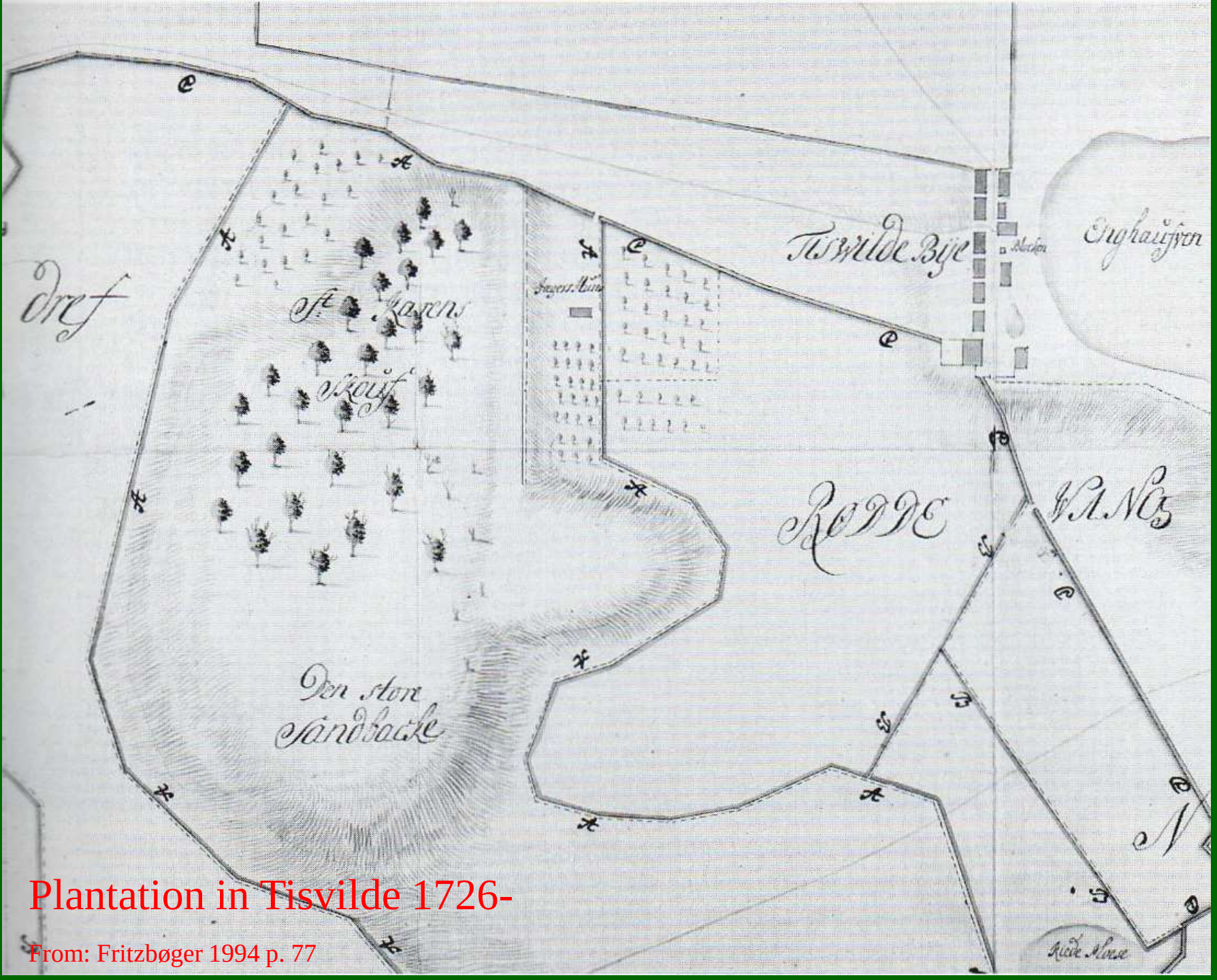
Vinderöd
Anrese
R
Hagendrup
I
Auderöd
ARRE SÖE
Brederöd
Videnskabernes Selskab

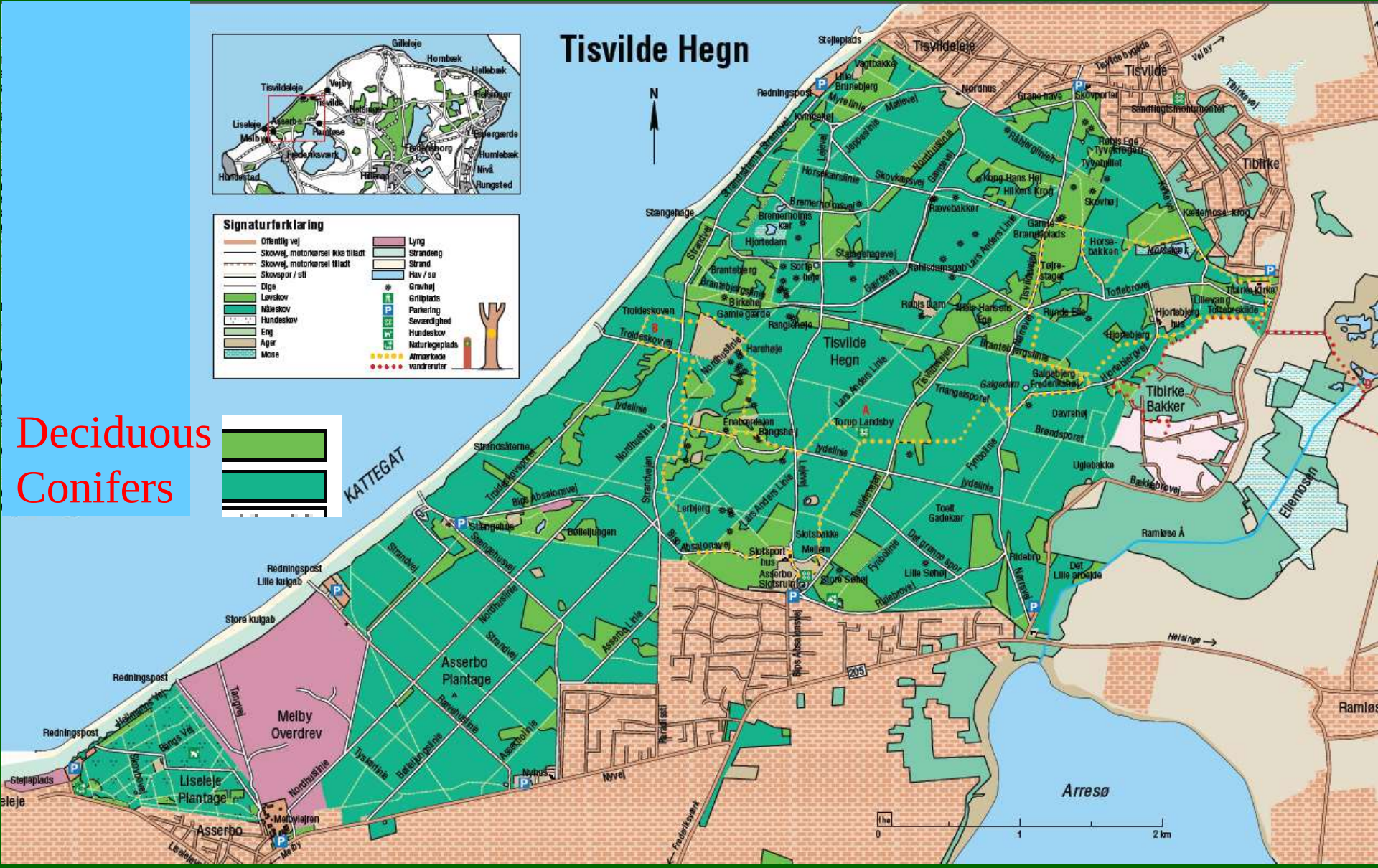


Plantation in Tisvilde 1726-

From: Fritzbøger 1994 p. 77

First (1750'ies), second and third generation

Tisvilde Hegn september 2012

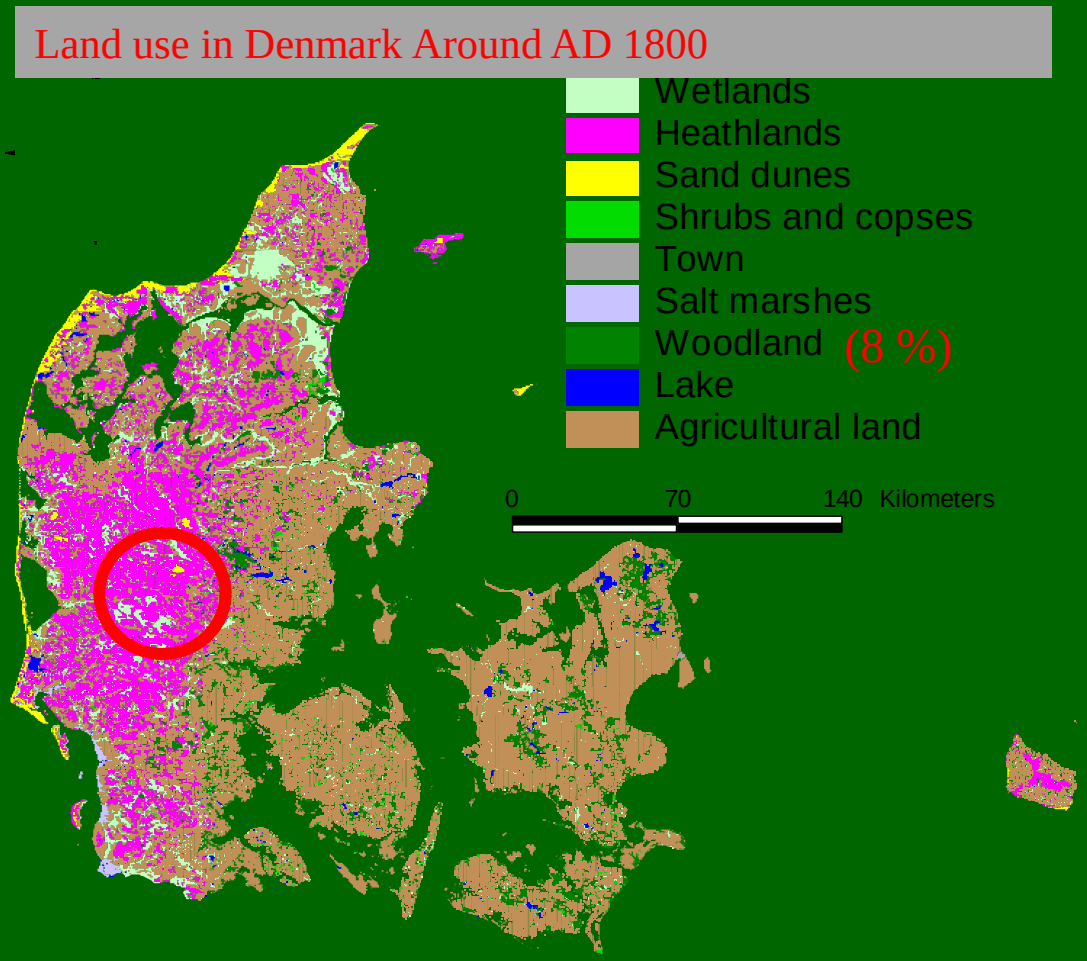


Dune plantation 1724-1738, 1793-1890

Tisvilde Hegn

1900 ha

Examples



Based on maps made by Videnskabernes Selskab 1768-1805.

”A Jutland shephard on the moors”
Frederik Vermehren 1855

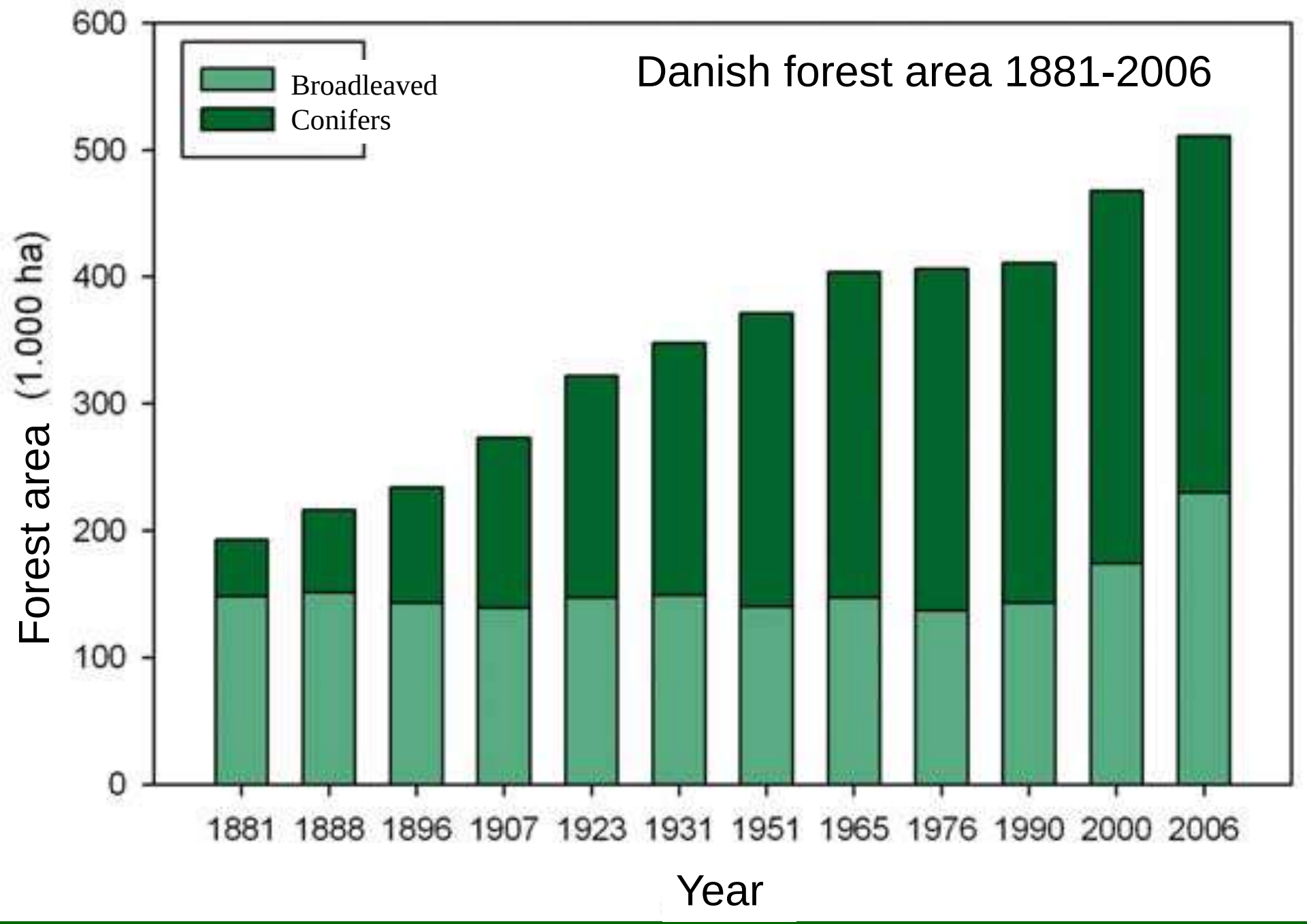
Videnskabernes Selskab 1803

Afforestation of heathland 1888

Palsgård, Nørre Snede, Central Jutland

Dansk Jagt- og Skovbrugsmuseum

Heathland plantation
Store Hjøllund
Central Jutland


Danish forest area 1881-2006
Broadleaved
Conifers
Forest area (1.000 ha)
600
500
400
300
200
100
0
1881
1888
1896
1907
1923
1931
1951
1965
1976
1990
2000
2006
Year

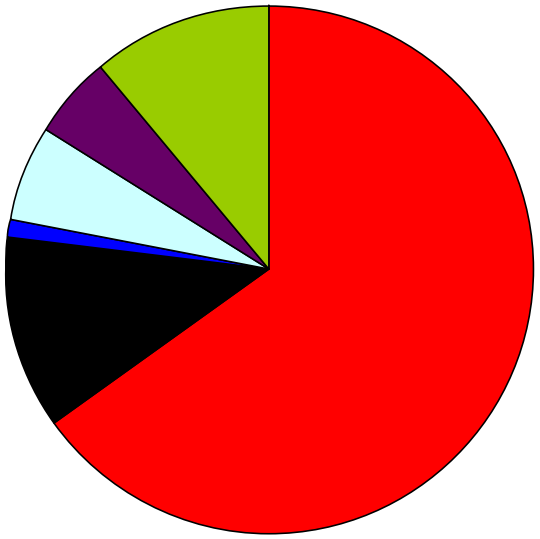
Afforestation on arable land (former heathland) 2012

Afforestation

Goal from 1989: Doubling the forest area within one tree generation: To ca. 25 % in 2050/2100.

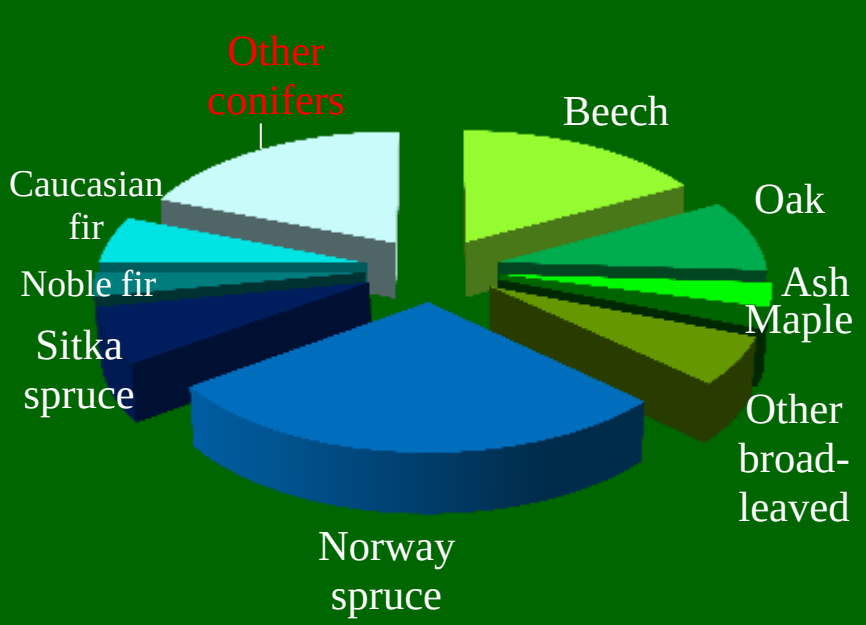
Forests in Denmark 2006

12,4 %

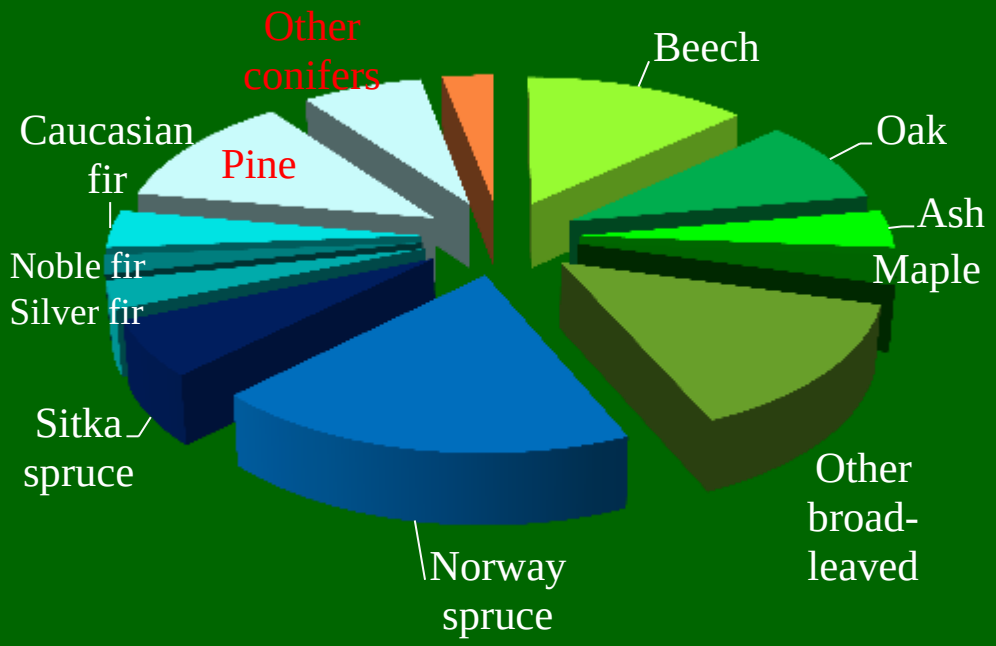


- Arable land
- Cities, roads etc.
- Lakes etc.
- Meadows etc.
- Heathland, bog, dune
- Forest, woodlands

Tree species distribution in the Danish forests

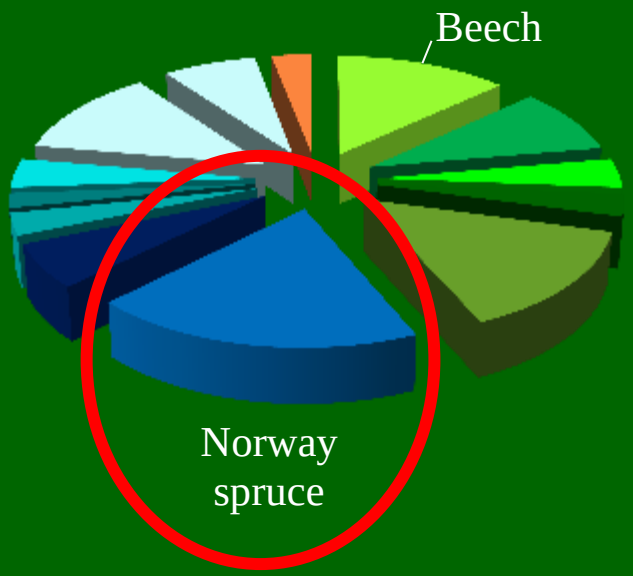


Trad. Forest statistics 2000



National Forest Inventory 2006

Beech
Is considered as the
national tree of Denmark


Beech
Norway
spruce

Conifer related species

Douglas fir
Pseudotsuga menziesii

1895
Height 52 meter
Volume 20 m^3

Silkeborg Østerskov Central Jutland

Douglas fir
Pseudotsuga menziesii

Age 800 years
Height 76 meter
Diameter 2,9 m

Cathedral Grove, Vancouver Island, BC

Douglas fir
Pseudotsuga menziesii

Age 800 years
Height 76 meter
Diameter 2,9 m

Cathedral Grove, Vancouver Island, BC, Canada

Problems ?

Problems !

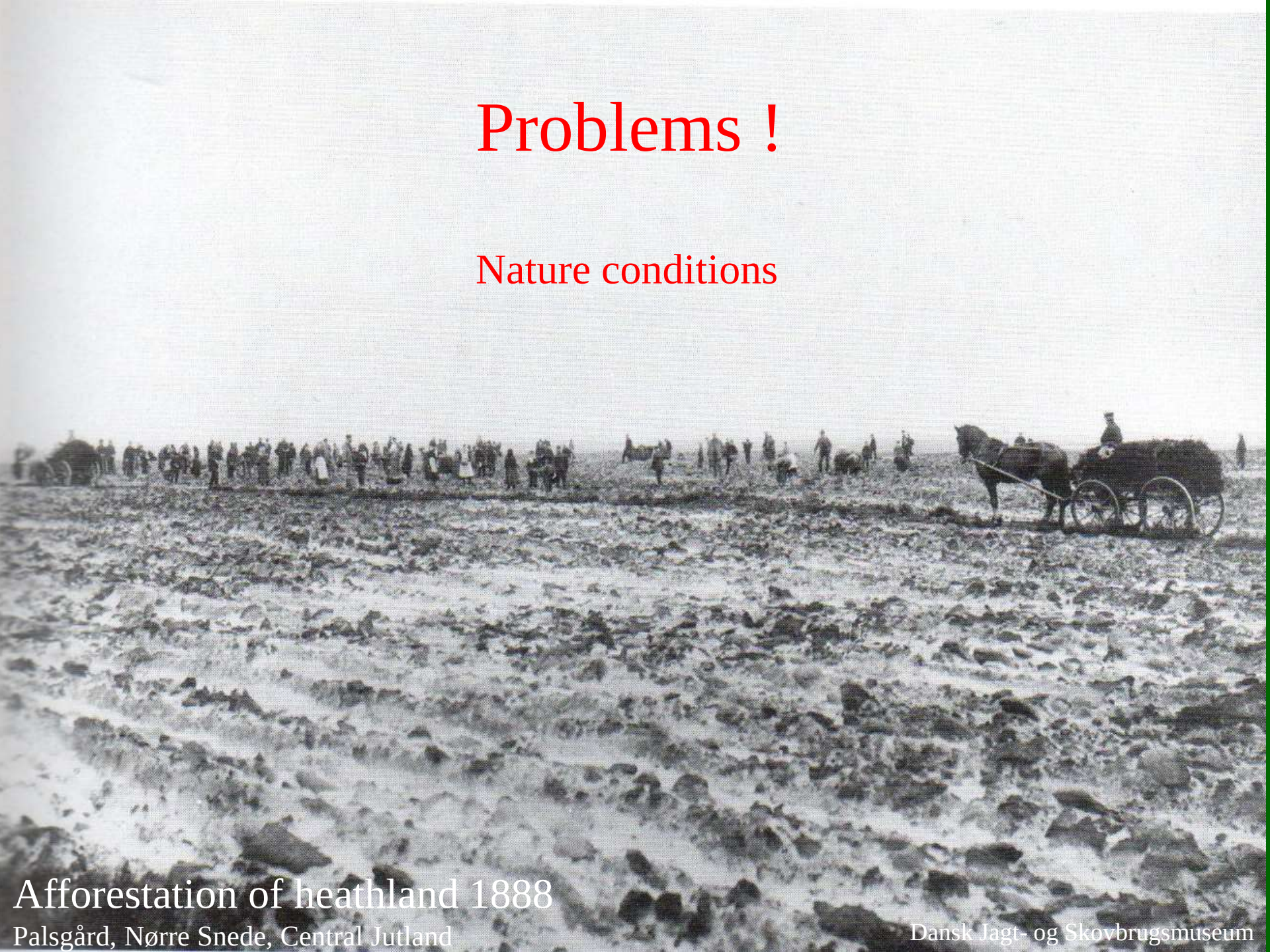
Afforestation of heathland 1888

Palsgård, Nørre Snede, Central Jutland

Dansk Jagt- og Skovbrugsmuseum

Problems !

Nature conditions



Afforestation of heathland 1888

Palsgård, Nørre Snede, Central Jutland

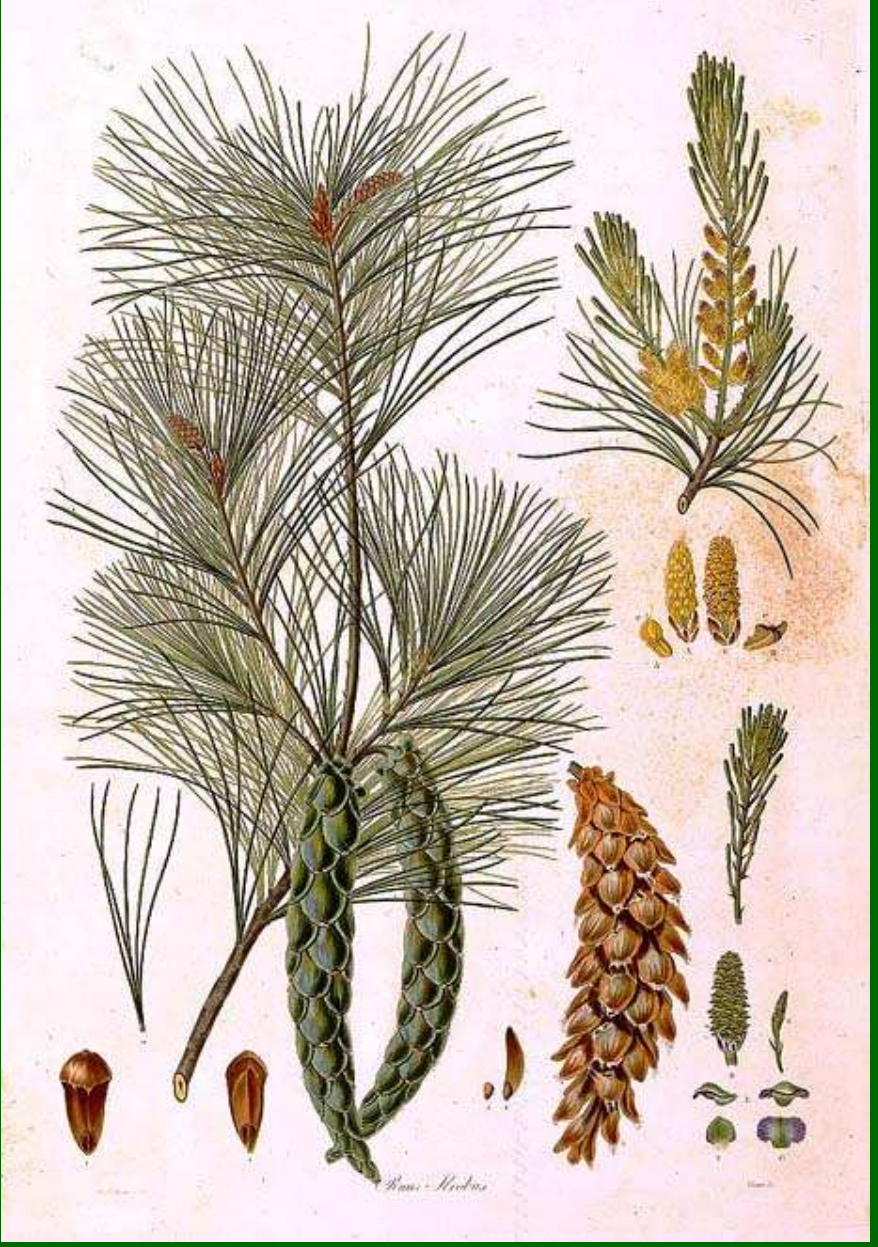
Dansk Jagt- og Skovbrugsmuseum

Problems !

Nature conditions
Insects
Fungi

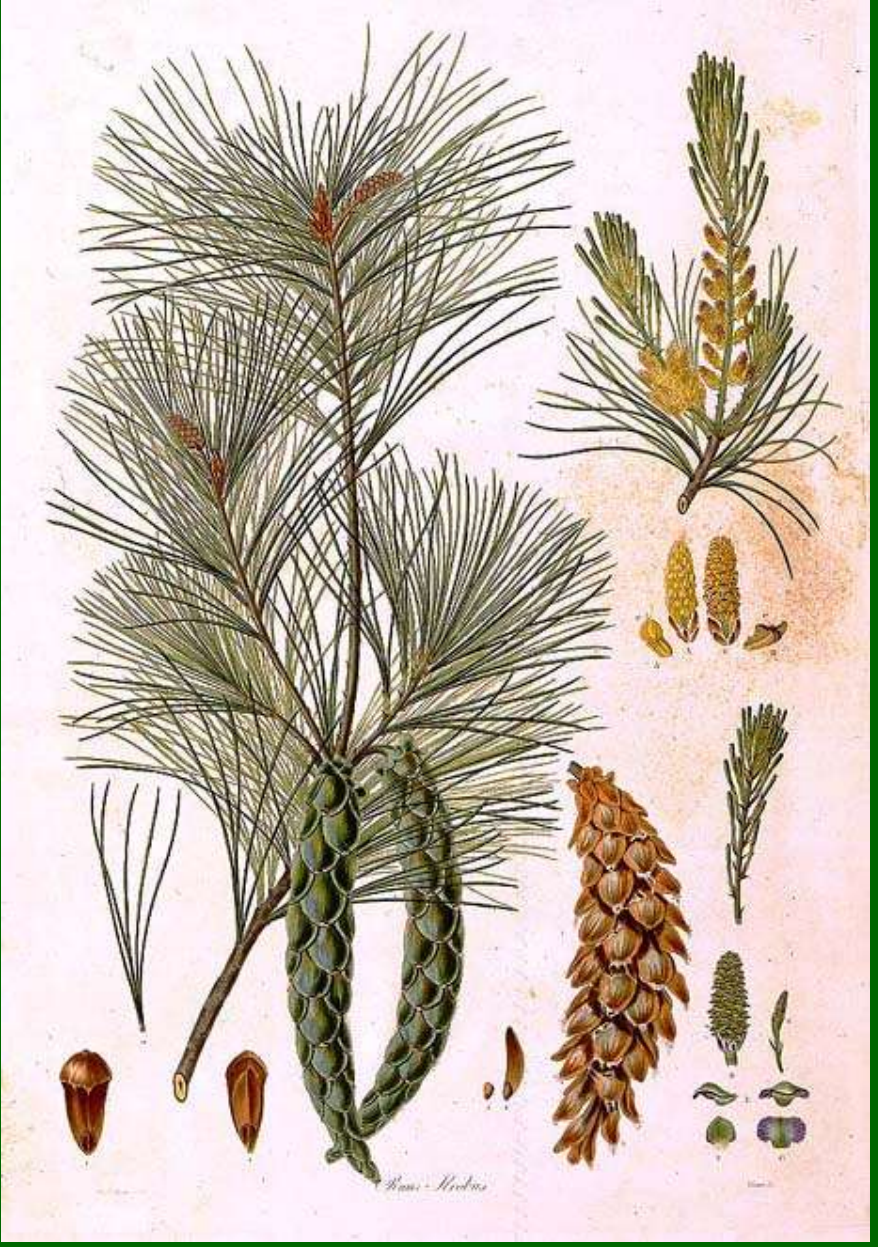
Afforestation of heathland 1888
Palsgård, Nørre Snede, Central Jutland

Dansk Jagt- og Skovbrugsmuseum



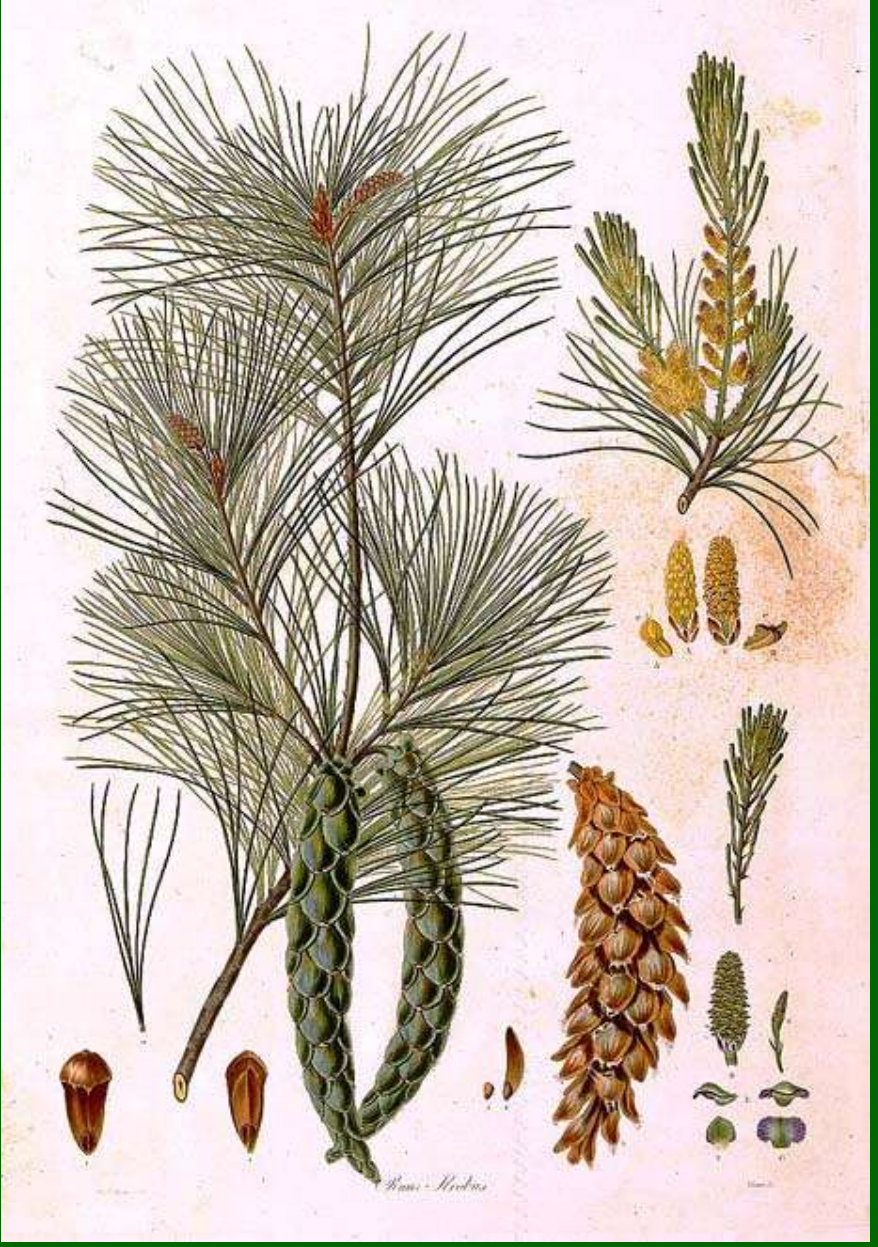
Weymouth Pine

Pinus strobus



Weymouth Pine
Pinus strobus

White Pine Blister Rust
Cronartium ribicola



Weymouth Pine
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White Pine Blister Rust
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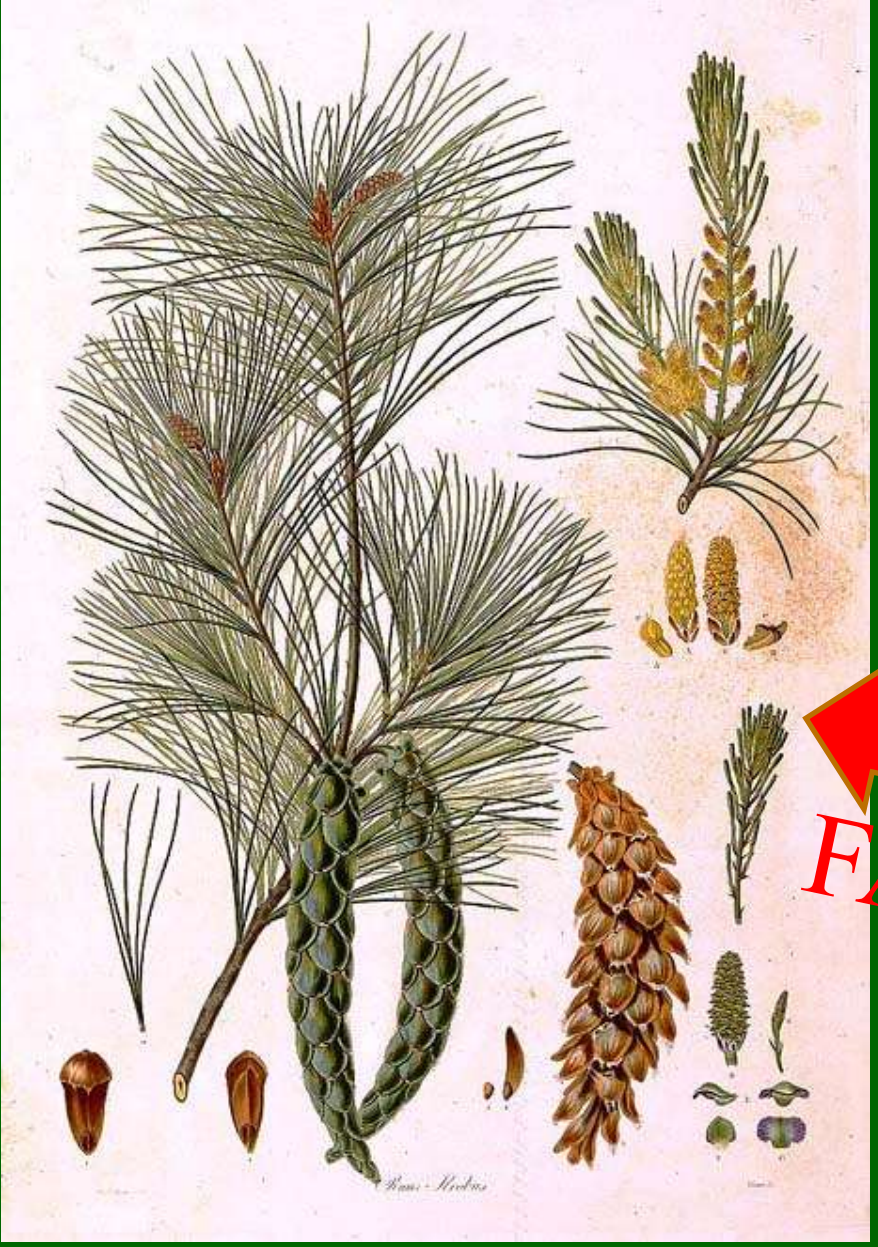
Ribes species ↔ Pinus cembra



Weymouth Pine
Pinus strobus

FATAL!

+/- 1870

White Pine Blister Rust
Cronartium ribicola

Ribes species ↔ Pinus cembra

Deformation due to **Pine Shoot Moth** *(Rhyacionia buoliana)*

Troldeskoven, Tisvilde Hegn

Problems ?

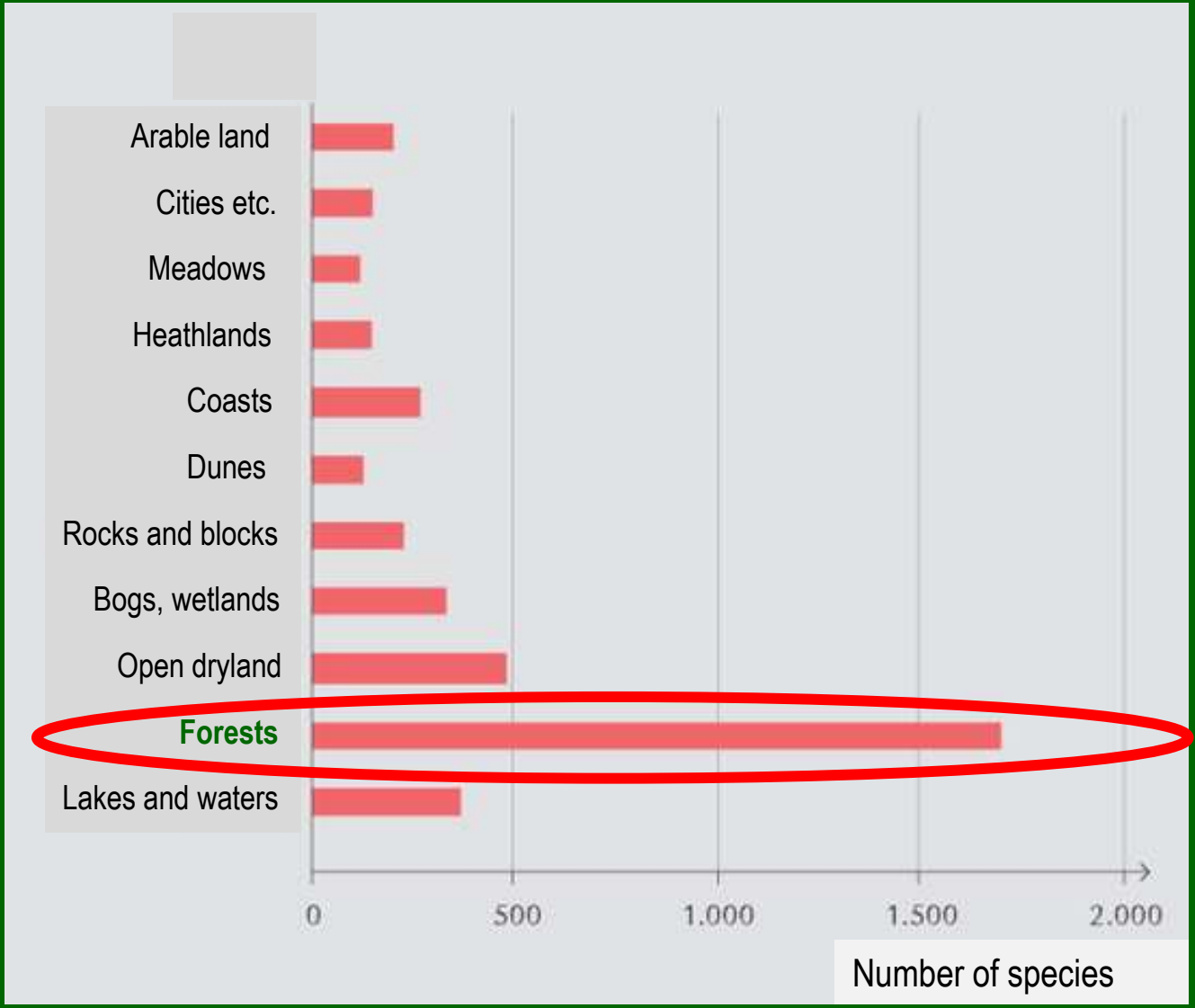

Problems !


Problems !
Due to silvicultural practise:
Large stands of evenaged monocultures


Clearcut by man or storm

Conifer related species

Number of redlisted species



Wilhjelmudvalget 2001

Elimination of ‘natural’ woodlands

From old, ‘natural’ beechwood to sitka spruce.

East Jutland. Spring 2012.

Invasive species

Prunus serotina
Pinus contorta
Pinus mugo
Picea sitchensis
(Acer pseudoplatanus)


Prunus serotina


Pinus mugo


Picea sitchensis

Sitka spruce

Great spruce bark beetle
Dendroctonus micans

Sitka spruce

Great spruce bark beetle
Dendroctonus micans

+

Green spruce aphid
Liosomaphis (Elatobium) abietina

Sitka spruce

”Norway spruce decline”

”Norway spruce decline”

- Salt intolerance

”Norway spruce decline”

- Salt intolerance
- Mild winters

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- Airpollution

”Norway spruce decline”

- Salt intolerance
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- Insects

”Norway spruce decline”

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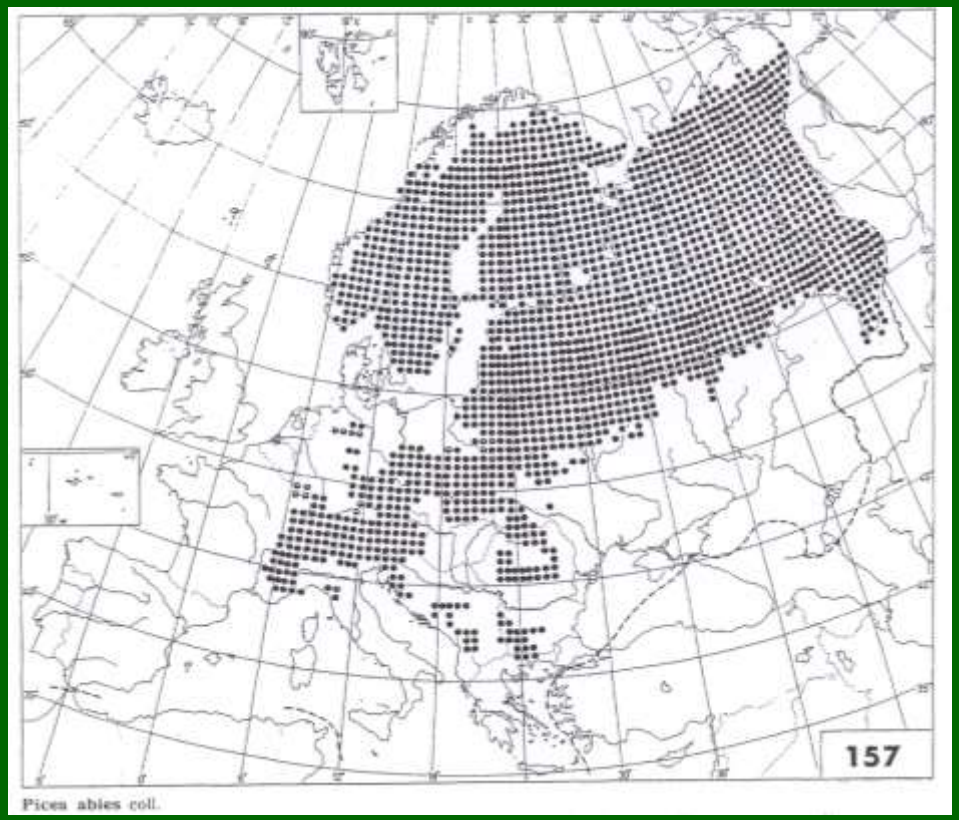
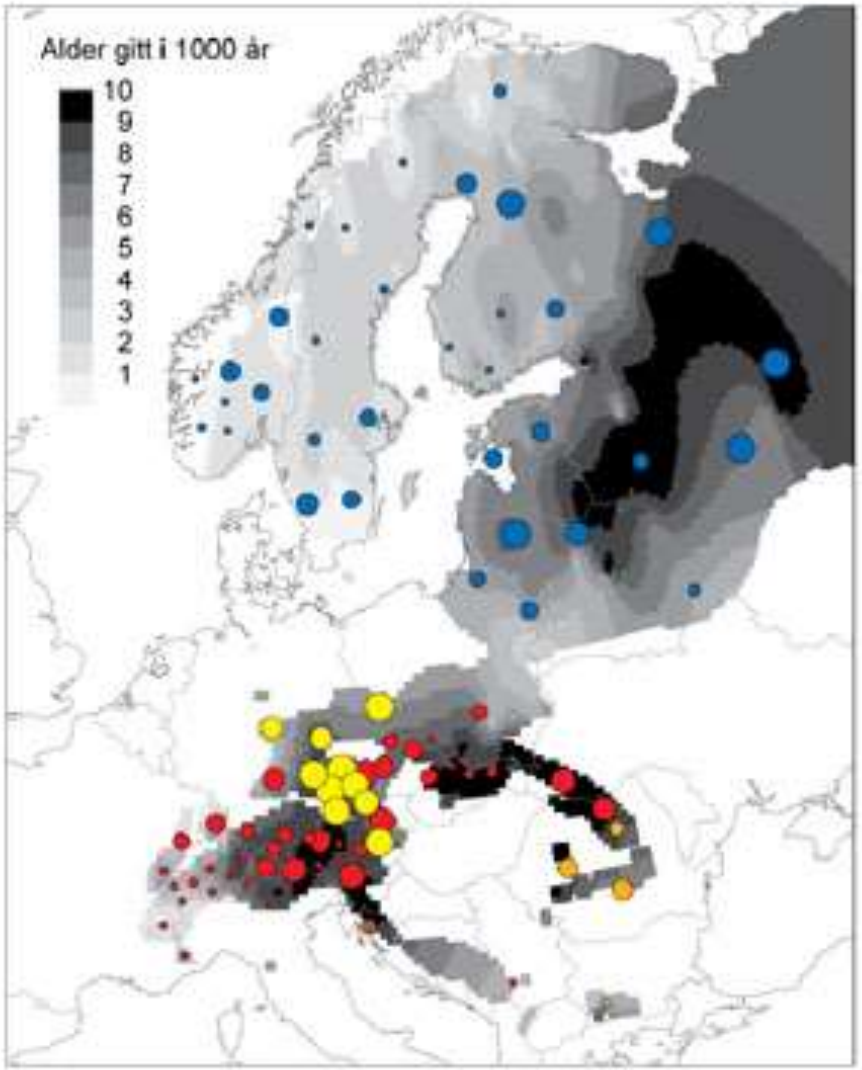
- Mild winters
- Airpollution
- Insects
- Fungi

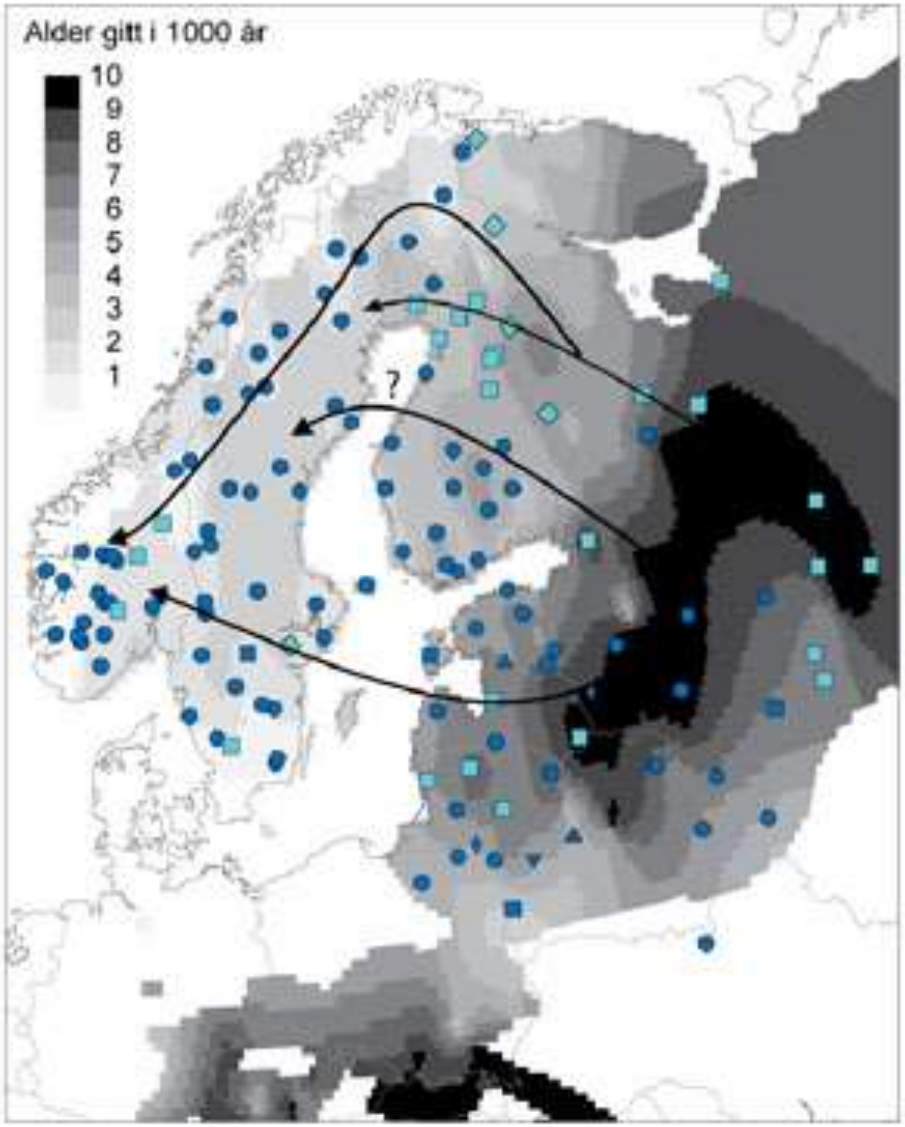
Norway spruce, *Picea abies*

Sykes, Prentice & Cramer 1996 p. 207



Natural distribution efter Atlas Florae Europaeae



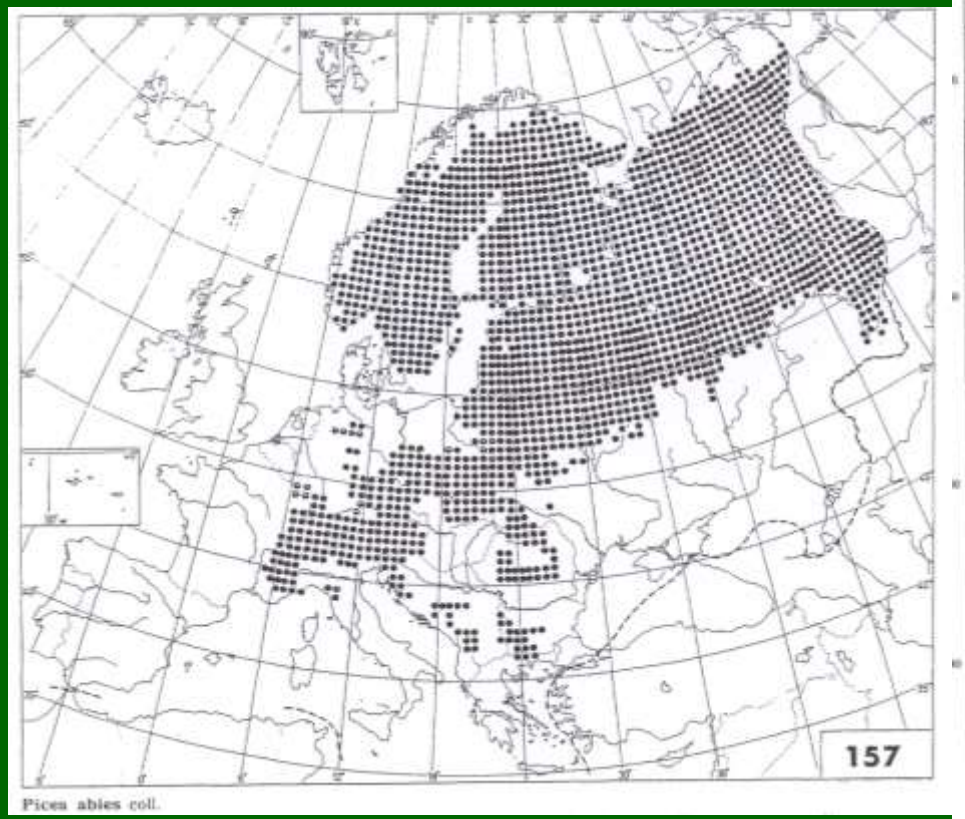


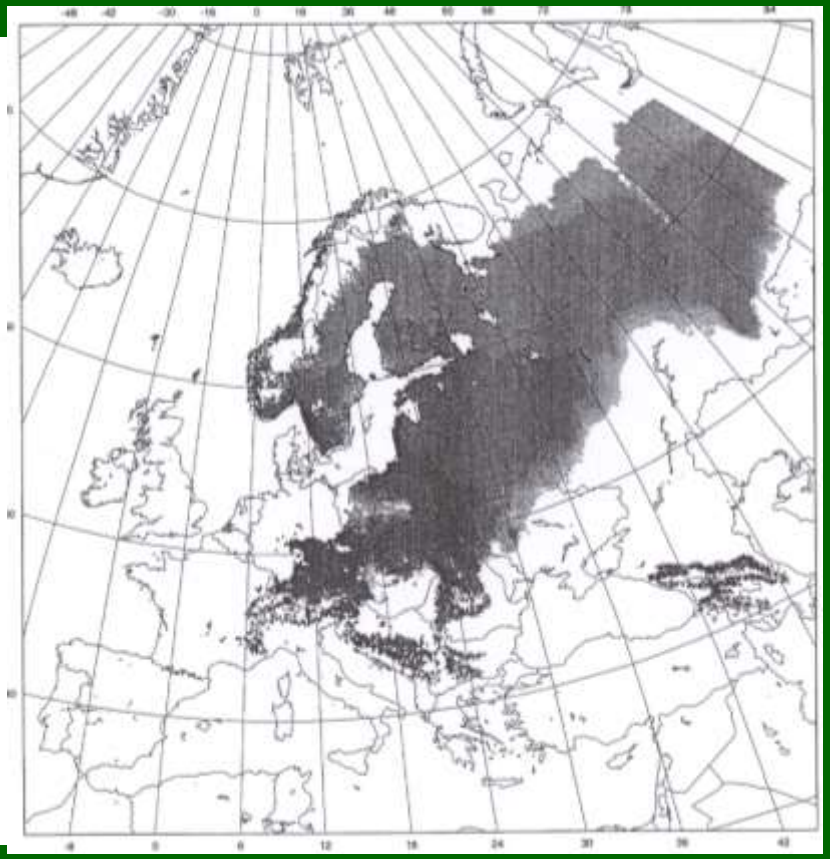
Migration routes of Norway spruce (*Picea abies*)

Tollefsrud et al. 2008

Norway spruce, *Picea abies*

Fra Sykes, Prentice & Cramer 1996 p. 207



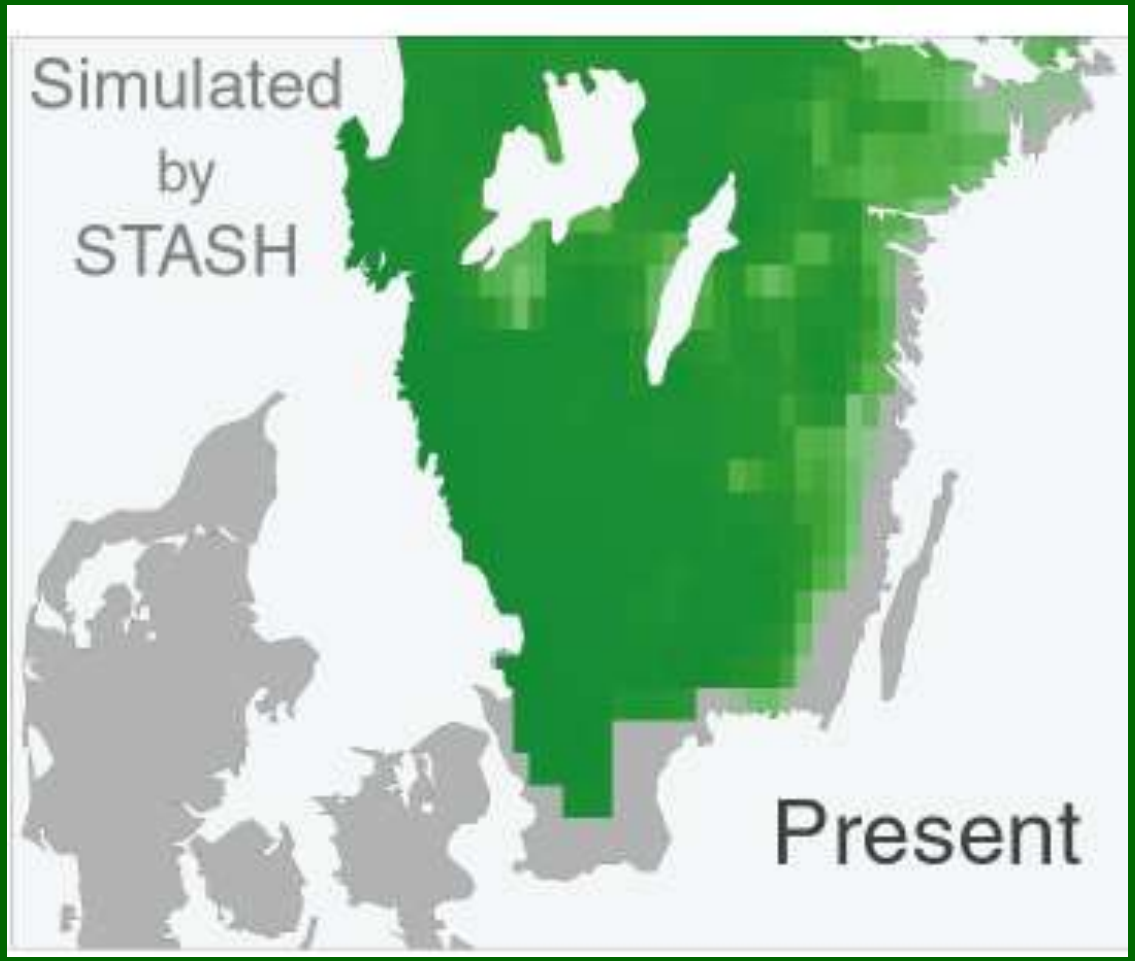


Natural distribution
Atlas Florae Europaeae

Simulated distribution

Norway spruce (*Picea abies*)

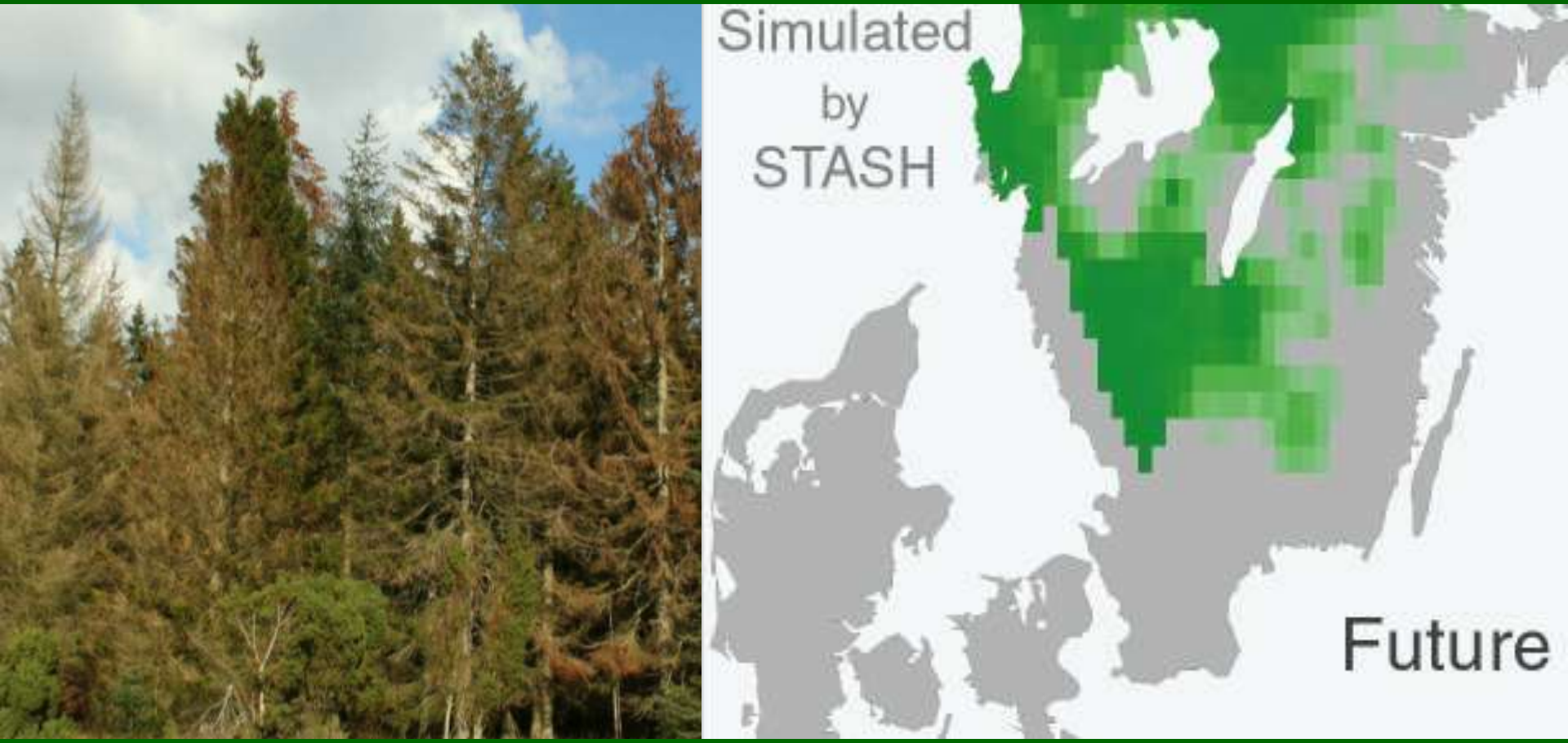
Model simulation of present distribution in southern Scandinavia



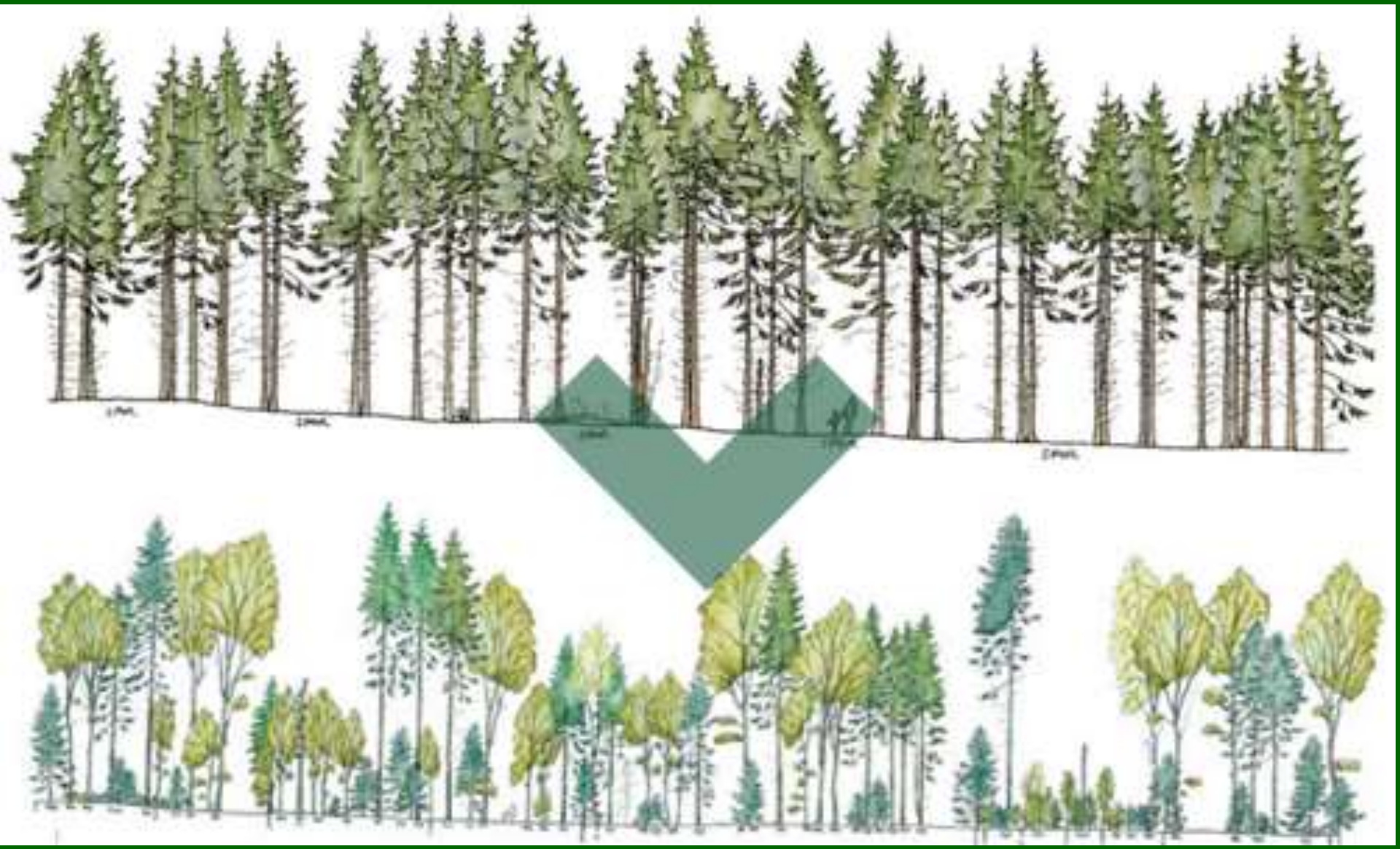
Bradshaw, Holmqvist, Cowling & Sykes 2000 p. 1995.

Norway spruce (*Picea abies*)

Model simulation of future distribution in southern Scandinavia by 2 x the present CO_2-content in the atmosphere



Bradshaw, Holmqvist, Cowling & Sykes 2000 p. 1995.



Problems / challenges to face

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- Sustainable production

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- Energy from biomass

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- Carbon fixation and storing

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Problems / challenges to face

- Sustainable production
- Energy from biomass
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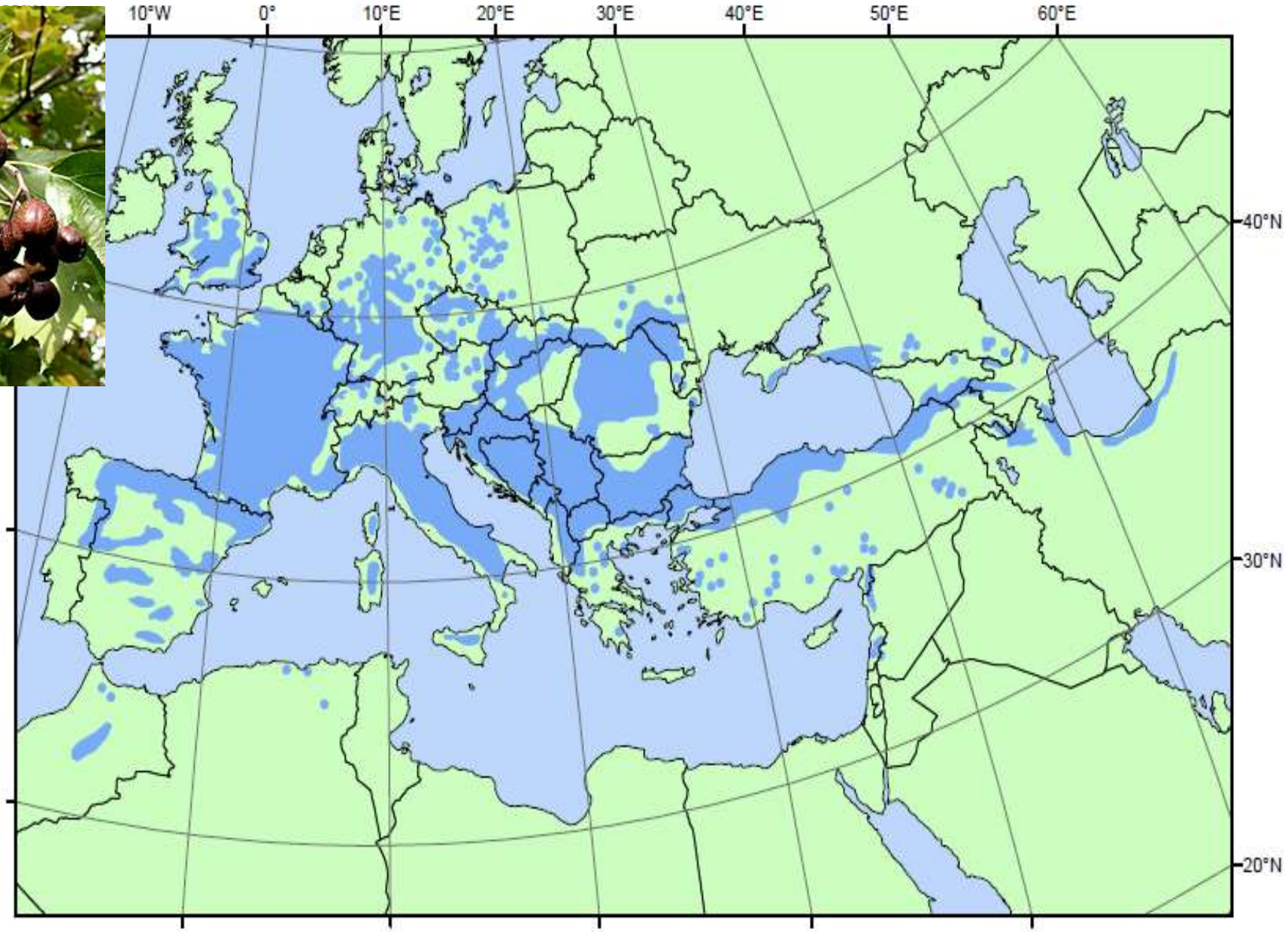
- Nature protection; biodiversity
- New diseases e.g. Phytophthora
- Climate change

Wild service tree

Sorbus torminalis



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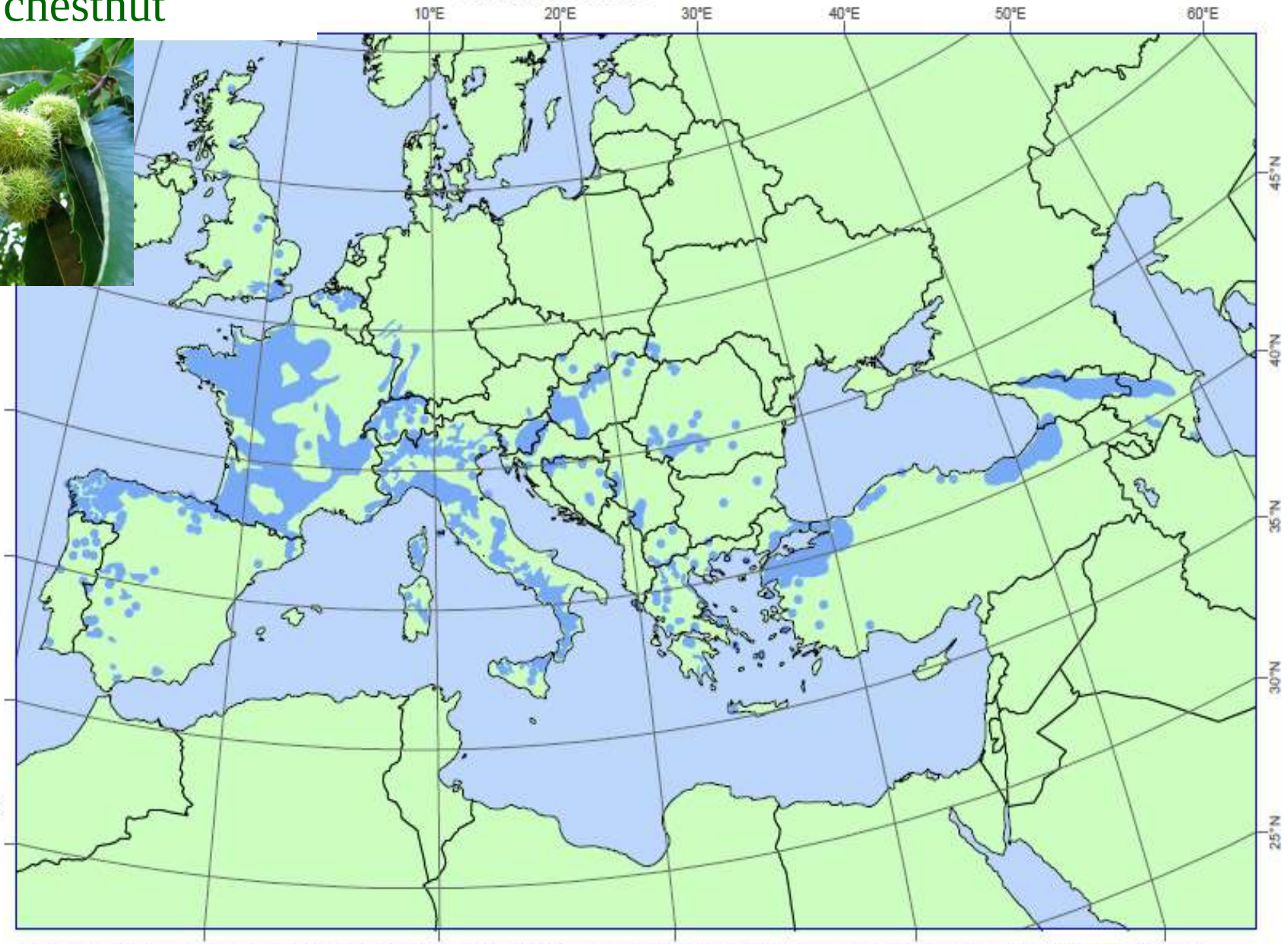
More information
and other maps at:
www.euforgen.org

This distribution map, showing the natural distribution area of *Sorbus torminalis* was compiled by members of the EUFORGEN Networks based on an earlier map published by Kutzelnigg, H., 1995: *Sorbus torminalis*. In: Scholz, H. (Hrsg.), 1995: Gustav Hegi. Illustrierte Flora von Mitteleuropa. Band IV, Teil 2B (2. Aufl.). Blackwell, Berlin: 343-349.

Sweet chestnut

Castanea sativa



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This distribution map, including both natural and naturalized occurrence, of *Castanea sativa* was compiled by members of the EUFORGEN Networks based on an earlier map published by (i) Maurer, W.D.; Fernández-López, J. in 2001 (Establishing an international sweet chestnut (Castanea sativa Mill.) provenance test: preliminary steps Forest Snow and Landscape Research. 76, 3: 482-486) and by (ii) Bounous G. in 2002 (Il Castagno: coltura, ambiente ed utilizzazione in Italia e nel mondo. Ed. Agricole – Bologna. Italy)

Citation: Distribution map of Chestnut (*Castanea sativa*) EUFORGEN 2009, www.euforgen.org.

First published online on 30 August 2006 - Updated on 23 July 2008

Km
0 250 500 1,000

Conclusions
‘Exotic’ tree species in Denmark

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- Successful afforestation

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Conclusions
‘Exotic’ tree species in Denmark

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- Production of high importance
- Problematic management systems
- Conflicts with nature protection
- A part of the solutions for the future


Thanks for your attention!