Finnish National Phenological Network

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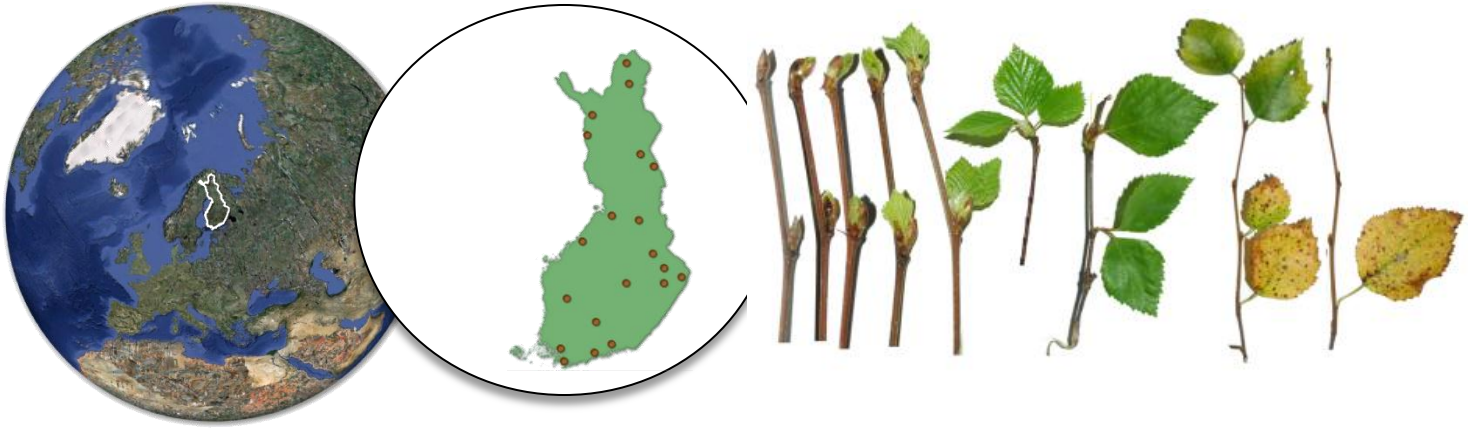
Finnish Forest Research Institute Oulu Unit[1] and Museum of Natural History[2]

Forest Knowledge Know-how METLA *Well-being*



Fifth Joint Finnish-Japanese Symposium on Northern Environmental Research
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Layout Tuula Aspegren

The definition of Phenology

Phenology is the study that records the timing of life cycle events in all living things

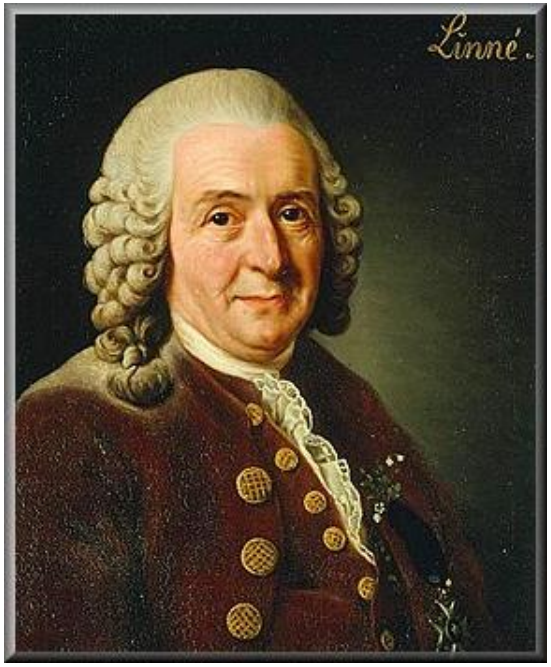
Life cycle events are also known as phenophases. In plants, this includes first leaf budburst, first flower, last flower, first ripe fruit, seed dispersal, and leaf colour change, among others

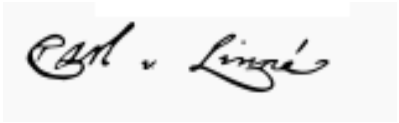
The USA National Phenology Network:

"Phenology is a sensitive measure of climatic variation and change, is relatively simple to record and understand, and is vital to both the scientific and public interest with or without climate change"

Content

1. **The Linnean time - background from history to present**
2. Finnish National Phenological Network
3. The use of the historical and present phenological data
4. Conclusions





Carl von Linné 1707 – 1778

- Regarded as ‘the father of phenology’
- Born in Southern Sweden
- Professor in Medicine
- Known best as a naturalist who created the taxonomy of the species

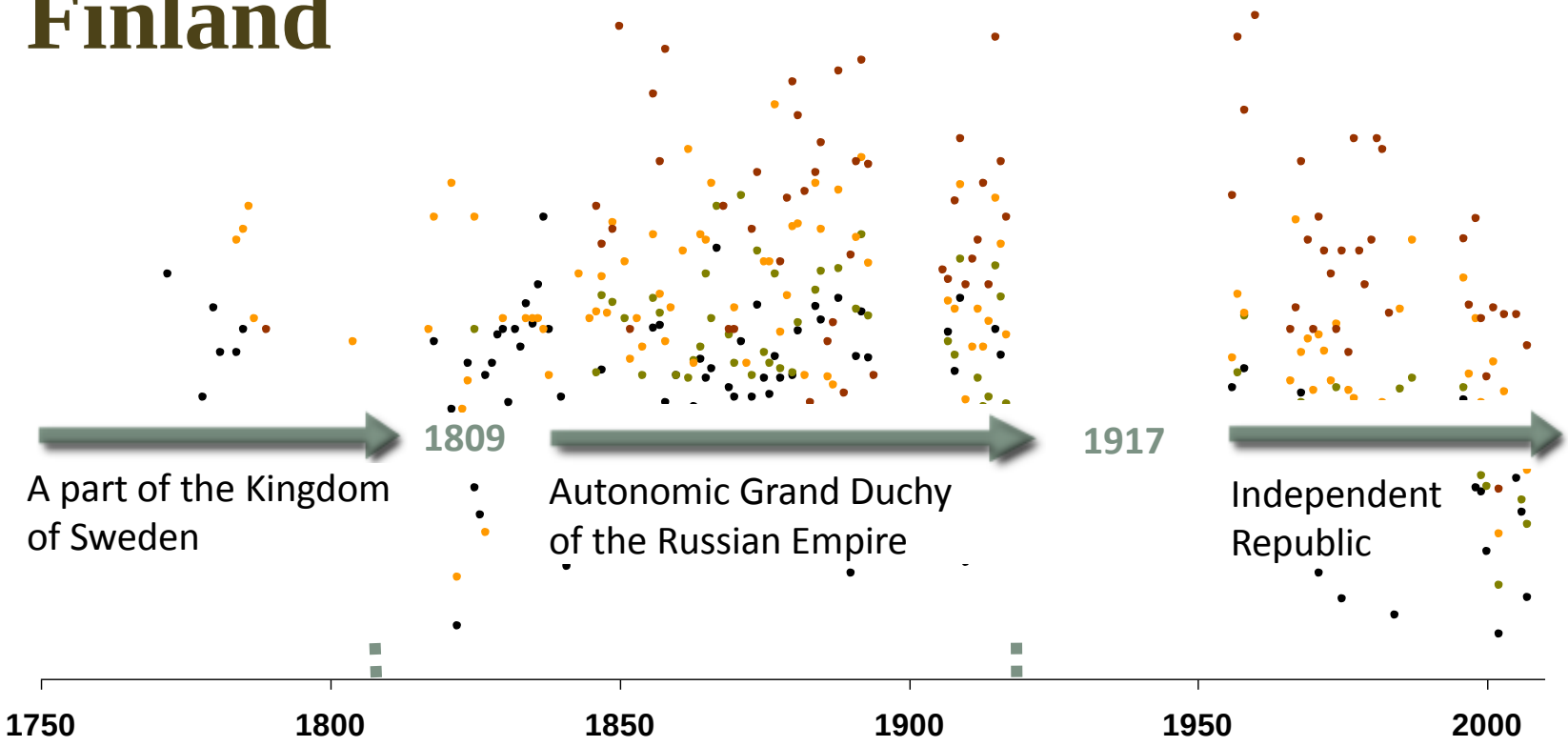
In 1749 asked the public to make phenological observations

In 1751 (Philosophia Botanica) Linné advocated that observations of first flowering, leafing, fruiting and leaf-fall should be made all over Sweden, along with local weather

Linne's time was also the beginning of Finnish phenology

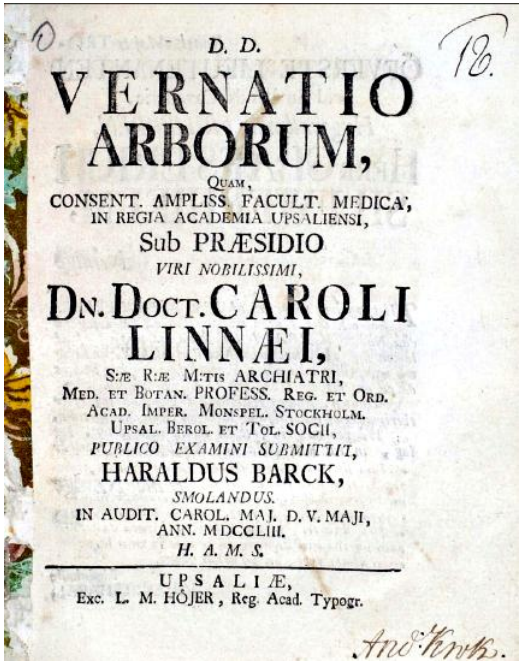
Finland was – up to 1809 – a part of the Kingdom of Sweden

Since that time phenological recording has continued over centuries in Finland



In 1753 the first phenological dissertation, *Vernatio Arborum*, defended by Harald Barck, was published in the University of Uppsala in Sweden.

There were observations from Turku and Pyhäjoki (Finland) and so the phenology in Sweden and in Finland had the same start.



D. D.

VERNATIO ARBORUM,

QUAM,
CONSENT. AMPLISS. FACULT. MEDICÆ,
IN REGIA ACADEMIA UPSALIENSI,
Sub PRÆSIDIO
VIRI NOBILISSIMI,

DN. DOCT. CAROLI LINNÆI,

S:Æ R:Æ M:TIS ARCHIATRI,
MED. ET BOTAN. PROFESS. REG. ET ORD.
ACAD. IMPER. MONSPEL. STOCKHOLM.
UPSAL. BEROL. ET TOL. SOCII,
PUBLICO EXAMINI SUBMITTIT,
HARALDUS BARCK,
SMOLANDUS.
IN AUDIT. CAROL. MAJ. D. V. MAJI,
ANN. MDCCLIII.
H. A. M. S.

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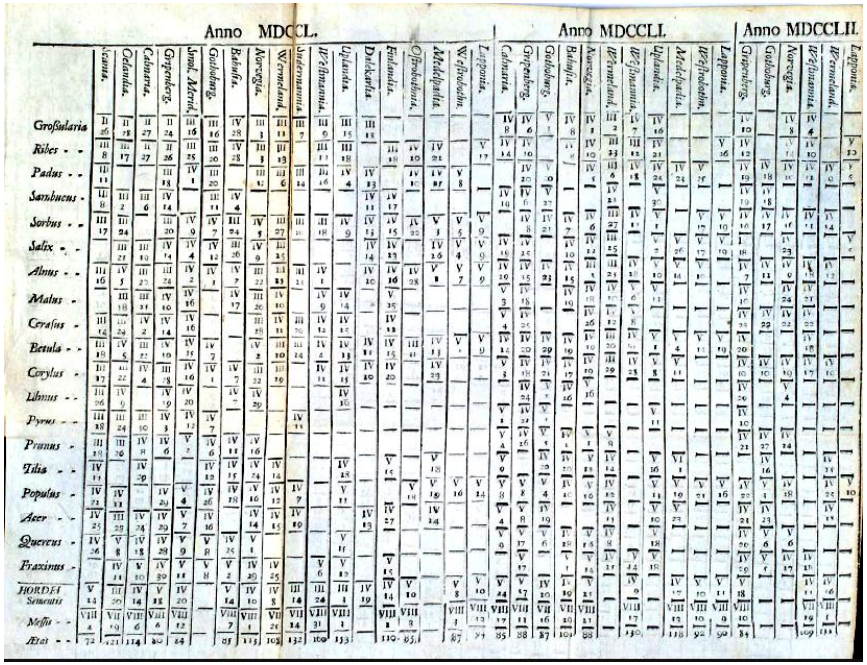
Exc. L. M. HÖJER, Reg. Acad. Typogr.



Recording in Finland continued

In 1856 Anders Moberg reported in wide resumé over 20 000 observations (plants, birds etc.) from Finland

“Naturalhistoriska dagganteckningar gjorda i Finland åren 1750 – 1845”

The publication based over 20 000 observations!

I	Vexter - *Plants*	181 species
II	Flyttfoglar – *Migratory birds*	52 species
III	Lektider – *Displays, etc.*	11 species (1 bird, 1 frog, 9 fishes)
IV	Insekter - *Insects*	15 species
V	Islossnig – *Ice thawing*	53 waters bodies
VI	Isläggning - *Freezing*	38 waters bodies
VII	Första snö om hösten – *First snow in Autumn*	19 sites

The next slide is an example of this old valuable report

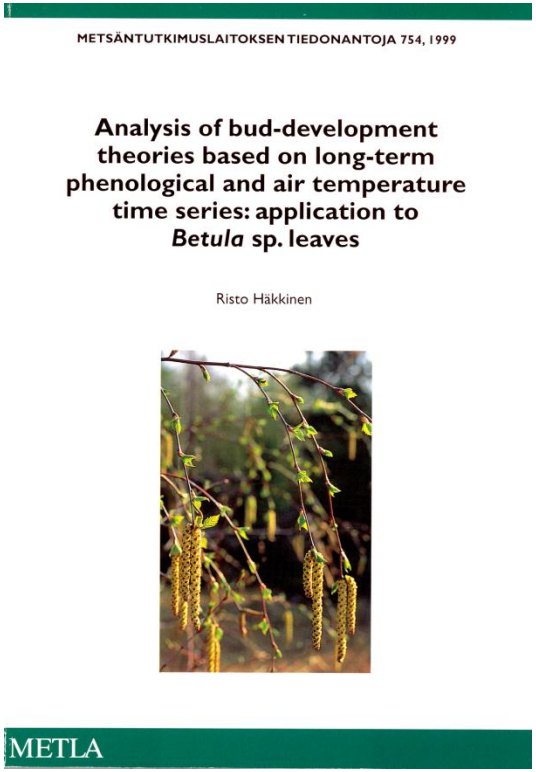
Upp-gift.	Observationsort.	Lat.	Long.	
				Betula alba Linn.
				Löffällning.
3.	Kuusamo ...	66°	46½°	**1803** IX 3.
23.	Sodankylä ..	67½	44	**1789** IX 17.
24.	Utsjoki.....	69¾	45	**1795** IX 29, **97** IX 25.
				Betula Alnus Linn.
				Löfspprickning.
4.	Finström ...	60¼	37½	**1824** V 6, **32** IV 24, **40** V 29, **42** V 2.
21.	Abo	60½	40	**1750** IV 27.
3.	Tammela ...	60¾	41½	**1818** V 17, **19** V 23, **20** V 18, **21** V 5, **22** IV 25, **24** V 10, **25** V 25, **26** V 11, **32** V 21, **35** VI 1.
7.	Tavastehus .	61	42	**1803** V 10.
8.	Jyväskylä ...	62¼	43½	**1841** V 1.
21.	Pyhäjoki ...	64½	42	**1750** V 9.
				Blomning.
4.	Finström ...	60¼	37½	**1819** IV 19, **26** IV 21, **28** V 25 (?), **29** V 12, **32** IV 12.
17.	Åbo	60½	40	**1783** IV 23.
12.	Svartå	60¼	41½	**1786** IV 21, **87** IV 15.
8.	Björneborg..	61½	39½	**1842** IV 6.
3.	Tammela ...	60¾	41½	**1822** IV 17.
7.	Tavastehus..	61	42	**1803** V 1.
6.	Lappajärvi..	63¼	41½	**1836** IV 24, **37** V 2, **38** V 3, **39** V 1, **40** IV 26, **43** IV 26.

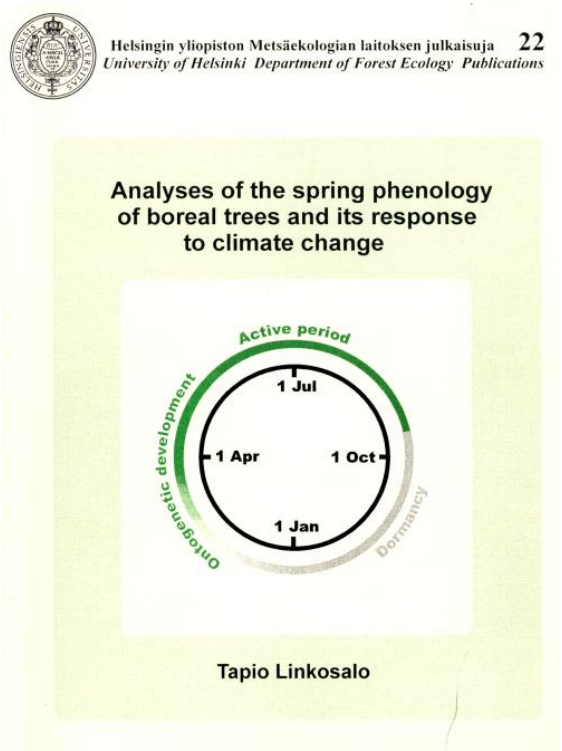
Upp-gift.	Observationsort.	Lat.	Long.	
				Betula Alnus Linn.
				Blomning.
8.	Jyväskylä...	62¼°	43½°	**1841** IV 19.
3.	Kuusamo ...	66	46½	**1804** V 24.
				Coniferae.
				Juniperus communis.
4.	Finström ...	60¼	37½	**1818** VI 20, **19** VI 12, **21** VI 19, **22** V 25, **23** VI 14, **24** V 29, **26** VI 5, **27** VI 1, **28** VI 9, **29** VI 19, **30** VI 17, **31** VI 14, **32** VI 12, **33** VI 13, **34** VI 11, **36** VI 18, **37** VI 16, **38** V 26, **39** VI 8.
3.	Sagu	»	40½	**1822** V 20.
2;3.	Åbo	60½	40	**1752** V 31, **60** VI 9, **80** VI 15, **82** VI 13, **85** VI 18.
12.	Svartå	60¼	41½	**1786** VI 24, **87** VI 17.
6.	Lappajärvi..	63¼	»	**1836** VI 17, **39** VI 8, **40** VI 17, **43** VI 28, **44** VI 12.
22.	Uleåborg ...	65	43	**1785** VI 22, **86** VI 18.
				Equisetaceae.
				Equisetum arvense.
2.	Åbo	60½	40	**1781** V 13, **82** V 16.
				Orchideae.
				Orchis sambucina.
3.	Åbo	60½	40	**1775** VI 5.

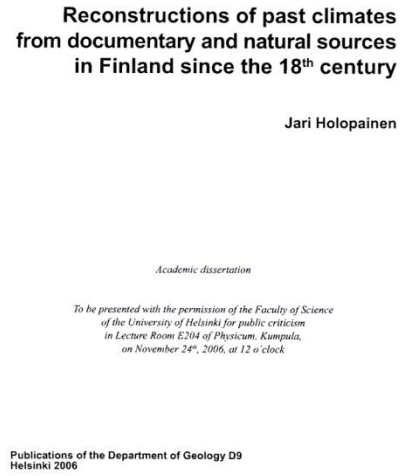
After Harald Barck (1753) and Alexander Malachias (1756) phenological dissertations the next doctoral thesis (1786) based phenological observations made in 1780 – 1785 in Finland

- *"Specimen Calenderii Florae et Faunae Åboensis"*
- After that prof. Hällström in 1844 wrote a manuscript about observations from Brussels to Utsjoki (50ºN to 70ºN) (unpublished)

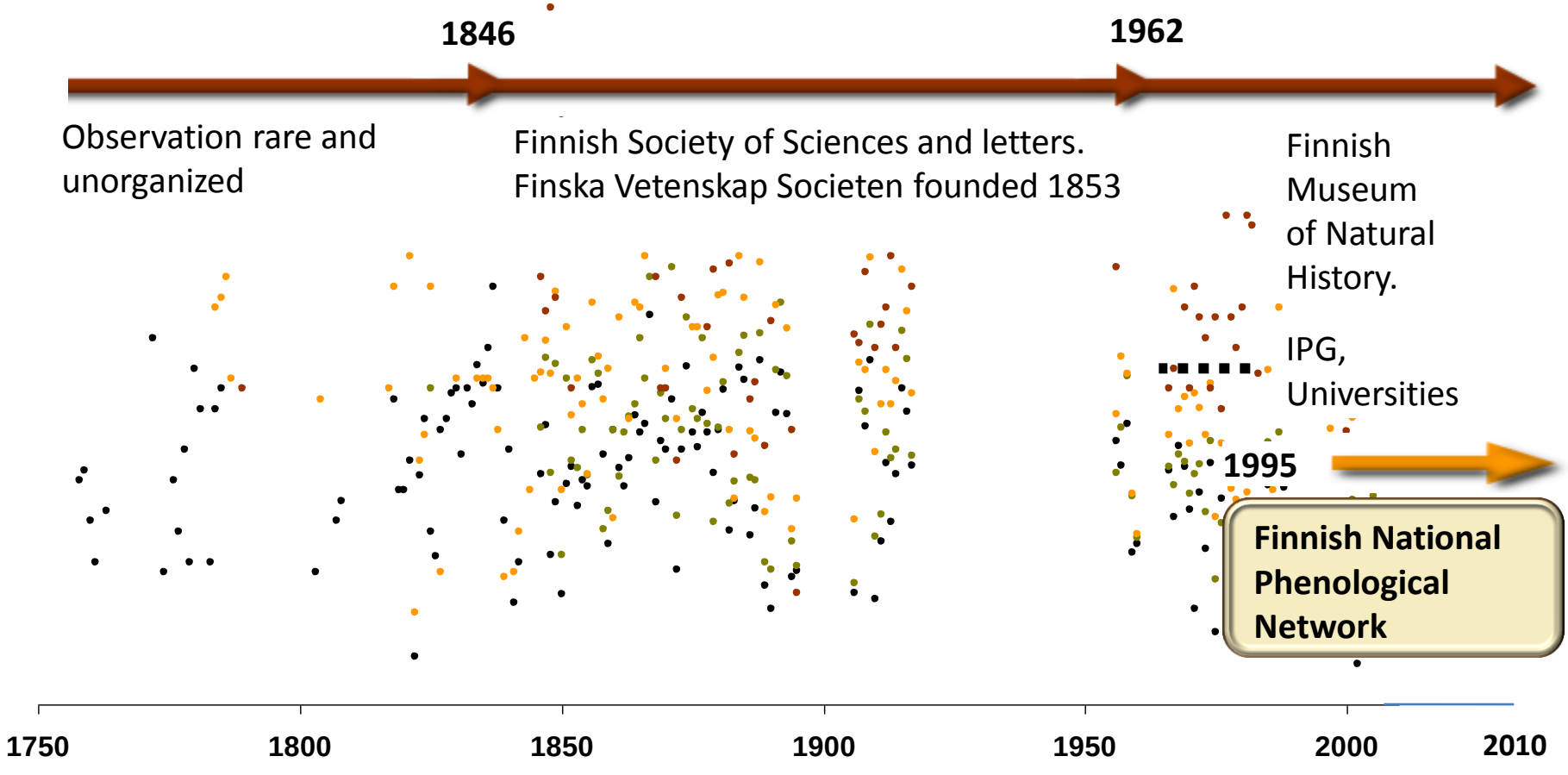
The old historical data has afterwards used for different doctoral theses eg. Häkkinen 1999, Linkosalo 2006, Holopainen 2006







The Finnish National Phenological Network was established 1990's to continue long-term monitoring since 1750's



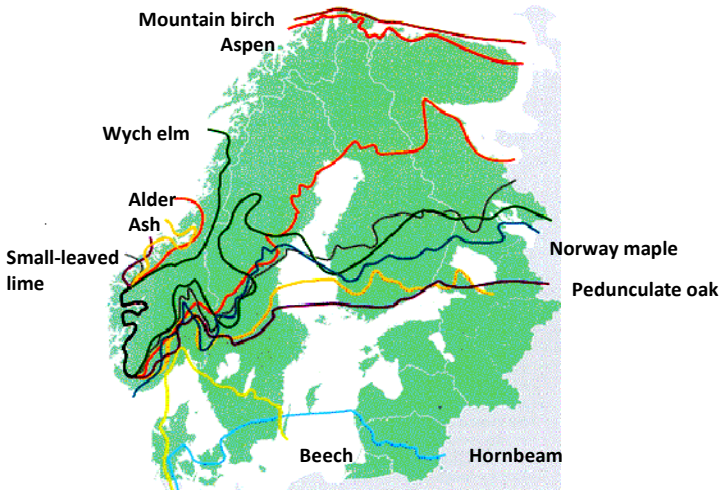
Observation by volunteers since 1751

Observation by office holders of different institutions since 1995

Phenology is again in the focus from the 1990's because of climate change

Facts in the North:

- Many species are growing in the Northern or Southern limits of distribution; response
- New tools for data processing
- Phenological events and human health
- Phenological events and economy
- Public interest to natural phenomena
- Etc.



Hallanaro, Eeva-Liisa & Pylvänäinen, Marja. 2002. Nature in Northern Europe – Bioversity in a changing environment. Nord 2001:13. Nordic Coujncil of Ministers, Copenhagen.

Content

1. **From history to present**
2. **Finnish National Phenological Network**
3. The use of the historical and present phenological data
4. Conclusions

2. Finnish National Phenological Network

2.1 Establishing the Network

2.2 Guided observations

2.3 Real time information to everyone

2.4 Domestic and international co-operation

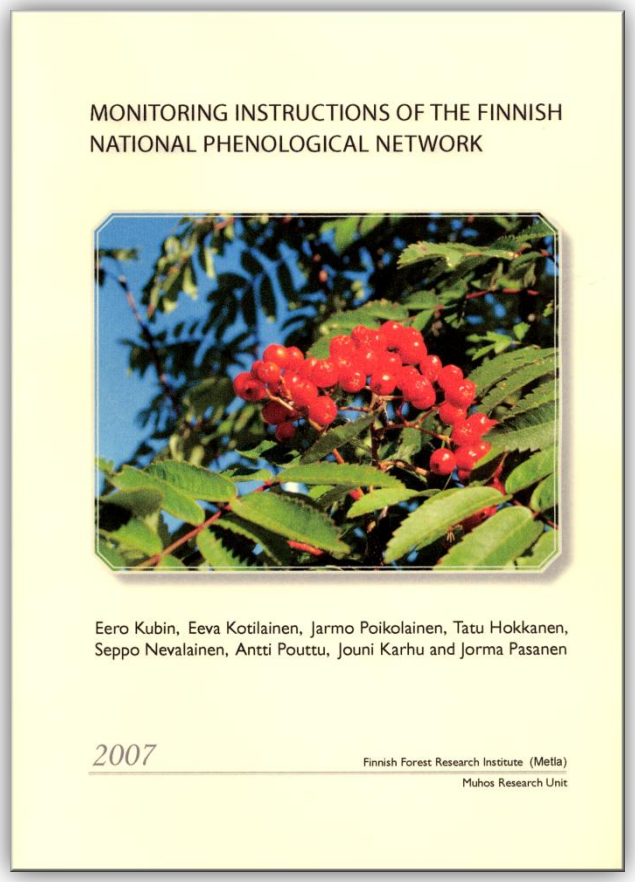
2.5 Digital photos and animations

2.6 Continuation

Between the long-term voluntary work and a new NPN Oulu University had a great influence

- Professor Paavo Havas highly recommended to intensify phenological investigation in Finland when it was nearly finished
- A seminar in Helsinki was organized to add ecological co-operation between universities and research institutes
- The Finnish Academy supported aims to start phenological recording all over the country at the beginning of 1990's
- **As a result Finnish National Phenological Network was established by the Finnish Forest Research Institute, Metla, a person in charge Eero Kubin**

Finnish National Phenological Network 1995 -



- Standardized observation guide
- Trained observers
- At least twice per week from the same tree individuals
- Recorded to the database immediately by using internet

4 MONITORED PLANTS AND PHENOMENA

4.1 Downy birch – *Betula pubescens* Ehrh.

Characteristics

Downy birch is smaller in size than Silver birch and its branches are not so thick. The young shoots of the Downy birch are smooth, hairy, and fairly stiff at the tip. Its leaves are usually ovate or roundish in shape, generally with single serration along the edges, and they lack the elongated tip typical of Silver birch. The leaf blade is at its widest at about midway along its length. When compared to the leaf blade, the petiole is shorter and broader than that of Silver birch. The dormant buds are sticky, and the bark at the butt end of the Downy birch is smooth and light in colour.

Mountain birch (*Betula pubescens* ssp. *cherepanovii* Orlova) is a subspecies of the Downy birch. Where Mountain birch occurs, the observations are recorded alongside Downy birch and this is indicated in writing.

Selecting the trees

The observations are made individually by observing five medium-sized and healthy Downy birch trees. The trees have been marked and numbered. All Downy birch observations are made of the same trees.

Phenomena to be monitored

Bud burst. BBCH07.

Leaves are in this phase when they are emerging from their buds. The leaves are still very small, the leaf blade has not yet opened, and the petiole is not visible. This phenomenon is deemed to have occurred when at least half of the leaves of each observation tree have reached this phase, i.e. when the crowns of birches appear green for the first time when viewed from a distance.

Onset of male flowering. BBCH61.

Male flowering is deemed to have begun when the first tree begins to release pollen. This is when the catkins become heavy and start to hang downwards at the tips of branches. In Southern Finland this usually occurs at the end of April, in Central Finland in mid-May, and in Lapland towards the end of May. The beginning of male flowering can be determined by tapping the branches of birches with a long pole or other equivalent.

Leaves full-sized. BBCH15.

The leaf has reached its full size and does not really grow any bigger. The leaves becomes dark green and thicker, and the foliage of the birch as a whole becomes denser in appearance within a short time. Cross measurements can also be used in connection with this observation by measuring the length and width of a few leaves.

Fig. 1. Male flowering of birch. When the branches are given a tap, the catkins release a distinct puff of pollen. Photos: Eeva Kotilainen

Shedding of seeds. BBCH89.

This phenomenon is deemed to have occurred when the first seeds are observed to be shed by birches. A sheet of plastic or some other suitable material can be spread underneath trees to help in making this observation. In Southern Finland this usually happens already at the end of July or early August; in Northern Finland it happens towards the end of August. The shedding of seeds usually continues well into autumn. If tree-specific shedding of seeds cannot be distinguished, this phenomenon is marked alongside tree no. 1 on the form.

Leaf colouring. BBCH92.

This is the point in time when more than half of the leaves on each observation tree have turned yellow. The discoloration caused by rust fungi is not to be taken as yellowing in the sense meant here. If there is an abundance of birch rust fungi, and this hinders the making of observations, this can be noted down separately. See pictures of birch rust on page 45.

Leaf fall. BBCH97.

The shedding of leaves is deemed to have occurred when more than half of the leaves of each observation tree have been shed.

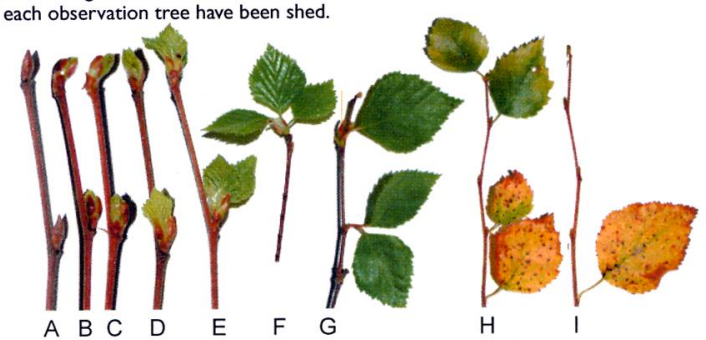


Fig. 2. Bud burst, leaf colouring and leaf fall of Downy birch. Flushing before the phase of bud burst (A-D); bud burst (E); leaves fully out of the bud (F); leaves full-sized (G); leaf colouring (H); and leaf fall (I). Photos: Eeva Kotilainen.

Examples from the monitoring guide

Bud burst, leaf colouring and leaf fall of Downy birch

A B C D E F G H I

Flushing before the phase of bud burst (A-D)
Bud burst (E)
Leaves fully out of the bud (F)
Leaves full-sized (G)
Leaf colouring (H)
Leaf fall (I)

Height growth of Scots Pine

Bud before onset of growth (A)
Onset of height growth (B)
Elongation of the shoot (D-H)
End of height growth (I)

Examples from the monitoring guide

Flowering of Scots Pine

Male inflorescences
before pollen release (A)
During pollen release (B)
A female inflorescence (C)

Examples from the monitoring guide

Flowering and berry ripening of bilberry

The points in time when the lowers have opened up (A)

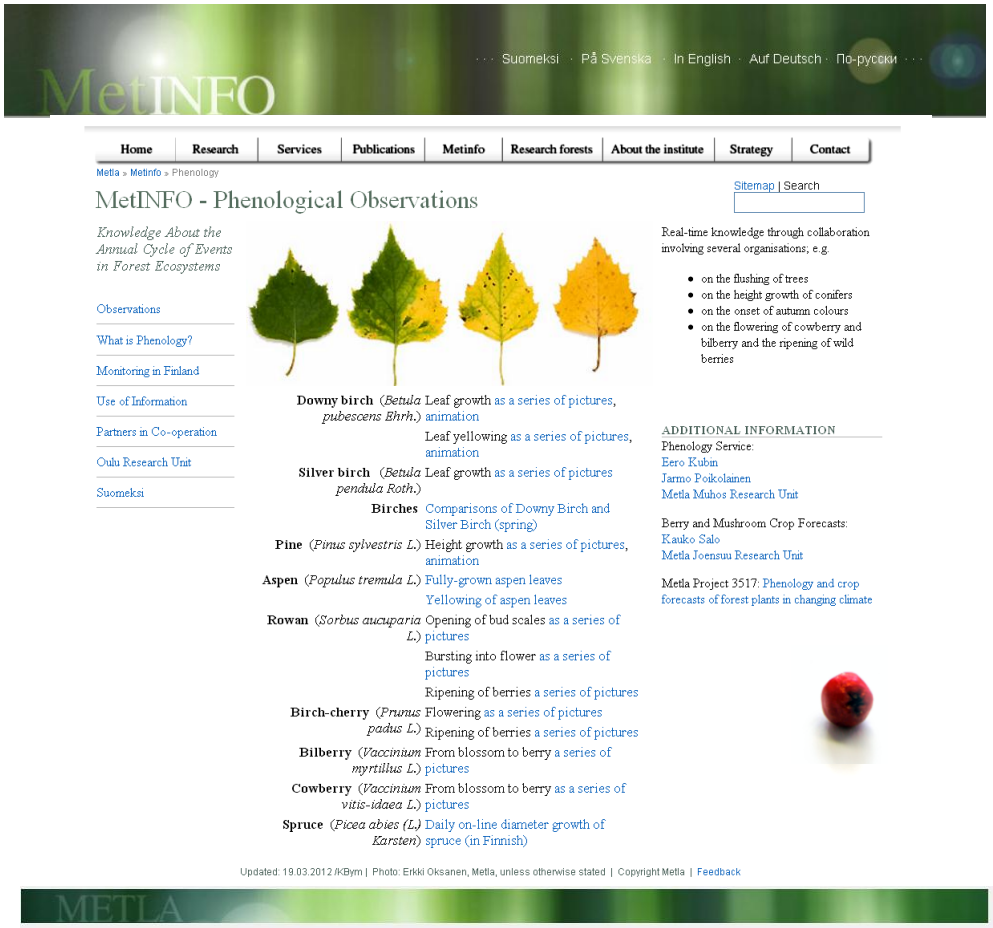
Flowering is over (B)

The berries are still unripe (C)

When the berries are ripe (D)

The www-pages

- updated twice a day
- real time internet information to everyone created by Jouni Karhu, Metla Oulu
- processed into maps and animations available at Metla's webpage, one of the most visited in Metla (***www.metla.fi/metinfo/fenologia/index-en.htm***)

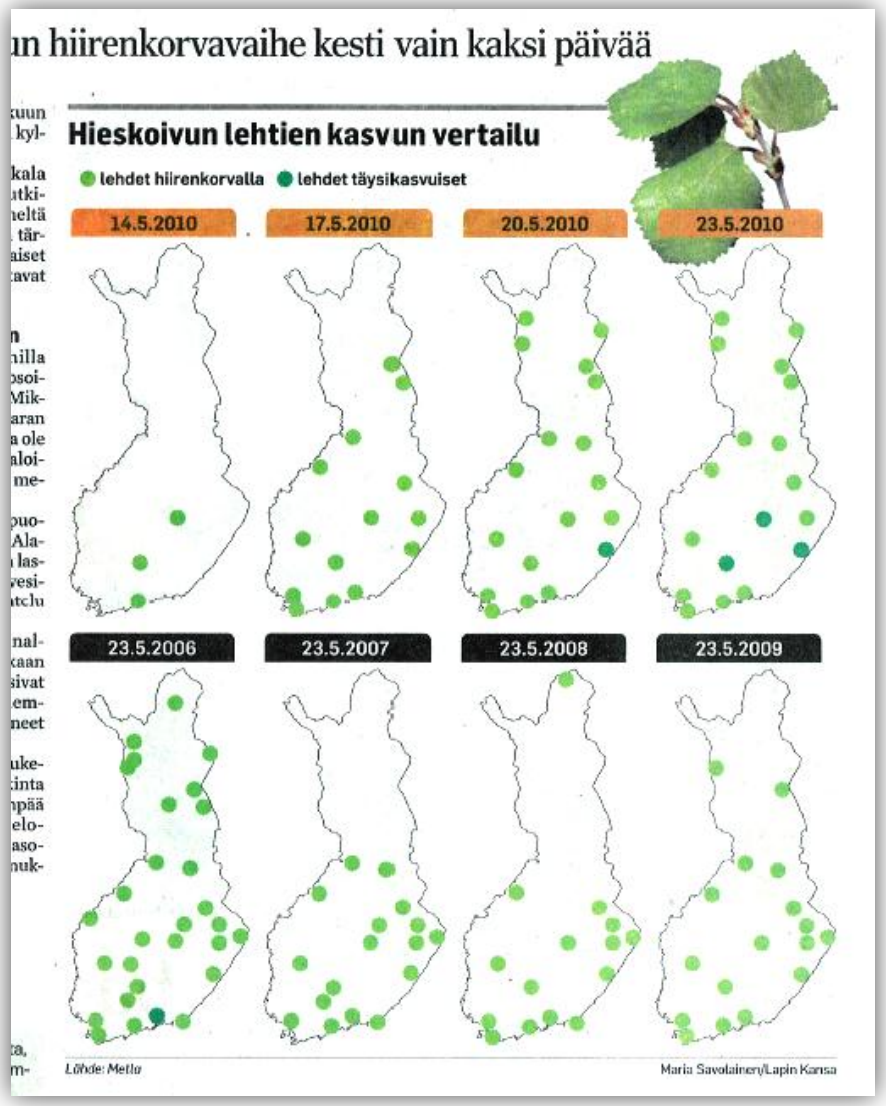


Public use the results

Public and media are interested in timing of phenological events and crop forecasts of forest plants

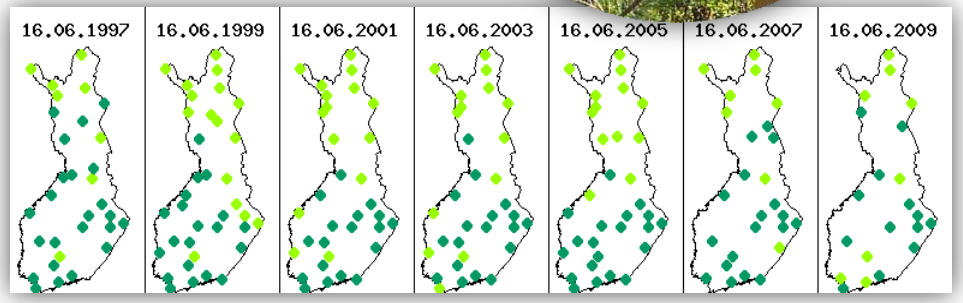
In 2009 interviews and others 139

E.g. newspaper Lapin Kansa published the maps from our www- pages – figure on the right

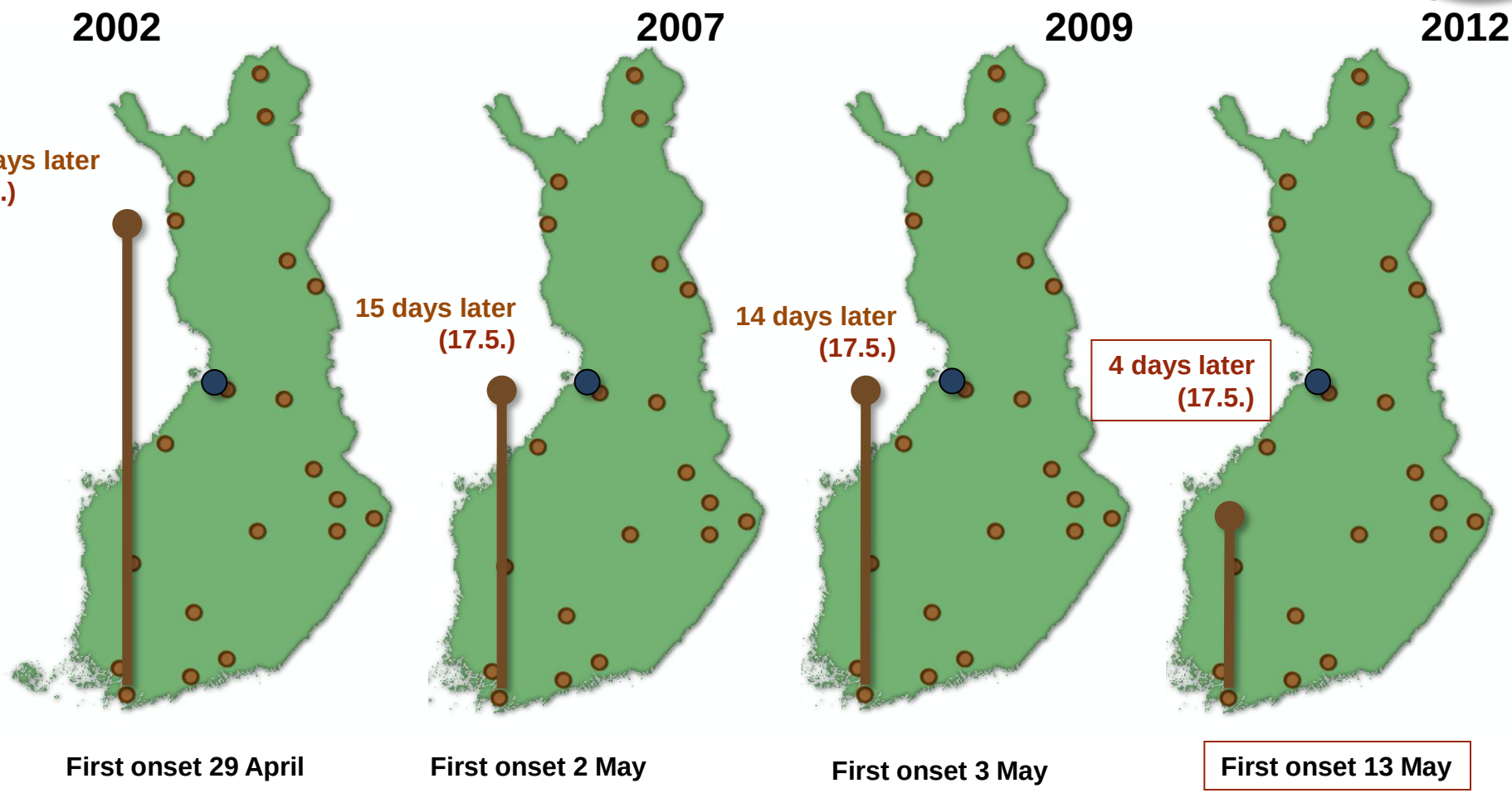


Lapin Kansa

Digital photos and animations



The emerging of the leaves – examples Downy birch (*Betula pubescens Ehrh.*)



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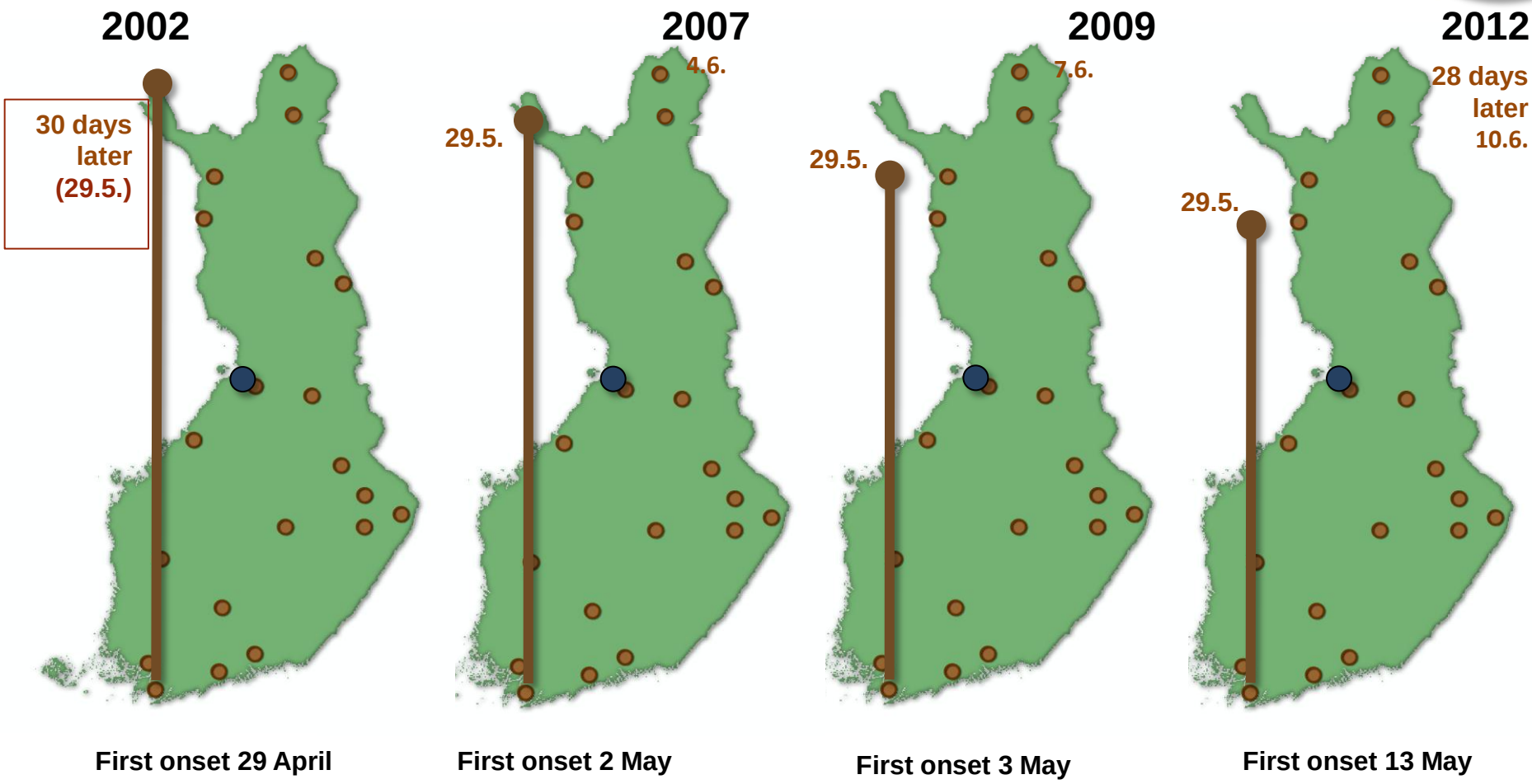
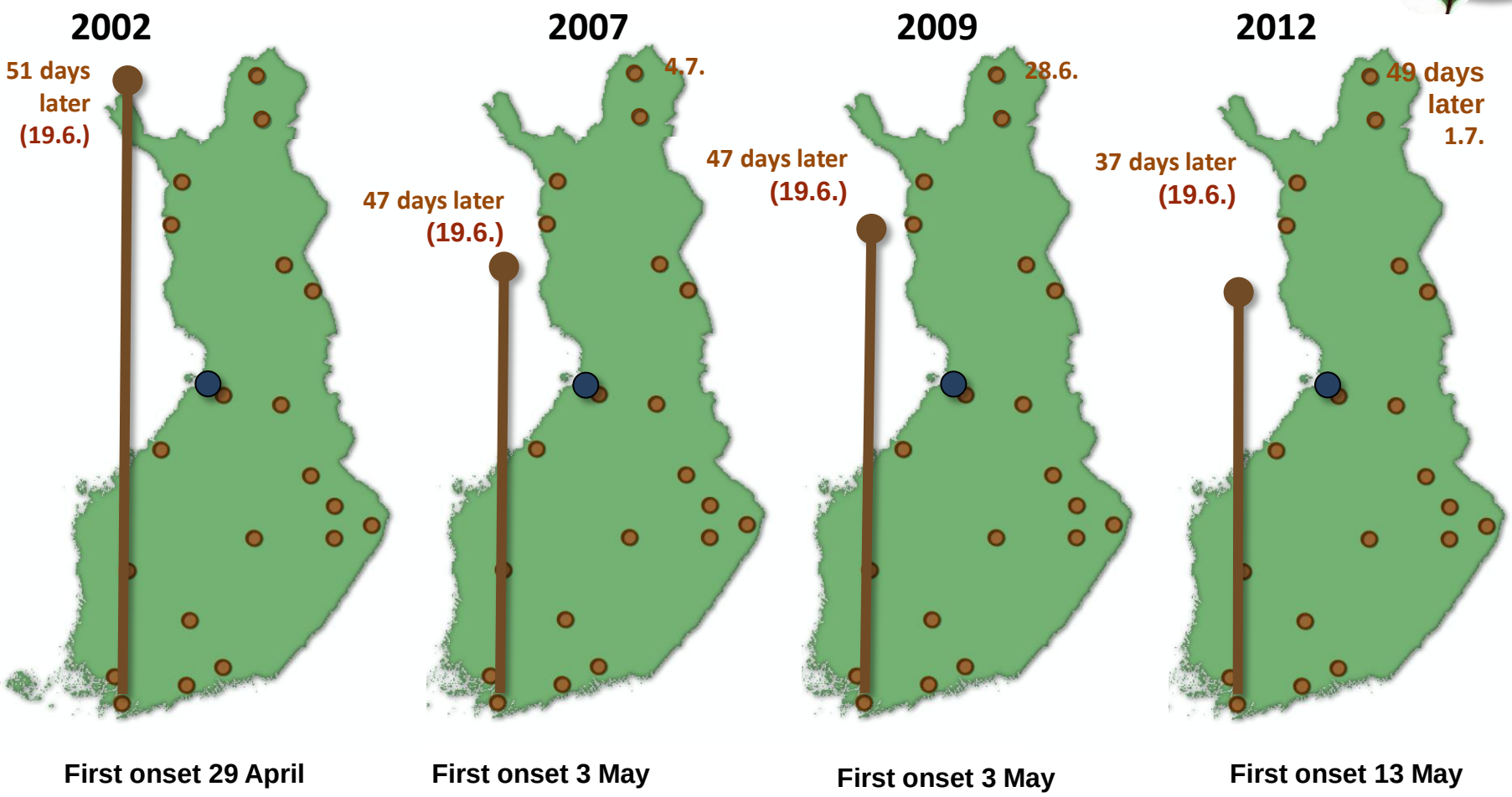
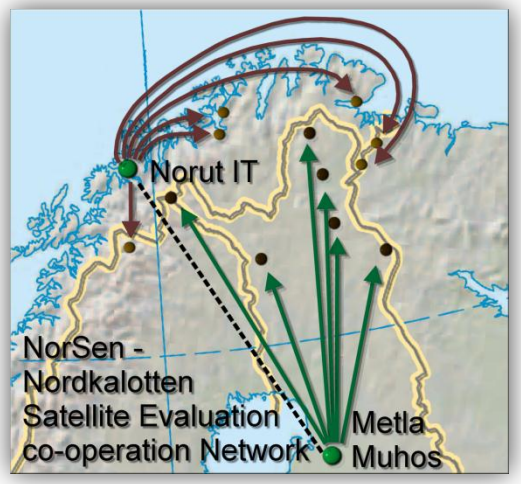
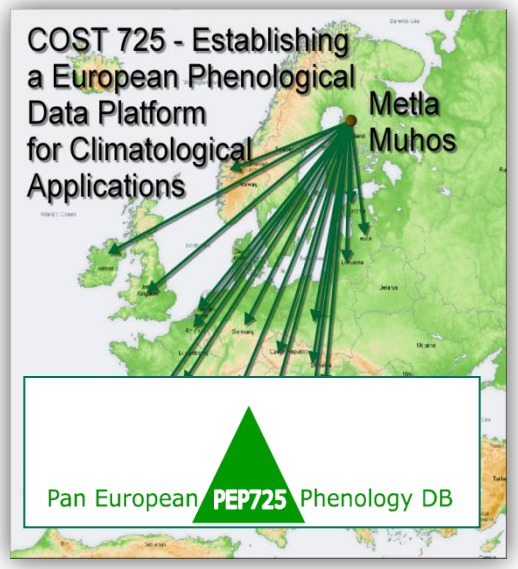


The full growth of the leaves– examples Downy birch (*Betula pubescens Ehrh.*)



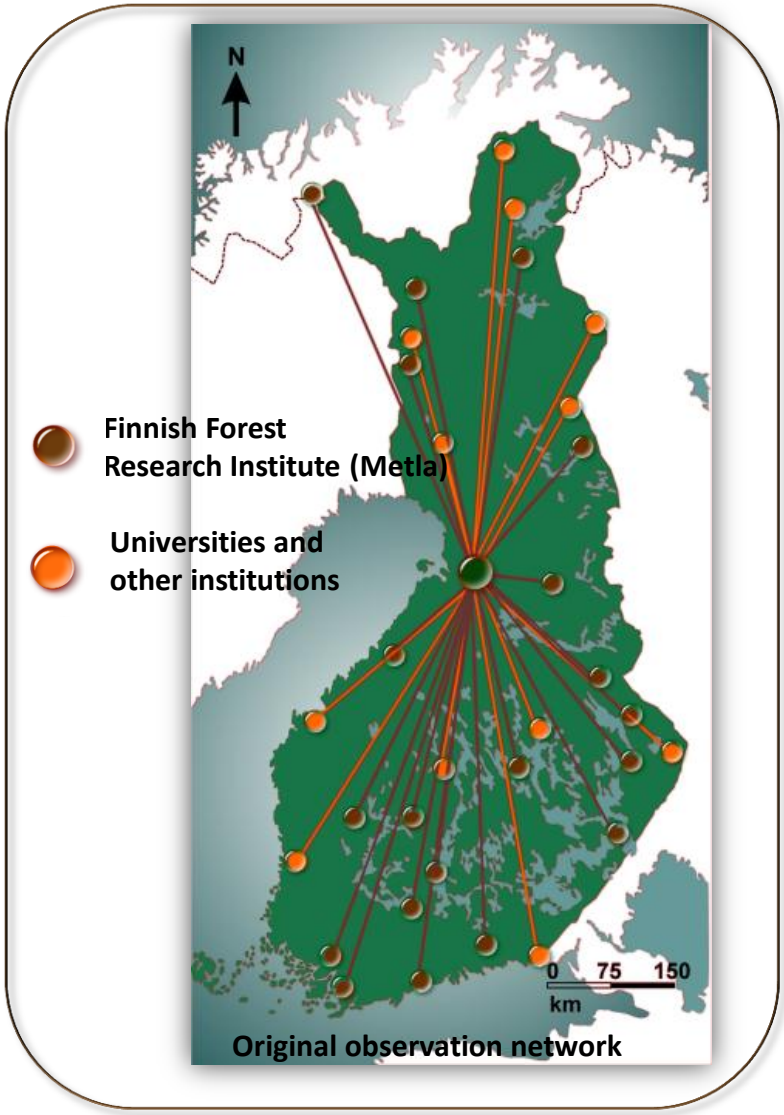
Domestic and international co-operation





Plenty of international and domestic co-operation

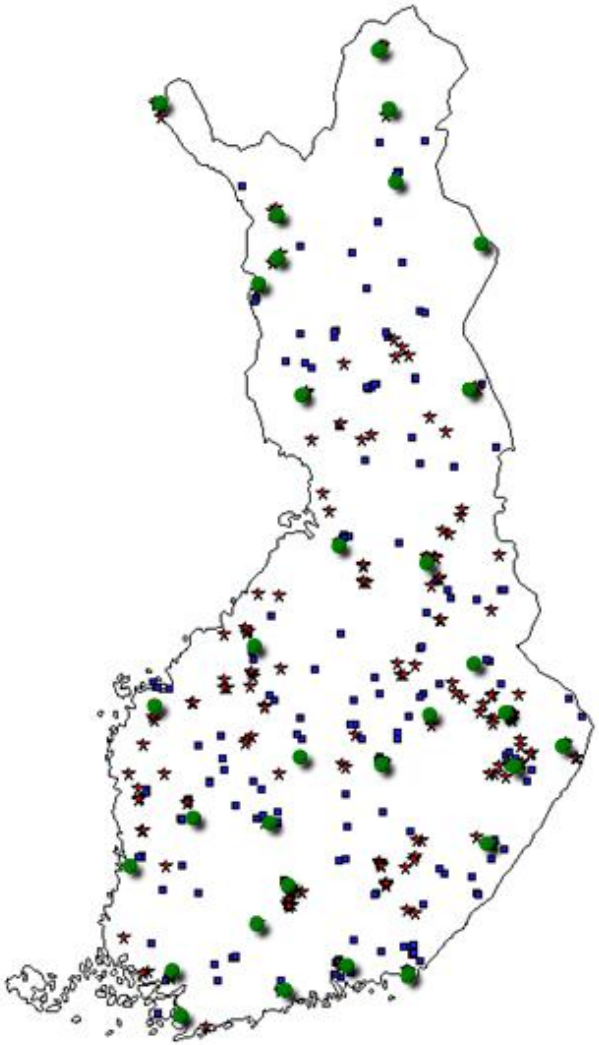
Collaborative Action on Nordic Countries–under process



Domestic co-operation with the Finnish Meteorological Institute, universities and other institutes is an essential part of the Network

The observation sites forming the present Finnish National Phenological Network

The weather stations of the Finnish Meteorological Institute



Monitoring networks in Finnish Forests Research Institute, Metla

- Plant phenological network
- Stands for forecast of wildberry and mushroom yields (in addition of phenological network)
- Stands for flowering and seed crops of forest trees

Finnish NPN continuation

- The research project ‘‘Phenology and crop forecasts of forest plants in changing climate” was launched for the years 2009 – 2013. The project will continue ongoing work of the Finnish National Phenological Network
- The aim is to improve monitoring and definition of the changes of the timing of phenological events and berry and seed crops
- The correlation between phenological events and climate change will be analysed
- Domestic and international co-operation, reporting and other forms of dissemination will be continued

Content

1. The Linnean time - backround
2. Finnish National Phenological Network
3. **The use of the historical and present phenological data**
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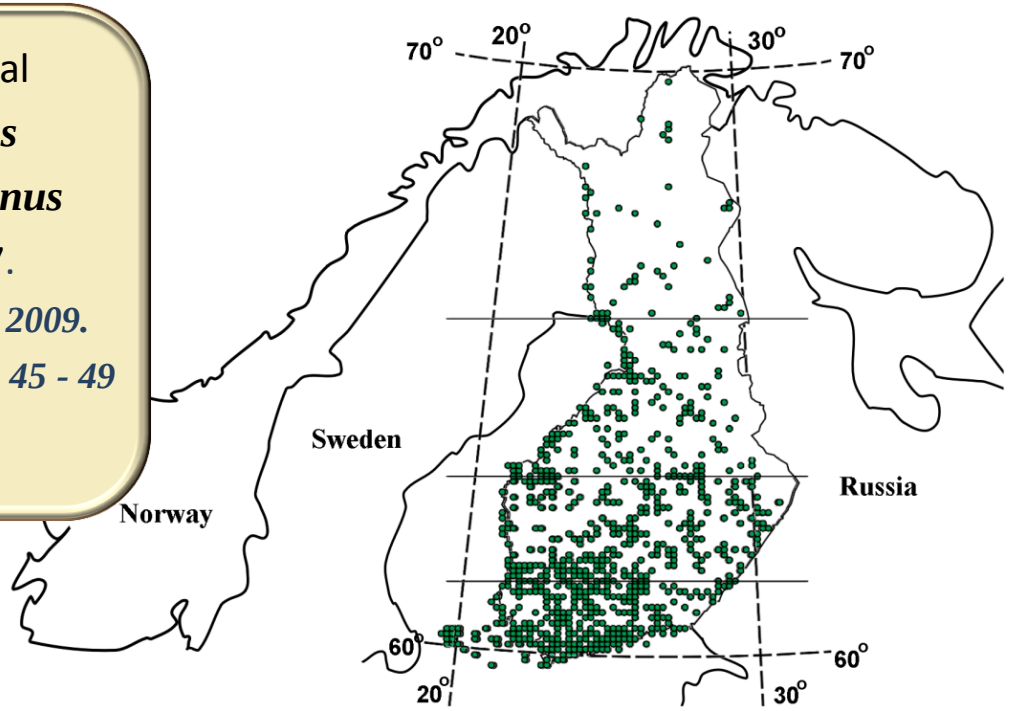
Long-term voluntary basic observation and the Finnish National Phenological Network

Figure. Localities for phenological data collection of rowan (***Sorbus aucuparia***) and bird cherry (***Prunus padus***) in Finland in 1752 - 2007. *Terhivuo, J., Kubin, E. & Karhu, J. 2009. Italian Journal of Agrometeorology. 45 - 49 (1) 2009 .*



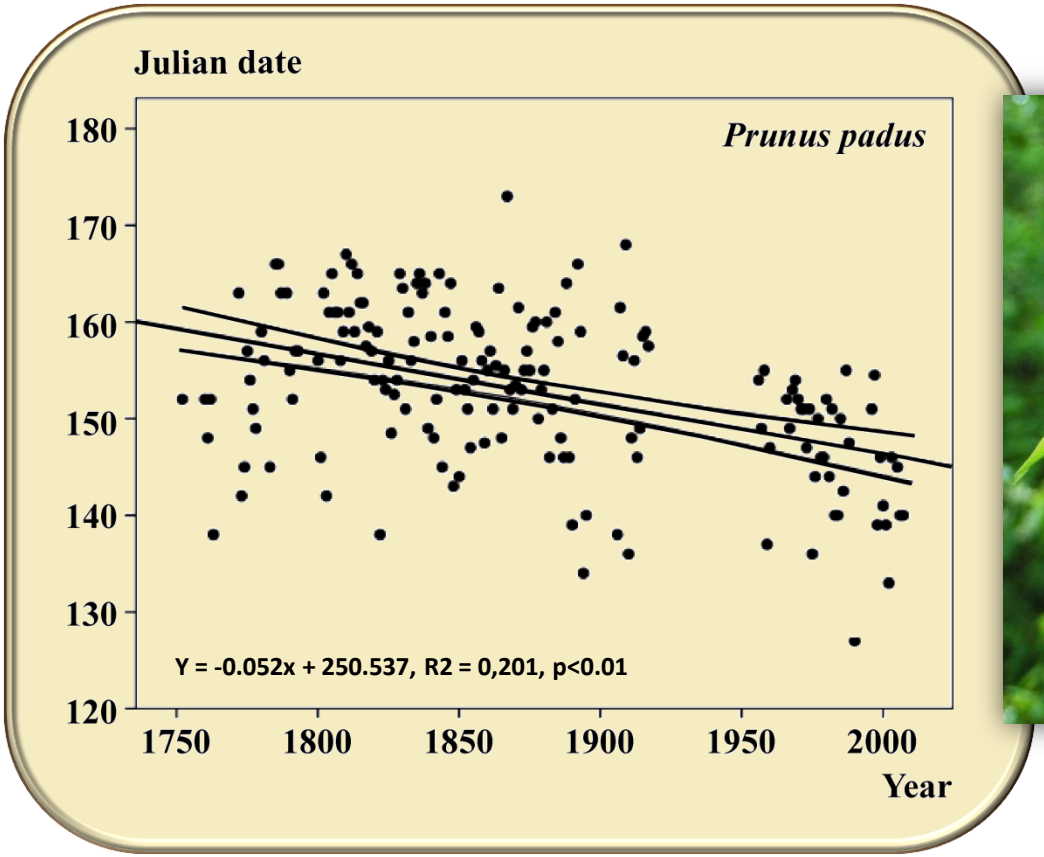
Voluntary observation sites 1752 - 2007

In the next four slides there are results of *Sorbus aucuparia* and *Prunus padus* blooming

(Kubin, Terhivuo and Karhu 2008. Presentation in Rome 2008, COST 725 WG1)

Sorbus aucuparia

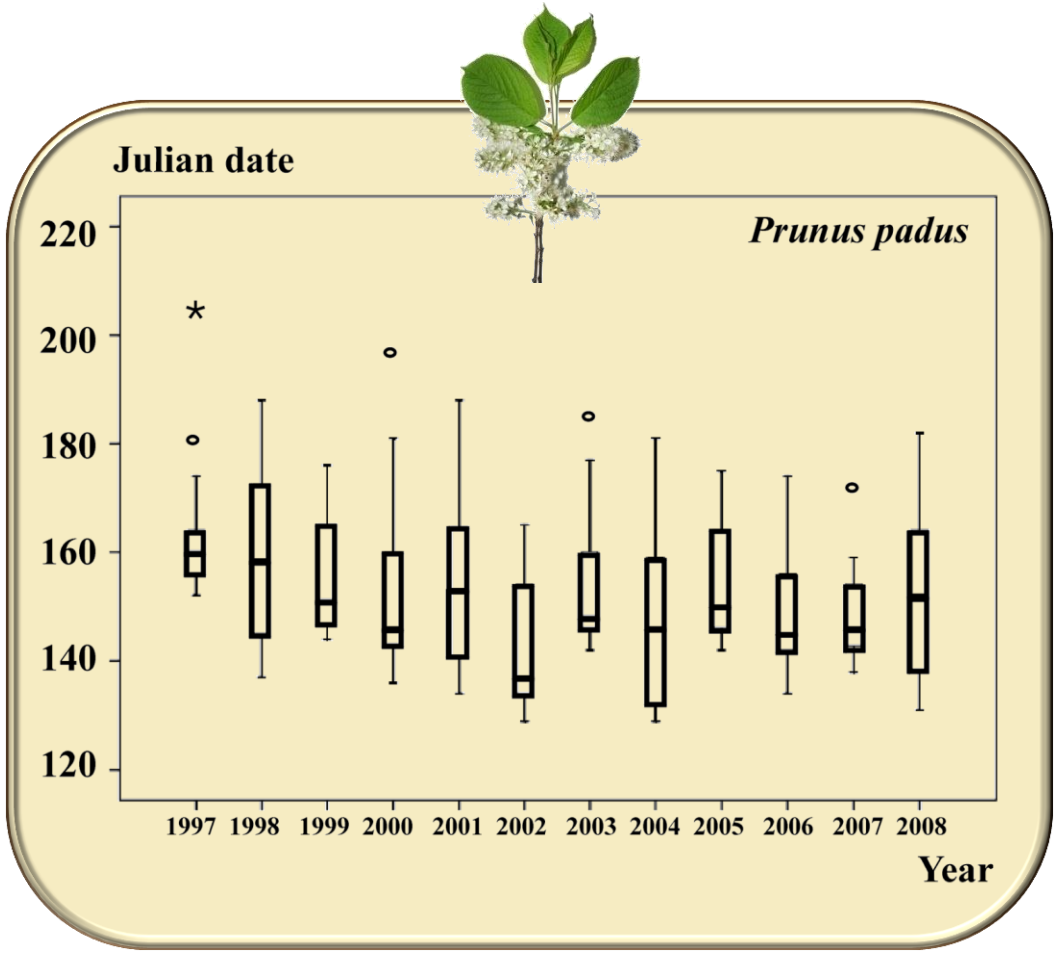
Prunus padus



The timing of flowering in bird cherry during the period of 1752 - 2007. **o** = median of annual observations. Traditional regression model and its 95 % confidence limits have been drawn into the figure. Flowering has been advanced every year 0.05 days since 1973. That is 5 days per one hundred years. ***Terhivuo, J., Kubin, E. & Karhu, J. 2009. Phenological observation since the days of Linne in Finland. Italian Journal of Agrometeorology. 45 - 49 (1) 2009 .***

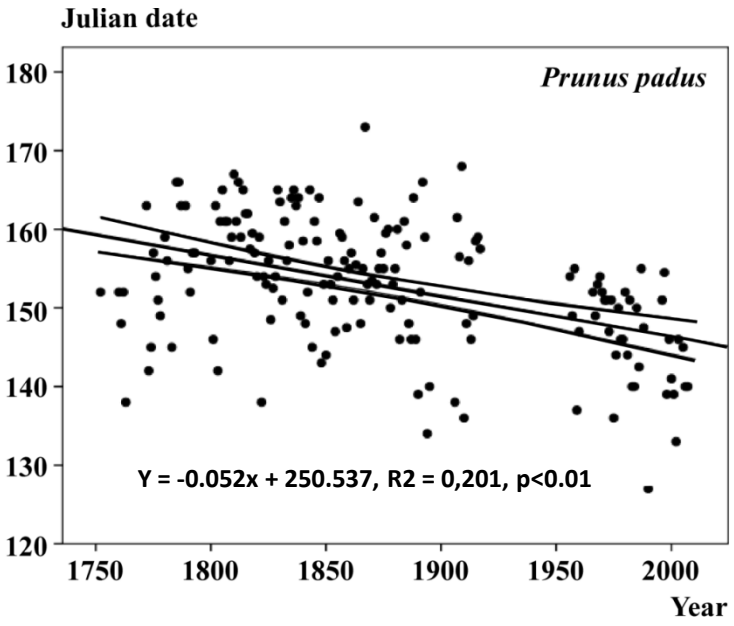
Applied non parametric sen's slope estimate for linear trend is y = -0,05348 (x- 1752) + 159,9627. Mann-Kendall test z = -5.7962 and sigificance < 0,001. According the model flowering Julian day in 1753 was 162,2 and onward from this to 2007 the flowering happened every year 0.053 days earlier. That is 5,3 days per one hundred years.

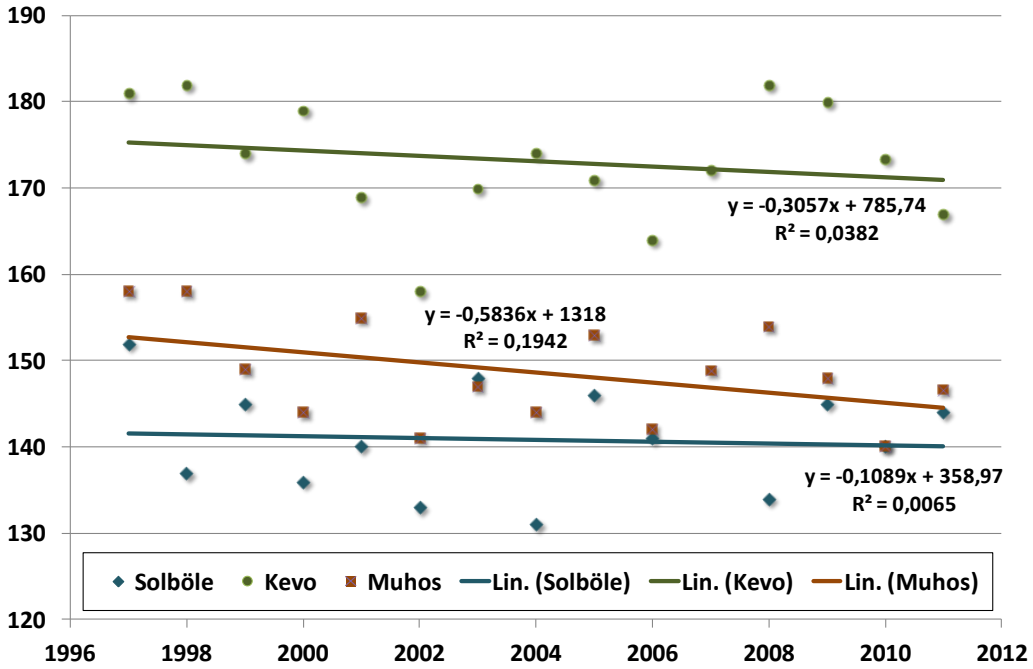
Observations made in the Finnish National Phenological Network are in line with long-term recording



The timing of flowering in bird cherry based on the material provided by Finnish National Phenological Network in 1967 - 2008.

Terhivuo, J., Kubin, E. & Karhu, J. 2009. Phenological observation since the days of Linne in Finland. Italian Journal of Agrometeorology. 45 - 49 (1) 2009 .

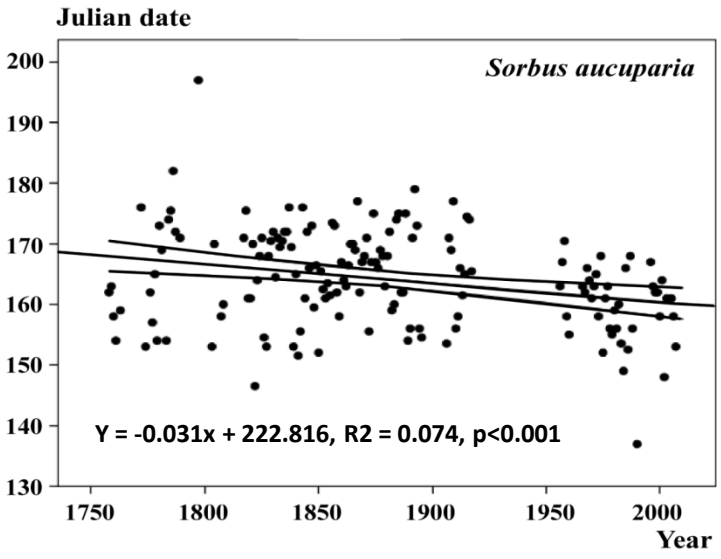


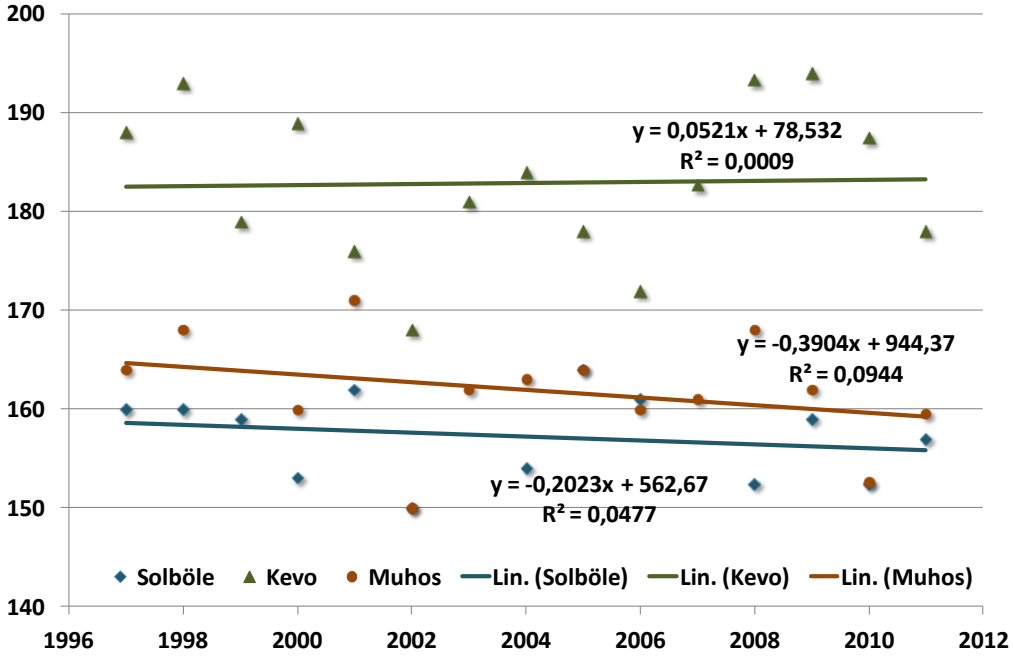


On the left. The timing of flowering in bird cherry during the period of 1753-2007. ● = median of annual observations. Traditional regression model and its 95 % confidence limits have been drawn into the figure. Flowering has been advanced every year 0.05 days since 1753. That is 5 days per one hundred years. *Terhivuo, J., Kubin, E. & Karhu, J. 2009. Phenological observation since the days of Linne in Finland. Italian Journal of Agrometeorology. 45-49 (1) 2009* .

Applied non parametric sen's slope estimate for linear trend is y = -0,05348 (x- 1752) + 159,9627. Mann-Kendall test z = -5.7962 and sigificance < 0,001. According the model flowering Julian day in 1753 was 162,2 and onward from this to 2007 the flowering happened every year 0.053 days earlier. That is 5,3 days per one hundred years.

On the right unpublished data of the Finnish National Phenological Network





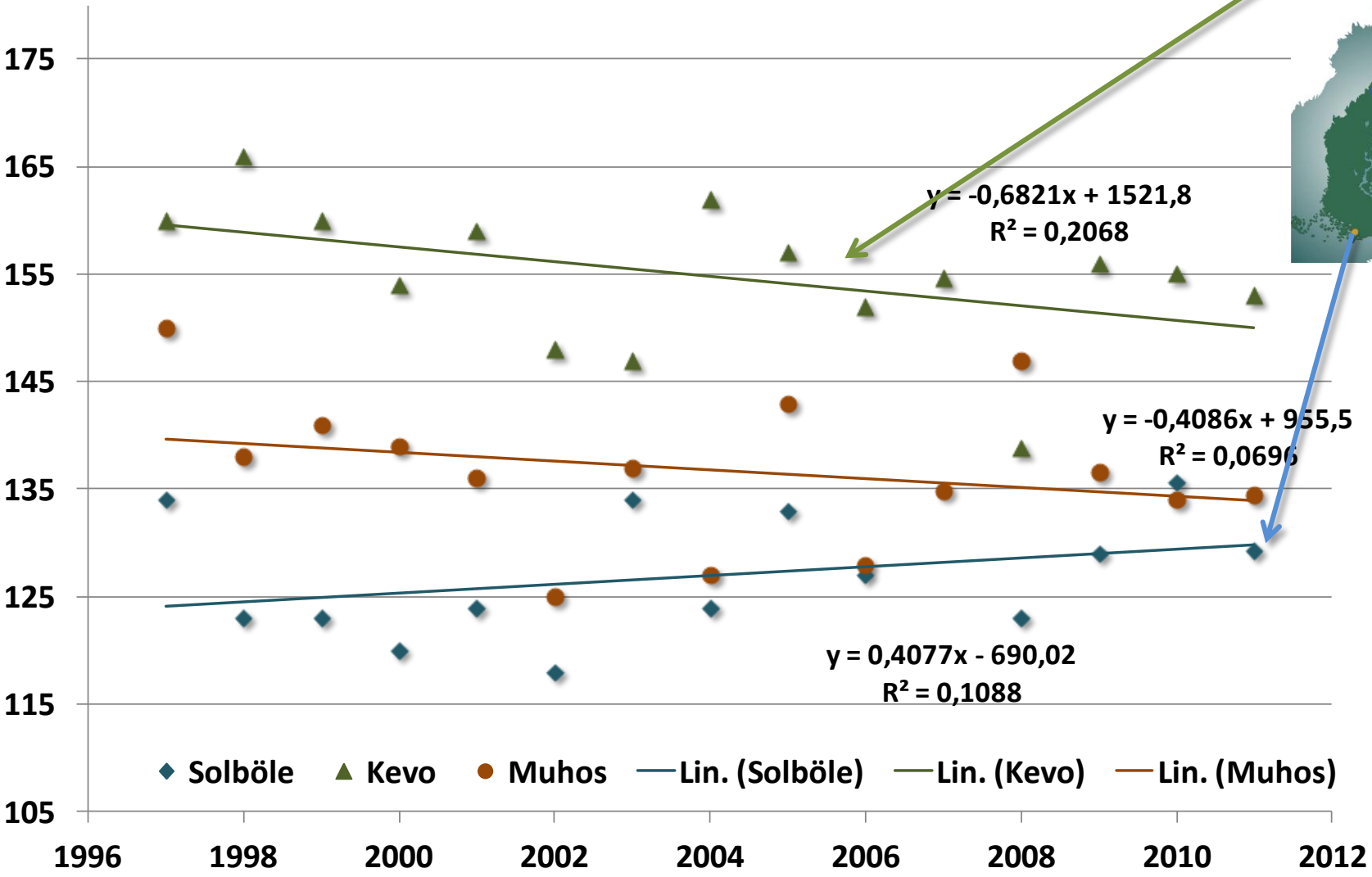
On the left. The timing of flowering in rowan during the period of 1753-2007. ● = median of annual observations. Traditional regression model and its 95 % confidence limits have been drawn into the figure. Flowering has been advanced every year 0.03 days since 1753. That is 3 days per one hundred years. *Terhivuo, J., Kubin, E. & Karhu, J. 2009. Phenological observation since the days of Linne in Finland. Italian Journal of Agrometeorology. 45-49 (1) 2009 .*

Applied non parametric sen's slope estimate for linear trend is y = -0,02941 (x- 1752) + 169,23. Mann-Kendall test z = -2.941 and sigificance < 0,01. According the model flowering Julian day in 1753 was 162,2 and onward from this to 2007 the flowering happened every year 0.029 days earlier. That is 2,9 days per one hundred years.

On the right unpublished data of the Finnish National Phenological Network

Downy birch (*Betula pubescens Ehrh.*)

The emerging of the leaves



Conclusions

- The Finnish National Phenological Network is a strong domestic and international collaboration network
- The results fit well with many European countries; spring phenophases are coming earlier due to climate warming
- Phenophases are more sensitive in northern latitudes
- Challenges are organization structure changes and decreasing staff concluding to less phenological stations

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Our phenology group at Metla Oulu Unit (***Eero Kubin, Jarmo Poikolainen, Jouni Karhu, Jorma Pasanen & Anne Tolvanen***) has done a great work for phenology.

Cooperation with the Finnish Museum of Natural History (***Juhani Terhivuo***) to utilize the old historical data since the Linnean time has given new possibilities to understand long time series

It is highly appreciated those volunteers of many generations carried out observations in the field as well as the office holders of Finnish Museum of Natural History, Finnish Forest Research Institute and other participating units all over the Finland

Finnish Museum of Natural History

METLA

Finnish Forest Research Institute

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Spring

Summer

Thank you for your attention!

Winter

Autumn