



Forest Genetic Monitoring an example from Germany

Darius Kavaliauskas and Barbara Fussi

Bavarian Office For Forest Genetics (AWG), Germany

Kaunas, 2022

Norway spruce forest in the Bavarian Forest National Park

Source: https://www.science.org/toc/science/374/6572

Source: https://www.dw.com/en/its-do-or-die-for-germanys-forests/g-58658030

ENVIRONMENT

It's do or die for Germany's forests

The health of German forests is in terminal decline. Global heating and poor management are at the roots of a countrywide die-off, an urgent issue being confronted by a national forest summit this week.

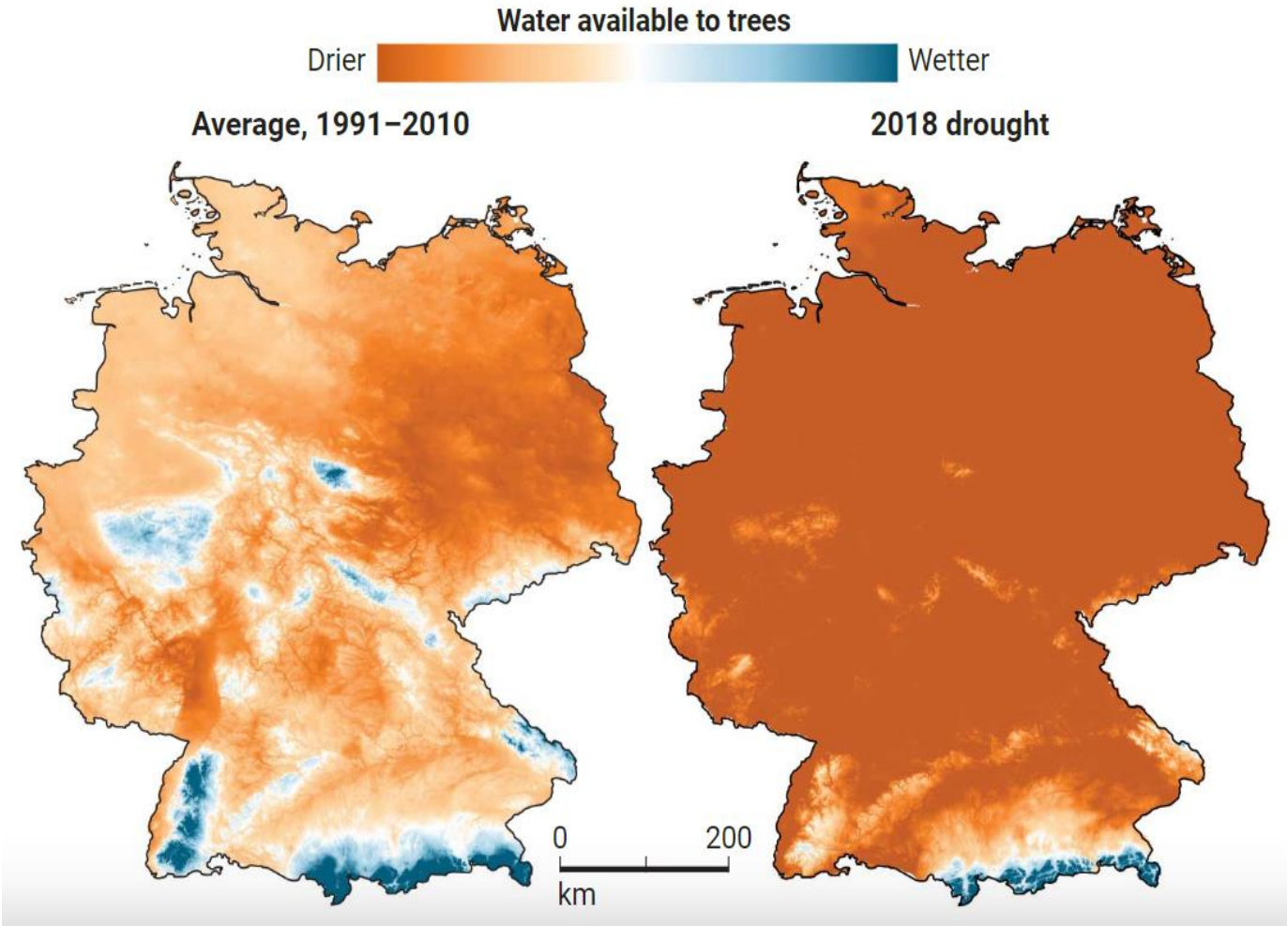
04.08.2021

The forests are dying

German forests are dying in part due to drier and hotter summers, and heat-loving bark beetle plagues that have destroyed ubiquitous spruce trees. More trees died in Germany in 2020 than in any other previous year, including beech trees planted widely in the past decade for their climate resilience. This week's national forest summit titled "Waldsterben 2.0" (Forest Dieback) asks what can be done.

Dry spell

A record 3-year drought that began in 2018 (right) set off a cascade of tree stress, fires, and insect attacks that killed more than 2.5% of Germany's forests. The destruction highlights the threat posed by climate change, researchers say.

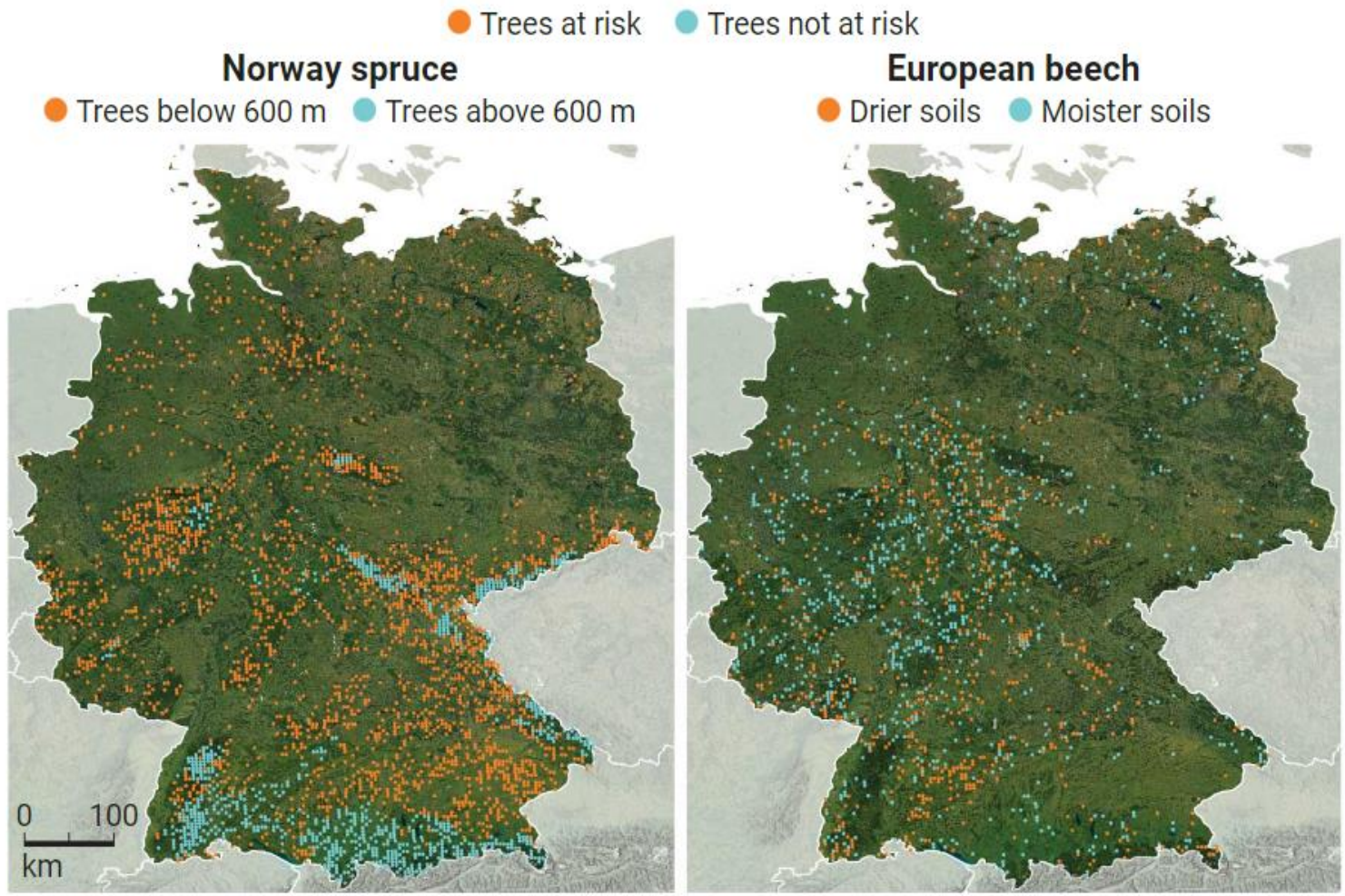


2 DEC 2021 (BY GABRIEL POPKIN)

Source: https://www.science.org/content/article/germany-s-trees-are-dying-fierce-debate-has-broken-out-over-how-respond

Stress maps

A rapidly shifting climate has made many of Germany's most important trees vulnerable to various threats, projections show. Droughts, which are predicted to become more severe, are expected to make Norway spruce growing in lower, warmer areas vulnerable to bark beetle attacks (left). A drier climate also threatens European beech trees growing in soils with less capacity to store water (right).

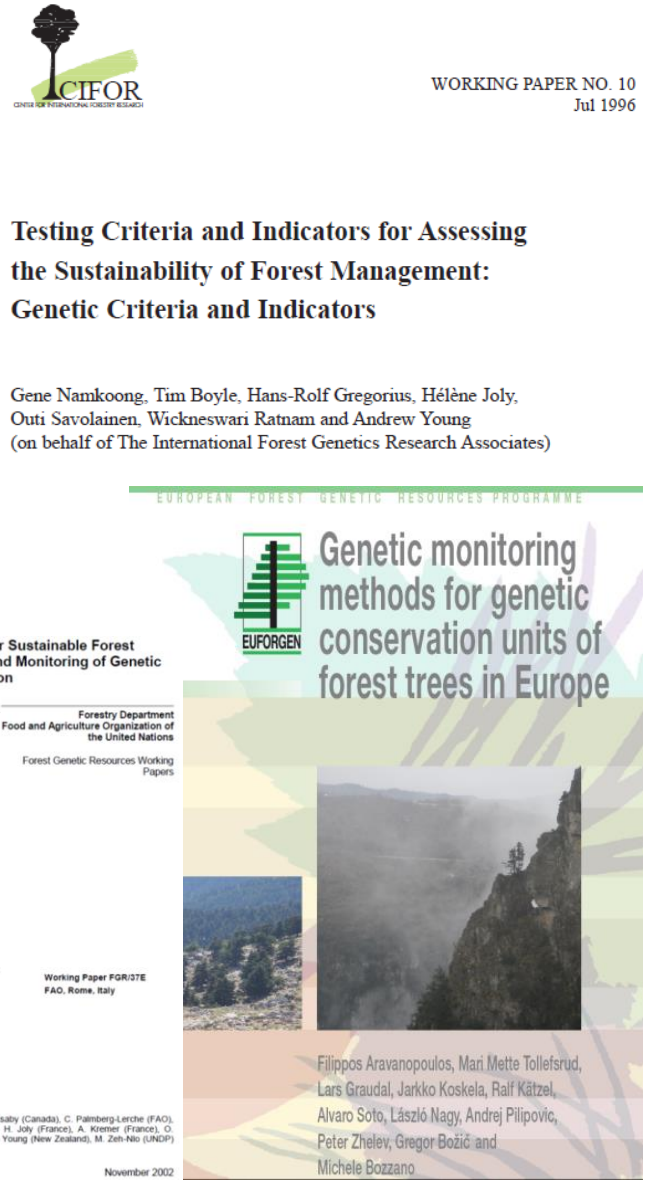


(GRAPHIC) K. FRANKLIN/*SCIENCE*; (DATA) ANDREAS BOLTE/THÜNEN INSTITUTE OF FOREST ECOSYSTEMS

Source: https://www.science.org/content/article/germany-s-trees-are-dying-fierce-debate-has-broken-out-over-how-respond

Forest Genetic Monitoring is an integral part of management of Forest Genetic Resources

- Theoretical basis
  - First proposed by experts from FAO, Group on forest genetic resources in 1996 (Namkoong et al. 1996, 2002)
  - The proposed monitoring system was **too time consuming**, **expensive and difficult** to implement practically in forests.
  - Simplified FGM scheme for practical use by experts from EUFORGEN working group on forest genetic monitoring (Aravanopoulos 2011, Aravanopoulos *et al.* 2015) and German programme for conservation of forest genetic resources (BLAG-FGR 2004 and Konnert *et al.* 2011)

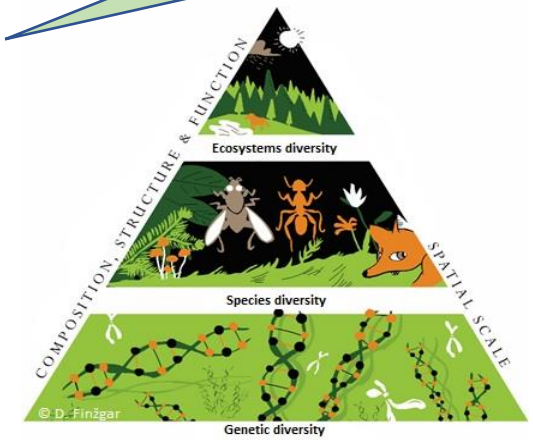


Starting point in Germany

IUFRO; EUFORGEN; CBD;

MCPFE; IPGRI; etc.

- National and international efforts for the conservation of FGR.
- Genetic diversity and its extent is the fundamental base of Biological Diversity.
- In forest monitoring programmes already established for observing environmental changes the genetic aspect was overlooked.
- In the Federal Republic of Germany since 1985 , conservation of FGR has been coordinated by a Federal-Länder Working Group "Forest Genetic Resources and Forest Seed Law" **(BLAG-FGR)**



(Fig. D. Finžgar (SFI))

BLAG-FGR group in Germany

- On the basis of a 5 year action plan, the Federal-Länder working group implements the measures and actions of the National Programme (Concept for the Conservation and Sustainable Use of Forest Genetic Resources in the Federal Republic of Germany) in a coordinated cooperation.

- Key areas of work are :
  - Coordination of selelection and evaluation of FGR;
  - *In-situ* and *ex-situ* FGR conservation measures;
  - Development of joint research projects, etc.
- In addition, BLAG-FGR supports the BMEL (Federal Ministry of Food and Agriculture) e.g. in European conservation initiatives such as EUFGIS/EUFORGEN and in international processes such as the Nagoya Protocol, Convention on Biological Diversity, etc.

FGM Implementation in DE

- "Concept for the Conservation and Sustainable Utilization of Forest Genetic Resources in the Federal Republic of Germany" (**2000)** (BLAG-FGR group, Paul et al. 2000)
- The pilot implementation was based on the “Concept of a Genetic Monitoring for Forest Tree Species in the Federal Republic of Germany” (BLAG-FGR **2004**)
- First national initiative – implementation started in Germany in **2004** (Konnert et al. 2011) on two species European beech (*Fagus sylvatica*) and wild cherry (*Prunus avium*).
- Diverse results and practical experience of this study displayed the necessity and urgency for developing and implementing FGM system at national and international levels (Konnert et al. 2011).

F. sylvatica FGM plot in Germany

Research Article - doi: 10.3832/ifor0571-004 ©iForest - Biogeosciences and Forestry

Collection: IUFRO RG 7.01 (2010) - Antalya (Turkey)
Adaptation of Forest Ecosystems to Air Pollution and Climate Change
Guest Editors: Elena Paoletti, Yusuf Serengil

Genetic monitoring in forests - early warning and controlling system for ecosystemic changes

Konnert M [1], Maurer W [2], Degen B [3], Kätzel R [4]

(1) Bayerisches Amt für forstliche Saat- und Pflanzenzucht, Forstamtsplatz1, D-83317 Teisendorf (Germany); (2) Forschungsanstalt für Waldökologie und Forstwirtschaft Rheinland-Pfalz, Schloss, D-67705 Trippstadt (Germany); (3) Institut für Forstgenetik des von Thünen-Instituts, Sieker Landstrasse 2, D-22927 Großhansdorf (Germany); (4) Landesforstanstalt Eberswalde, Fachbereich Waldentwicklung und Monitoring, Alfred-Möller-Strasse 1, D-16225 Eberswalde (Germany).

@ Monika Konnert
(monika.konnert@asp.bayern.de)

“Concept of a Genetic Monitoring for Forest Tree Species in the Federal Republic of Germany” (BLAG-FGR 2004)
BLAG German Expert Group proposed a scheme for species selection suitable for FGM in the Federal Republic of Germany

	Criteria	Valuation scale		
1	Risk of extinction	1 = no	2 = medium	3 = high
2	Rarity	1 = no	2 = medium	3 = high
3	Economic significance	1 = no	2 = medium	3 = high
4	Manner of pollination	W = wind	I = insects	
5	Range of seed dispersal	F = far	M = medium,	N = near
6	Availability of primary data from different monitoring programs	1 = no	2 = medium	3 = high
7	Availability of methods for identifying genetic markers	1 = no	2 = limited,	3 = un-problematic
8	Representativeness	1 = low	2 = medium	3 = high
9	Share within the stand	P = principal tree species	M = mixed tree species	

Following this procedure, selected species for FGM should belong to each of this four categories (BLAG-FGR 2004):

1. deciduous tree species;
2. coniferous tree species;
3. insect-pollinated tree species;
4. relict tree species.

Results of the evaluation procedure and immediate focus on:

1. two deciduous tree species: European beech, oak *spp*.
2. two coniferous tree species: European silver fir, Norway spruce
3. two insect-pollinated tree species: Small-leaved lime, wild cherry
4. two relict tree species: Black poplar, elm *spp.*

	Status of endangering	Rarity	Economic significance	Pollination	Seed dispersal	Availability of primary data	Markers	Representativity of plots	Share relevance for the stand	Priority
Sycamore maple *(Acer pseudoplatanus)*	1	2	2-3*	W	F	1	3	2	M	3
European beech *(Fagus sylvatica)*	1	1	3	W	F/N	3	3	3	P	1
Oak *(Quercus spec.)*	1	1	3	W	F/N	3	3	3	P	1
Wild cherry *(Prunus avium)*	2	2	2	I	F/N	1	2	1	M	3
Small-leaved linden *(Tilia cordata)*	2	2	2	I	M	1	2	1	M	3
Wild apple *(Malus sylvestris)*	3	3	1	I	N	1	2	1	M	3
Wild pear *(Pyrus pyraster)*	3	3	1	I	N	1	2	1	M	3
Black poplar *(Populus nigra)*	3	3	1	W	F	1	3	1	M/P	2
Elm *(Ulmus spec.)*	3	3	1	W	M	1	2	1	M	3
European ash *(Fraxinus excelsior)*	1	1	2	W	M	1	3	1-2	M	3
Birch *(Betula spec.)*	1	1	2	W	F	1	1	2	M	3
Black alder *(Alnus glutinosa)*	3	1	2	W	M	2	2	2	P/M	2
Wild service tree *(Sorbus torminalis)*	3	3	2	I	N	1	2	1	M	2
Service tree *(Sorbus domestica)*	3	3	2*	I	N	1	2	1	M	2
European silver fir *(Abies alba)*	1	2	3	W	M	3	3	2	P	1
Norway spruce *(Picea abies)*	1	1	3	W	M	3	3	3	P	1
Scots pine *(Pinus sylvestris)*	1	1	3	W	M	3	3	3	P	1
European larch *(Larix decidua)*	1	2	3	W	M	3	2	2	P	2
Douglas-fir *(Pseudotsuga menziesii)*	1	1	3	W	M	2	3	2	P	2
Yew *(Taxus baccata)*	3	3	1	W	F/N	1	2	1	M	3

**regionally specific*
grey shaded: recommended tree species

	Status of endangering	Rarity	Economic significance	Pollination	Seed dispersal	Availability of primary data	Markers	Representativity of plots	Share relevance for the stand	Priority
Sycamore maple *(Acer pseudoplatanus)*	1	2	2-3*	W	F	1	3	2	M	3
European beech *(Fagus sylvatica)*	1	1	3	W	F/N	3	3	3	P	1
Oak *(Quercus spec.)*	1	1	3	W	F/N	3	3	3	P	1
Wild cherry *(Prunus avium)*	2	2	2	I	F/N	1	2	1	M	3
Small-leaved linden *(Tilia cordata)*	2	2	2	I	M	1	2	1	M	3
Wild apple *(Malus sylvestris)*	3	3	1	I	N	1	2	1	M	3
Wild pear *(Pyrus pyraster)*	3	3	1	I	N	1	2	1	M	3
Black poplar *(Populus nigra)*	3	3	1	W	F	1	3	1	M/P	2
Elm *(Ulmus spec.)*	3	3	1	W	M	1	2	1	M	3
European ash *(Fraxinus excelsior)*	1	1	2	W	M	1	3	1-2	M	3
Birch *(Betula spec.)*	1	1	2	W	F	1	1	2	M	3

KONNERT et al. 2011 / BLAG-FGR 2004 proposed FGM I & V

Tab. 1 - Indicators and verifiers of the genetic processes. (P): number of polymorphic loci; (A/L): mean number of alleles per locus; (F-value): fixation index.

Indicators	Verificators
Level of genetic variation	Gene frequencies, genetic diversity, P, A/L, variation in phenological parameters, F-value, Number of potential parent trees
Directional change in gene or genotypic frequencies	Differences between cohorts: - in allele, genotype and phenotype frequencies, - in the distribution of age classes
Changes in mating system processes	Mating system, rate of cross-fertilization, rate of biparental inbreeding, number of effective pollen donors, proportion of empty/full seed and germinability
Gene migration between populations	Dispersion of pollen and seeds, differentiation between populations of the same age, isolation, family structures

Overview of proposed indicators

Author	No. of indicators	No. of verifiers
NAMKOONG et al. 1996	4	18
NAMKOONG et al. 2002	4	21
KONNERT et al. 2011 / BLAG-FGR 2004	4	18 (*Fagus sylvatica*) 14 (*Prunus avium*)
ARAVANOPOULOS 2011	3	7
EUFORGEN (ARAVANOPOULOS et al. 2015)	2	11
GRAUDAL et al. 2014	28	-

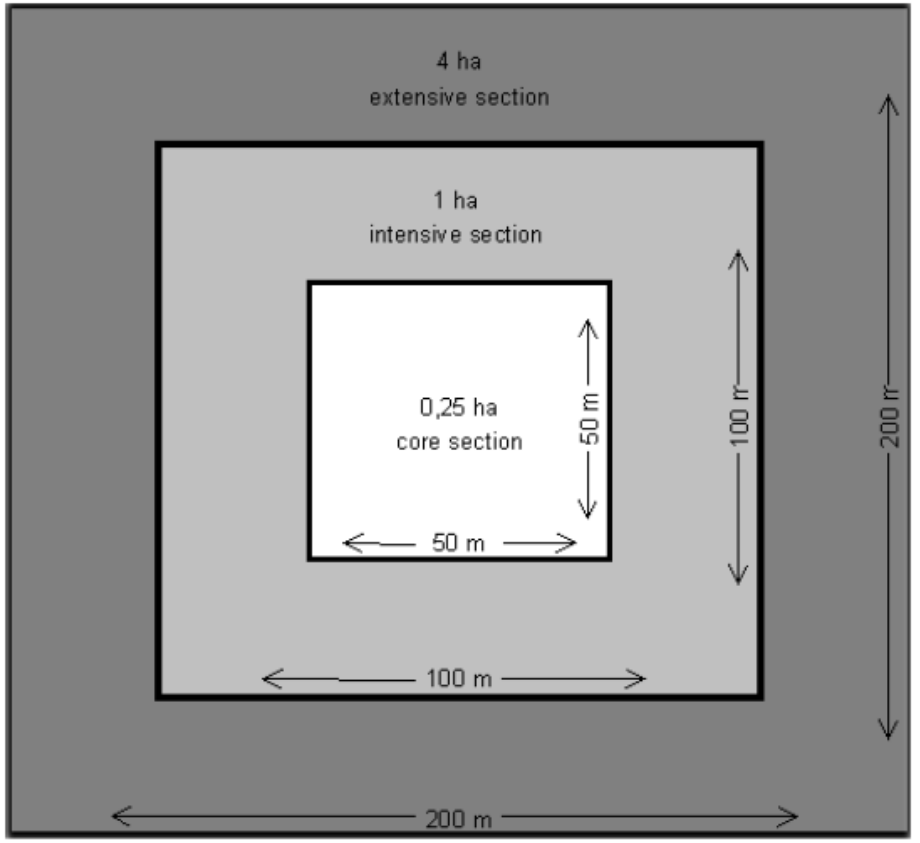
The indicators proposed in current theoretical concepts (NAMKOONG et al. 2002; ARAVANOPOULOS 2011; BLAG Expert Group 2004) and put into practice for two species in Germany (KONNERT et al. 2011) refer to state indicators describing demographic and genetic conditions of selected populations.

KONNERT et al. 2011 / BLAG-FGR 2004 proposed experimental beech FGM plots design

A total area of 4 ha

- central part of 50 x 50 meters ("**core section**", 0.25 ha);
- surrounded by a square of 100 x 100 meters which is called the "**intensive section**" (1.0 ha);
- 200 x 200 meters is delimited which is called the "**extensive section**" (4.0 ha).

Sampling of adult trees, natural regeneration and seeds was performed within these different zones at different intensities.



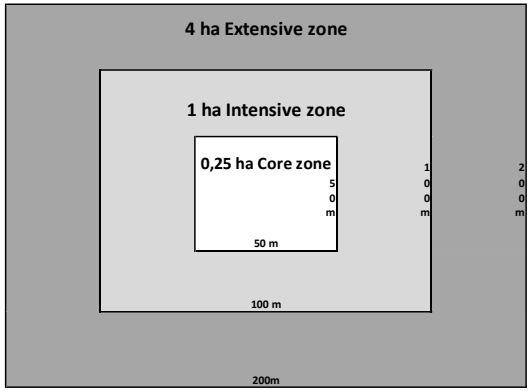
- core zone/intensive/extensive zone
- core zone fenced as in ICP-level II plots

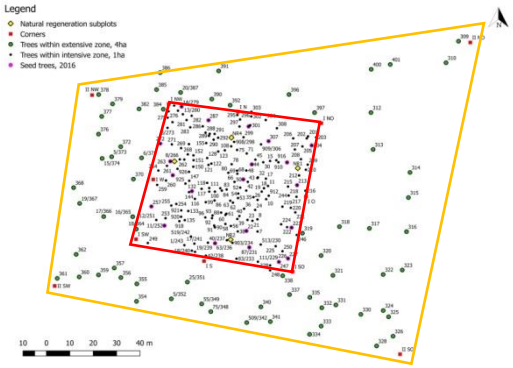
ICP Level II / Waldklimastationen, Bavaria (0,25 ha)

(Foto: A. Kühn, LWF)

Overview of the sampling procedure in *Fagus sylvatica* FGM plots

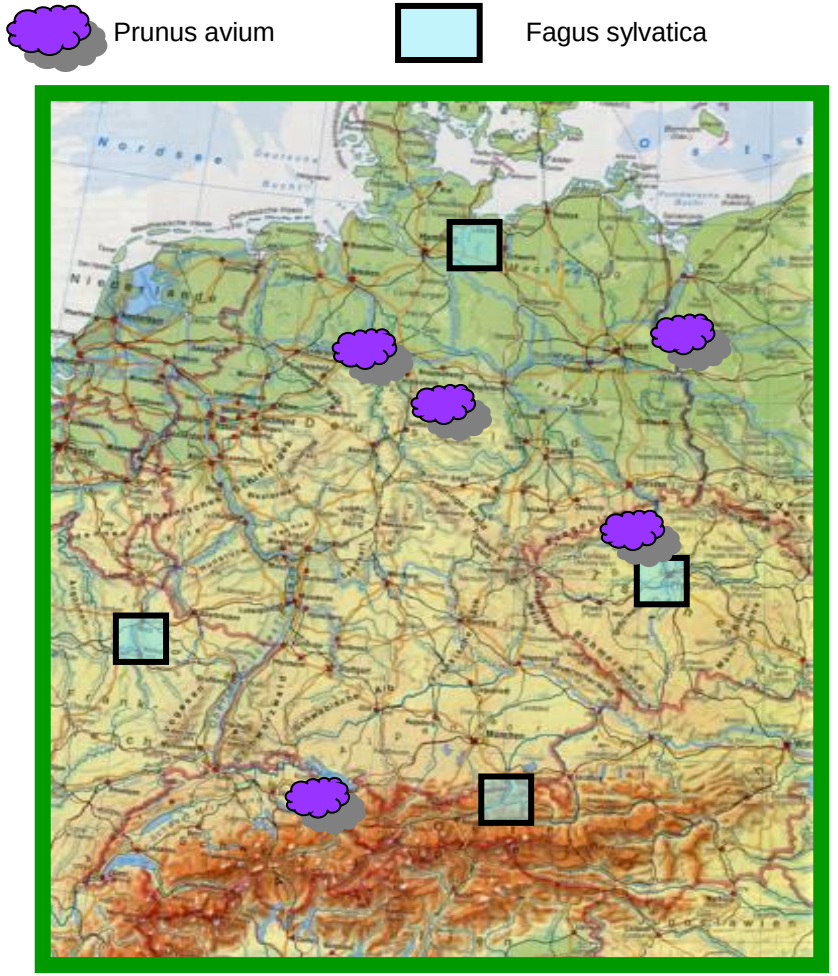
Development state	Intensive section including core section	Extensive section
Genetic Studies		
adult trees	all individuals present	additional individuals up to max. 300
natural regeneration	200 young plants representative for the overall plot	
	4 clusters of natural regeneration comprising 50 individuals each	
beechnuts seeds	from 20 adult trees beechnuts were collected separately	
Quality structure of beechnut seeds		
beechnuts seeds	seed mixture of the overall stand	





First pilot study in Germany conducted on:

- **European beech** *(Fagus sylvatica)* as an important predominant wind-pollinated species (Maurer et al. 2008);
- 4 beech stands located in north (N), east (E), central (C) and south (S) of Germany.
- **Wild cherry** *(Prunus avium)* as a rare species pollinated by insects (Degen et al. 2008);
- 5 wild cherry stands located in north (N), north-east (NE), east (E), central (C) and south (S) of Germany.



Localization of the experimental plots

Experimental wild cherry FGM plots

- Because of its low density, the plot size for *Prunus avium* was defined as the area that includes 150 reproductive trees.
- The size of wild cherry plots varied from 0.6 ha to 18.1 ha.
- Seeds were collected from at least 30 trees within each plot.
- In each plot 150 saplings were sampled in a statistically representative way over the whole area.
- The spatial position, diameter, natural social class, and flowering phenology for of the reproducing trees were measured and the quality of seeds was tested.

- First results in Konnert et al. 2011
- Variation in genetic diversity of European beech seed from different reproductive years (2006 VS 2016) and its importance for FOREST GENETIC MONITORING (**XXV IUFRO World Congress 2019, Brasil**)

Research Article - doi: 10.3832/ifor0571-004 ©iForest - Biogeosciences and Forestry

Collection: IUFRO RG 7.01 (2010) - Antalya (Turkey)
Adaptation of Forest Ecosystems to Air Pollution and Climate Change
Guest Editors: Elena Paoletti, Yusuf Serengil

Genetic monitoring in forests - early warning and controlling system for ecosystemic changes

Konnert M [1], Maurer W [2], Degen B [3], Kätzel R [4]

(1) Bayerisches Amt für forstliche Saat- und Pflanzenzucht, Forstamtsplatz1, D-83317 Teisendorf (Germany); (2) Forschungsanstalt für Waldökologie und Forstwirtschaft Rheinland-Pfalz, Schloss, D-67705 Trippstadt (Germany); (3) Institut für Forstgenetik des von Thünen-Instituts, Sieker Landstrasse 2, D-22927 Großhansdorf (Germany); (4) Landesforstanstalt Eberswalde, Fachbereich Waldentwicklung und Monitoring, Alfred-Möller-Strasse 1, D-16225 Eberswalde (Germany).

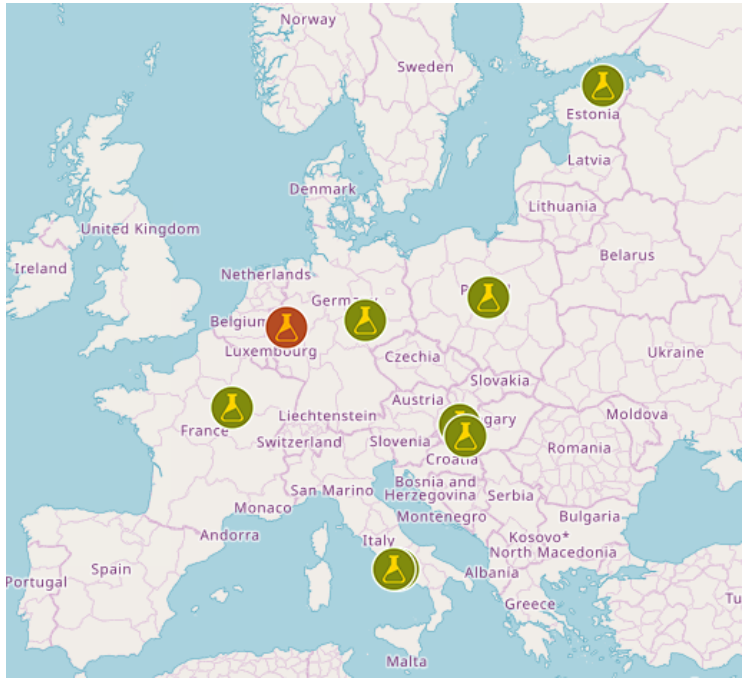
@ Monika Konnert
(monika.konnert@asp.bayern.de)

Material:

- *Fagus sylvatica* stand 120 years old
- Seeds collected from trees by climbing
- 20 seed trees in 2006 and 2016
- 20 seeds per seed tree
- genotyping based on 16 nSSR loci

EU projects with focus on FGM - FORGER

- **FORGER** Towards the Sustainable Management of Forest Genetic Resources in Europe (March 2012 – February 2016)
- Conducted a pilot study on genetic monitoring of four European forest species (*Fagus sylvatica, Quercus robur, Picea abies and Pinus pinaster*).
- In each plot, adults, seedlings and seeds were sampled and genetically analysed at two types of molecular markers (SSR and SNP).
- Spatial configuration of stands, demographic parameters and geographic position were analysed together with genetic parameters to find correlates of genetic diversity.
- Proposed FGM protocols.



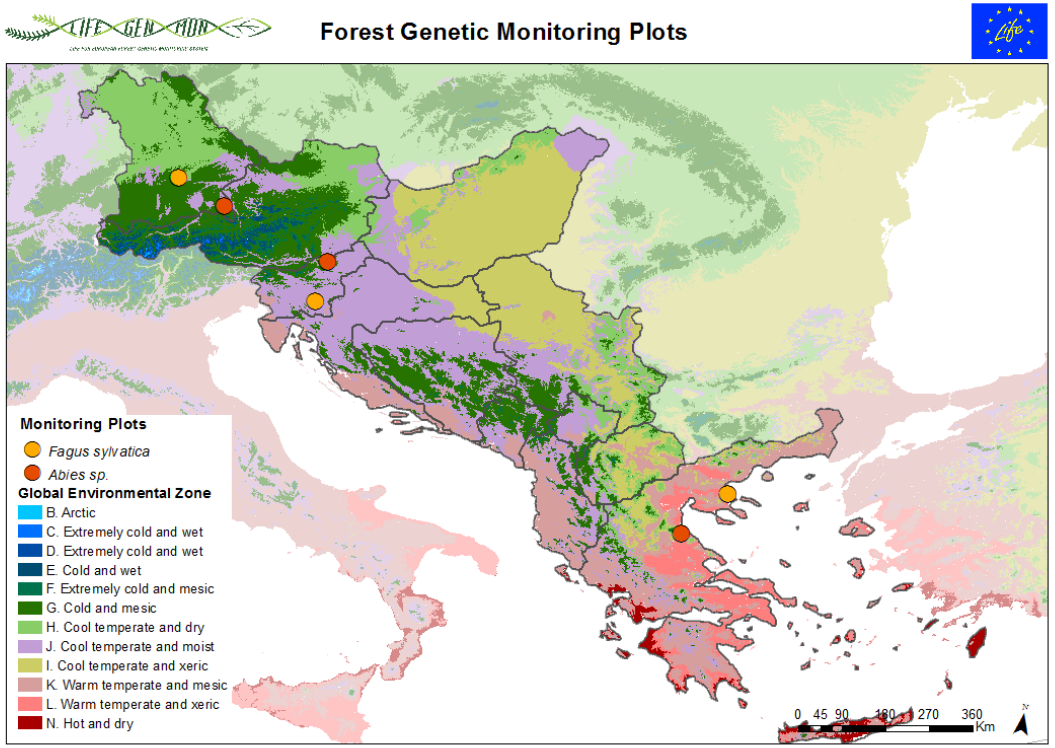
EU projects with focus on FGM - GENTREE

- **GenTree** – Optimizing the management and sustainable use of forest genetic resources in Europe (March 2016 – February 2020)
- Partners: 22 public and private research organizations and enterprises
- WP1 – Test strategies and methods for monitoring the network of *in-situ* dynamic genetic conservation units (DCUs) and *ex-situ* collections, and propose strategies for their implementation in everyday forestry
- Task 1.4 installed FGM network for four tree species (*Fagus sylvatica, Populus nigra, Pinus sylvestris and Taxus baccata*) across Europe
- In total 20 populations (GCUs or proposed GCUs) included in order to test an affordable and uniform monitoring system for forest gene conservation purposes in Europe.
- The monitoring scheme used three different indicators: A) selection B) level of genetic variation and C) mating system and including a species-purity–check.

EU projects with focus on FGM - LIFEGENMON

LIFE FOR EUROPEAN FOREST GENETIC MONITORING SYSTEM

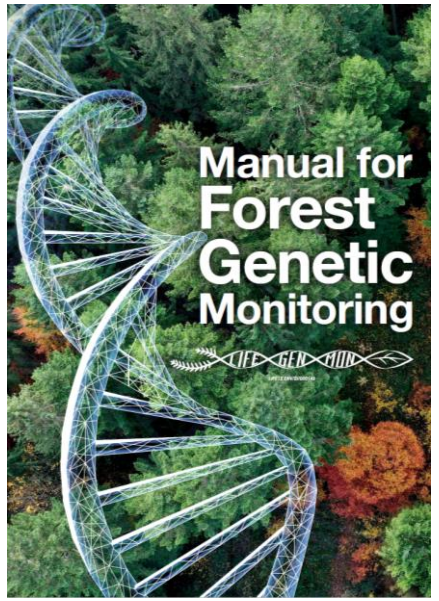
- **LIFEGENMON** - LIFE for European Forest Genetic Monitoring System (July 2014 - June 2020)
- 6 partner institutions in 3 countries SLO, DE, GR (SFI, AUTH, AWG, SFS, CNVOS, GDDAY-DAMT)
- Two target tree species: *Abies alba/Abies borisii-regis and Fagus sylvatica*
- 6 FGM plots (3 plots per *spp.*)
- The main aim of the LIFEGENMON project was to develop a system for FGM to serve as an early-warning system to aid in the assessment of a species' response to environmental change on a long-term temporal scale.



The aims of **LIFEGENMON project (1)**:

LIFE FOR EUROPEAN FOREST GENETIC MONITORING SYSTEM

1. To **define optimal indicators and verifiers** for FGM.
2. To prepare **guidelines for forest genetic monitoring.**
3. To prepare a **Manual for Forest Genetic Monitoring** for implementation at the EU level.
4. To prepare a **Decision support system** for an optimal choice of the level of forest genetic monitoring based on needs and means.



The aims of **LIFEGENMON project (2)**:

5. To organize series of **workshops/trainings for the forestry sector.**

6. To prepare **background professional documents/guidelines for policy makers** at the national, regional and the EU level.

7. **To discuss and disseminate** the FGM among different target audiences and stakeholders.

8. To establish a **well functioning internationally linked team of forestry professionals** working in and for forest genetic monitoring.

Overview:

- FAO (Namkoong et al. 1996, 2002)
- EUFORGEN (Aravanopoulos et al. 2015)

Discussions: Aravanopoulos FA 2011, Graudal et al. 2014, Aravanopoulos FA 2016, Fussi et al. 2016, etc.

Testing and implementation:

- Pilot study in Germany (Konnert et al. 2011)
- FORGER (March 2012 – February 2016)
- GENTREE (March 2016 – February 2020)
- LIFEGENMON (July 2014 - June 2020)

Project GenMon

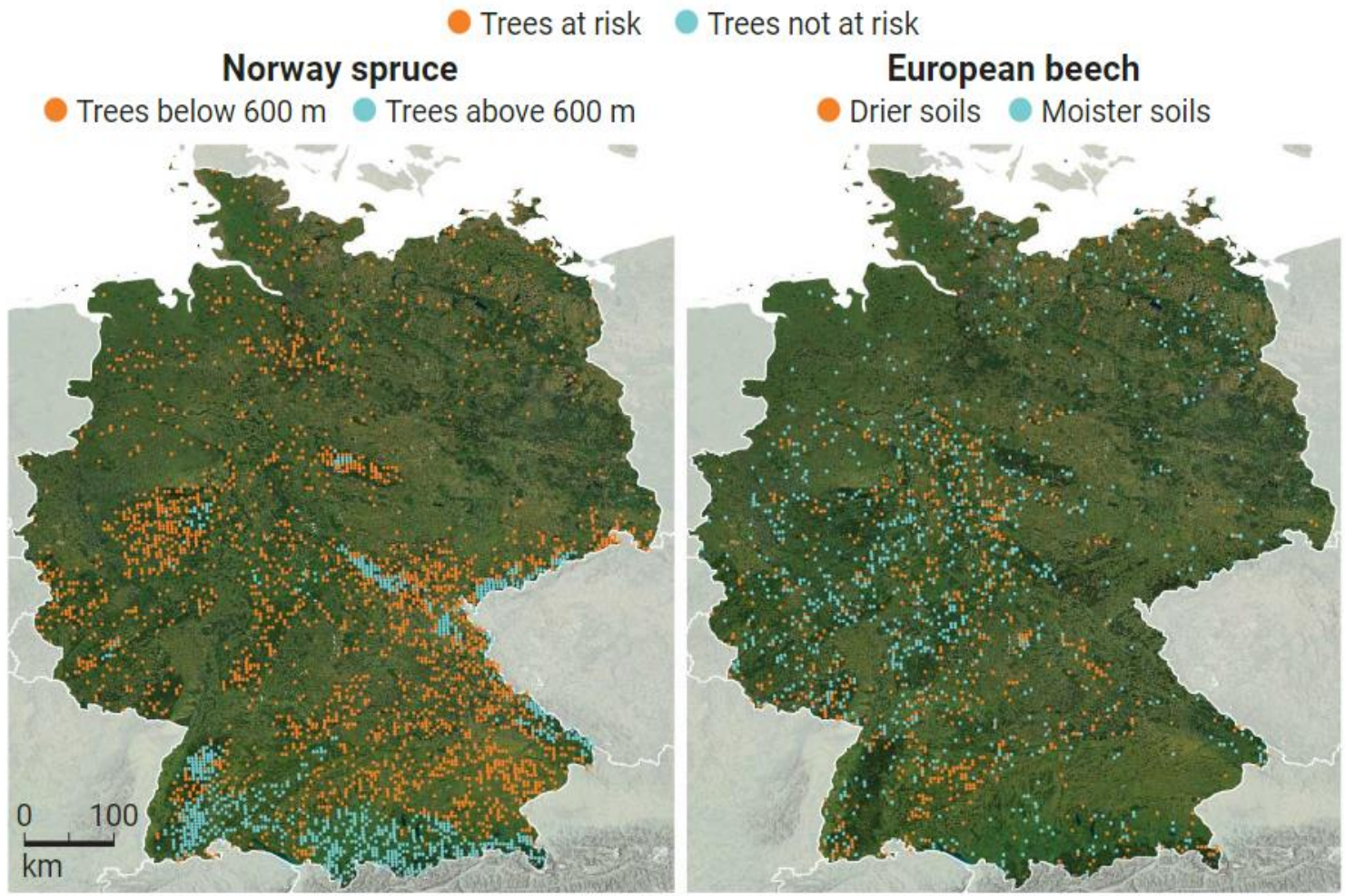
1. Bayerisches Amt für Waldgenetik (AWG)
2. Forstliche Versuchsanstalt Baden-Württemberg (FVA)
3. Landesbetrieb Forst Brandenburg, Landeskompetenzzentrum Forst Eberswalde (LFE)
4. Landesforst Mecklenburg-Vorpommern, Betriebsteil Forstplanung, Versuchswesen, Forstliche Informationssysteme
5. Nordwestdeutsche Forstliche Versuchsanstalt (NWFVA), Abteilung C – Waldgenressourcen
6. Forschungsanstalt für Waldökologie und Forstwirtschaft (FAWF), Ref.6.1 FB Nachhaltige Waldbewirtschaftung, FG Waldwachstum & FG Forstliche Genressourcen & Forstliches Genressourcenzentrum (FoGZ)
7. Staatsbetrieb Sachsenforst, Kompetenzzentrum Wald und Forstwirtschaft
8. Thüringen Forst, Forstliches Forschungs- und Kompetenzzentrum Gotha (FFK Gotha)
9. ISOGEN am Institut für Forstgenetik der Universität Göttingen
10. Thünen-Institut für Forstgenetik

Overview

- **GenMon** project – 10 partner institutions
- From June 2016 – March 2020
- Aim - The establishment of a Germany-wide FGM network
- 14 plots for beech (*Fagus sylvatica*) and 10 plots for Norway spruce (*Picea abies*) have been established, sampled and analyzed
- Genetic analysis were done on old trees, NR and seeds + seed testing (ISTA 2020)
- 16 nSSR for the DNA analyses
- Phenology observations (flushing, flowering intensity and fructification) + vitality were observed according to standardized procedures.

Stress maps

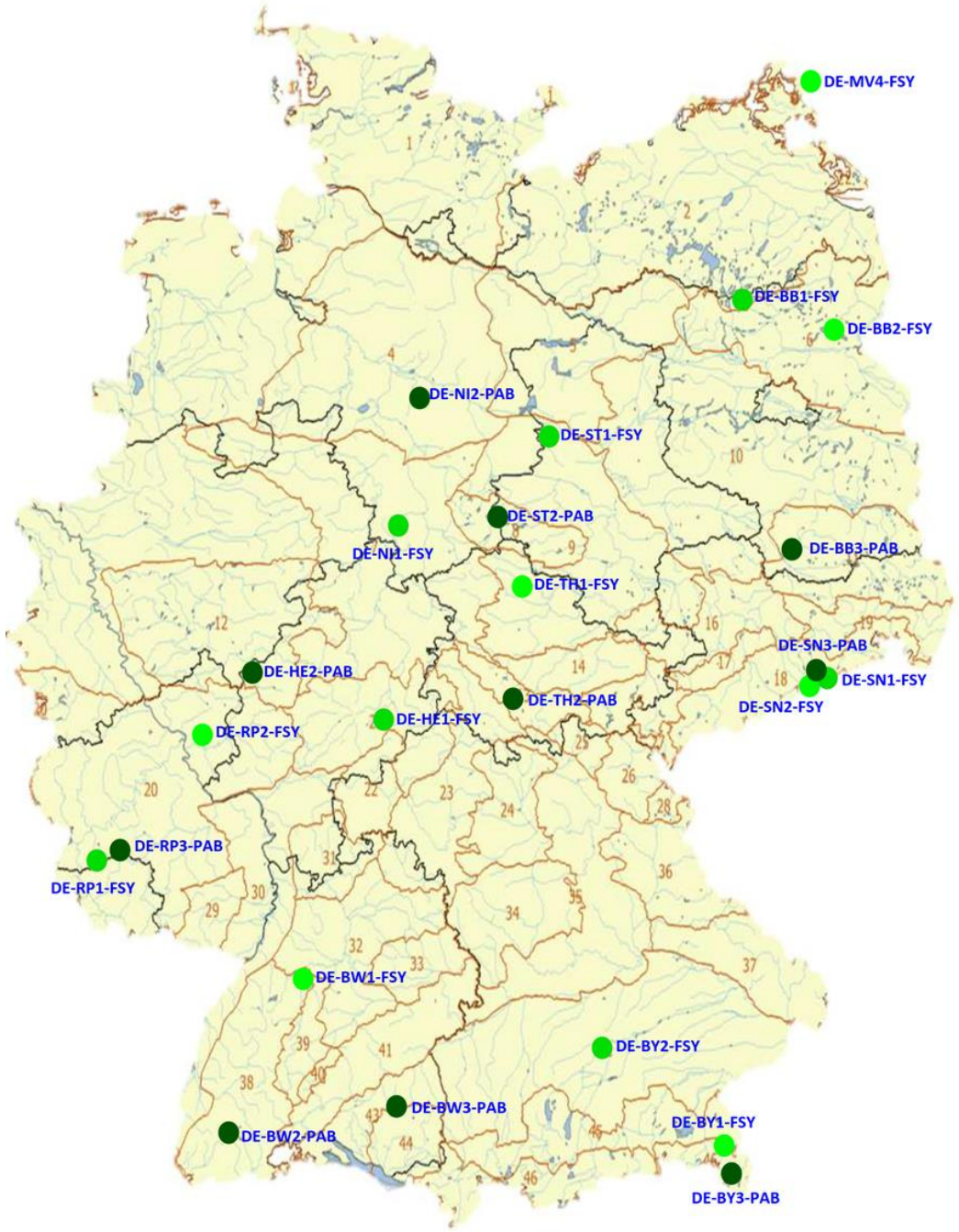
A rapidly shifting climate has made many of Germany's most important trees vulnerable to various threats, projections show. Droughts, which are predicted to become more severe, are expected to make Norway spruce growing in lower, warmer areas vulnerable to bark beetle attacks (left). A drier climate also threatens European beech trees growing in soils with less capacity to store water (right).



(GRAPHIC) K. FRANKLIN/*SCIENCE*; (DATA) ANDREAS BOLTE/THÜNEN INSTITUTE OF FOREST ECOSYSTEMS

Source: https://www.science.org/content/article/germany-s-trees-are-dying-fierce-debate-has-broken-out-over-how-respond

Source: https://www.gen-mon.de/monitoringfl%C3%A4chen/



FGM plots in Germany

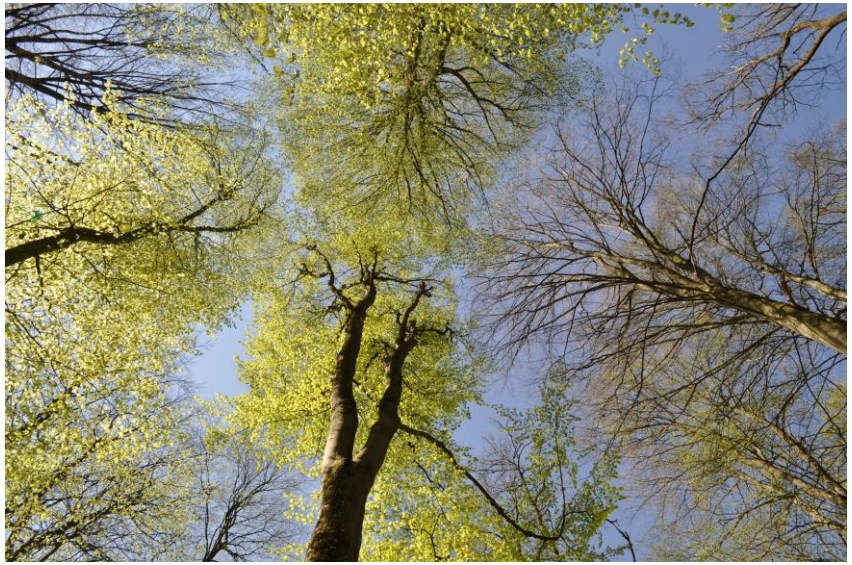
14 plots for beech (*Fagus sylvatica*)
10 plots for Norway spruce (*Picea abies*)

- Ökologische Grundeinheiten - Basic ecological units
- FSY The altitude was taken into account by selecting plots from lower altitudes (approx. 75 m) to the higher altitudes of the Alps (over 1,000 m). Stands in different sites – a good representativeness of beech in Germany.
- PAB The altitude was taken into account by selecting plots from lowlands (approx. 50 m) to montane to high-montane sites of the Harz Mountains and the Alps (approx. 1,100 m).

GenMon

Fagus sylvatica FGM plots

- 14 FGM plots in Germany
- Four of these plots are integrated into an international permanent forest monitoring network (ICP Level II plots)
- The WKS are each located on a fenced area of 50 x 50 metres. They are identical to the GenMon core area.
- On the other monitoring plots, climate parameters are collected via data loggers.
- All plots are located in the State forests.
- 13 beech stands have emerged from natural regeneration.



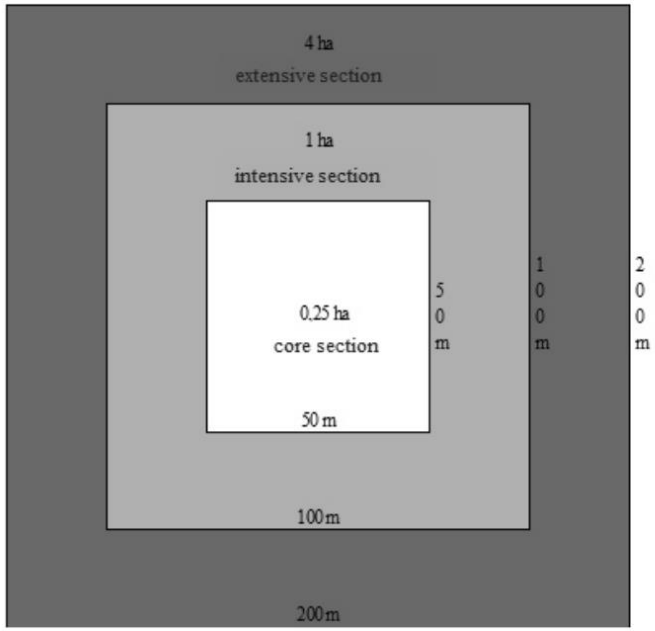
Picea abies FGM plots

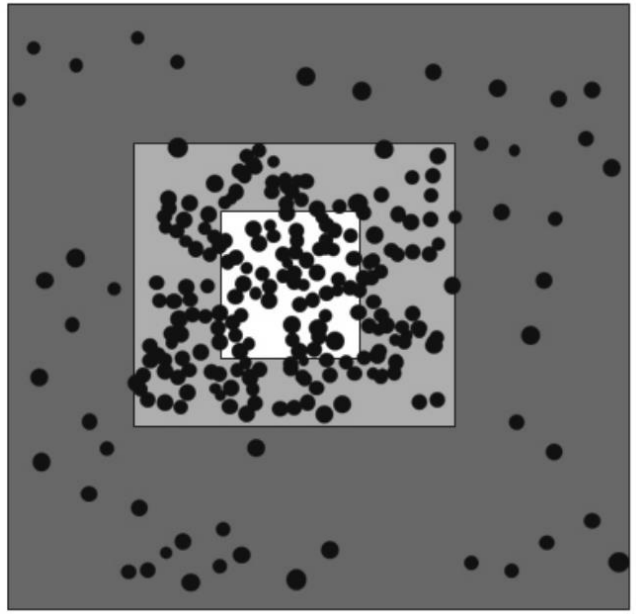
- Norway spruce: 10 FGM plots, established in 2017.
- Managed and unmanaged forests were included into the FGM network.
- Two areas are integrated into the ICP Level II permanent monitoring network.
- All areas are located in the State forests.
- Combined natural regeneration and planting.
- The trial sites represent the broad site amplitude of this tree species.

Sampling design within GENMON project

Development state	Intensive section including core section	Extensive section
Genetic studies		
Adult trees	All individuals present	Additional individuals up to 250
Natural regeneration	200 young plants representative for overall plot	
	4 clusters of natural regenerations comprising 50 individuals each	
Seeds	Single tree collections of seeds from 20 adult trees	
Qualitiy structure of seeds		
Seeds	Seed mixture from entire stand area	

1050 samples per FGM plot, in total more than 25 000 samples!!!





Source: Schmiedel J, Tröber U, Wolf H, Fussi B, Kunz M (2017) GenMon - Implementation of a Genetic Monitoring System in European Beech (*Fagus sylvatica* L.) and Norway Spruce (*Picea abies* [L.] Karst.) Populations in Germany. In: Degen B, Krutovsky KV, Liesebach M (eds) (2018) German Russian Conference on Forest Genetics - Proceedings - Ahrensburg, 2017 November 21-23. Braunschweig: Johann Heinrich von Thünen-Institut, Thünen Rep 62, S. 76-81.

GENMON project Outlook (1)

- Results represent a “snapshot” of the current condition of the investigated populations.
- To display the dynamics of the genetic system and its processes over time it is necessary to repeat certain investigations periodically.
- **Seed sampling every 4 years** (if fructification is sufficient) and **actualizing the list of adult trees** and **new sampling of natural generation every 10 years**.
- The re-estimation/re-examination of the selected indicators and verifiers allows a review of the suitability of FGM as an early warning system for ecosystem changes.
- It should reveal reactions of the genetic system to influences of a changing environment and enlighten our understanding about mechanisms of evolutionary reactions of tree populations.

GENMON project Outlook (2)

- Final “GenMon” project conference (3.3.2020, Freising, Germany) and first FGM results displayed the necessity for continuation of FGM.
- Communication and discussions with representatives from Bavarian Ministry of Food, Agriculture and Forestry showed strong support for the already established FGM system.
- It was agreed, that all now established FGM plots should be maintained and regularly assessed.
- In addition, new target tree species (e.g. *Abies alba, Quercus robur, Prunus avium, Pinus sylvestris,* etc.) should be selected and included into FGM network (BLAG 2004).
- Endangered (*Fraxinus excelsior*) and introduced tree species (*Abies grandis, Pseudotsuga menziesii*) were also discussed to be included into the German FGM network.

GENMON project Outlook (3)

- Further FGM plot maintenance and field data collection falls on each Federal State within The Federal Republic of Germany.
- FGM coordination, data analysis, decisions for actions and recommendations for practitioners should be organised by a coordinating institution and the BLAG group.
- Existing FGM actions in Germany and other countries confirm the importance of the topic and show a clear need and mandate for forest genetic monitoring (FGM), especially under CC when monitoring the adaptiveness of trees, stands, and ecosystems is of paramount importance.
- Specific attention should be designated to communication with society and decision makers/politicians to ensure continuity of FGM through permanent financial support.

GenMon Projektflyer (Stand 10/2019)

GenMon Projektflyer
GenMon - Entwicklung eines genetischen Monitorings für Rotbuche und Fichte in Deutschland
GenMon - Projektflyer_2019b_AWG.pdf
Adobe Acrobat Dokument [8.3 MB]

Download

POSTERBEITRÄGE

GenMon-Posterbeitrag auf IUFRO-Tagung 2017 in Freiburg

GenMon-Posterbeitrag IUFRO 2017
Titel: Installation of a genetic monitoring network for beech and spruce in Germany to evaluate the genetic adaptability of species to climate change.
Poster_GenMon.pdf
Adobe Acrobat Dokument [2.2 MB]

Download

GenMon-Posterbeitrag auf FOWITA 2018 in Göttingen

Bewertung der genetischen Anpassungsfähigkeit von Buche und Fichte im Klimawandel
Kunz M, Liesebach H, Eusemann P, Becker F, Coker A, Fussi B (2018) Bewertung der genetischen Anpassungsfähigkeit von Buche und Fichte im Klimawandel. In: Ammer C, Bredemeier M, Arnim G von (eds) FowiTa : Forstwissenschaftliche Tagung 2018 Göttingen ; Programm & Abstracts ; 24. bis 26. September 2018. Göttingen: Univ Göttingen, Fakultät für Forstwissenschaften und Waldökologie, p 41
Poster_GenMon_FOWITA-gr.pdf
Adobe Acrobat Dokument [2.3 MB]

Download

Posterbeitrag auf der 6. Tagung der Sektion „Forstgenetik /

https://www.gen-mon.de/

GenMon

darius.kavaliauskas@awg.bayern.de
darius.kavaliauskas@vdu.lt