Trans-national collaboration in tree breeding and use of forest reproductive material (FRM)

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Meeting HealGenCar

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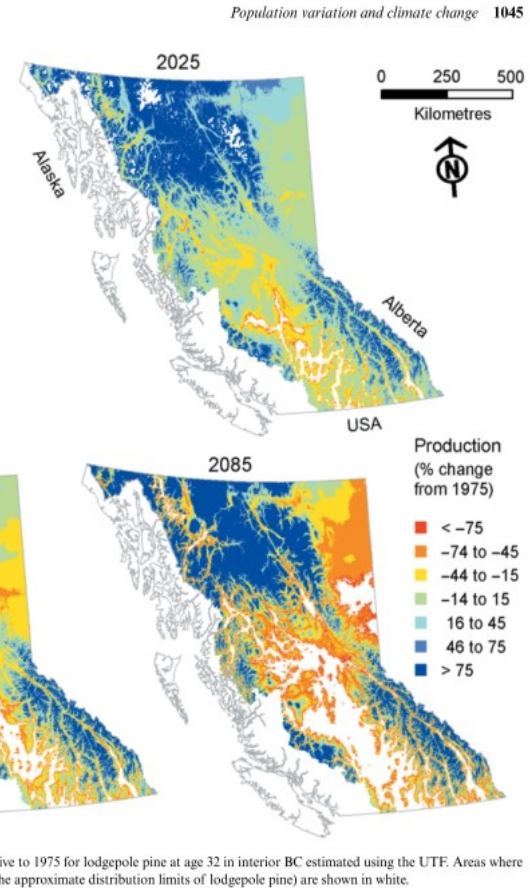
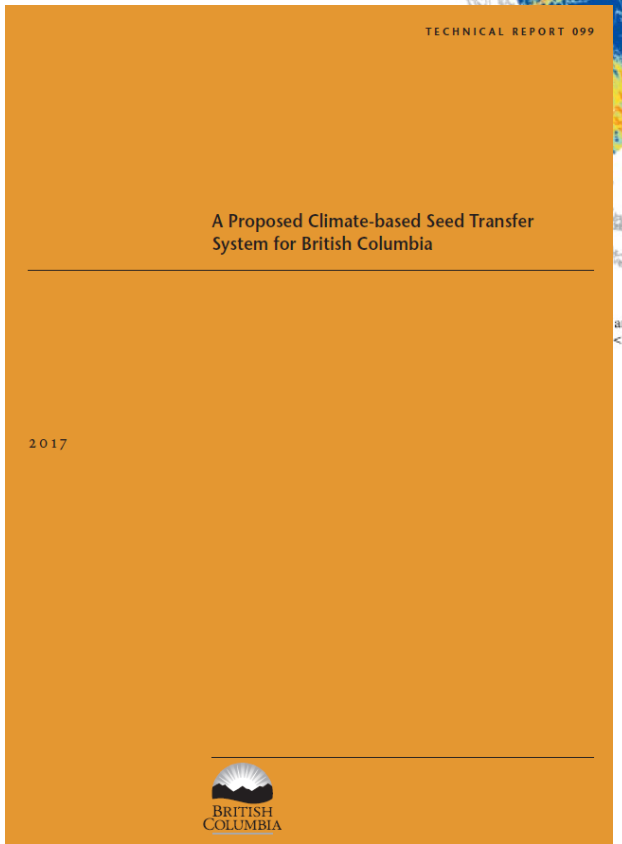
SKOGFORSK

Why 1 – Climate change matters

- Affects adaptive properties (growth rhythm).
- Affects production potential
- Important to know reaction patterns in clones/populations/FRM

- Climate adapted breeding programmes and deployment platforms.





(O'Neill et al, 2008)

Why 2 – Increased efficiency in Breeding programs

- More sites and climatic conditions for testing genetic material (not found within the country).
- Joint analysis with more genetic material can increase BV estimation and selection efficiency.
- Coordination and learning. Using knowledge from other research organizations.
- More genetic material may be available (e.g. if unknown calamitites occur).
- Opportunities to develop joint breeding efforts for ”smaller” species with less resources.

Why 3 – Nordic/Baltic market for FRM

- A joint and coordinated platform for evaluation and ranking allows trans-national use of FRM.
- This can relieve shortages of seed/plant supply of improved material for certain regions, if surplus exists in neighboring countries.
- The likely use of more different FRMs will lead to a higher genetic diversity on the landscape level (risk management by diversification).

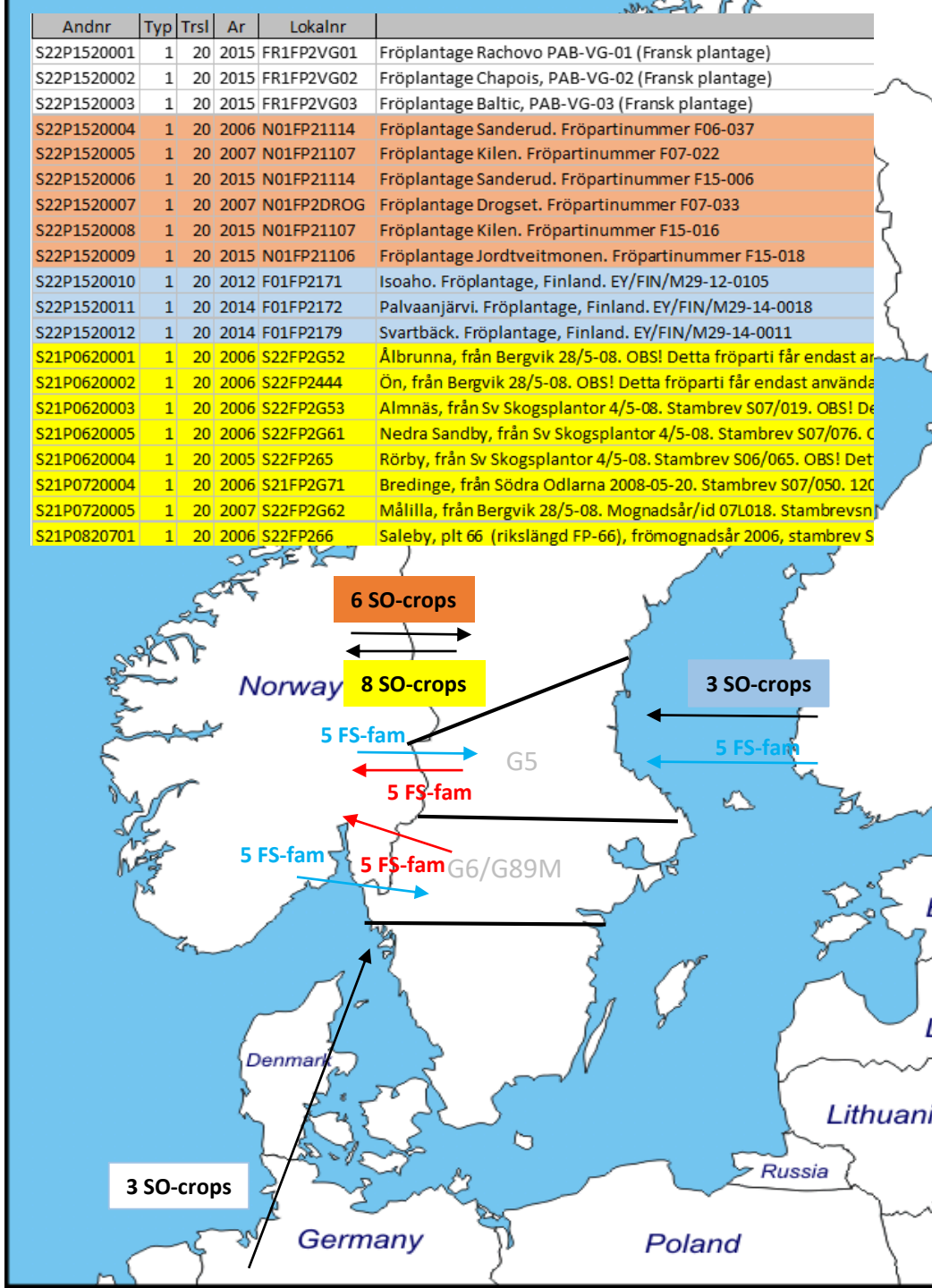
How 1 – Collaboration in operative breeding

- By developing genetic connectivity between operative tree breeding field trials across borders. ”Bridging material”.
- Include relevant check-lots in the field trials (e.g. standard set of stand seed and seed orchard crops).
- Standardization in data management (databases, field measurements) and analysis.
- Long-term commitment a pre-requisite.

Example – Norway spruce

- Exchange of material 2015/2016.
- Sweden, Norway and Finland
- Both ”bridging” material and benchmark seed orchard crops.
- Two Swedish breeding populations in two seed zones.
- Sowing of donor plants in spring 2016.

Andnr	Typ	Trsl	Ar	Lokalnr	
S22P1520001	1	20	2015	FR1FP2VG01	Fröplantage Rachovo PAB-VG-01 (Fransk plantage)
S22P1520002	1	20	2015	FR1FP2VG02	Fröplantage Chapois, PAB-VG-02 (Fransk plantage)
S22P1520003	1	20	2015	FR1FP2VG03	Fröplantage Baltic, PAB-VG-03 (Fransk plantage)
S22P1520004	1	20	2006	N01FP21114	Fröplantage Sanderud. Fröpartinummer F06-037
S22P1520005	1	20	2007	N01FP21107	Fröplantage Kilen. Fröpartinummer F07-022
S22P1520006	1	20	2015	N01FP21114	Fröplantage Sanderud. Fröpartinummer F15-006
S22P1520007	1	20	2007	N01FP2DROG	Fröplantage Drogset. Fröpartinummer F07-033
S22P1520008	1	20	2015	N01FP21107	Fröplantage Kilen. Fröpartinummer F15-016
S22P1520009	1	20	2015	N01FP21106	Fröplantage Jordtveitmonen. Fröpartinummer F15-018
S22P1520010	1	20	2012	F01FP2171	Isoaho. Fröplantage, Finland. EY/FIN/M29-12-0105
S22P1520011	1	20	2014	F01FP2172	Palvaanjärvi. Fröplantage, Finland. EY/FIN/M29-14-0018
S22P1520012	1	20	2014	F01FP2179	Svartbäck. Fröplantage, Finland. EY/FIN/M29-14-0011
S21P0620001	1	20	2006	S22FP2G52	Ålbrunna, från Bergvik 28/5-08. OBS! Detta fröparti får endast ar
S21P0620002	1	20	2006	S22FP2444	Ön, från Bergvik 28/5-08. OBS! Detta fröparti får endast använda
S21P0620003	1	20	2006	S22FP2G53	Almnäs, från Sv Skogsplantor 4/5-08. Stambrev S07/019. OBS! De
S21P0620005	1	20	2006	S22FP2G61	Nedra Sandby, från Sv Skogsplantor 4/5-08. Stambrev S07/076. C
S21P0620004	1	20	2005	S22FP265	Rörby, från Sv Skogsplantor 4/5-08. Stambrev S06/065. OBS! Det
S21P0720004	1	20	2006	S21FP2G71	Bredinge, från Södra Odlarna 2008-05-20. Stambrev S07/050. 120
S21P0720005	1	20	2007	S22FP2G62	Målilla, från Bergvik 28/5-08. Mognadsår/id 07L018. Stambrevsn
S21P0820701	1	20	2006	S22FP266	Saleby, plt 66 (rikslängd FP-66), frömognadsår 2006, stambrev S



Example – Norway spruce

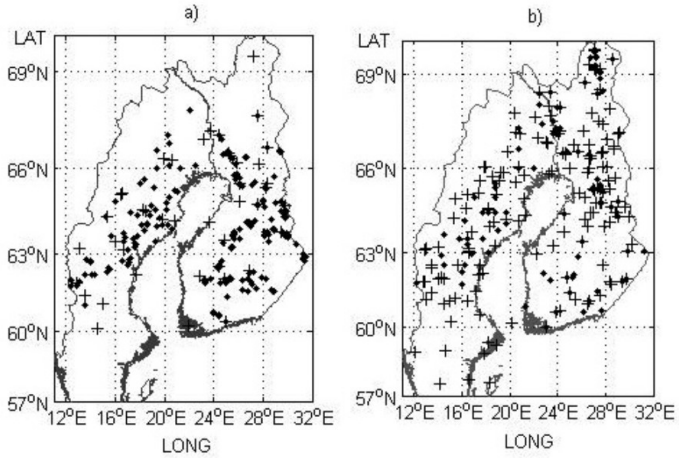
- Field trials with cuttings 2021/2022
- 4 trials per breeding population
- If possible, could be established in neighboring countries with matching breeding zone conditions/photoperiod.

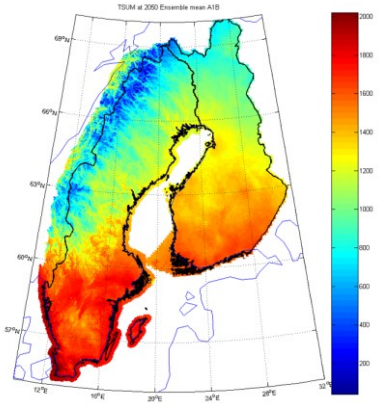
How 2 – Develop joint transfer effect models/deployment recommendations for contemporary FRM

- Use trans-national field and climate data.
- Use provenance and ”check-lot” data to build models and progeny data to test the model.
- Coordination in estimating gentic gain levels and other FRM charateristics (pollen contamination, standardized origin, etc).
- National rules and legislation.
- Implement model platform in decision support tool (Planters guide)

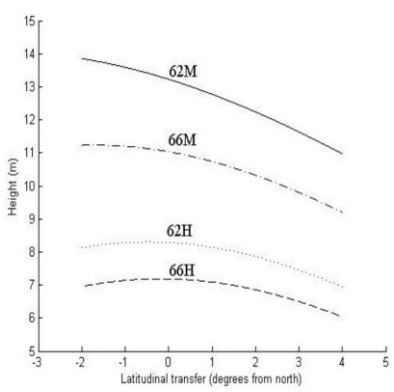
Example – Scots pine models and deployment platform for Sweden and Finland

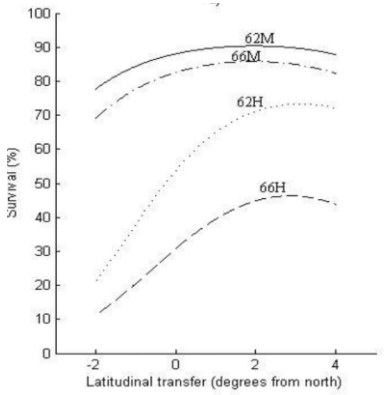
Field and climate data compilation/preparation





Development of models, valid for both countries



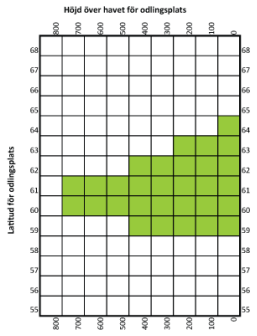


Coordinating SO-charateristics and including national rules/legislation

	Baseline		Selection gain		Selective harvesting		Gain from extra pollen sources		Genetic thinning		Linear deployment	
Category	H	S	H_{tot}	S_{tot}	H_s	S_s	H_{ex}	S_{ex}	H_t	S_t	H_{ld}	S_{ld}
1g	10	0	0	0	A	B	?	?	C	D	0	0
1.25g	10	0	2.5	0	A	B	?	?	C	D	0	0
1.25gS	10	0	0	2.5	A	B	?	?	C	D	0	0
1.5g	10	0	15	0	A	B	?	?	C	D	E	0
1.5gS	10	0	10	5	A	B	?	?	C	D	E	E

Tillåtet användningsområde är grönmarkerat.

Resultat

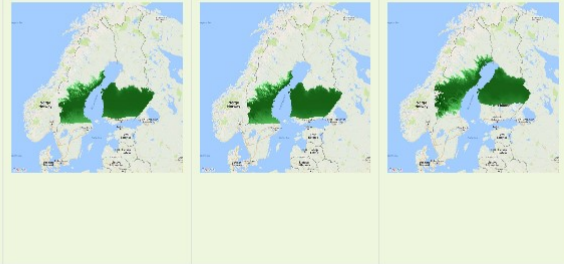


Development of trans-national deployment platform

Seed orchards

No	Name	Country	Ind	Sur	Grow	PC	Lat	
	Local origin		100	73.7	100		62.7	
FP-633	TreO T13 Njuparna	Sweden	122	70.3	129.1	40	62.1	☑
Sv404b	Suhola 2	Finland	122	70.1	129.1	49	62	☑
Sv404a	Suhola 2	Finland	120	70.2	127.1	49	62	☐
FP-629	Nedansjö Elit	Sweden	118	78.9	116.6	40	63.4	☑
FP-621	Västerhus T10	Sweden	118	76.3	118.6	40	63.6	☐
Sv414	Kokko	Finland	116	71.1	121.4	88	62.2	☐
FP-630	Sundsvall Elit	Sweden	116	79.6	113.2	40	63.9	☐
Sv408	Hinkka	Finland	115	62	130.8	68	61	☐
FP-620A	Gnarp T12	Sweden	115	75.5	115.4	40	62.4	☐

Name	TreO T13 Njuparna	Suhola 2	Nedansjö Elit
Country	Sweden	Finland	Sweden
Index	122	122	118



How 3 – Make sure models and deploment recommendations are valid for contemporary and advanced generation improved material.

Transfer effect models are often developed using unselected material (provenance data). Models need to be valid for improved material as well:

- Use existing trial data (with improved material) to validate model performance for contemporary FRM.
- By being pro-active and establish new field trials that can provide relevant data to ensure model validity in the future.

Example – using existing data

- Comparing unselected (provenance stand seed) with selected material (plus-trees).
- By looking at model residuals
- By looking at model interaction terms.

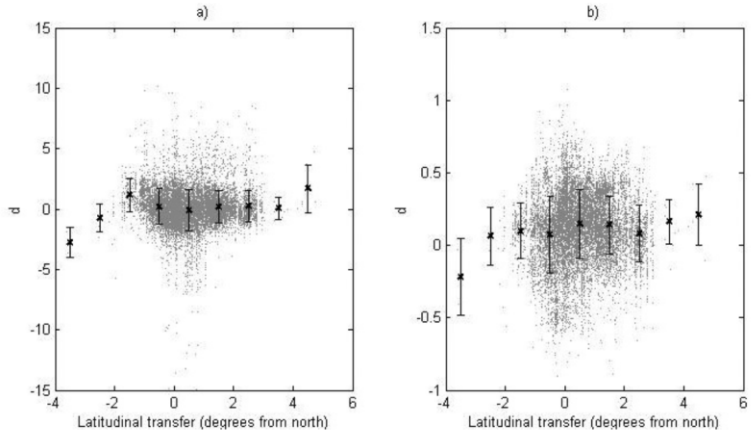
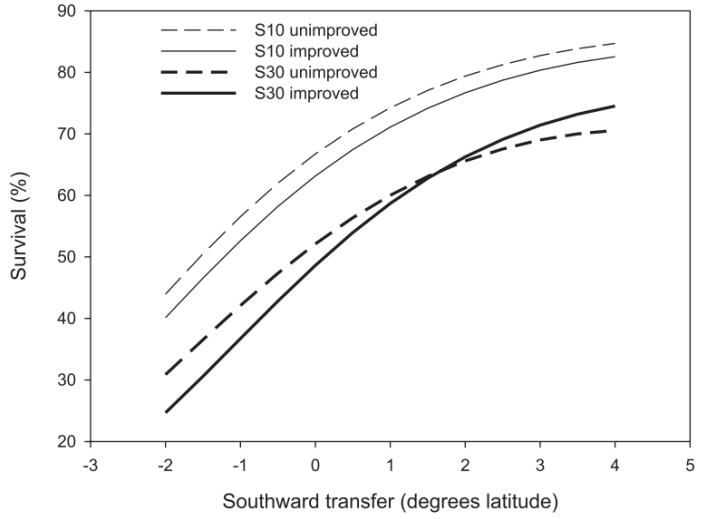


Fig. 5. The deviation, *d*, between the recorded value and the predicted value of (a) the logit transformed survival and (b) the ln-transformed height for the genetic entries in the progeny data. For each latitude class the mean value (black cross) and standard deviation (bars) are given.

(Berlin et al, 2016)



(Andersson et al, 2007)

Example - Establishment of new field trials

For advanced generation genetic material:

- It is possible that reaction patterns are altered (selection of ”generalists”)
- The definition of ”origin” is not obvious.
- Thus, new field data is neccessary for future improved FRM:

1) Through trials specifically designed to investigate transfer effects and reation patterns (plasticity). Could e.g. contain seed orchard crops/bulked cuttings (stand seed as reference?).
2) Realized gain trials to validate the size of the genetic gain (and for demonstration purposes)

Ongoing and planned projects

- Release of the Swedish/Finnish deployment recommendation tool for Scots pine FRM (Planter's guide). During 2017?
- Norway spruce data from the Nordic and Baltic countries has been compiled and pre-analyzed.
- Two PhD-students (one in Sweden and one in Norway) are currently working with related topics.
- Trans-national collaboration and use of improved FRM key in new big EU Horizon-2020 application (B4EST).
- New national applications (e.g. in Sweden,…)

Summary – how can we increase collaboration?

Establish systematic and long-term exchanges of genetic material in the breeding populations.

- Exchange of genetic material has been started Swe/Nor/Fin.

Develop joint transfer effect models and FRM deployment recommendation platforms

- Scots pine for Sweden and Finland is a ”benchmark”

Ensure that FRM deployment platforms are valid also for future generation improved FRM

- New field data will be neccessary.

Challenges

- How to handle ”ownership” of genetic material derived from breeding efforts in other countries? (”Bridging material”)
- Obstacles when establishing field trials in other countries (transfer of plants, establishment methods, ”trial management”,…)
- Handling pedigree and field assessment practices.
- Long-term commitment.
- Trade-offs and coordination when developing joint FRM deployment platforms (various calculations/assupmtions; national rules).
- Where to find resources to develop and establish new field trials?

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