Ecological evaluation of clonal forestry with cutting-propagated Norway spruce

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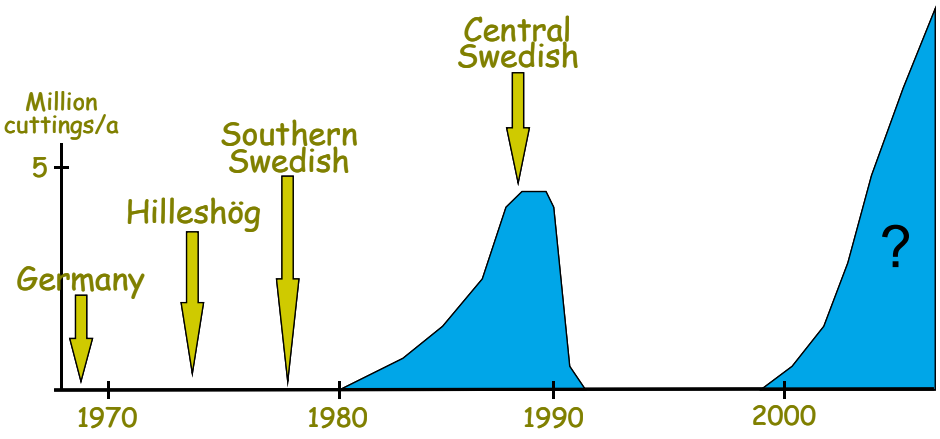
- The study was requested by a number of Swedish forestry companies in connection to a revision of the Swedish FRC standard.
- All comparisons with the situation in our managed forests.
- Follow-up to report by *D. Lindgren et al.*. from 1990
- Not always a clear distinction between tested clones and bulk propagated materials
- ISBN 1103-6648.

Spruce cuttings in Sweden



- So far most plantations with tested clones, but bulk-propagation becoming more and more common
- Don't get the impression that cuttings are very common. We plant some 300 million seedlings per year in Sweden

Legal restrictions

Country		Testing period	Minimum number of clones in mixture
Sweden	S2	9 years	29
	S1	6 years	40
	S0	Nursery	67
Finland	C1	12 years	4
	C2	7 years	11
	C3	Nursery	33
Norway		Not defined	30 eller 50/ha
Denmark		Clones should not be used	
Germany		Not defined	500
Outher countries			

- This type of restrictions a clear indication that there is a public concern
- I will not go through the entire report which will available for the participants at the end of the presentation. I will just briefly mention a little about some of the issues which have caused much of the opposition to clonal plantations and vegetative propagation): 1. Clones are seen as something unnatural, something men create. 2. There is no variation in clonal plantations. 3. Clonal plantations are particularly harmful to the environment in which they are established.

Table 2. Genotypic diversity of some clonal species in nature (after Widén *et al.*, 1994). A—Number of populations investigated; B—Mean number of genotypes per population and (range); C—Percentage of genotypes confined to one population; D—Percentage of genotypes found in >75% of the populations.

Species	A	B	C	D
Alnus incana	4	5	0	100
Agrostis stolonifera	6	7.5 (1-15)	98	0
Antennaria rosea	63	3.5 (1-11)	89	0
Betula glandulosa	9	3 (1-5)	53	0
Erigeron annuus	3	14 (13-15)	12	59
Filipendula rubra	25	5.5 (1-15)	99	0
Glechoma hederacea	4	34.8 (15-98)	100	0
Oenothera biennis	44	1.5 (1-5)	76	0
Oenothera laciniata	60	6.5 (1-16)	58	1
Populus tremuloides	7	31.7 (30-40)	100	0
Pteridium aquilinum	4	24.8	100	0
Rubia peregrina	3	39.3	71	2
Rubus saxatalis	2	9 (8-10)	100	0
Solidago altissima	4	10.3 (3-20)	100	0
Taraxacum hollandicum	7	1.4 (1-4)	75	25
Taraxacum tortilobum	20	3.3 (1-7)	53	13

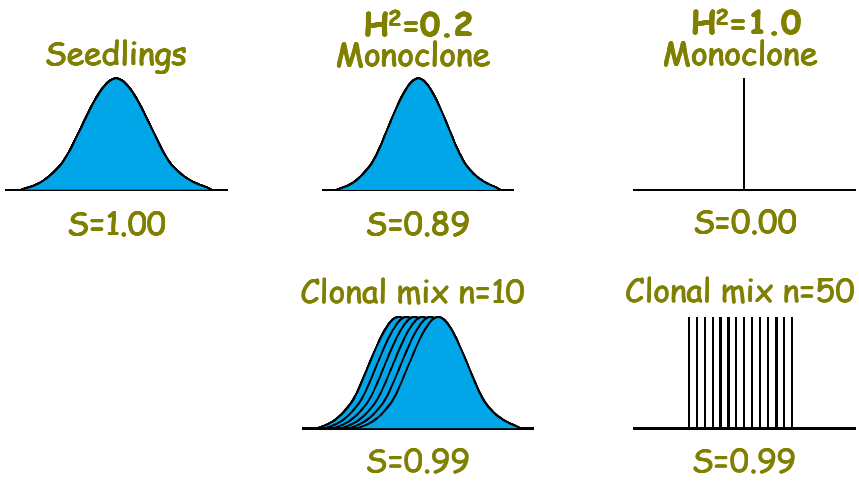
- Use aspen as an example
- After Cook 1985.

Clones in nature

- Common and widespread. Clonal reproduction successful in times of stress when combined with limited sexual reproduction.
- Individual clones can reach great ages (>10^3-years) and occupy vast areas (>10^2 ha).
- Natural cloning of conifers is relatively rare.
- In Scandinavian forests, clones are most characteristic of the understory, herbaceous vegetation where they can dominate.
- Clonal trees formerly widespread in northern temperate forest. Disturbances, largely caused by humans have favored predominantly aclonal species, e.g. *Abies sp.* and *Fagus sp.*
- 3–15 genotypes per clonal population represents a typical natural situation .

- Clones seen as something man made. This of course wrong.
- In temperate forests 70% of all plant species able of clonal growth, many only under very special environmental conditions, however.
- Clonal growth much more common among monocotyledons than among the dicotyledons.
- Clonal growth rare among conifers. Normally only through layering in extreme (alpine or maritime) environments.

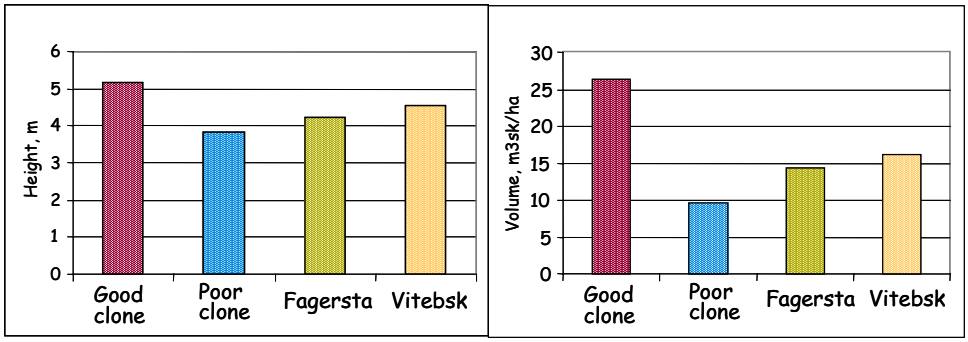
Phenotypic variation



- Again, phenotypic variation us what is critical for associated species, what they are exposed to.
- Figures apply to neutral traits, to be exact. Traits under selection will have slightly lower variation.
- H^2 for most growth traits typically around 0.2. Higher for e.g. a number of wood properties.

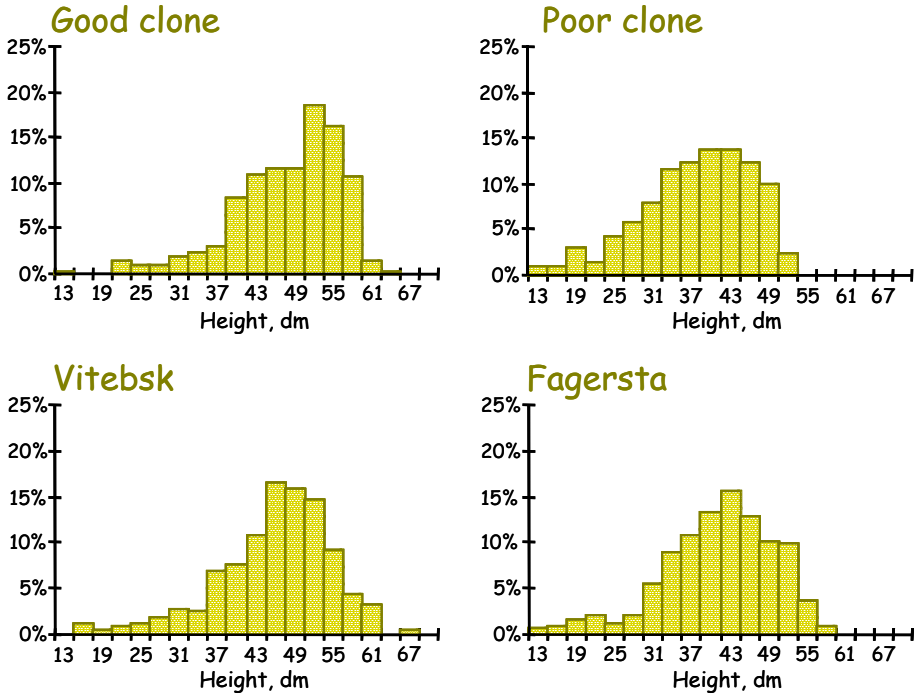
Bubbarsbo demonstration plots

- Established 1987 by Hilleshög AB
- 400 tree plots
- 2 replications



- Fagersta is a local provenance, Vitebsk a recommended Byelorussian provenance.

Height class distribution



Effects on flora and fauna

- Few scientific studies.
- Silviculture and forest management has a greater influence then genetic composition.
- Species living on or from spruce may be affected in monoclonal plantations or plantations with few clones.

  - Remember why we use clonal plantations; higher production, more uniform products, and faster multiplication rate of rare seed. We should then compare clonal forestry to alternative ways of reaching these goals.

Table 1. Some large plant clones (after Cook, 1985).

Species	Diameter (m)	Estimated age (years)
Gaylussacia brachycerium	1,980	13,000
Holcus mollis	880	1,000+
Populus tremuloides	510	10,000+
Pteridium aquilinum	489	1,400
Lycopodium complanatum	250	850
Festuca rubra	220	1,000+
Convallaria majalis	83	670+
Calamagrostis epigeios	50	400+
Picea mariana	14	300+
Festuca ovina	8	1,000+
Larrea tridentata	8	11,000+

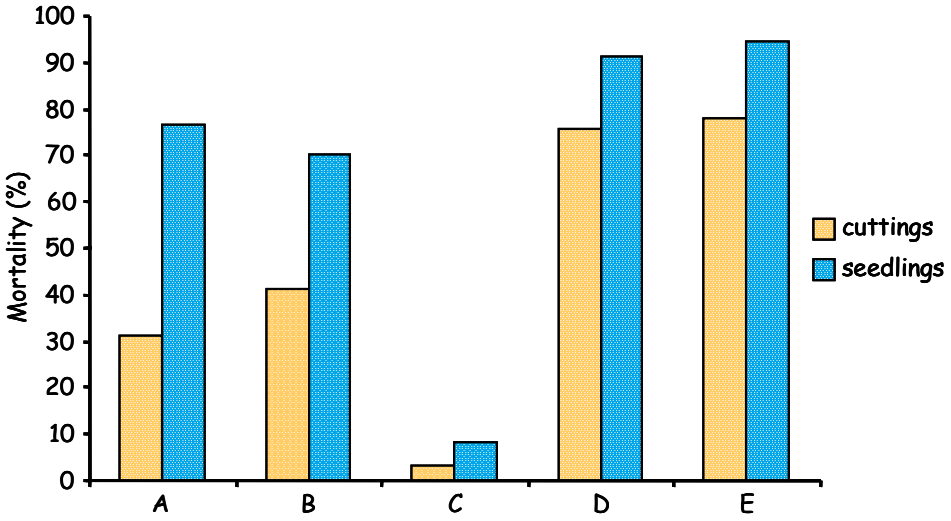


Figure 2.
Mortality of rooted cuttings and seedlings of the same diameter caused by pine weevil at five sites in southern Sweden (Mattsson & Thorsén, 1992)

- You find unexpected results in these type of studies.