The effect of harvesting intensity on the genetic diversity of broadleaved seed crops

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Overview

- Justification: Prospects and limitations for conservation of noble hardwoods in Finland under future climate

- The concept of forward conservation

- Optimization of seed harvest from ex situ GCUs for efficient gene conservation: a simulation approach

- Implications for future management and research of *ex situ* units

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Prospects and limitations for conservation of noble hardwoods in Finland under future climate

Prospects

- **Possibly longer vegetation period under CC**
- Important elements of protected forest areas in Finland (e.g. herb-rich forests)
- Maybe alternative tree species in areas where Norway spruce and Scots pine are already under severe stress
- Good soil protecting properties in extreme sites (rocks, slopes, shallow soils)

Limitations

- Low economic value
- **Low natural migration capacity**
- **FRM for these species is sparse!**

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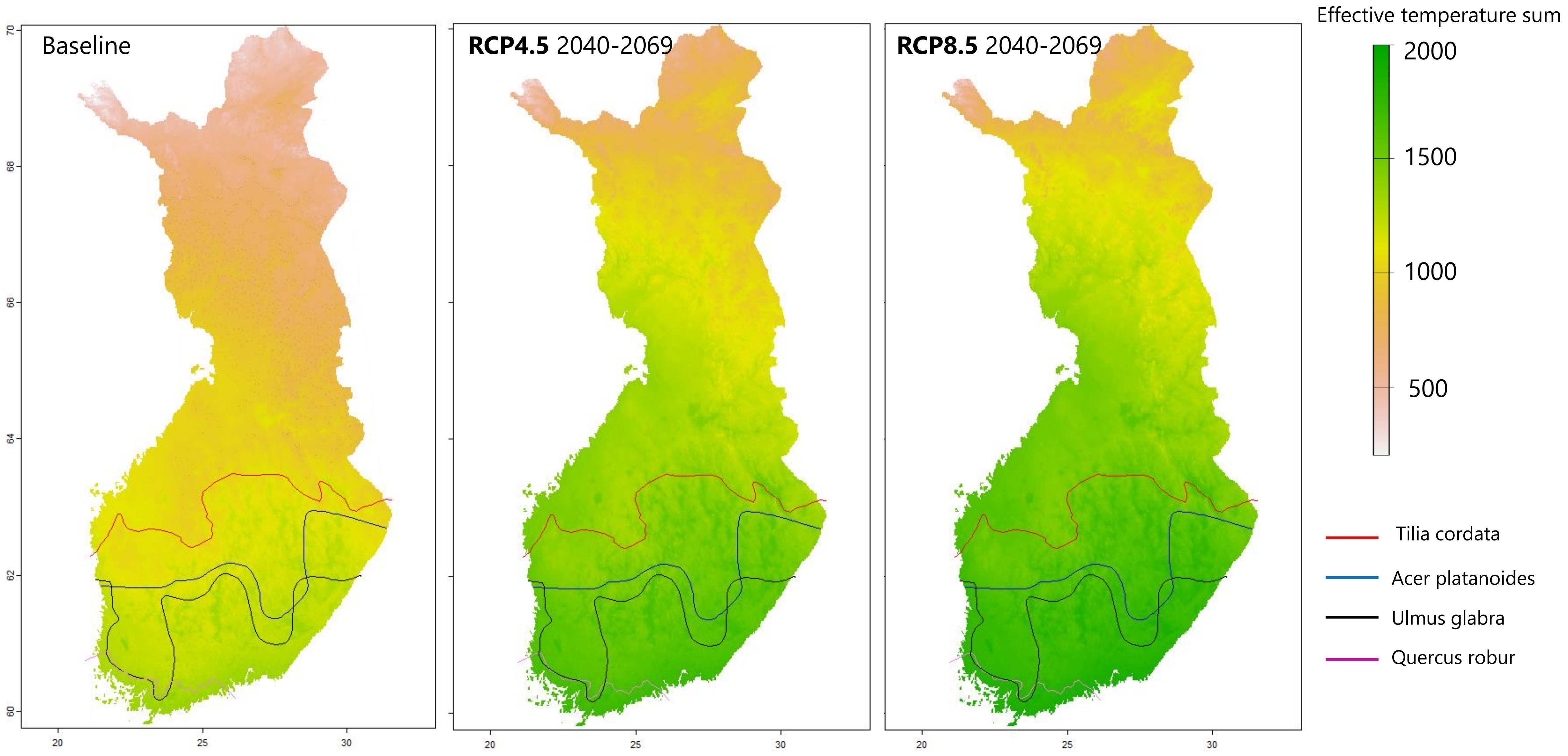
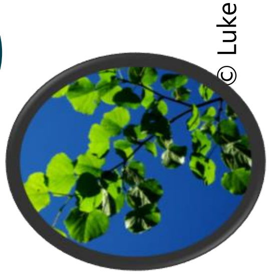
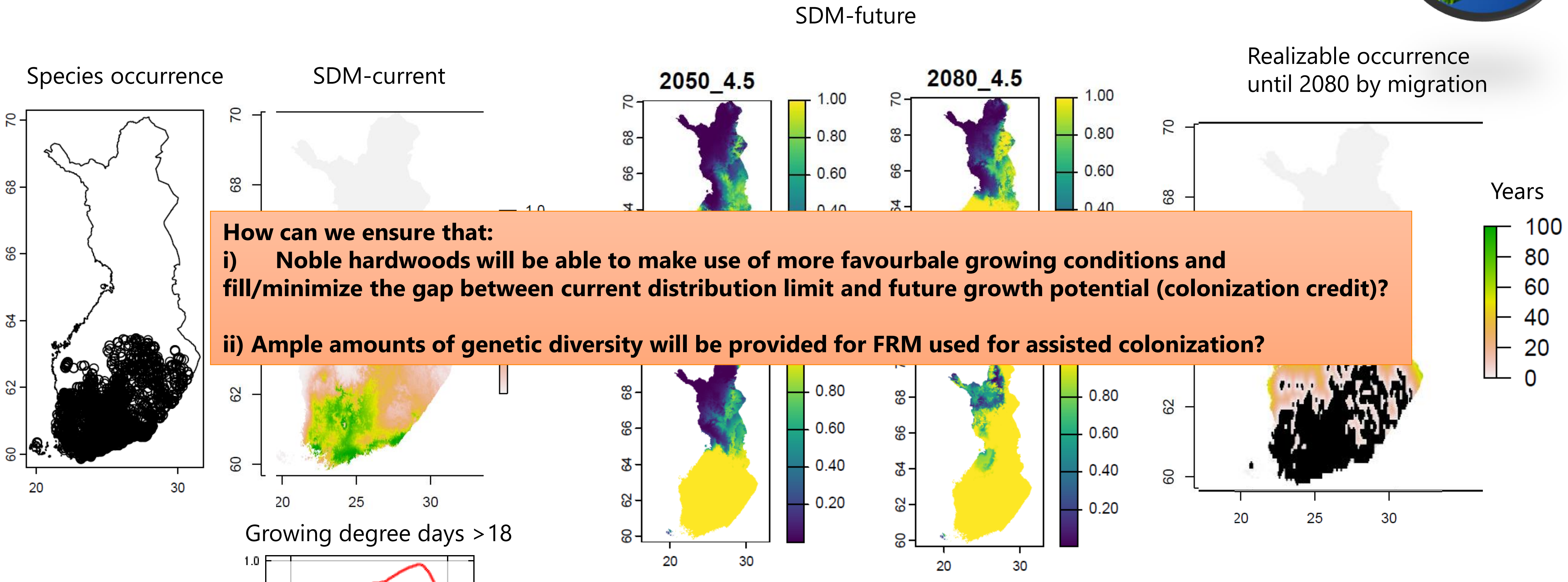
Climate projections for Finland under CC
Growing degree days >5^{0}C (GDD)
Climate Data originally from Heikkinen et al. 2020 (upscaled to 1x1Km)



Example: small-leaved linden (*Tilia cordata*)



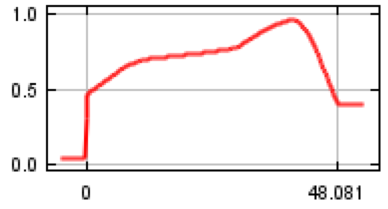


How can we ensure that:

i) Noble hardwoods will be able to make use of more favourbale growing conditions and fill/minimize the gap between current distribution limit and future growth potential (colonization credit)?

ii) Ample amounts of genetic diversity will be provided for FRM used for assisted colonization?

Growing degree days >18



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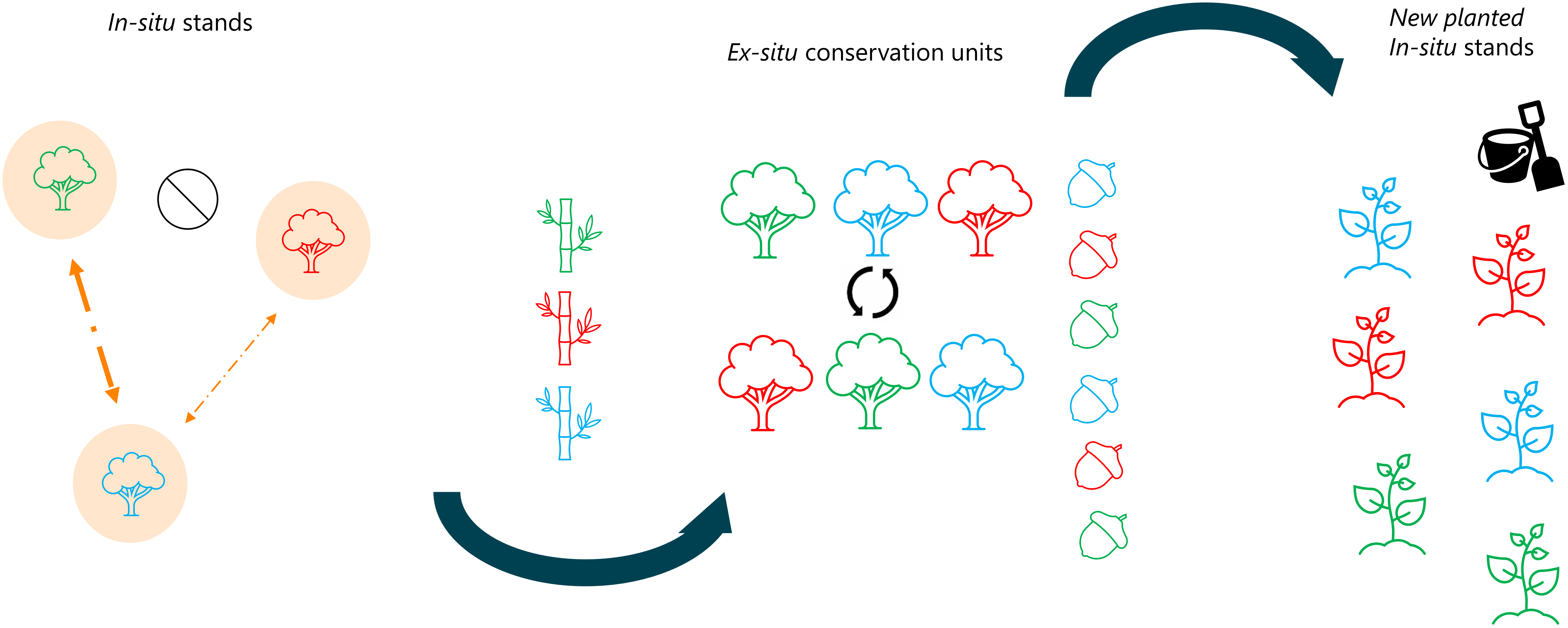
Forward conservation concept



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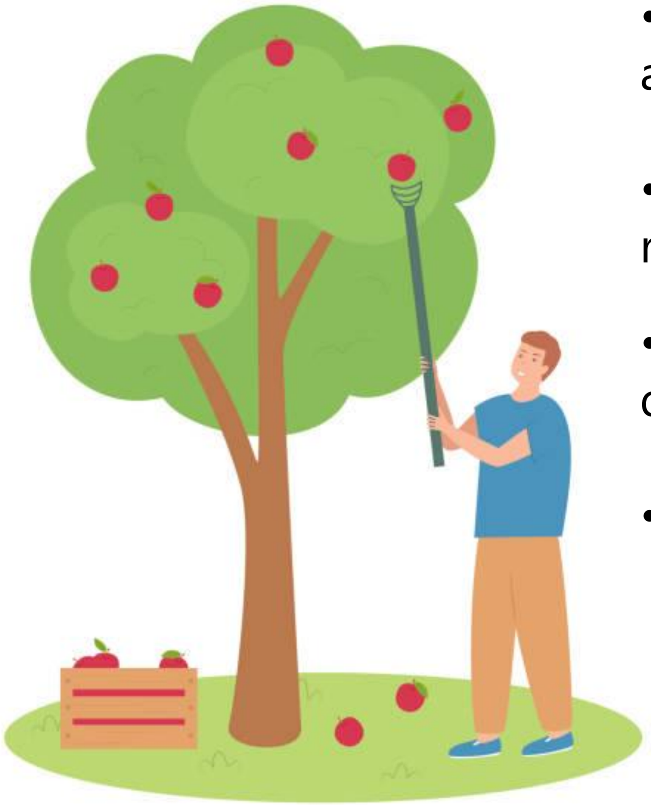
Sampling & harvesting problem



- Usually large variation in fertility/seed production among clones and among years
- Harvesting seed primarily from high-fertility clones is effective, but reduces gene diversity (expressed as N_S)
- Setting constraint on maximum number of seed/tree increases gene diversity, but **wastes a lot of seed** and **takes more time**
- How to optimize seed harvest in different years?

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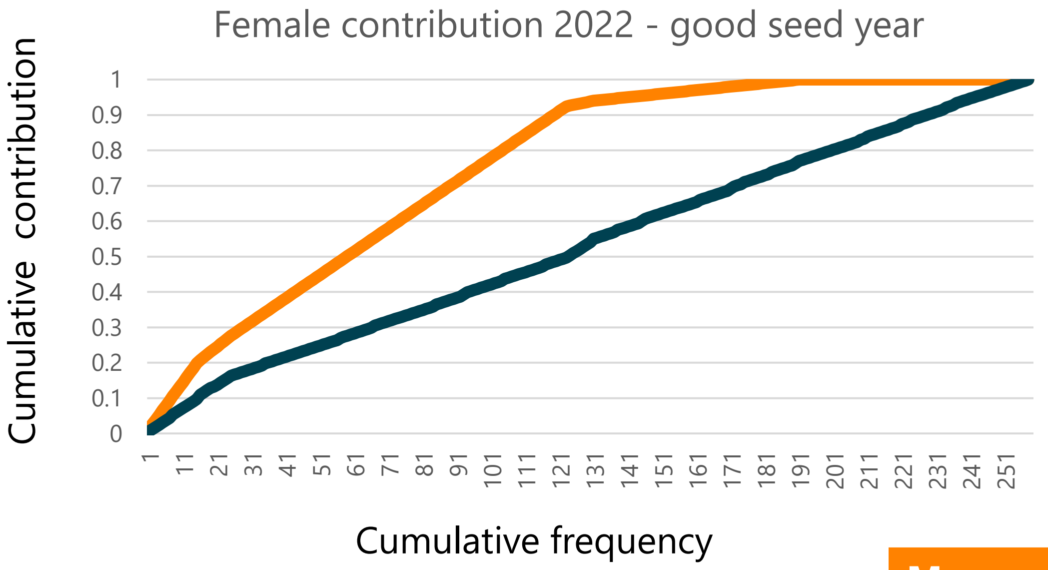
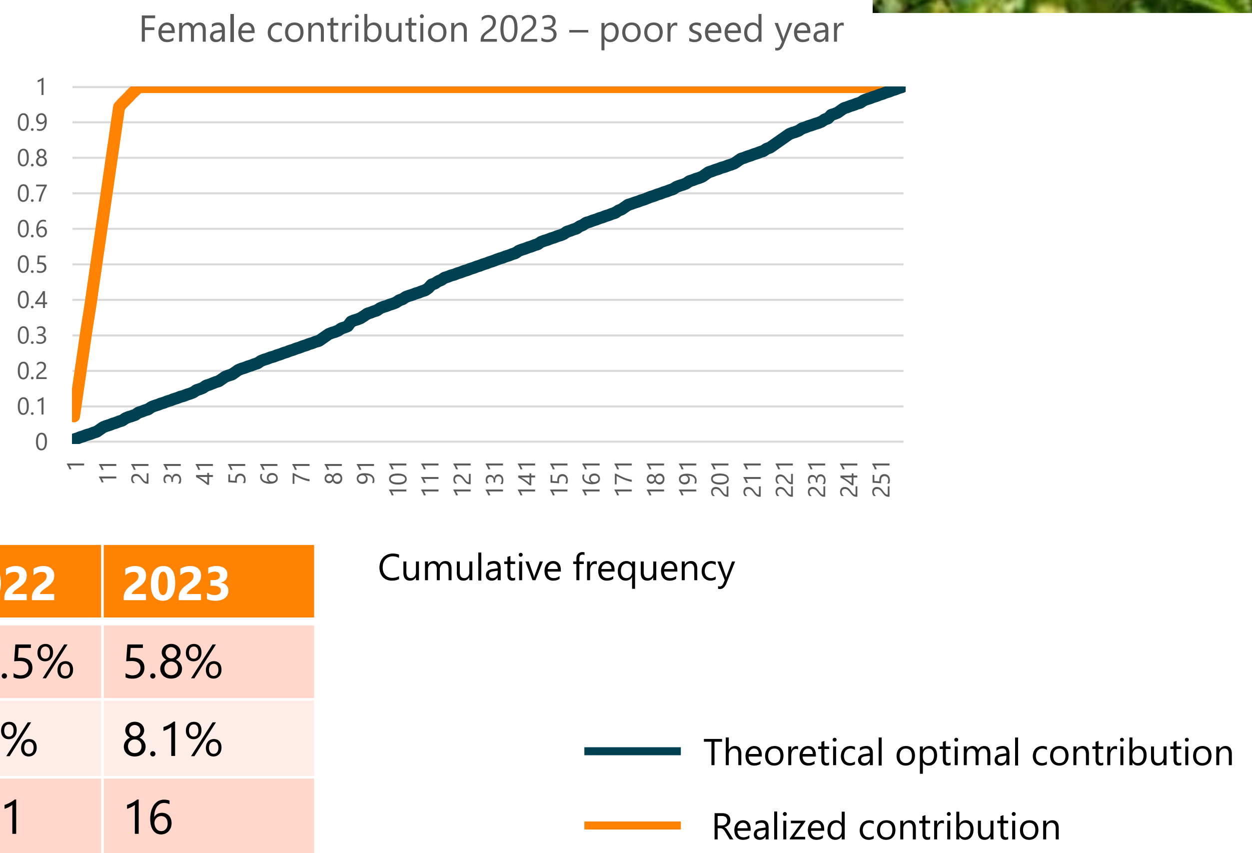
Optimal vs. realized female contribution varies from year to year….





Measure	2022	2023
N_{90}	46.5%	5.8%
N_{total}	74%	8.1%
Status number (N_p)	131	16
Rel. Status number (N_r)	50.8%	6.2%

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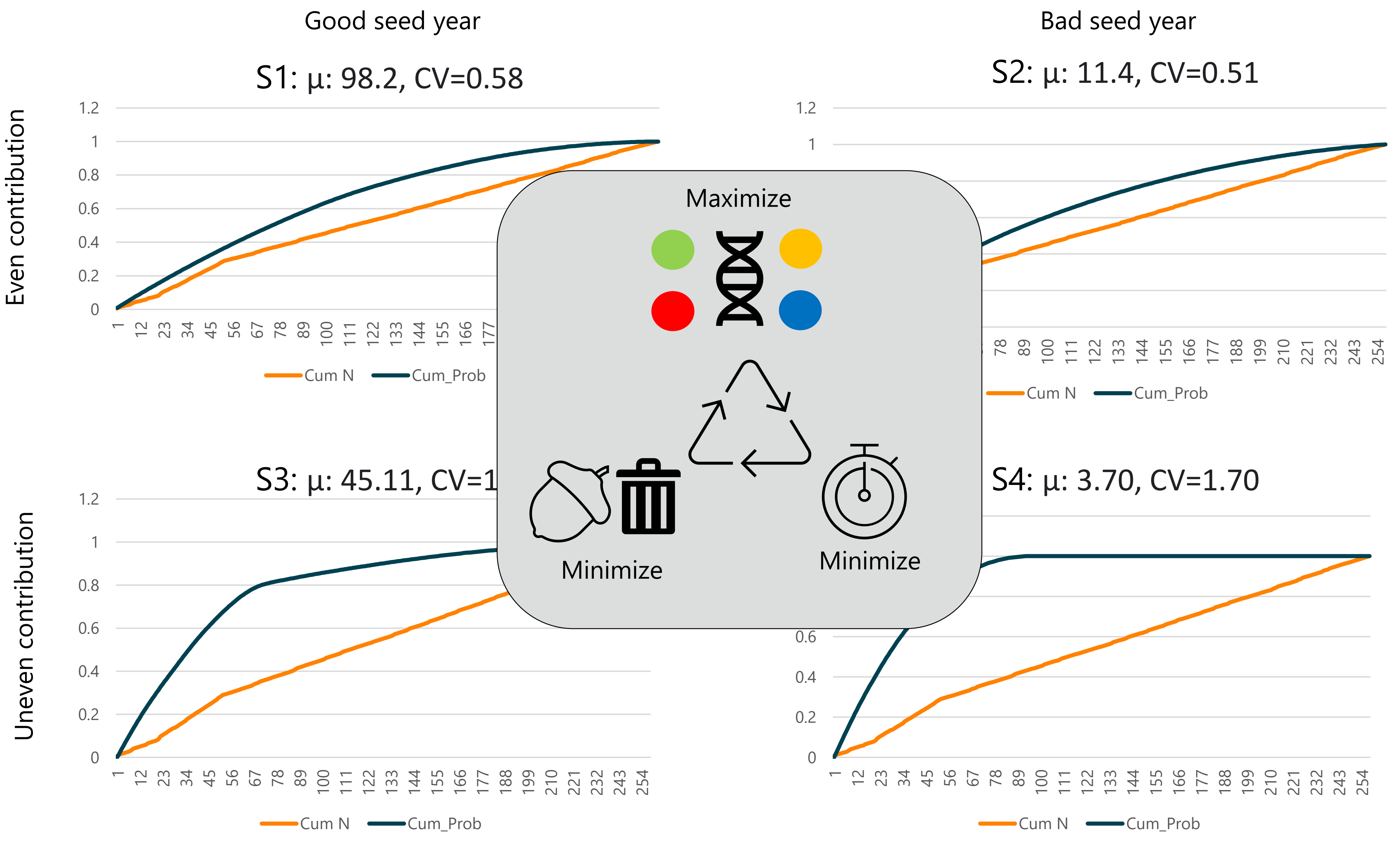
Scenario and optimization tool for seed deployment from underutilized species



Collection schemes

- **C1**: equal number of seed from all seed-bearing trees with >50 (10) seed (25 (5),50 (10))
- **C2**: Complete seed from Top 20% of fruiting trees, equal amount of seed from all other trees with >50 (10) seed: (25 (5),50 (10))
- **C3**: no seed from lowest 20% of trees, equal amount of seed from the top 20% of trees (25 (5), 50 (10)), all seed from remaining fraction
- **C4**: All available seed

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Results

S1: Good seed year/equal contribution

	C1		C2		C3		C4
	25	50	25	50	25	50	Complete
Ns	0.998	0.998	0.42	0.67	0.62	0.65	192.42
Seed wasted	0.81	0.62	0.63	0.47	0.38	0.35	0.00
Time needed	0.19	0.38	0.37	0.53	0.62	0.65	25331

S2: Poor seed year/equal contribution

	C1		C2		C3		C4
	5	10	5	10	5	10	Complete
Ns	0.65	0.65	0.41	0.57	0.66	0.70	205.16
Seed wasted	0.81	0.62	0.63	0.47	0.38	0.35	0.00
Time needed	0.23	0.45	0.38	0.56	0.64	0.69	4419

S3: Good seed year/unequal contribution

	C1		C2		C3		C4
	25	50	25	50	25	50	Complete
Ns	0.71	0.71	0.30	0.46	0.59	0.63	96.32
Seed wasted	0.85	0.71	0.68	0.56	0.38	0.35	0
Time needed	0.15	0.29	0.32	0.44	0.62	0.65	11639

S4: Poor seed year/unequal contribution

	C1		C2		C3		C4
	5	10	5	10	5	10	Complete
Ns	0.73	0.73	0.45	0.65	0.64	0.69	66.06
Seed wasted	0.75	0.50	0.60	0.39	0.36	0.31	0.00
Time needed	0.25	0.50	0.40	0.61	0.64	0.69	1432.50

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Conclusions

- Truncation harvest is a suitable concept to ensure time-efficient harvesting by accounting for genetic diversity

- Collection schemes **C1 could be applied in good seed years**, regardless of whether clones contributed equally or not

➔ Nursery demand will determine how many seed can be wasted!

- Collection scheme **C3 is slightly superior/equal to C1 in poor seed years**, but wastes considerably less seed

-> Might be important in poor seed years, because a minimum amount of seed will be needed by the nursery

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Outlook & obstacles

- Status number is an easy concept, but not neccessarily the most realistic (e.g. assumes panmixia, no year-to-year correlation)
- Genetic markers and parentage analysis would help to to make the model more realistic, but are expensive…
- Time considerations are purely based on gut feeling, rather than on empirical data…
- How to monitor flowering/seed production in *ex situ* units in near-real time in the future?

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Thank you very much

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