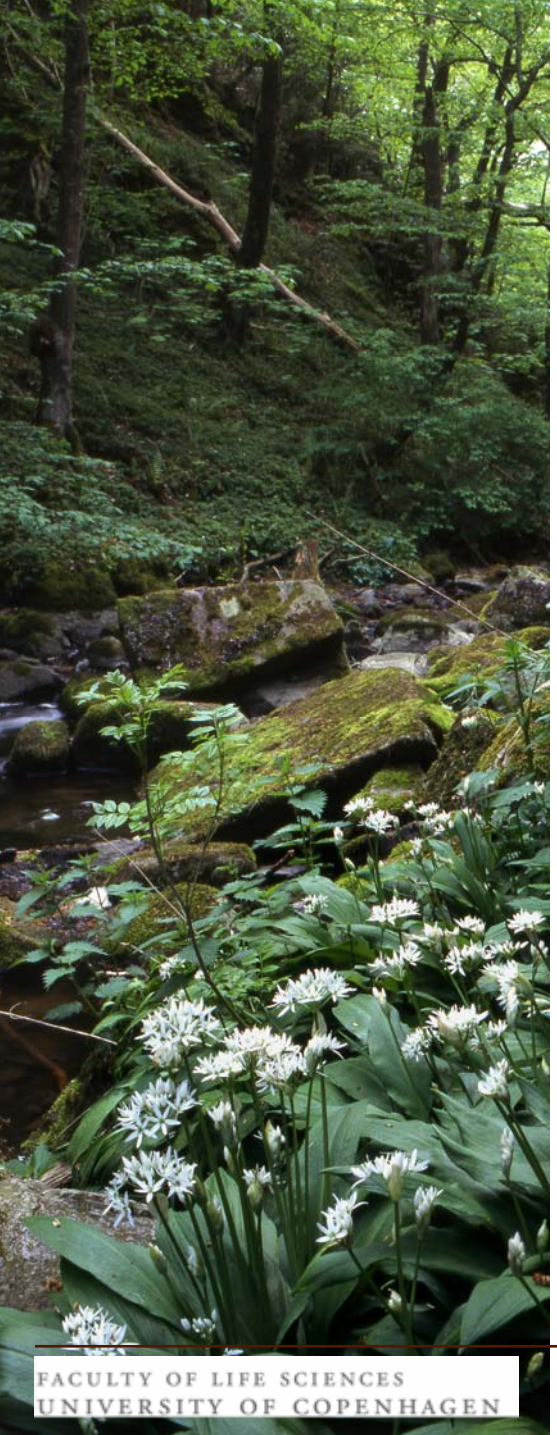

Estimating forest cover in the presence of missing observations

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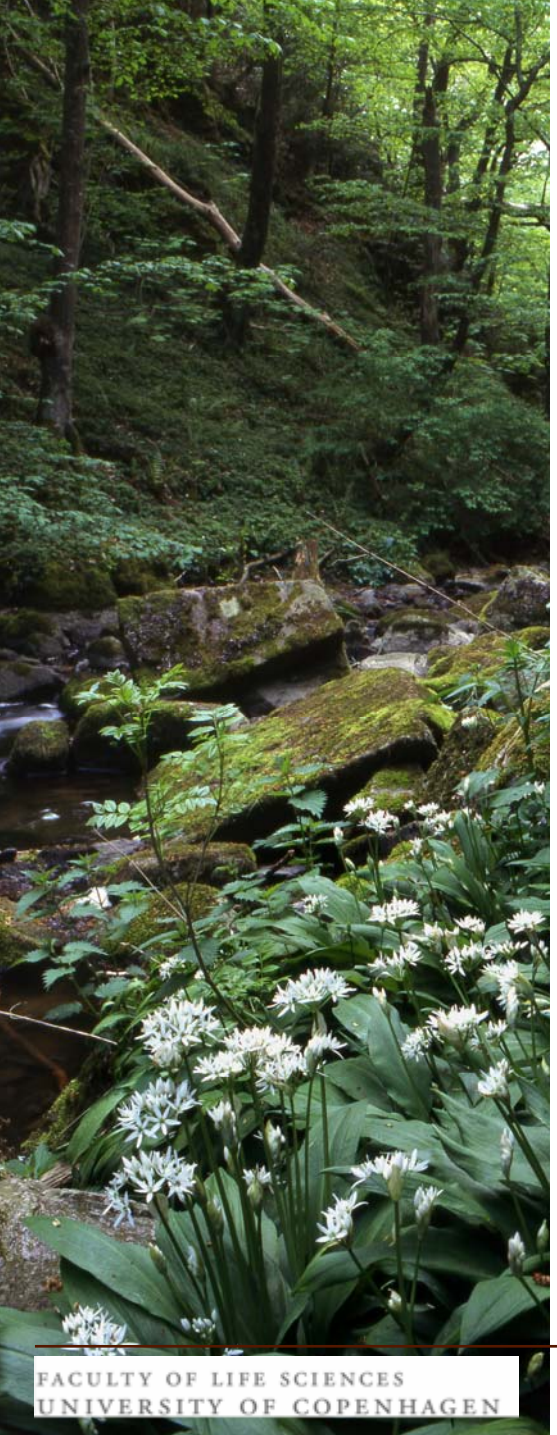
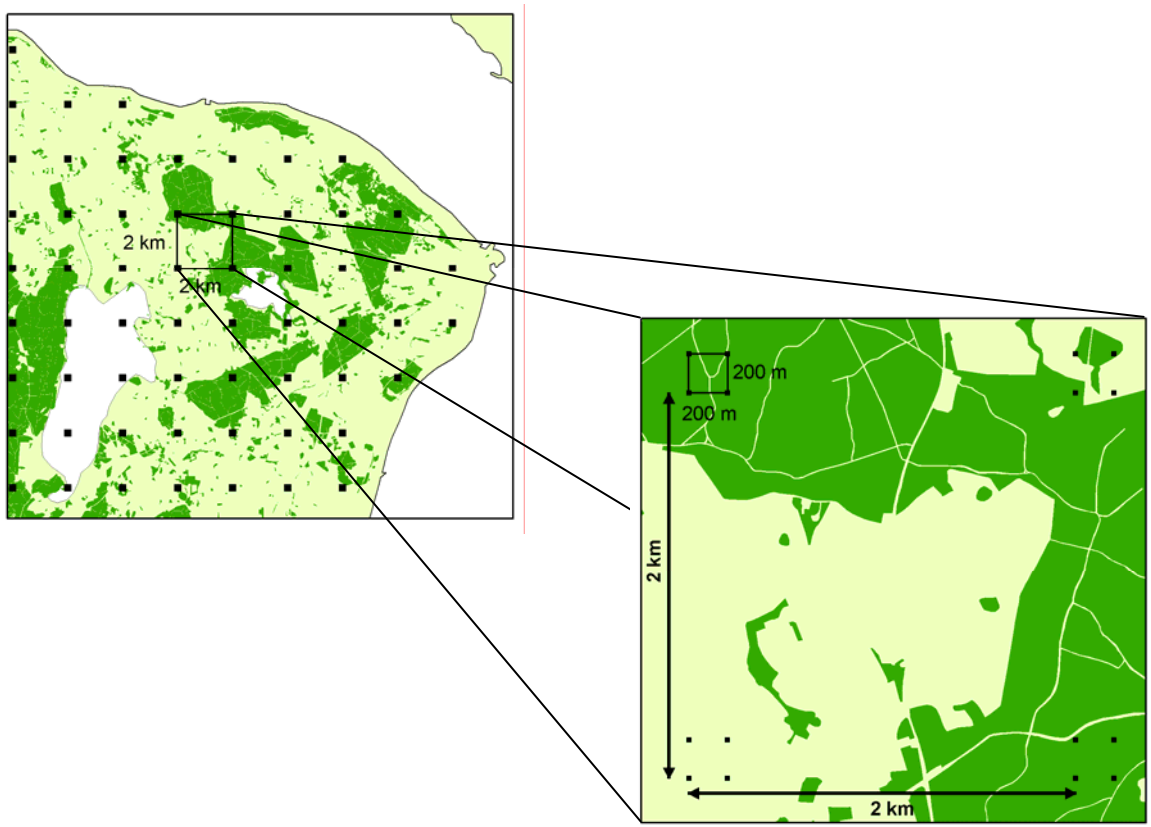
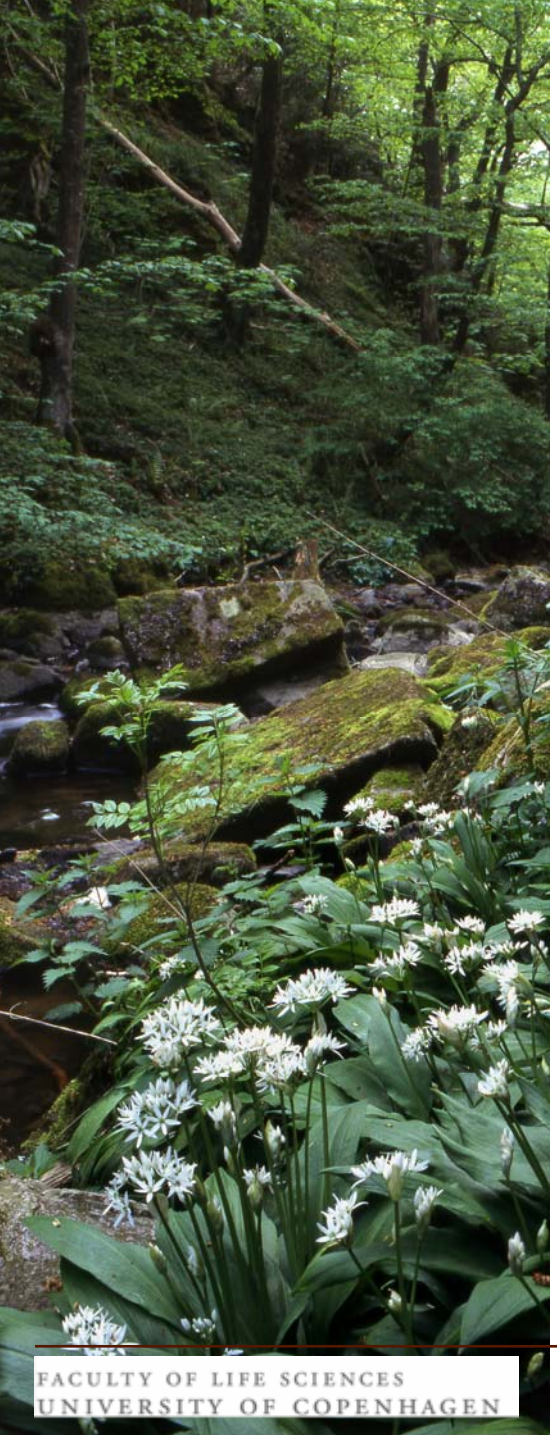


Sampling design in the Danish NFI

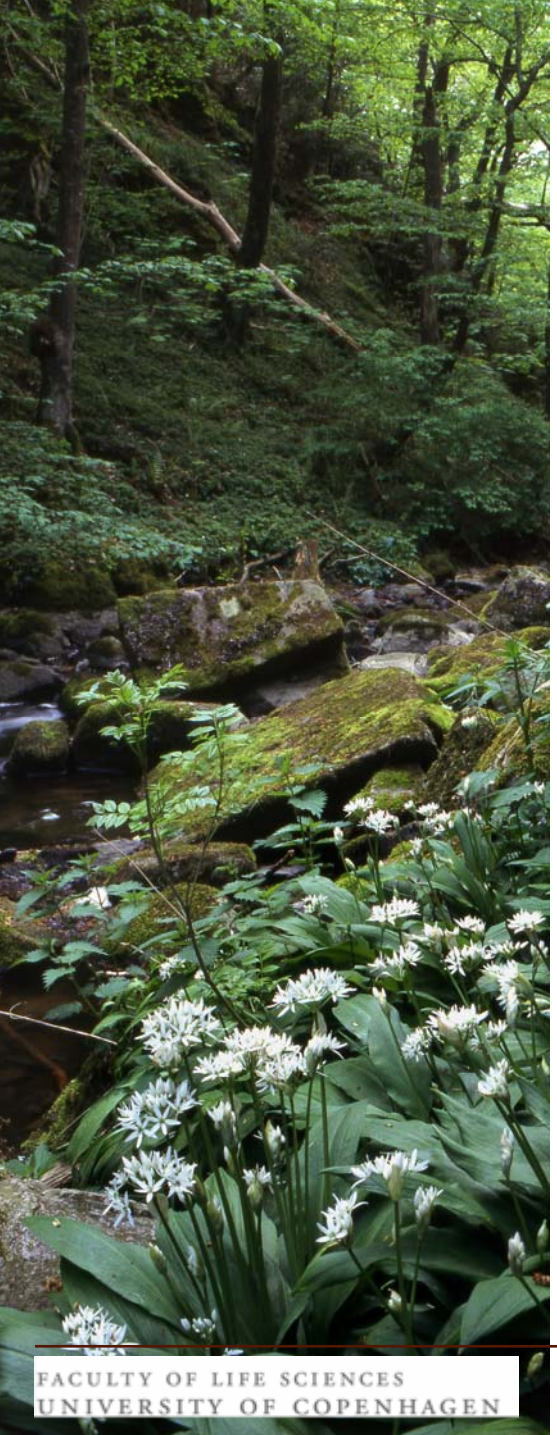




Measurements 2002-2006

Year	Not forest		Forest		OWL	
	Total	Measured	Total	Measured	Total	Measured
2002	7195	561	1145	617	254	104
2003	7129	721	1264	955	233	162
2004	7010	630	1312	972	275	183
2005	7004	1080	1409	1275	181	157
2006	6911	1112	1425	1279	194	166
Total	32249	4104	6555	5098	1137	772

~23.7 % of the SSU's are missing

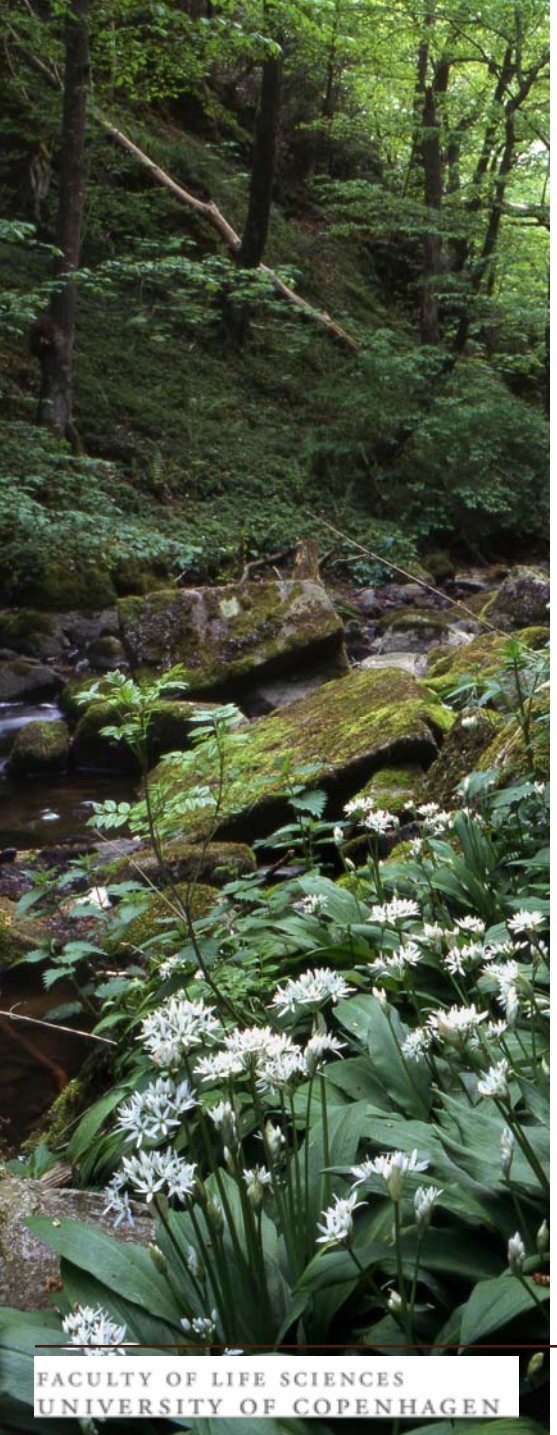


Estimator of forest cover

Complete case estimator:

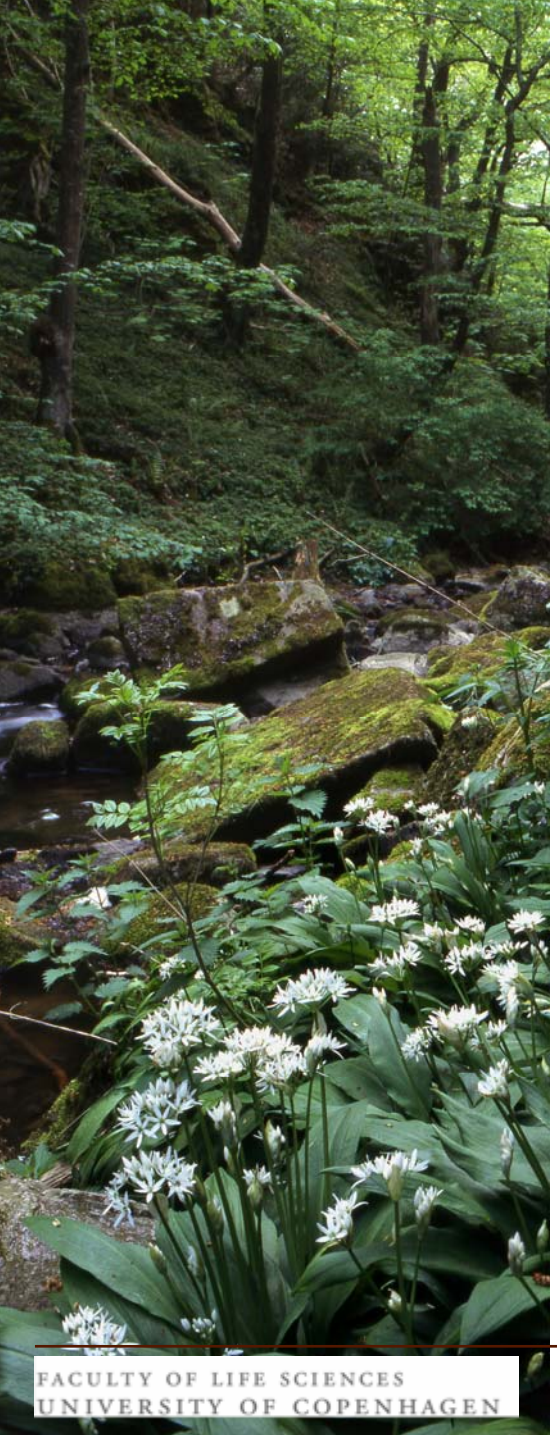
$$\hat{\mu} = \frac{\sum X_{ij}}{n}$$

$$\sigma^2_{\hat{\mu}} = \frac{1}{\sqrt{n}} \frac{1}{n-1} \sum_{i=1}^{n} \left(X_i - \hat{\mu} \right)^2$$



Estimation of mean and variance when observations are missing

- Ignore
- Simple imputation of mean values
- NN-imputation
  - kNN-imputation
- Multible imputation
- EM-algorithm



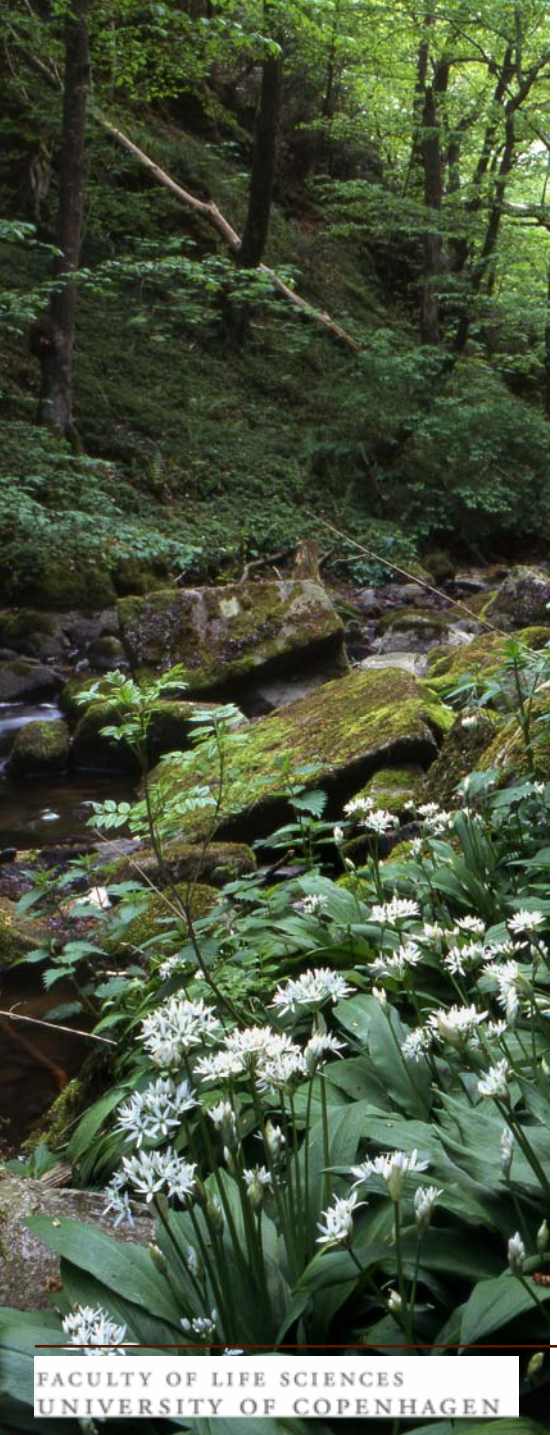
Estimator of forest cover mean

$$\hat{\mu} = \left(\sum_{Z_{ij}} X_{ij} R_{ij} + N_{12} \hat{\mu}_1 + N_{22} \hat{\mu}_2 \right) / n$$

-where:

$$\hat{\mu}_1 = \frac{1}{N_{11}} \sum_{Z_{ij}=1} X_{ij} R_{ij}$$

$$\hat{\mu}_2 = \frac{1}{N_{21}} \sum_{Z_{ij}=2} X_{ij} R_{ij}$$



Estimation of forest cover variance

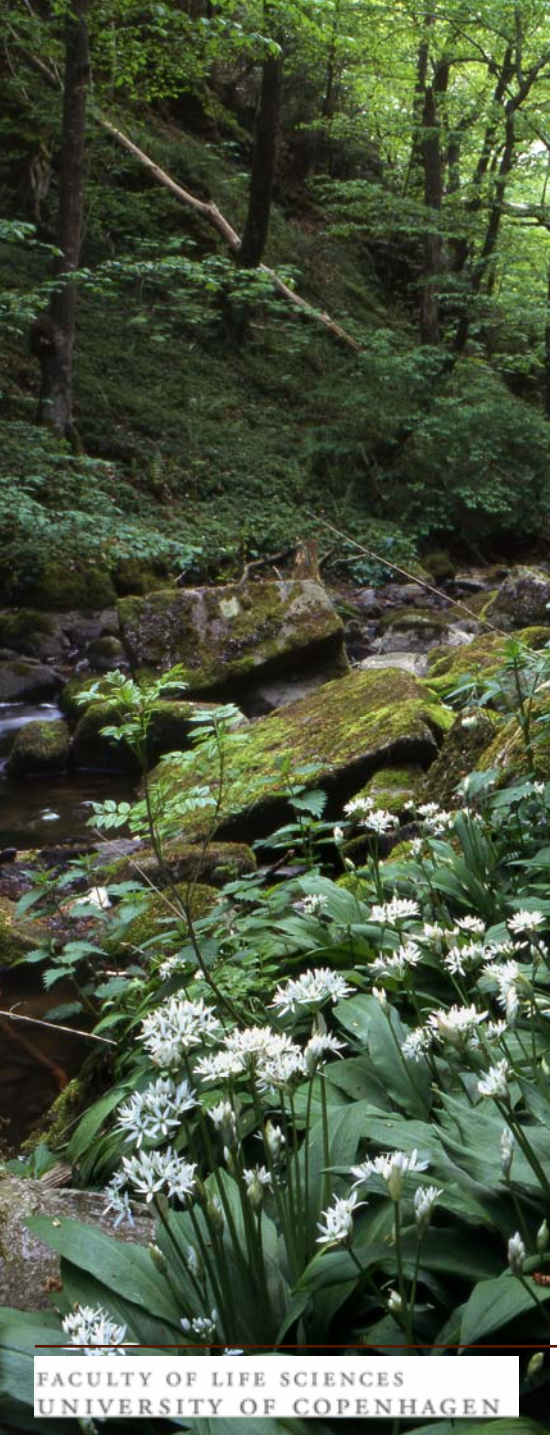
$$\sigma^2 = \frac{\sqrt{m}}{n}\sum_{i=1}^{m}\left(\delta_{iT}^2 + \delta_{iV}^2 + \delta_{iW}^2 + \delta_{iY}^2 + \delta_{iZ}^2\right)$$

$$+2\sum\left(\delta_{iT}\delta_{iV} - \delta_{iT}\delta_{iW} + \delta_{iT}\delta_{iY} - \delta_{iT}\delta_{iZ} - \delta_{iV}\delta_{iW} + \delta_{iV}\delta_{iY} - \delta_{iV}\delta_{iZ} - \delta_{iW}\delta_{iY} + \delta_{iW}\delta_{iZ} - \delta_{iY}\delta_{iZ}\right)$$

- where:

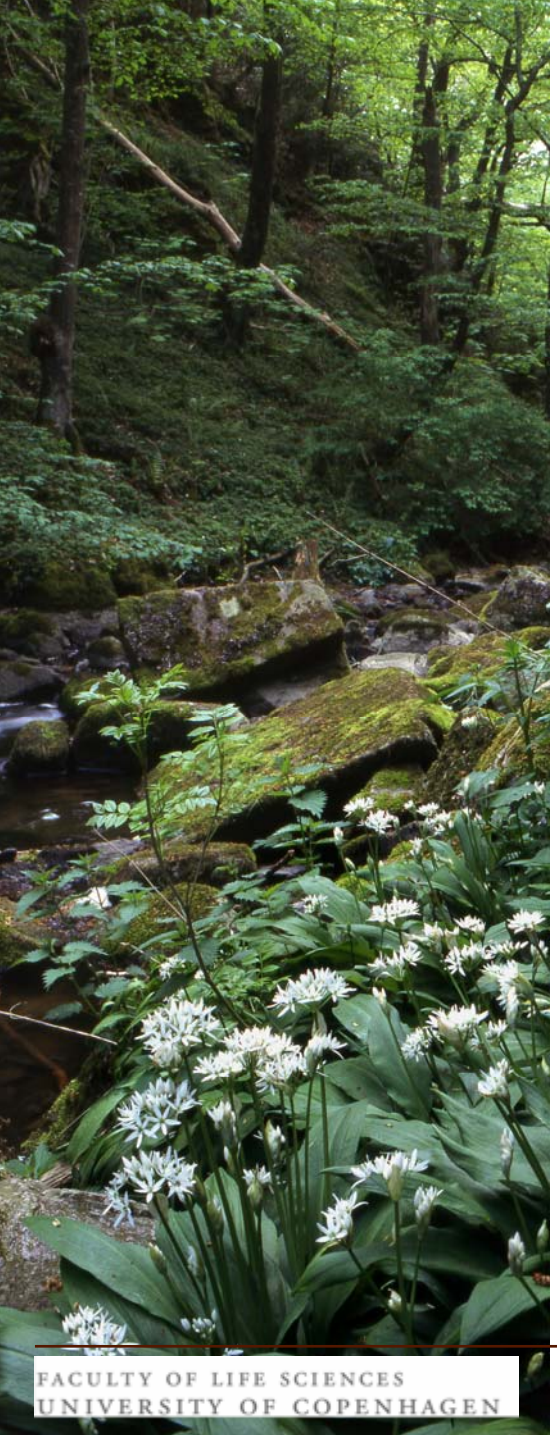
  - δ_{iT} is the variance component from measured plots

  - δ_{iV}, δ_{iW}, δ_{iY}, and δ_{iZ} are corrections for missing observations



Simulation results

		Full data		Proposed estimator		
n	q	μ	s	μ	s	Coverage
4·500	20%	0,1200	0.005	0,1200	0.005	0,954
	40%	0,1200	0.005	0,1200	0.005	0,957
4·1000	20%	0,1200	0.004	0,1200	0.004	0,955
	40%	0,1199	0.004	0,1199	0.004	0,944
4·2000	20%	0,1199	0.003	0,1199	0.003	0,946
	40%	0,1200	0.003	0,1200	0.003	0,948



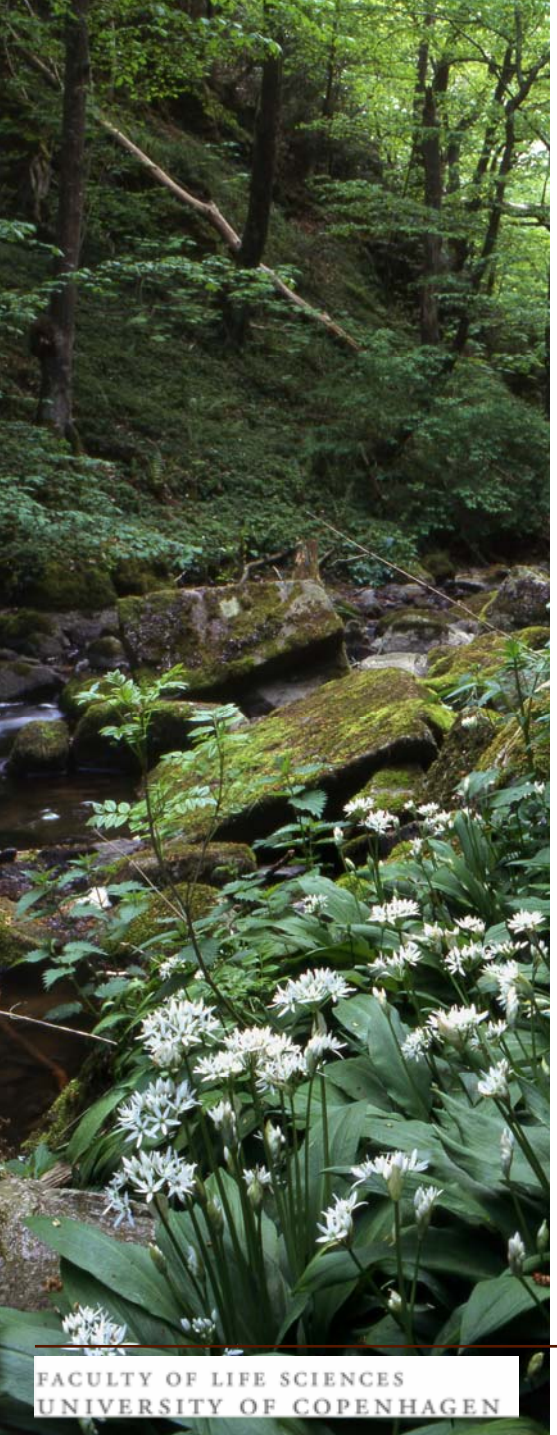
Danish forest area

Forest area:

12.4 % (11.9-12.9 %)

Other wooded land:

1.0 % (0.8-1.1 %)



Conclusion

- 12.4 % forest cover
- Unbiased estimator of forest cover mean and variance
- Correct coverage of the 95%-konfidence interval