Developing Biometric Sampling Systems and Optimal Harvesting Methods for Medicinal Tree Bark in Southern Africa

Trees for health – forever

Implementing sustainable medicinal bark use in Southern Africa.

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Towards a Simple *Bark Yield Model*

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Background

- Sustainability of natural renewable resources utilization means essentially that the resource base is not damaged, not on the short and not on the long run.
- If we wish to guarantee sustainability, we must have some basic information on the resource, in particular on
  - the existing growing stock and
  - the changes (increment, regeneration, mortality).

Background (ctd.)

- In forestry, there is a very long experience in sustainability of wood production.
  For wood volume production, there are
  - many data
  - many models to calculate wood volume
  - many growth models and yield models
  - and sophisticated mensuration protocols
  all over the world.
- However, when it comes to *bark production*, there is not much out there (except maybe for cork).
- So, we had essentially the task
  - to start from scratch with data collection in order
  - to build all the types of models listed above.

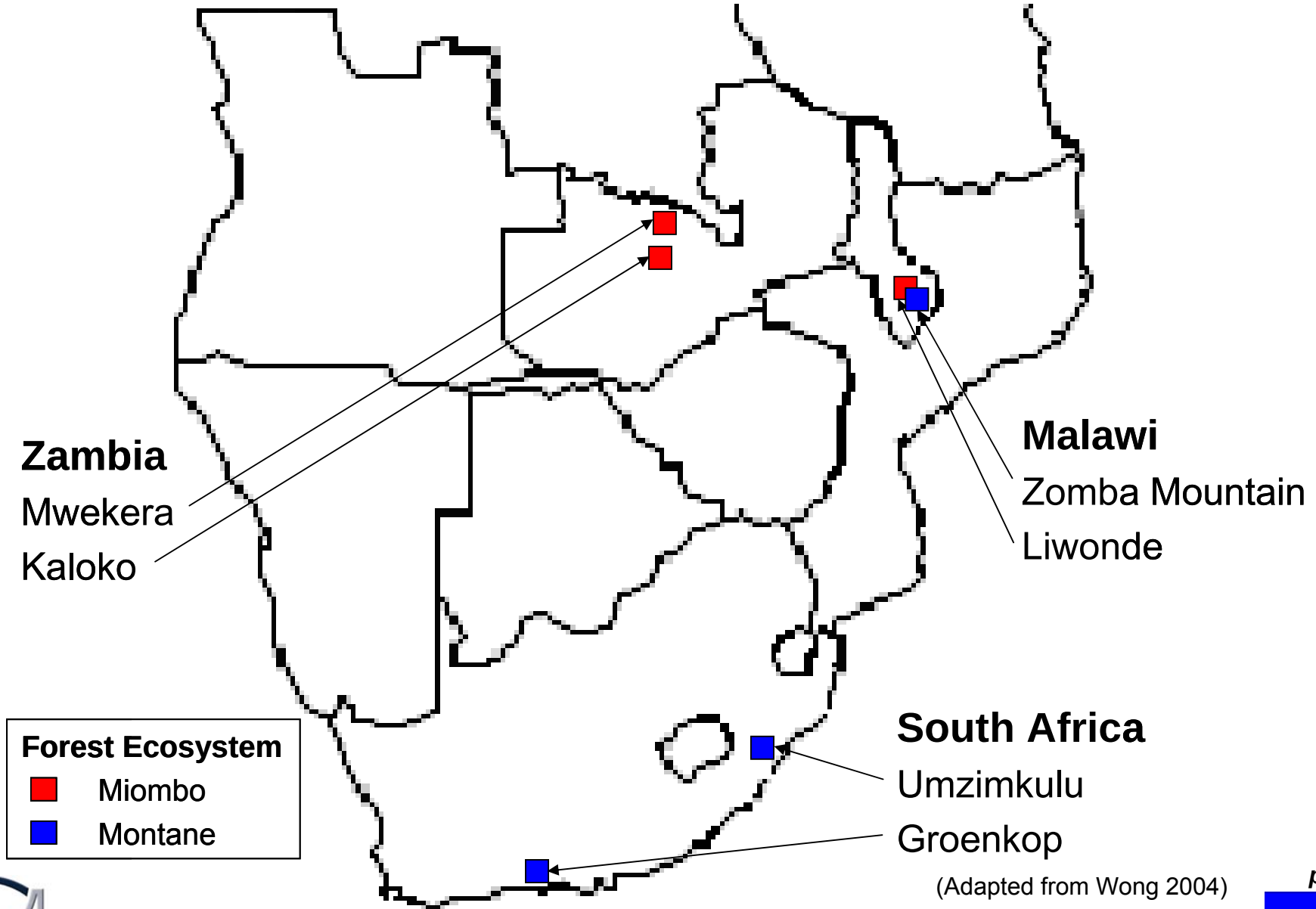
Objective & Approach

- Development of a basic **bark yield model,** with a focus on two elements:

  - **Bark growing stock**:
    Development of bark volume models for two harvesting techniques.

  - **Bark productivity**:
    Estimation of annual bark growth per tree/stand for two harvesting techniques.

Study Sites



(Adapted from Wong 2004)

Two (theoretical) harvesting techniques

… for which, of course, the respective growing stock is different:

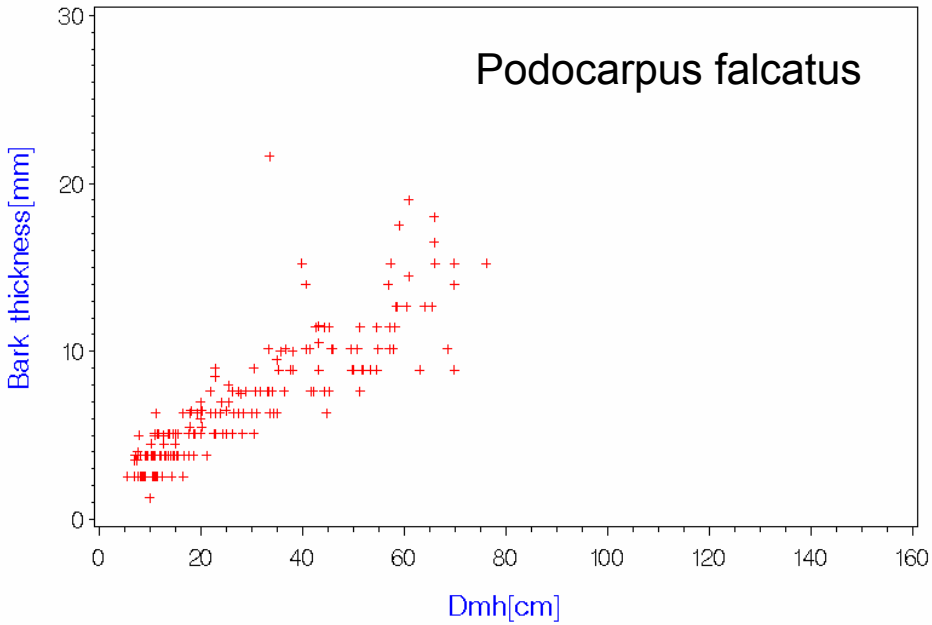
- **Bark strip volume:**
  Removal of a standard bark strip of 100cm * 10cm from standing tree

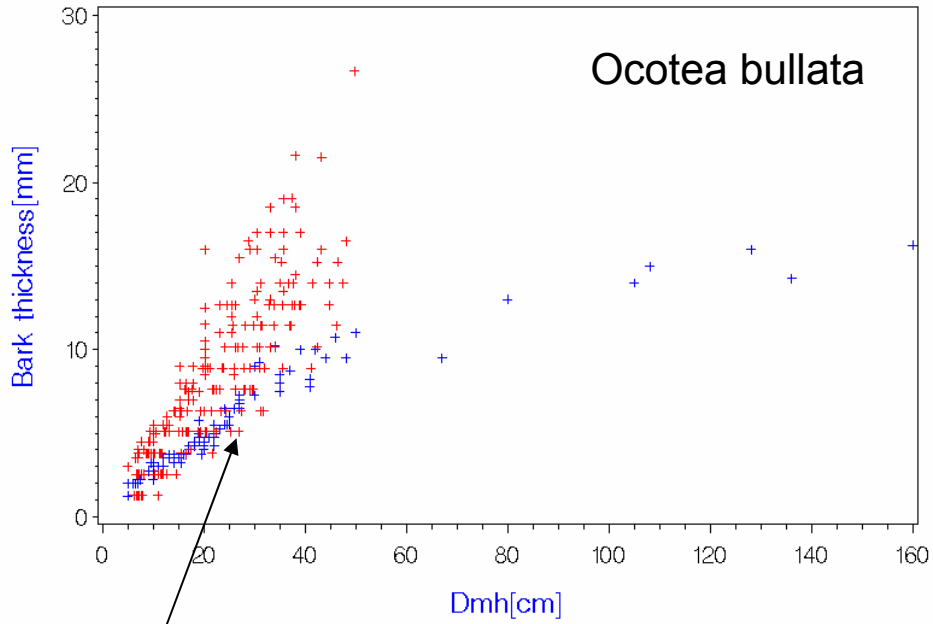
  → There, we obviously do only need information on bark thickness as input data.

- **Total bark volume:**
  Total tree bark (stem and branch bark) that would require tree felling.

Bark thickness as *f* (stem diameter) – from Groenkop data

$$barkthickness[mm] = b_0 + b_1 Ln(stemdiameter[cm])$$

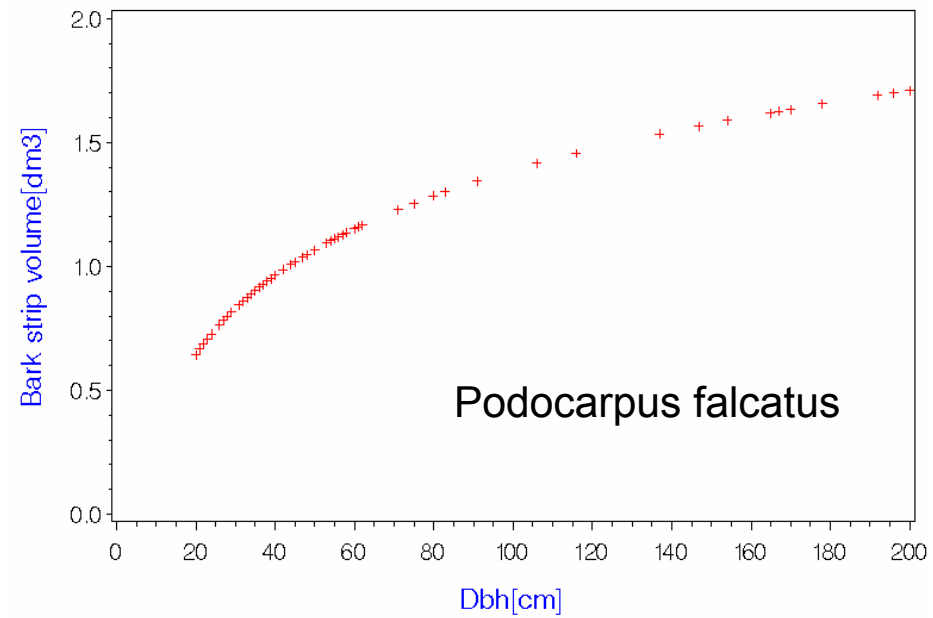


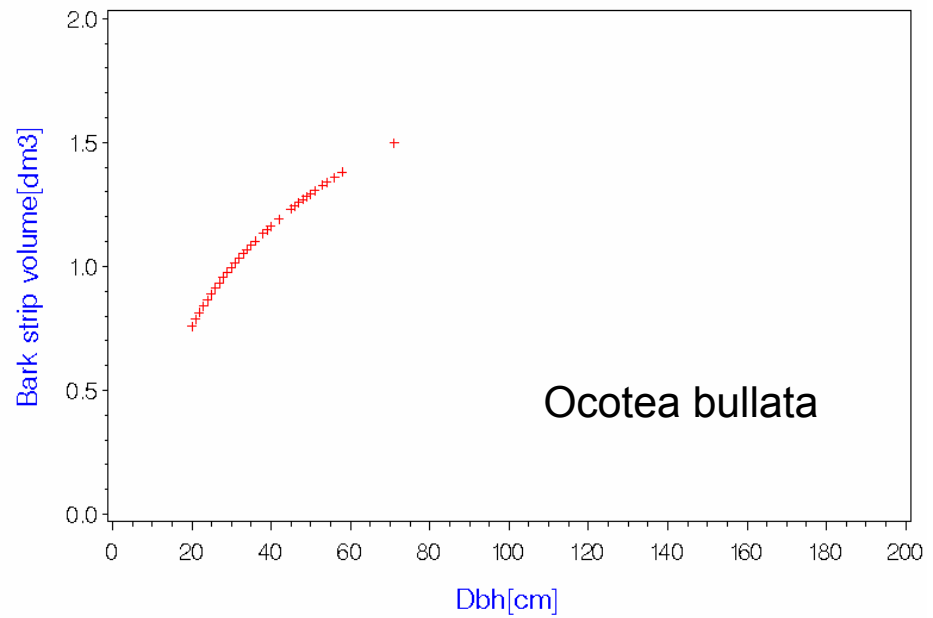


- High variability (also site specific)
- *Static relationships – but here also taken as growth curves*

A. Bark strip volume - Groenkop 1972

$$barkstripvolume[dm^3] = (barkthickness[mm]/100) * 10dm^2$$





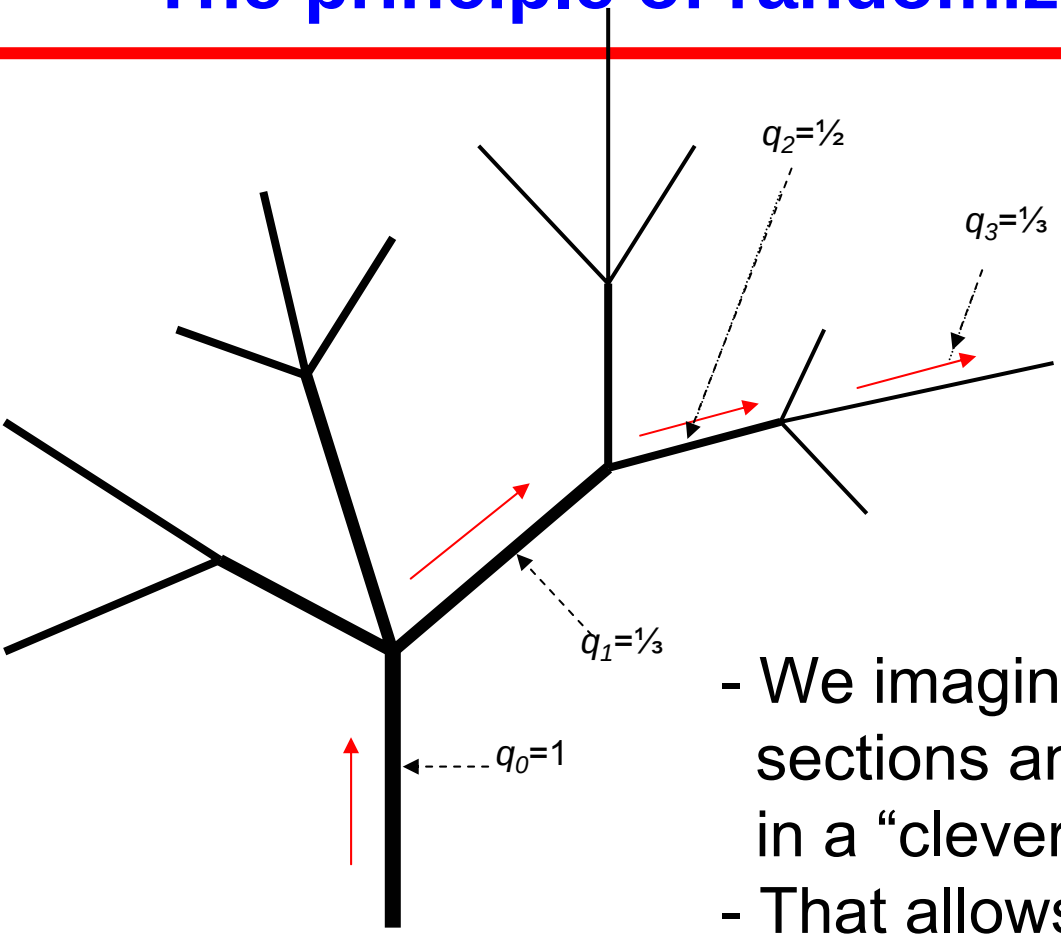
- No variability here, because it is not measurements but *model predictions*.
- *Static relationships – but here also taken as growth curves (!)*

B. Total Bark Volume

- Total bark volume as f (dbh)
  → Data from completely measured and from sampled trees (*Randomized Branch Sampling)*

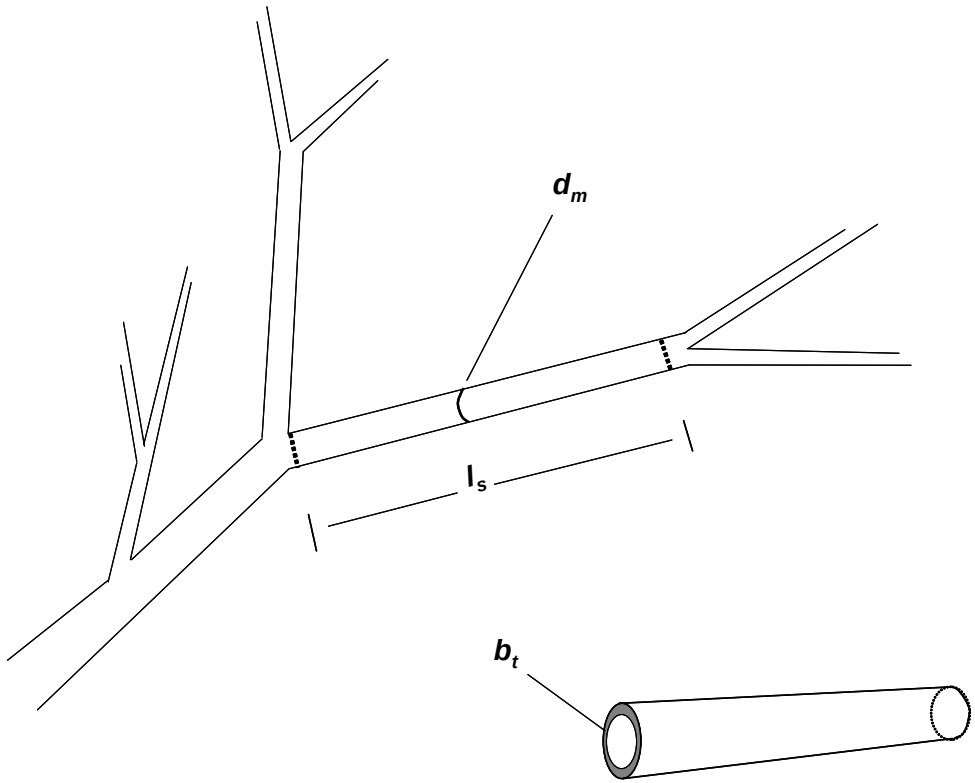
  (*Publication in preparation with Gerald Meke and Martin Jere on that topic*)

The principle of randomized branch sampling



- We imagine the tree composed of many sections and select a sample of then in a “clever manner”.
- That allows estimation of any tree attribute, also bark volume.
- However, this is not a measurement but sample based estimation.

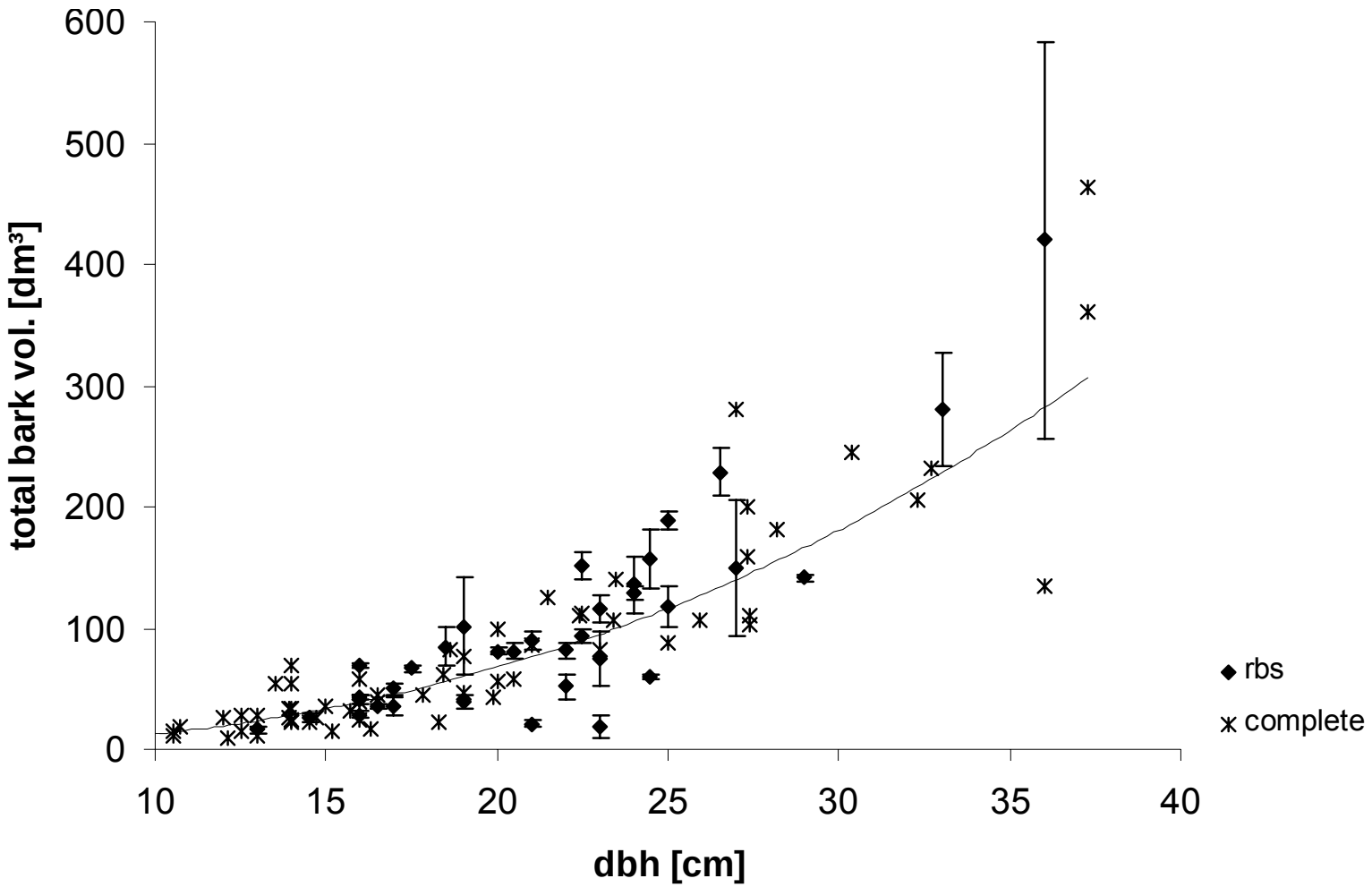
Simple geometric model for bark volume calculation of a stem or branch section.



Bark volume is calculated as difference of the volume of two frustums.

Example of bark volume regression (data from FRIM)

Pooled data set for <u>all species</u> from <u>two study sites</u> = overall model for prediction of total bark volume from dbh.



Bark Productivity

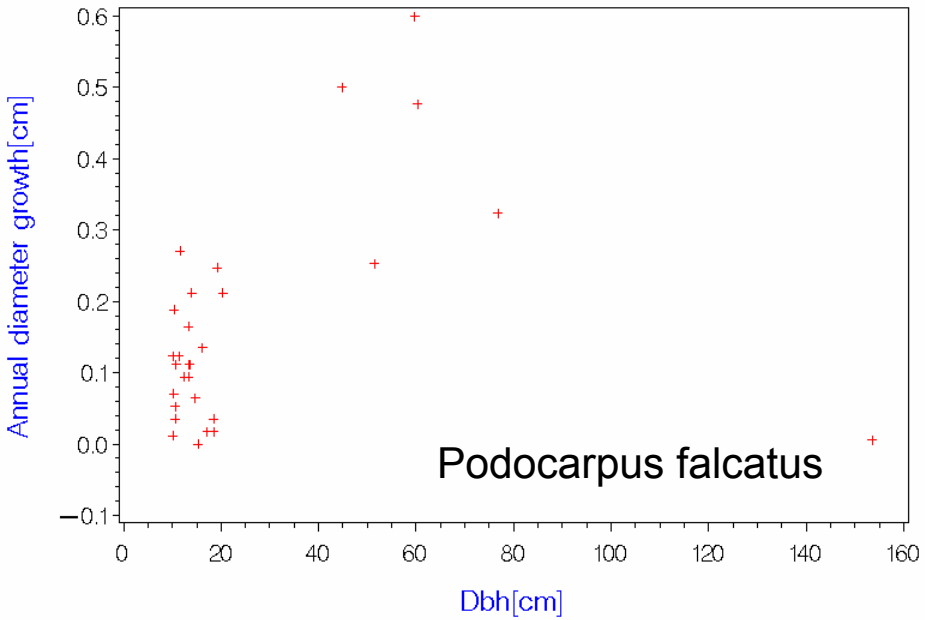
- Bark productivity of a stand is made up of the following components:

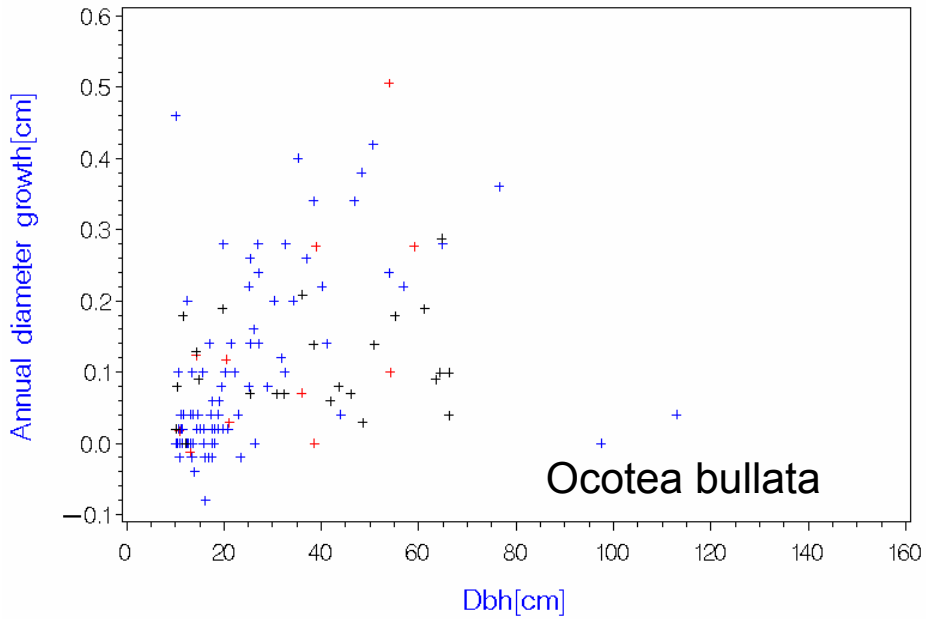
  - **Total bark harvesting:**
    - ➢ Growth of the individual trees, and
    - ➢ population dynamics (recruitment and mortality).

  - **Bark strip harvesting:**
    - ➢ In addition:
      Wound response of the trees after bark removal
      → Data need to come from *Bark Wound Response Experiments.*

Growth Rates - Annual Diameter Growth (only Groenkop…)

$$annual.diameter.growth[cm] = b_0 + b_1 * dbh[cm] + b_2 * dbh[cm]^2$$





- High variability, again.
- From this dbh growth model, growth models can also be derived for bark thickness and total and bark strip volume (with the presented models).

Population Dynamics – Annual Recruitment and Mortality

- Annual recruitment and mortality rate was calculated as a percentage of trees with dbh ≥ 20 cm.

Species Code	N_{total}	$N_{\geq 20cm}$	Recruitment		Mortality	
			N	$\%_{annual}$	N	$\%_{annual}$
16	32	10	1	0.60	0	0
118	138	65	3	0.23	3	-0.62
397	53	24	4	0.86	0	0
415	144	46	8	0.88	0	0
513	5	4	0	0	0	0
570	268	133	16	1.11	6	-0.23
578	47	28	6	1.17	3	-0.56

- While the available data sets were relatively big – they turned out too small for analysis of mortality – and for most species, there was no mortality at all.
- Much more data will be needed to include the population dynamics into the yield calculations!!

Conclusions:

- In the project, we were able to establish the basic models that allow building a bark yield model,
- for what we needed to make a number of model assumptions.
- However, the efforts were immense – as are the remaining uncertainties.
  And the models turned out to be very species-specific.
- A much greater number of well maintained permanent observation plots would help considerably (= the eternal complaint of the forest researcher).


Thanks