The development of Variable Plot Sampling

by Kim Iles

Imperial measurements

There are only 3 serious methods for timber cruising.

- **Fixed** Plots (ancient, but simple)

- **Variable** Plots (1946, end of WWII)

- **3P** Sampling (1960's, the beetles)

What is the trend?

- Each newer method <u>further</u> divides the field work into parts that are :

- <u>Quick</u> vs. <u>slower</u>

- <u>Unskilled</u> vs. <u>skilled</u> work

- <u>Estimates</u>, with a <u>correction</u>

<u>Efficiency</u> issue   **<u>Accuracy</u> issue**

Walter Bitterlich **had an idea, based on circular tree cross-sections**.
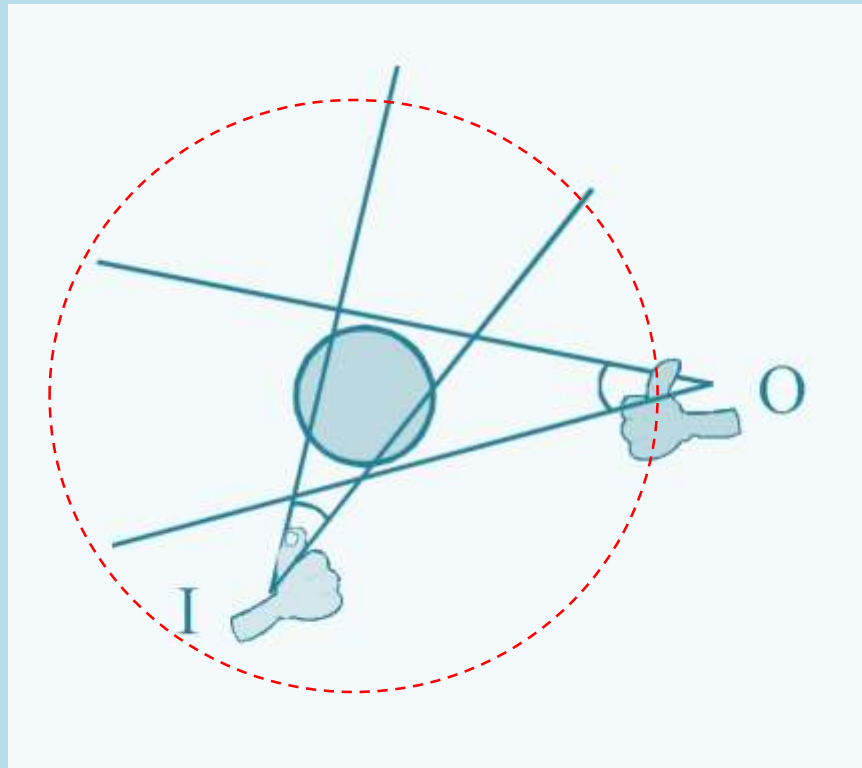
Bitterlich – 1946, said …

- Just "<u>count</u>" trees – that gives you **basal area**.

- Counting is in percent (no units involved).

- You then assign units **(43,560 ft ^{2} /acre)**
  (10,000 m ^{2} /ha)

- The <u>angle</u> gives the "Basal Area Factor"

Are you "in" or "out" of an **invisible** circle around each tree?

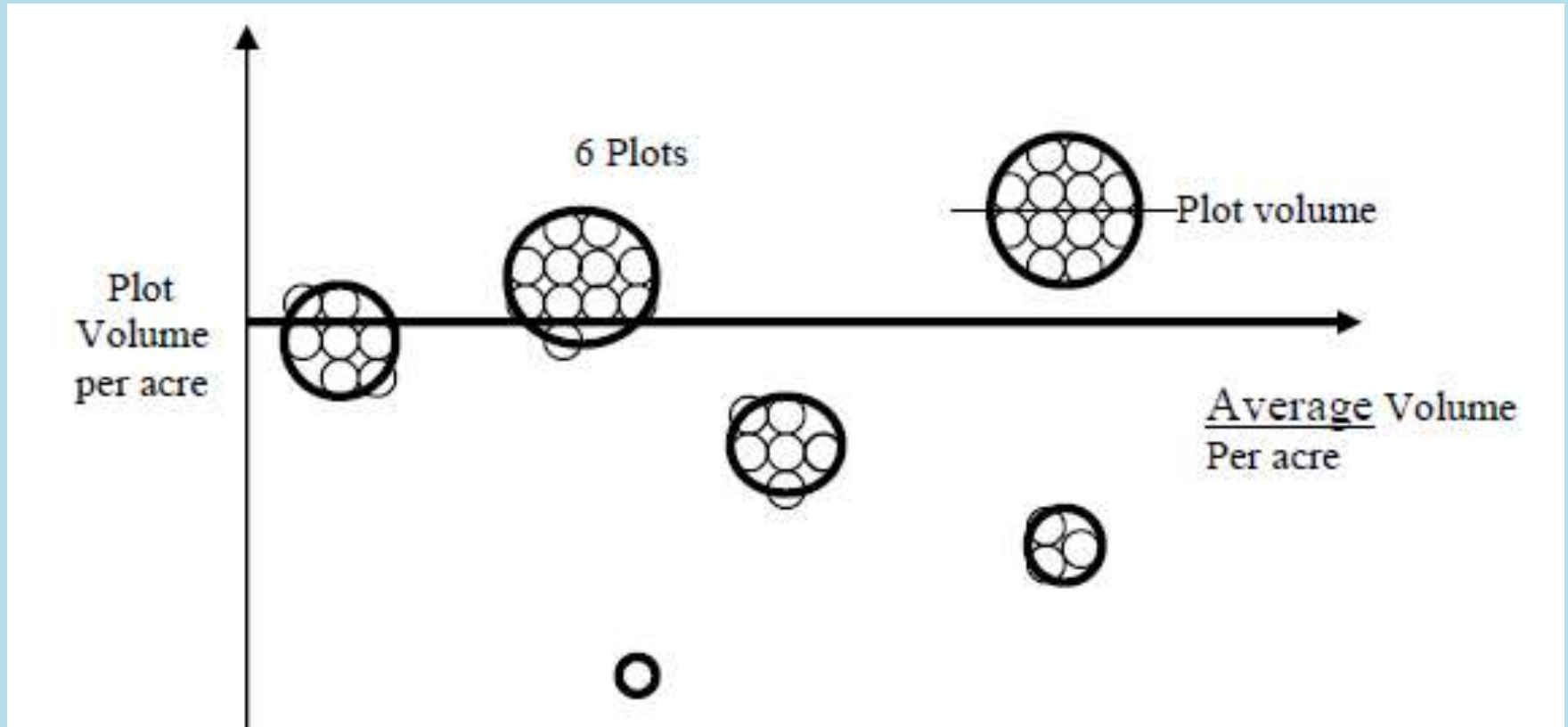- Just use an angle to decide that.

- Imagine using your thumb.

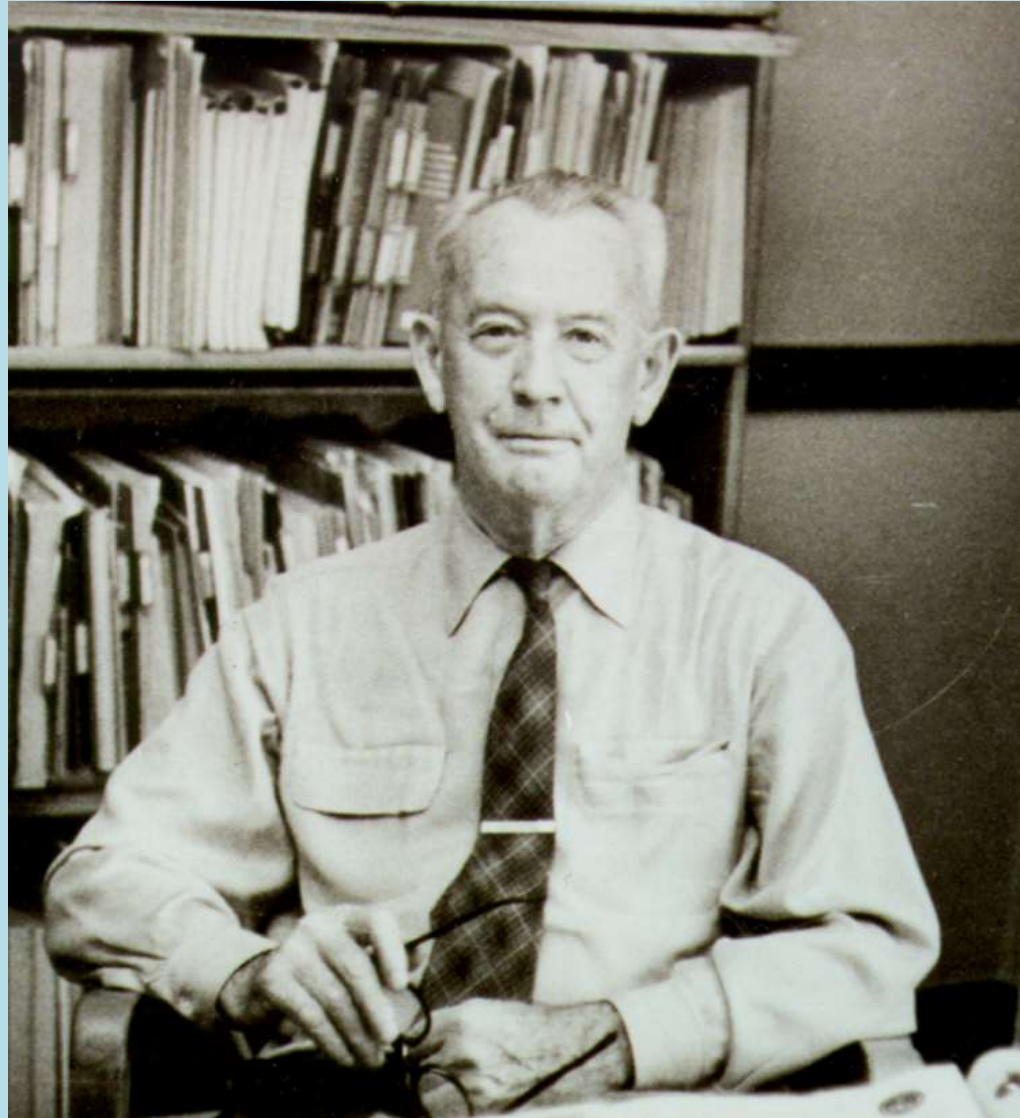# Lew Grosenbaugh immediately reads about this idea in 1947.

He thinks …

- If you <u>have</u> the basal area, just find out how much is "sitting on each square foot" to calculate **any** other stuff.

- This **V**alue / **B**asal **A**rea **R**atio is called "**VBAR**".

Grosenbaugh treated it like a Fixed Plot

Next, Don Bruce

Mason Bruce and Girard (1950) introduce "**Count and Measure**" plots.

- Just measure the trees on <u>some</u> <u>of the plots</u>, only counting trees on the others.

- Sum **plot** Vol's / Sum **plot** BA's = **VBAR Ratio**

- If plots were too far apart, people <u>lost</u> <u>their</u> <u>nerve</u> … at about a 4 or 5 counts per measure.

How it is done

1)   Do <u>all</u> plots for some easy and quick variable (basal area, in this case).

2)   Measure <u>some</u> plots for a ratio, then use the ratio to convert <u>all</u> the other basal areas.

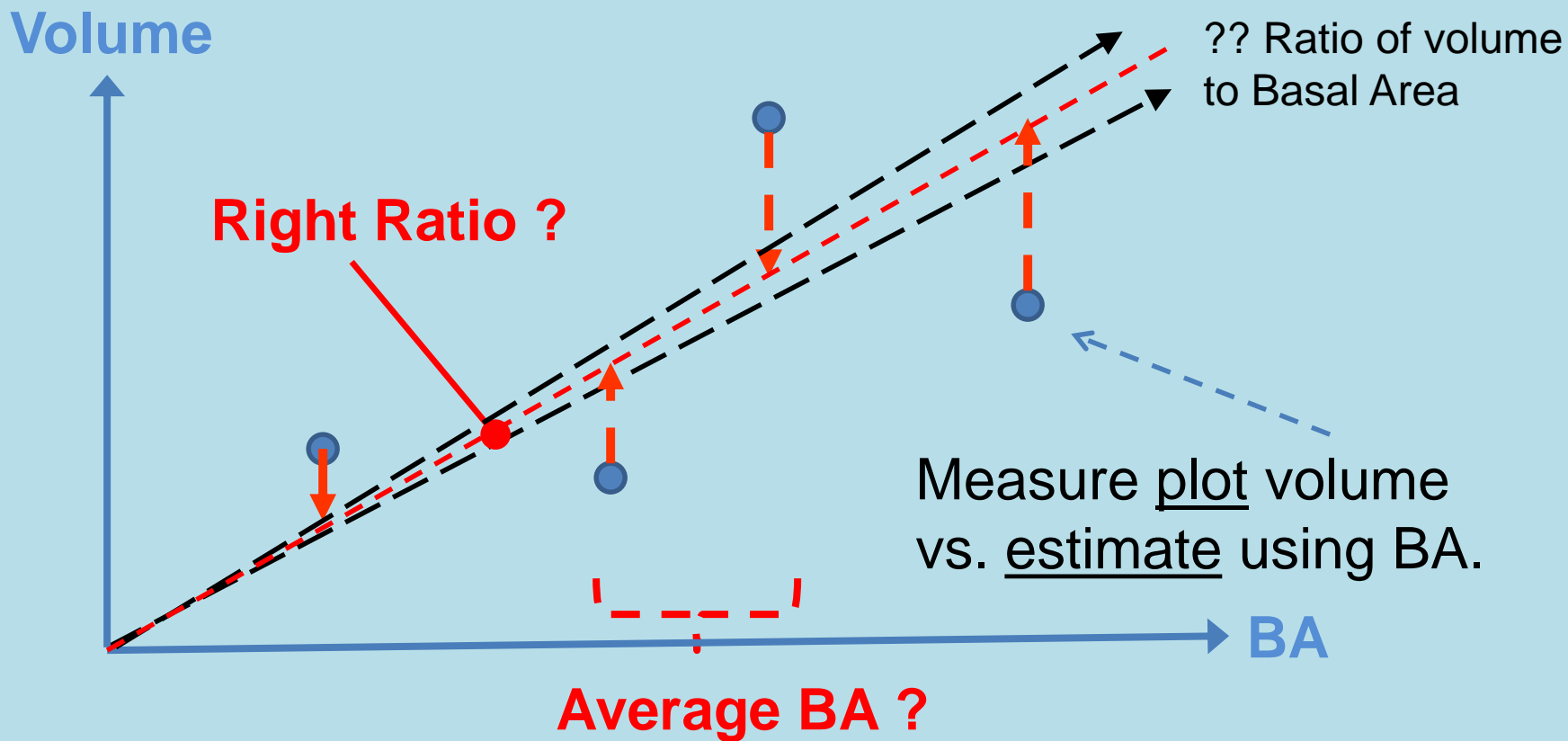3)   PS … You do the same tree measurements with <u>any</u> of these systems.

It's called "Double Sampling" and uses <u>Plot</u> volumes & BA's
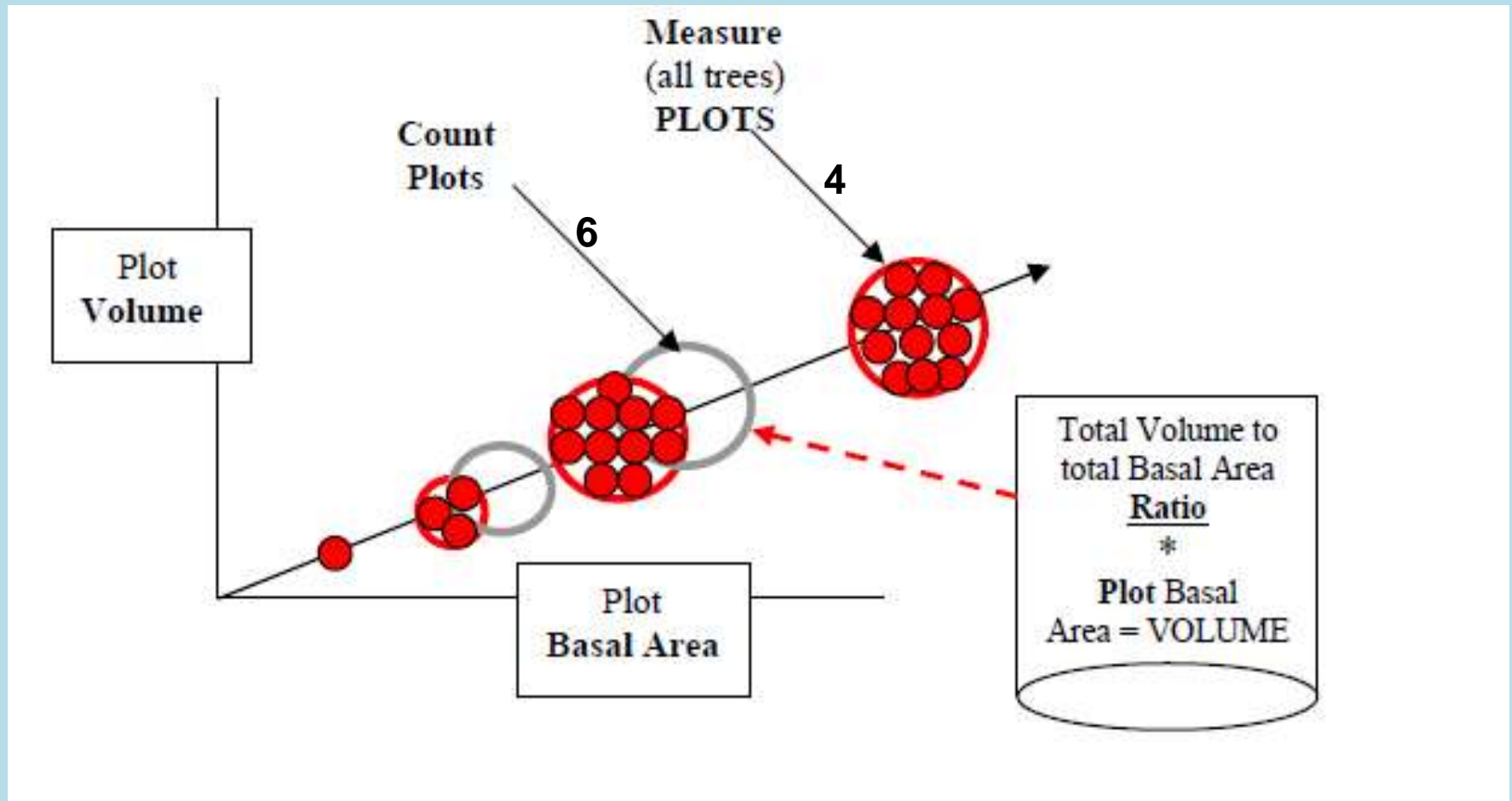
Key points

1) These trees are <u>measured</u> in "clusters"
on the measured points.

2) Many <u>counts</u> are done to improve the final result.

There is sampling error in the average Basal Area and the Vol/BA correction.

The statistical formula is **messy** for Double Sampling

Known as

"Johnson's Formula" in forestry

Next, DAVE Bruce – the son

He said : A "Product Estimator" could also be used here.
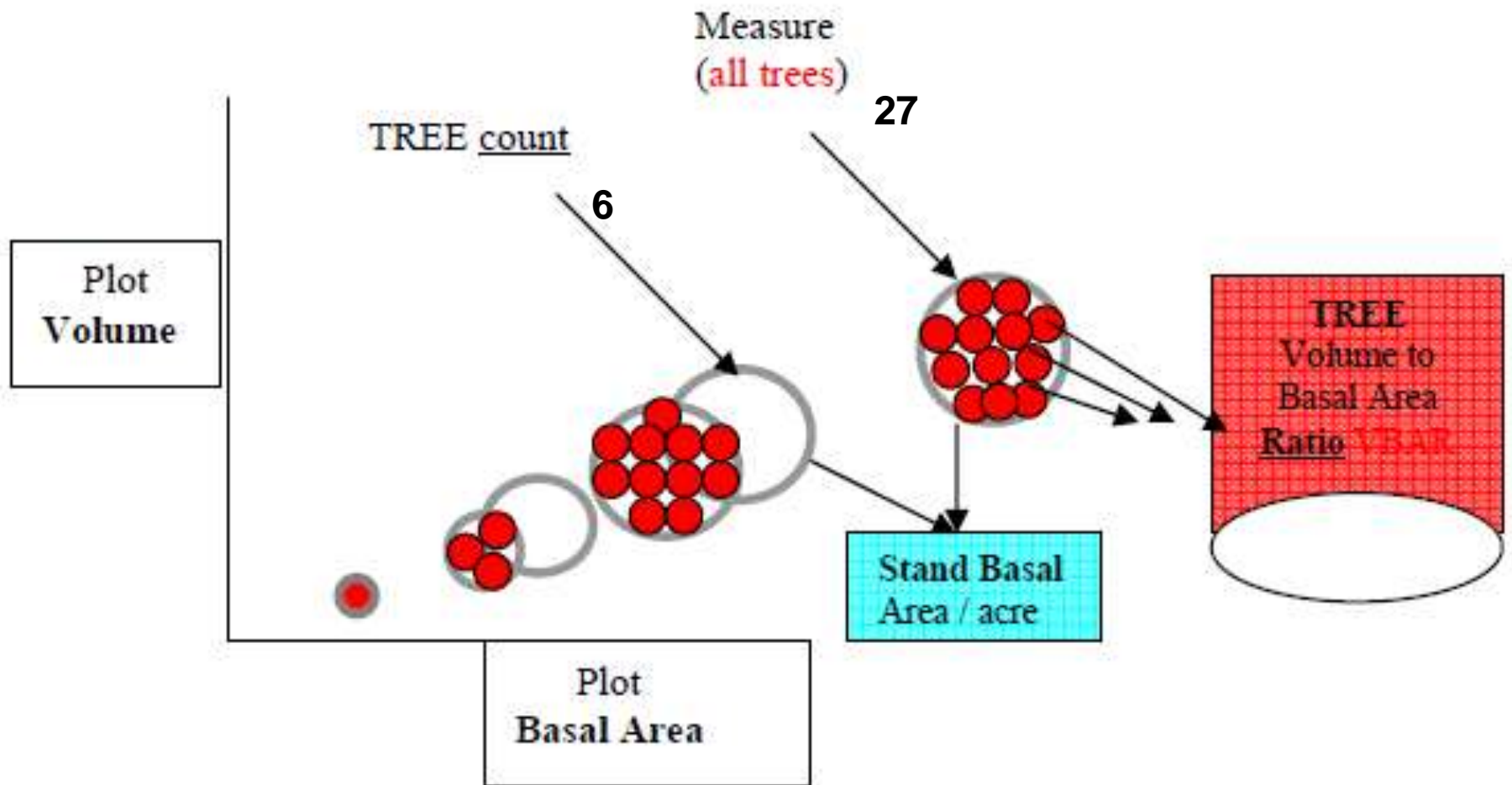
(Dave also invented the wedge prism)

(1) Find BA *somehow ...* ft^2

(2) Find the VBAR *somehow ...* BF/ft^2

(3) **Multiply** them together ...   BF

This clearly <u>separates</u> steps (1) and (2), *although we <u>often</u> do both on the same sample points*.

The "Product Estimator"

Easy Statistics : (Bruce's Formula)

$$\text{SE\% } \underline{\text{combined}} = \sqrt{\left(\text{SE\% basal area } \mathbf{plots}\right)^2 + \left(\text{SE\% VBAR } \mathbf{trees}\right)^2}$$

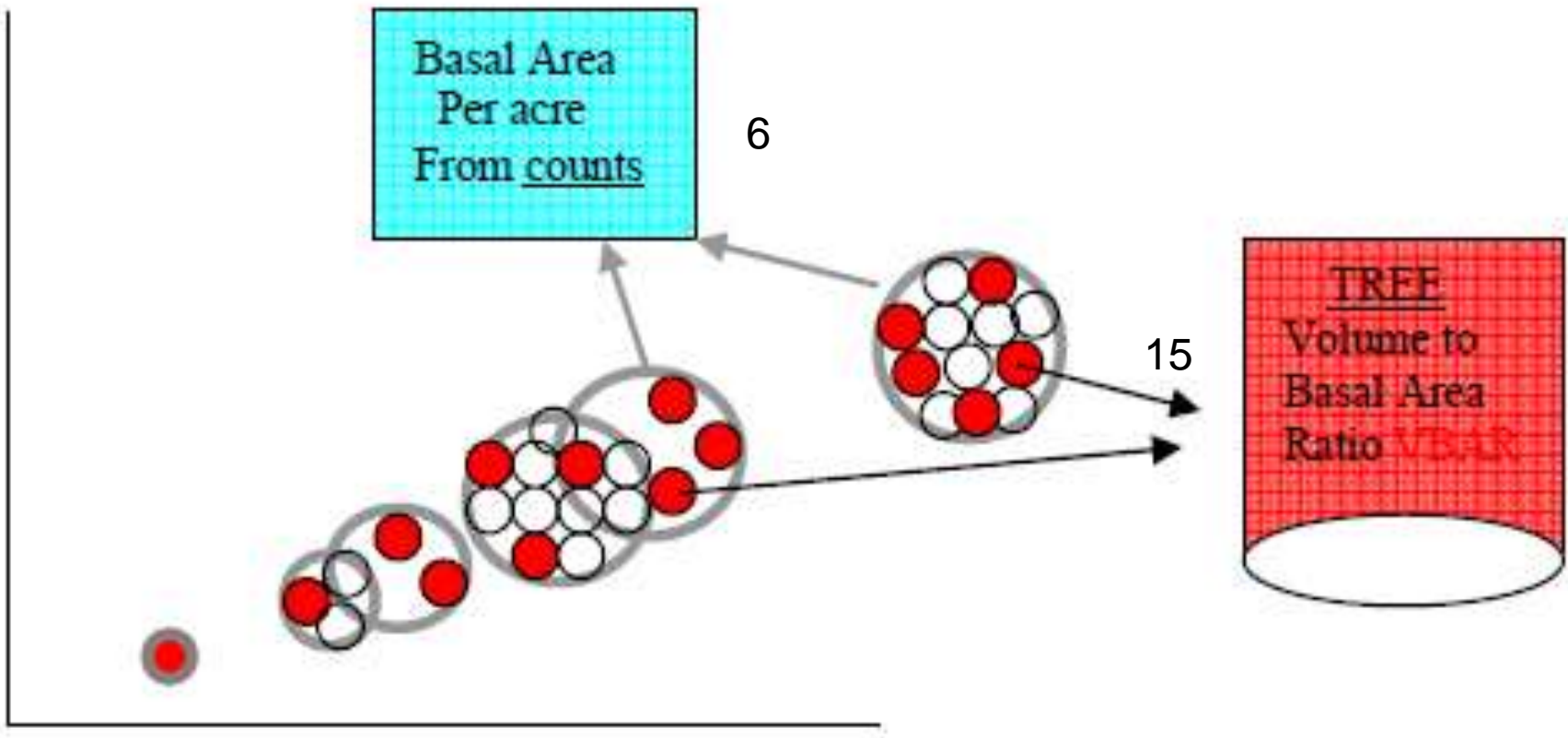**Combined SE%**

VBAR SE%

Basal area SE%

A 30 year gap …
Finally - Big BAF sampling (1980)

- Now you <u>systematically</u> "spread out" the trees through the stand, and get about <u>double</u> the affect of taking trees in clumps on "measure plots".

- **The <u>advantage</u> is the Systematic Sampling**

BIG BAF : Spread out the tree measurements

At every plot

- Choose the trees to <u>count</u> by a **small angle**, this gives you the stand basal area.

- Choose just a few <u>measured</u> trees with a **large angle** to find out their Volume/BA ratio.

- If the BAF is 5 times larger, you get 1/5th the trees, and they are closer and easy to see.

- Other methods to "spread out" VBARs
  (see the John Bell Newsletter for these)

How many **of each type?** (TC **vs. VBARs**)

- Effort in each type is pretty much given by :

  CV of **Tree Count** vs. **CV** of **VBARs**

- **40%** and **30%** indicate [40 counts & 30 trees], in multiples sufficient for the SE% you want.

- There is a simple EXCEL spreadsheet for the exact sample size computation.

What data matters?

- It's easy to tell – just add or subtract data and **recompile** the results to see if anything changes.

Beliefs do not matter here …

this is algebra, not theology

It is usually the case that you need more counts.

What will more measured trees do for you?

- Tree measurements will give better underlined percentages of log products.

- Products will never be known better than the basal area they are multiplied by.

- All totals will change proportionally with BA for virtually all variables (BF, Grade, $, etc).

What will more **Count Plots** do for you?

- Tree measurements will give better <u>percentages</u> by species and better <u>BA</u>.

- Much better <u>efficiency</u> for the cruise.

- Better totals of <u>anything</u> that uses Basal Area in its compilation (almost everything).

VBAR

-   <u>Usually</u> done by measuring a tree for its total volume, then dividing by that tree's basal area at DBH.

VBAR = **Volume** / tree **basal area** = **BF/ft**^{2}.

- "Solid cylinder height"
- There are other ways as well.

DBH
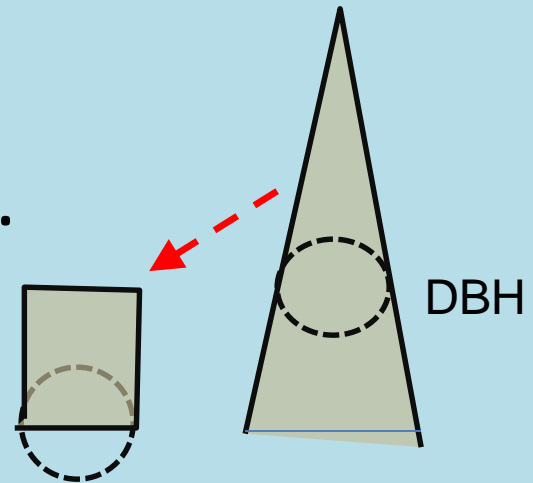
Another way to get VBAR

- Estimate the logs in the tree (MB&G, 1950's) for logs/ft^2, then measure BF/log to correct that.

The extra units cancel out …

$$ft^2/\textbf{acre} \; * \; logs/ft^2 * \textbf{BF}/log \; = \; \textbf{BF/acre}$$

More ways to get VBAR

- Use a **percentage of tree or stand** <u>**height**</u> roughly (**2 * total tree height**) = **BF/ft^2** For cubic (**Ht/3**) = **ft^3/ft^2**

- Use the vertical distance to where the tree is "borderline" ("**critical height**" **...** Relascope).

- Use "**Pressler's Height**" (use Relascope).

- Use **historical data** .

What data should you see?

- Any computer program needs to report how variable the **TC** and **VBAR** are.
  (The "CV" statistic for each).
  VBAR can be any tree measurement divided by the tree basal area (giving statistics).

- The program should give you the measured tree data, so you can research it on your own.

What is next?

- **3P sampling**, which :

Makes quick <u>estimates</u> for everything.
then <u>corrects</u> those estimates.

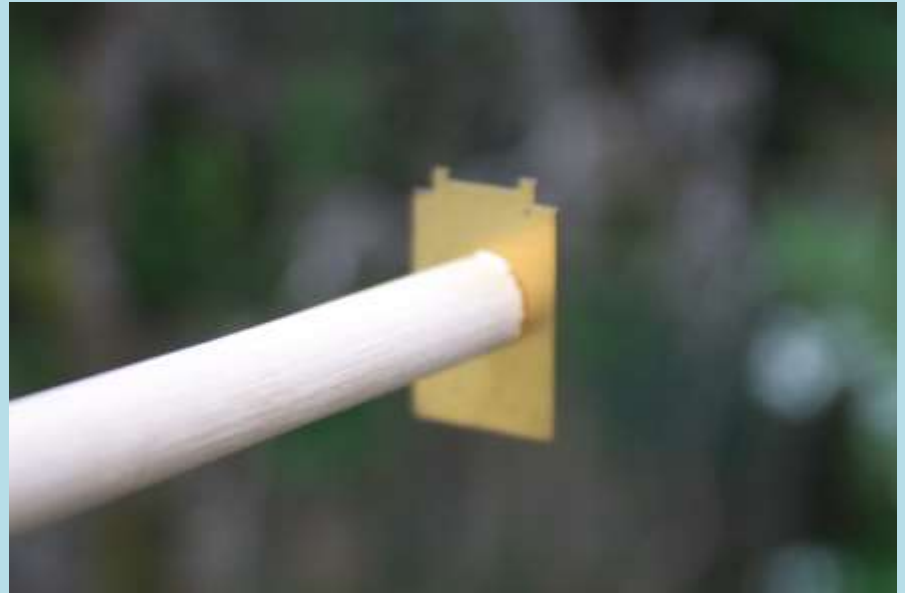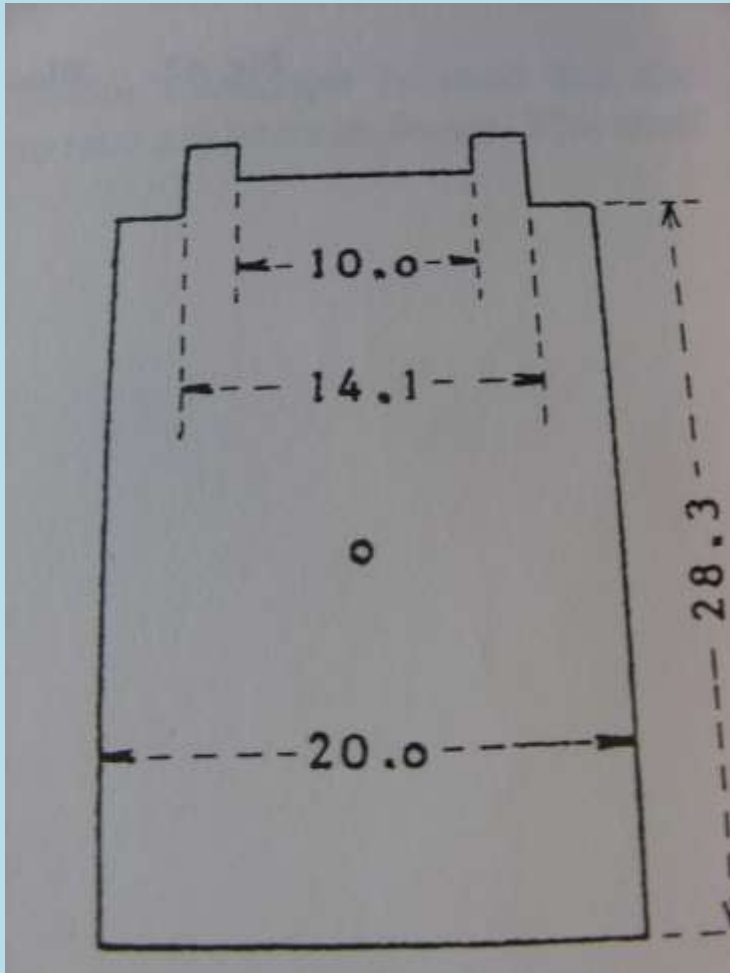3P is good for <u>anything</u>, not just trees.

Thanks for your patience

I know it's not scaling, but

You are the <u>timber</u> measurements society.

Some instruments of cruising, for you to look over later.

The first Relascope target

Bitterlich wanted this target etched on his tombstone

Bitterlich's first Relascope

Bitterlich's Wooden Relascope

The 8-power Relascope

The Bitterlich teaching tool
2, 3, and 4 dimensional VP sampling

The first "wedge prism"

The first published prism (6X)

Also, some handouts on …

- **VP sampling** (and the story of its development, according to Bitterlich)

- **Prism Cruising**
- Story of the development of it (by Bruce)