

Sampling at Permanent Sites; What Do We Mean, Why Should We Care, and is it Worth It?

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Basic Sources of Variability

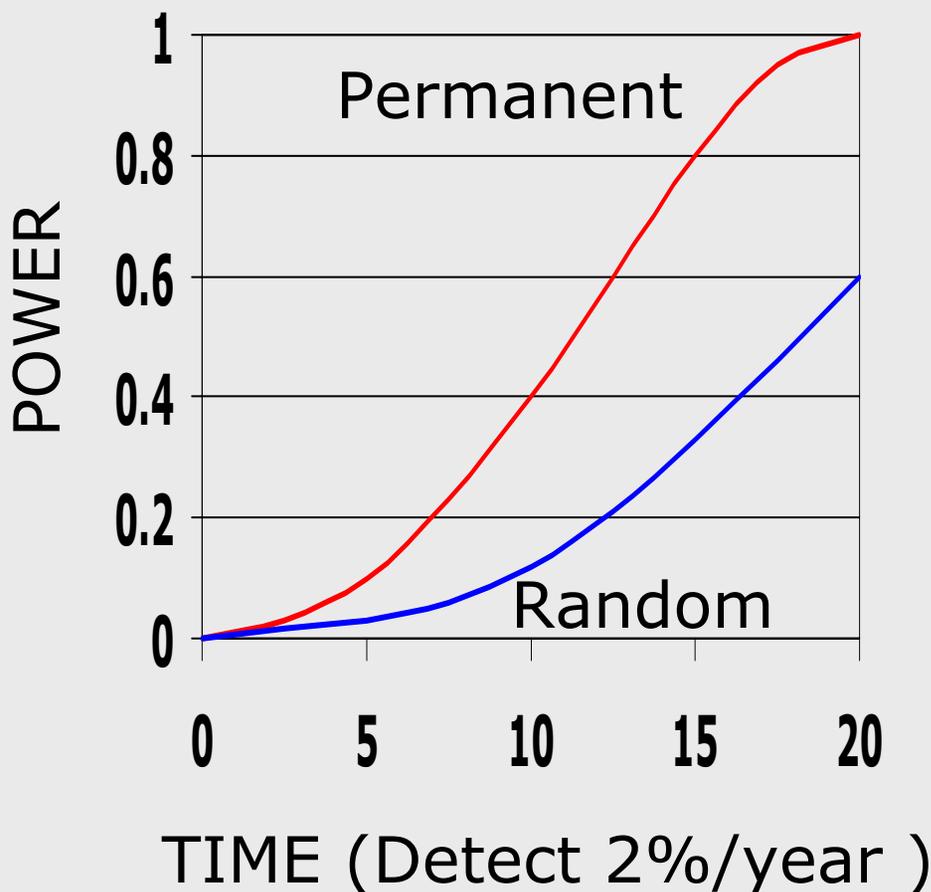
In Long-Term Regional Sampling Designs, Sampling Variance Can be Decomposed into;

- **Year**
- **Site**; Differences between Sites
- **Residual**; Composed of Observer Variability, Year by Site Interaction, Time Within Index Window Differences, Random Error, Demonic Intervention...).

How Can Permanent Sites Improve Trend Detection?

- Using Permanent Sites CAN Reduce the Total Variance in the Model by Eliminating Between Site Variability (environmental heterogeneity).
- This results in either:
 - Greater Power to Detect Trends
 - Detecting Changes Quicker
 - Lower Sample Sizes

Trend Detection in Permanent and Temporary Sampling Designs.

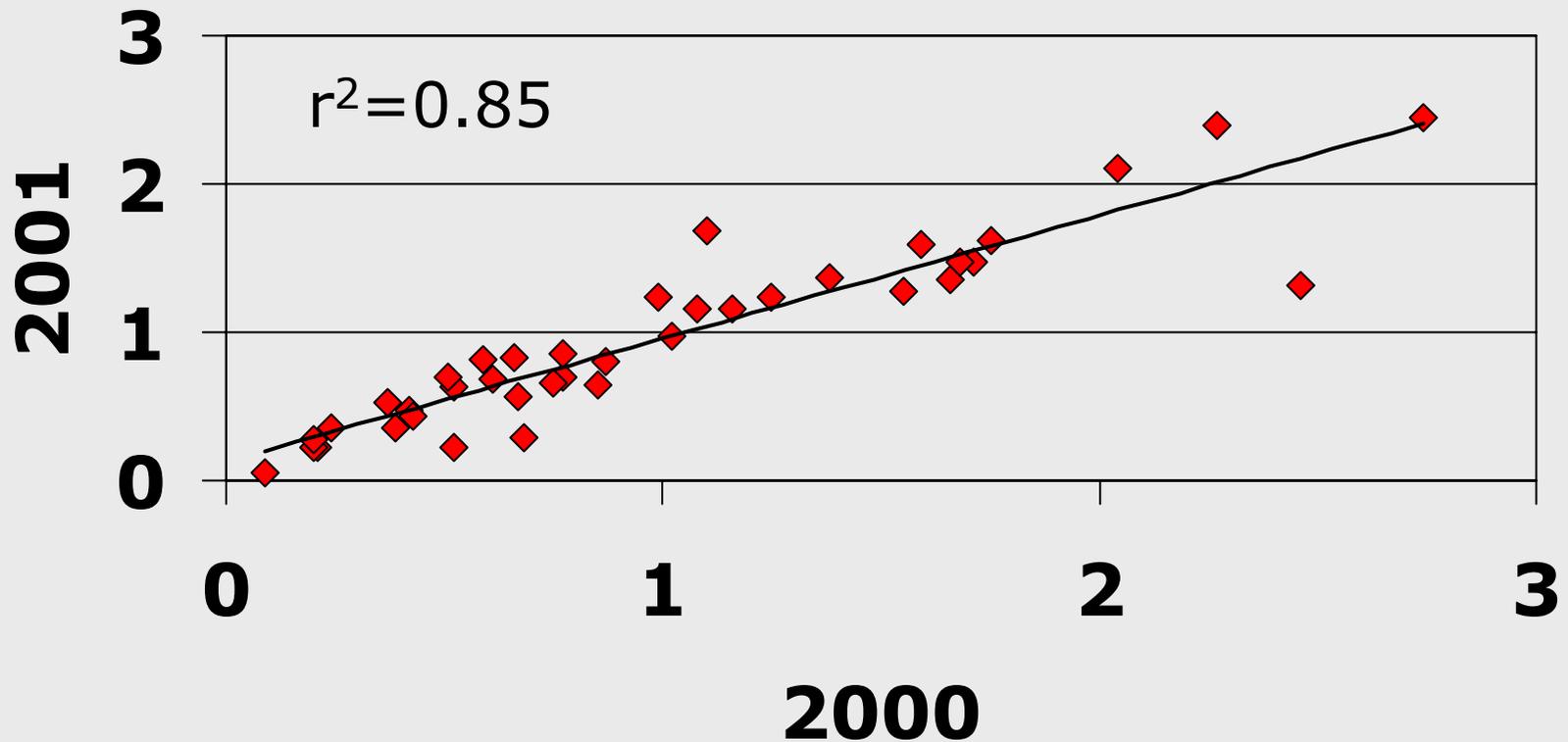


Permanent assumes no variability

Actual line will vary depending on whether values recorded at repeated visits to the same sites are similar – Are they correlated

Gradient at Permanent Sites

r^2 = Coefficient of Determination



So at What Point Does it Make Sense
to Collect Data at Permanent Sites?

For a Simplistic Example

$S_{\text{site}}=4$ $S_{\text{resid}}=1$ $S_{\text{year}}=0$

One Step Further

$$S_{\text{site}}=4 \quad S_{\text{resid}}=1 \quad S_{\text{year}}=0$$

Lets Look at This Question through Statistical Efficiency (i.e. Reduced Variance).

$$S_{Adj_total} = S_{Total_time1} \sqrt{2(1 - \sqrt{r^2})}$$

From Elzinga 2001, Monitoring Plant Populations

For Example

$$S_{\text{site}}=4 \quad S_{\text{resid}}=1 \quad S_{\text{year}}=0$$

$$S_{Adj_total} = S_{Total_time\ 1} \sqrt{2(1 - \sqrt{r^2})}$$

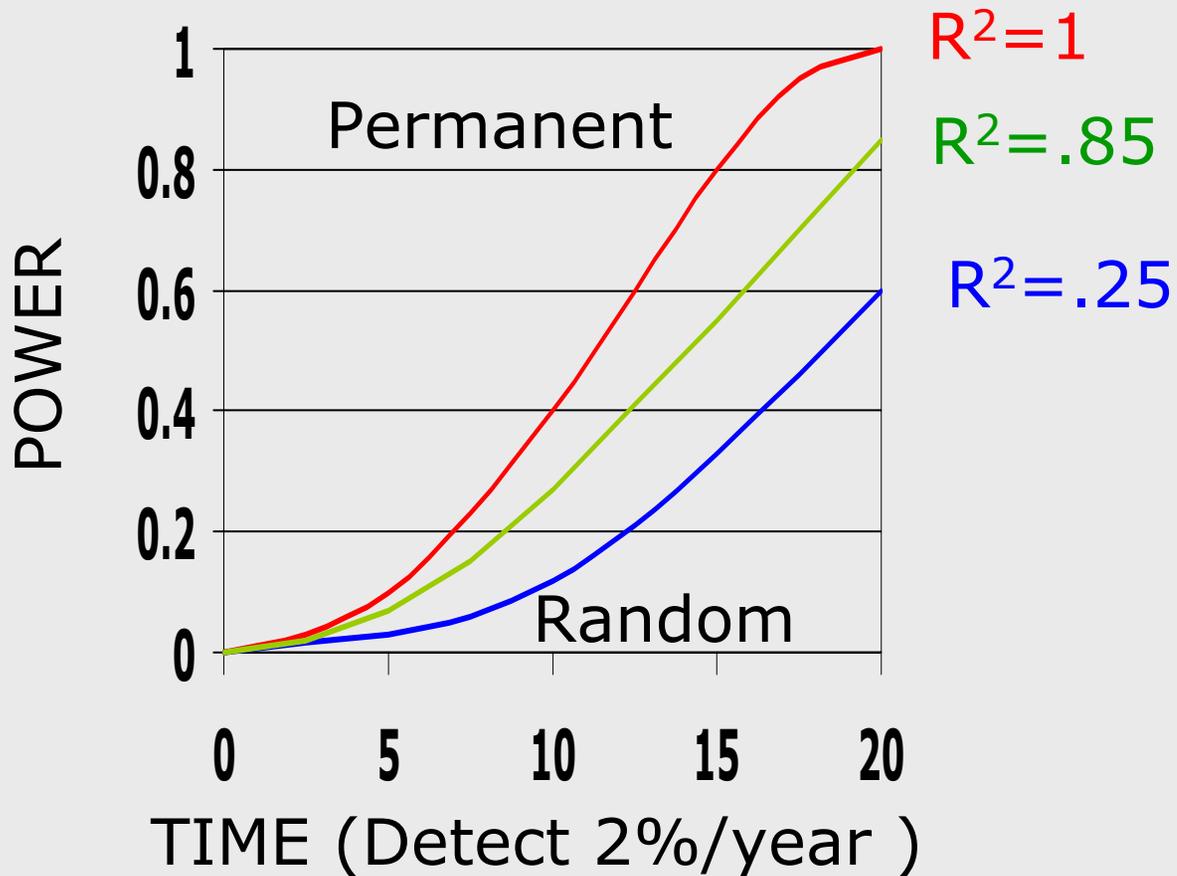
$$S_{Adj_total} = 5 \sqrt{2(1 - \sqrt{1})} = 5 \sqrt{0} = 0$$

$$S_{Adj_total} = 5 \sqrt{2(1 - \sqrt{.25})} = 5 \sqrt{1} = 5$$

$$S_{Adj_total} = 5 \sqrt{2(1 - \sqrt{.85})} = 5 \sqrt{.3} = 2.75$$

Effect of r^2 on Trend Detection

!!This is a Cartoon!!



So if $r^2 > .25$
(given some assumptions)

Then there Will be an Advantage to
Sampling at Permanent Sites

If $r^2 < .25$ or is negative,
there is no advantage to permanent
sites

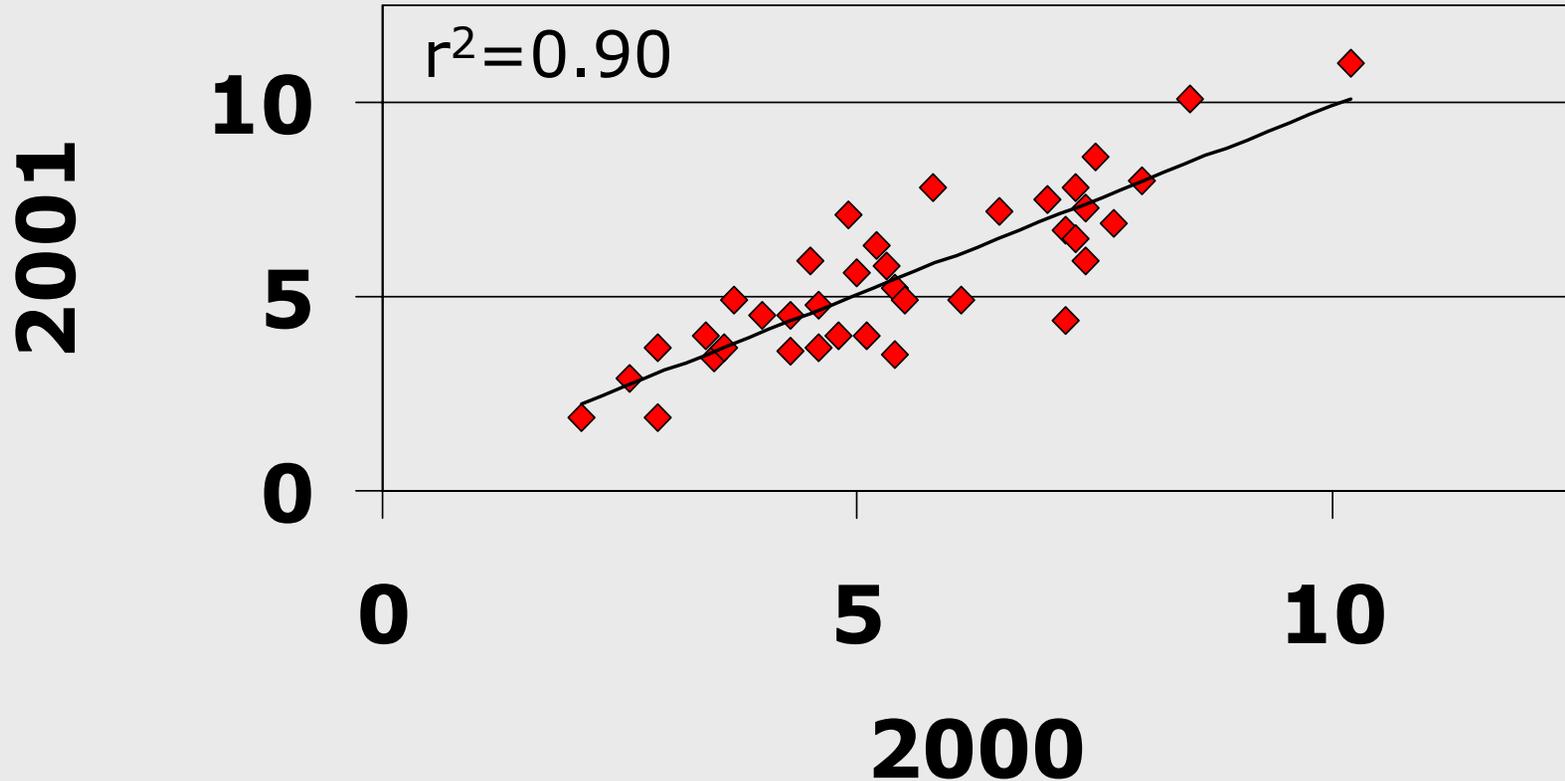
Study Objectives

- How advantageous is it to sample permanent sites???
- How exact do we have to be when relocating sites???

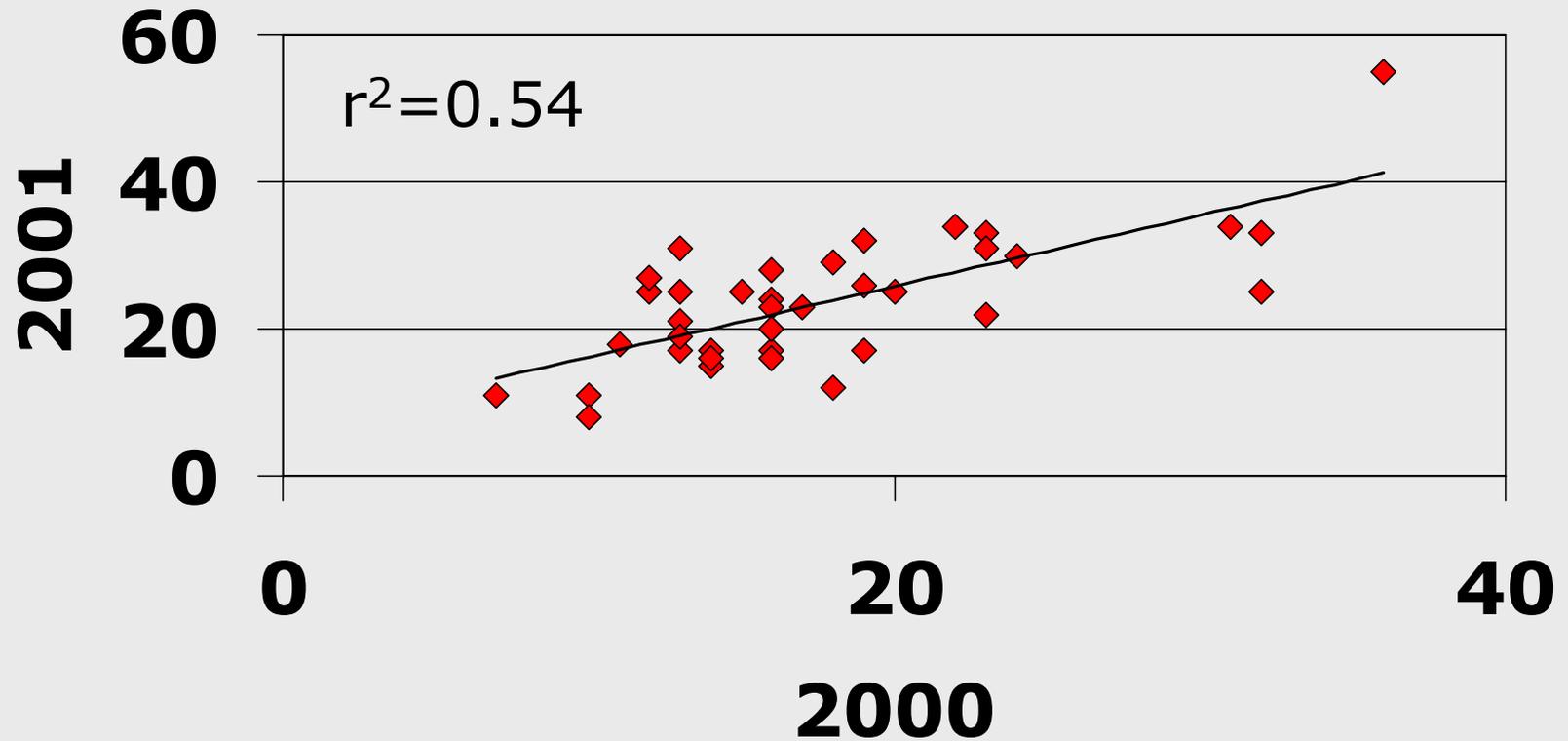
So What Do We Mean By “Permanent”

- 37 sites were sampled in 2000 and 2001. Sites were relocated using GPS coordinated, site maps, written descriptions, and photographs
- Below Bankfull Conditions for both years
- Evaluated 10 Commonly Collected Physical Attributes

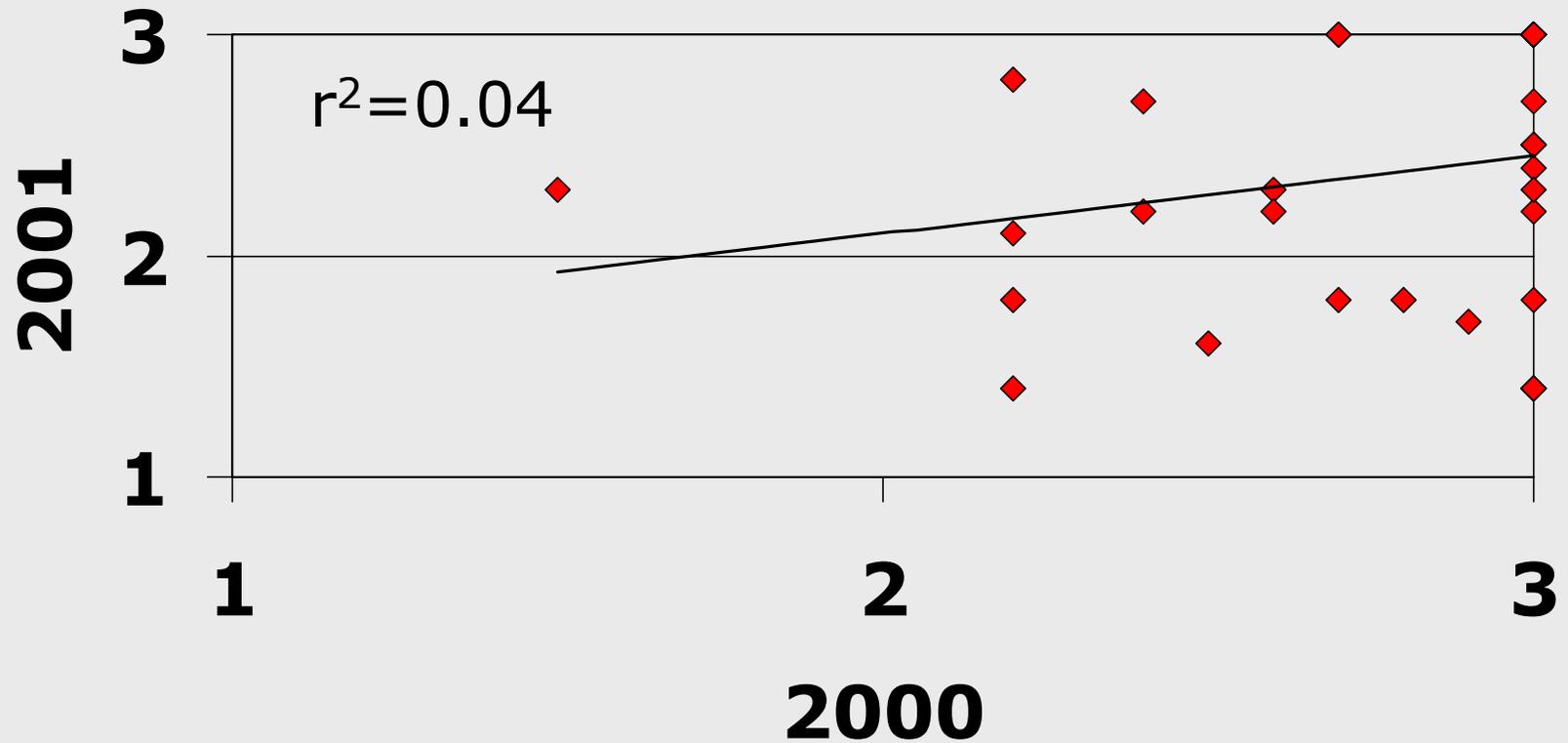
Bankfull Width at Permanent Sites



Width-to-Depth at Permanent Sites.



Entrenchment at Permanent Sites.



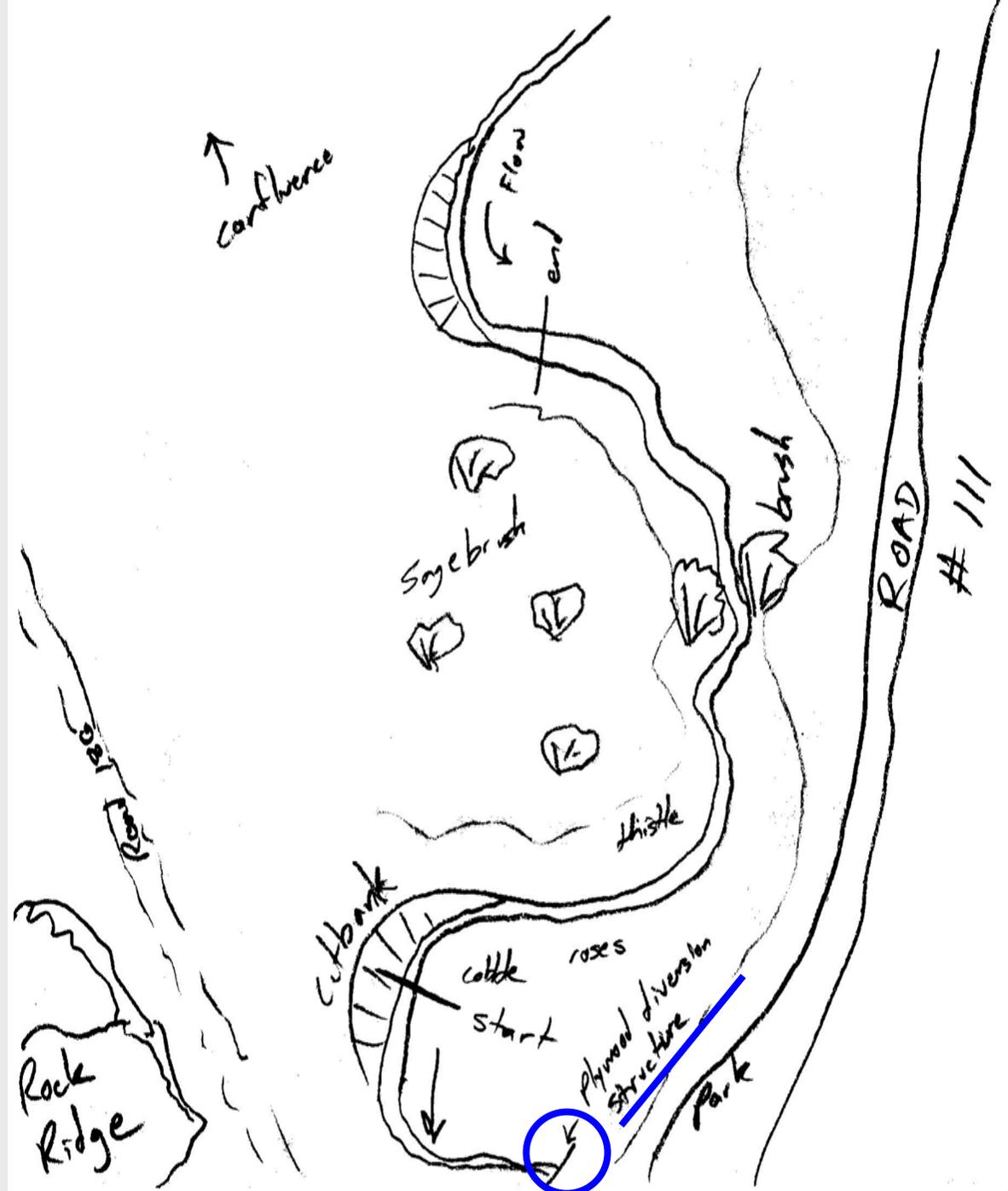
r^2 for all attributes

Attribute	r^2 value	Attribute	r^2 value
Gradient	0.85	% pools	0.74
Sinuosity	0.82	Res. pool depth	0.86
BF width	0.90	% riffle fines	0.78
W:D ratio	0.54	D50	0.70
Entrench	0.04	Bank stability	0.36

So What Can We Conclude About Permanent Sites.

- For Most Attributes We Can Reduce the Total Variation By Using Permanent Sites.

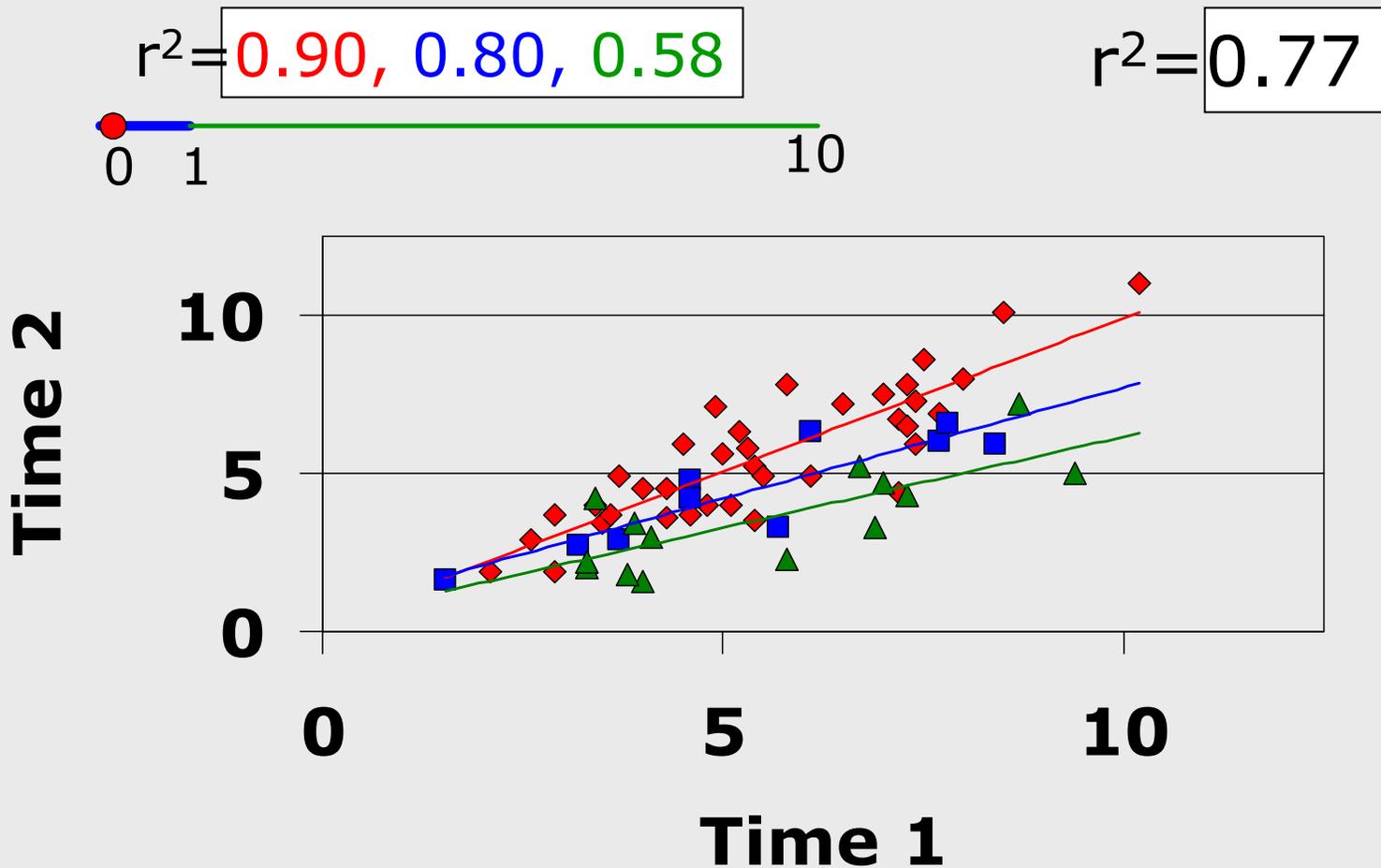
Objective 2 -
How exact do we
have to be when
relocating
sites???



Compared the “ r^2 ” values from 3 Groups

- 3 Groups
 - GPS Determined Locations (n=37)
 - Between 0.1 and 1 km Apart (Same General Stream Segment) (n=14)
 - Between 1 and 10 km Apart (Same Reach Type/Watershed) (n=14)
- Below Bankfull Conditions for 2000 & 2001 and most sites in 2002
- Evaluated 10 Commonly Collected Physical Attributes

Bankfull Width at All Distances.



"r²" For Each Strata

Attribute	Perman. sites	0.1-1 km	1-10 km	RRI
Gradient	0.85	0.68	0.04	0.50
Sinuosity	0.82	0.02	0.09	0.39
BF width	0.90	0.80	0.58	0.77
W:D ratio	0.54	0.07	0.01	0.36
% pools	0.74	0.60	0.14	0.54

"r²" For Each Strata

Attribute	Perman.	0.1-1 km	1-10 km	RRI
Res. Pool depth	0.86	0.70	0.49	0.80
% riffle fines	0.78	0.32	0.23	0.49
D50	0.70	0.13	0.12	0.45
Bank stability	0.36	0.23	0.04	0.28
Entrench	0.04			
Total	9 of 10	5 of 10	2 of 10	9 of 10

So How Permanent Does It Have to Be?

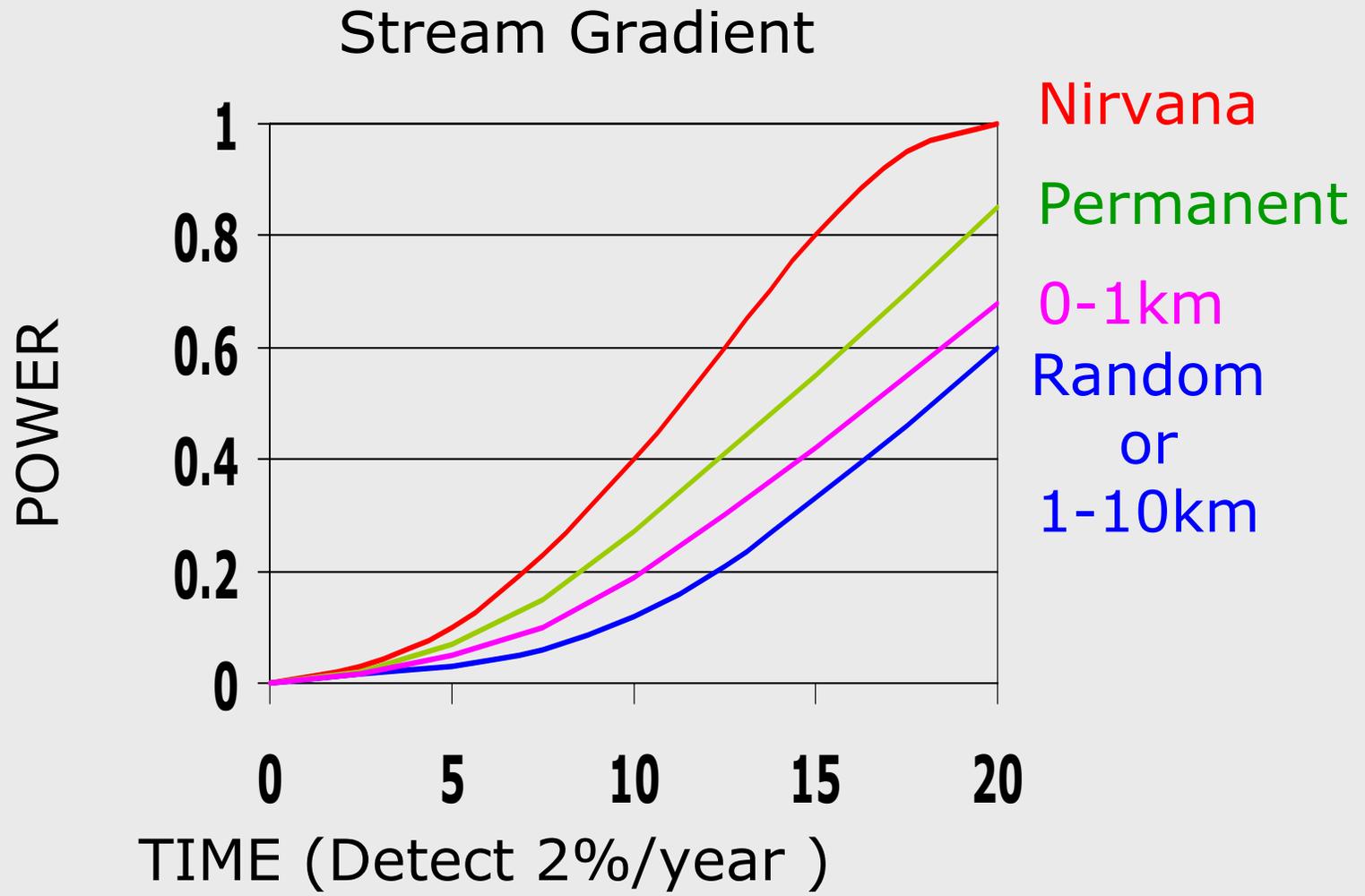
Depends Upon the Variable

- Close May Be Good Enough – Bankfull Width and Residual Depth.
- Close Hurts But May Be Workable – Gradient, % Riffle Fines, % Pools, and D_{50} .
- Exact May Not Be Close Enough – Width-to-Depth and Bank Stability
- Or maybe we need to be closer – monument location of all measurements?

Conclusions

- Re-sampling permanent sites will increase our ability to detect TRENDS for most variables
- Close is not good enough,
Permanent = Exact Same Location

Where Are We Going From Here !!This is still a Cartoon!!



Where Are We Going from Here

- How often sites are re-sampled?
- Sites need to be “more” permanent?
- How does sample size effect the curves?
- How does year to year variation affect this?