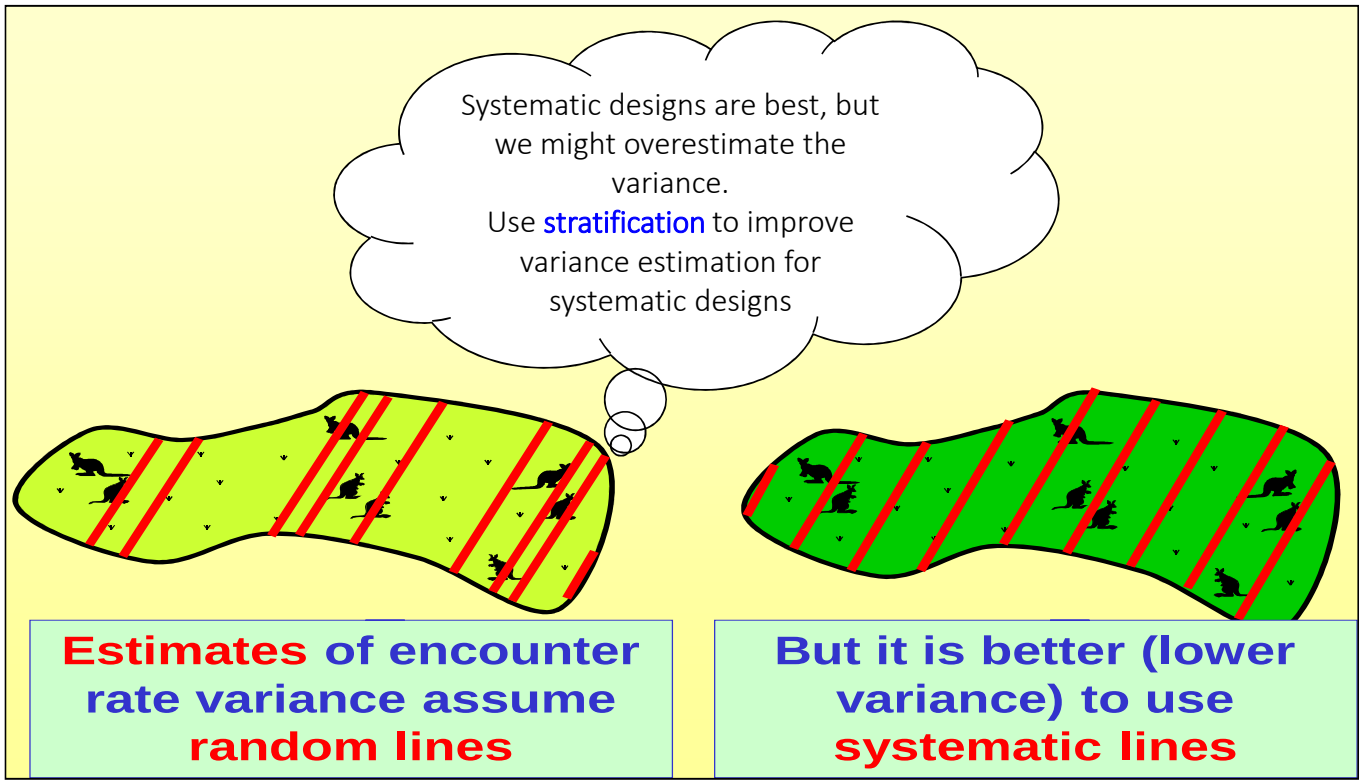
Producing a better estimate of variance when systematic samplers are used

• Fewster, RM, Buckland, ST, Burnham, KP, Borchers, DL, Jupp, PE, Laake, JL, and Thomas, L. 2009. Estimating the encounter rate in distance sampling. Biometrics 65: 225-236.

Systematic samples

Problem:

Systematic designs give the best variance, but the worst variance estimation!

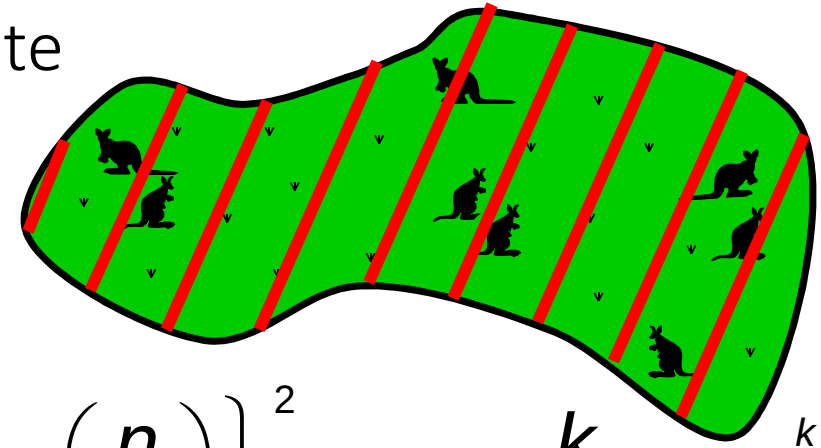


No unbiased estimator exists for estimating variance from a single systematic sample

Systematic samples advice

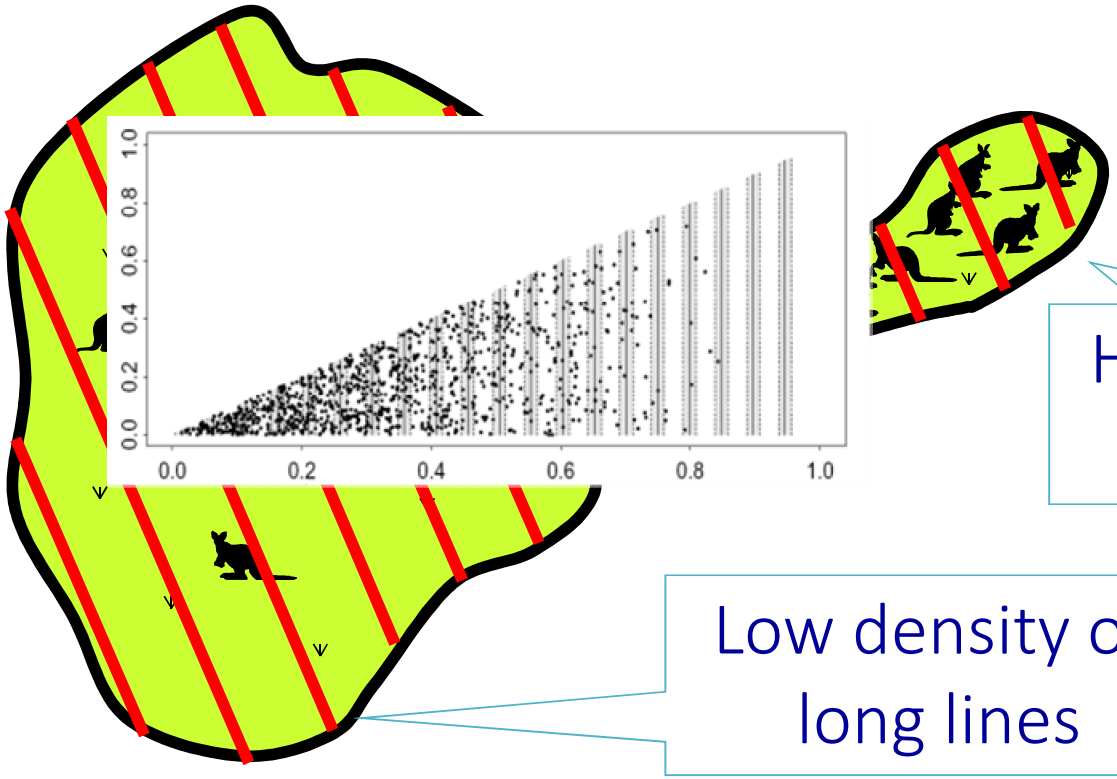
Usually, do nothing!

Variance estimation based on random lines will not be perfect, but adequate



$$\left\{ cv\left(\frac{n}{L}\right)\right\}^2 = \frac{k}{n^2(k-1)}\sum_{i=1}^{k}\lambda_i^2\left(\frac{n_i}{\lambda_i}-\frac{n}{L}\right)^2$$

If there are strong trends, variance might be significantly overestimated

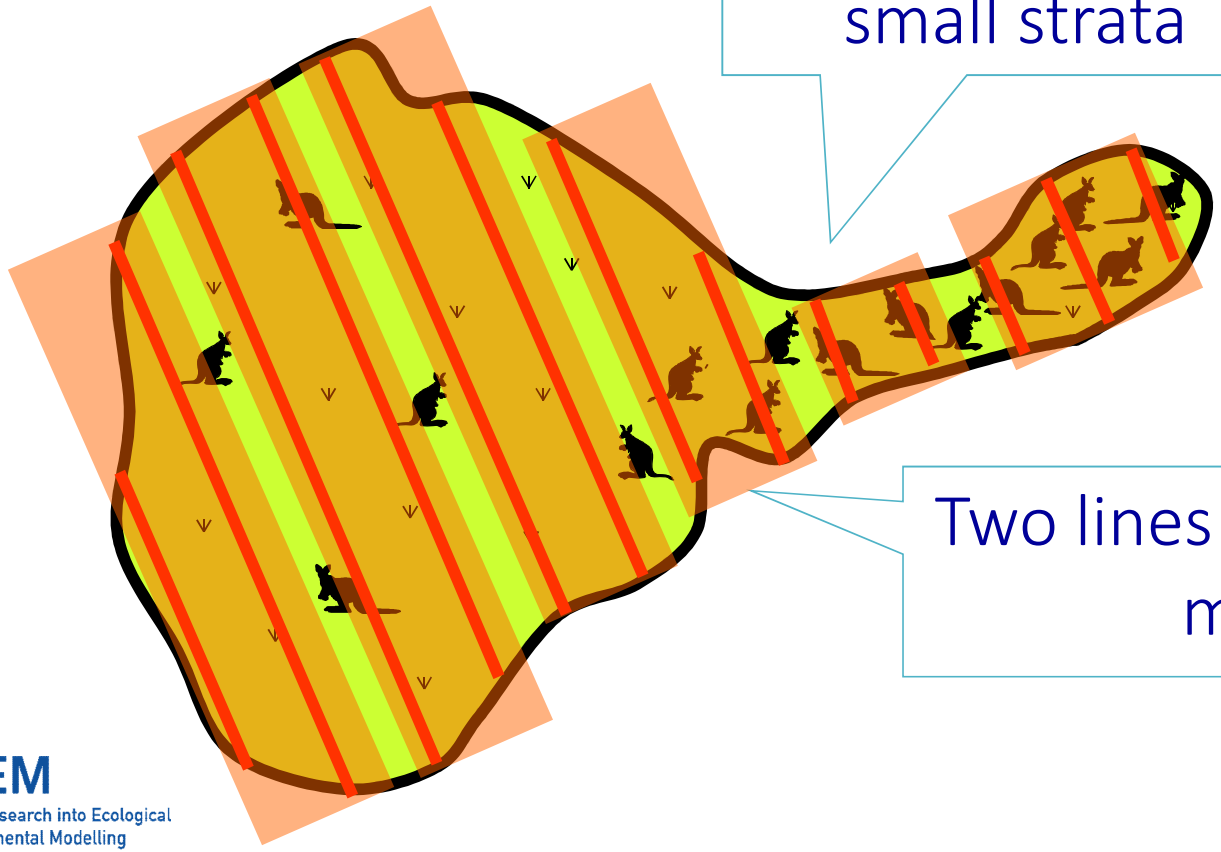


Worst case!

High density on short lines

Low density on long lines

Post-stratification can give much better variance estimates



Group lines into small strata

Two lines per stratum, or at most three

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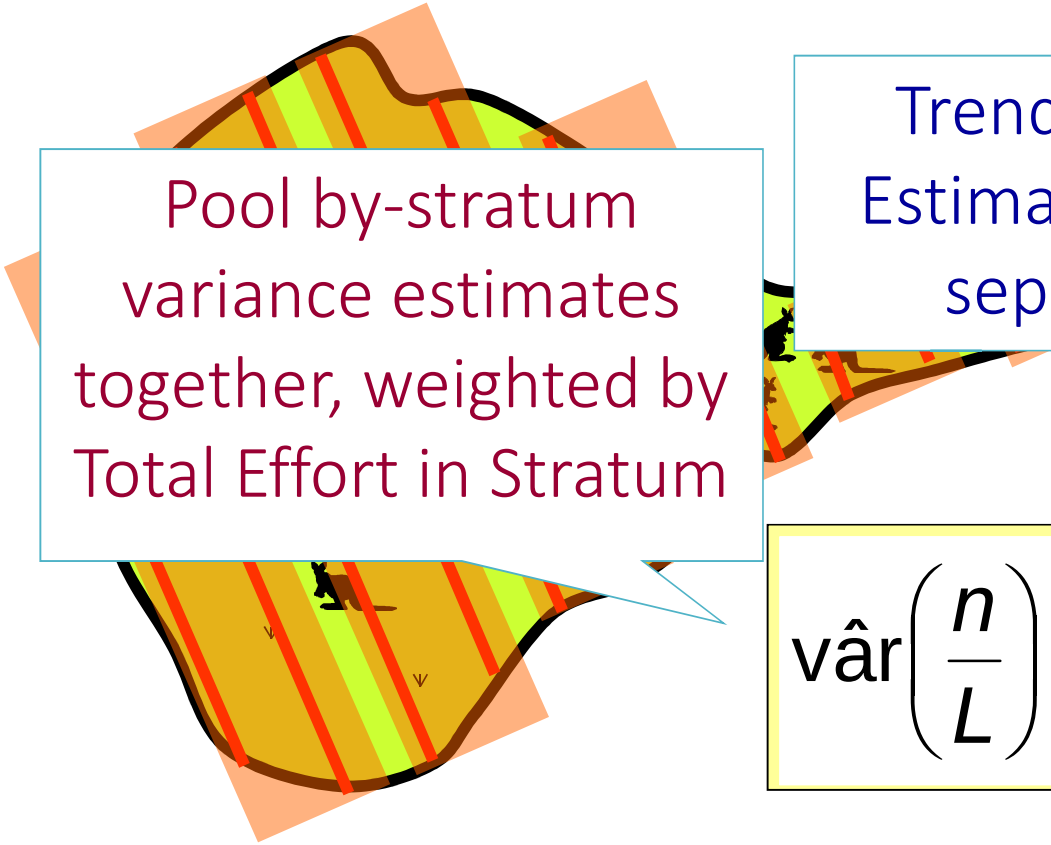
Post-stratification can give much better estimates of variance



Pool by-stratum variance estimates together, weighted by Total Effort in Stratum

Trends within strata are minor; Estimate encounter rate variance separately for each stratum

$$\hat{\text{var}}\left(\frac{n}{L}\right) = \frac{1}{L^2}\sum_{h=1}^{H} L_h^2 \,\hat{\text{var}}_h\left(\frac{n_h}{L_h}\right)$$

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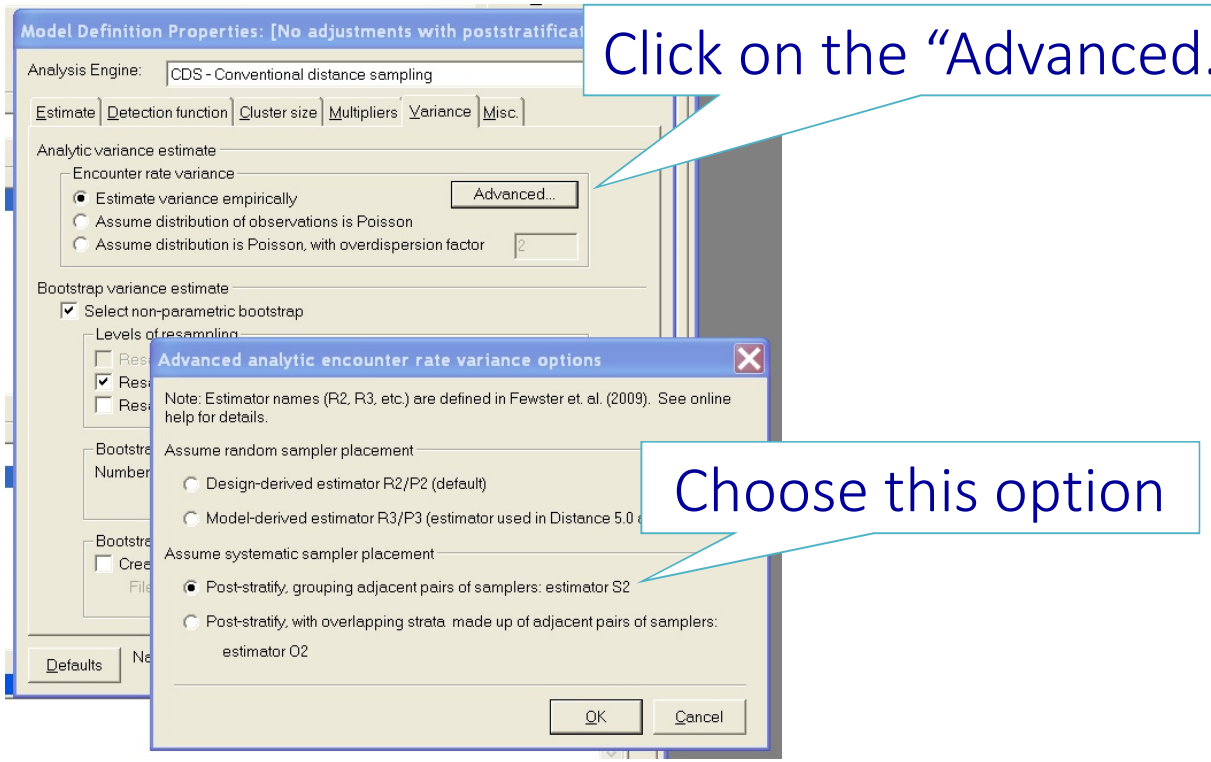
In Distance 7:



Successive pairs of lines will be grouped together, according to their ID in the sample layer (1 & 2, 3 & 4, etc). (If there are an odd number of lines, the last 3 will be grouped.)

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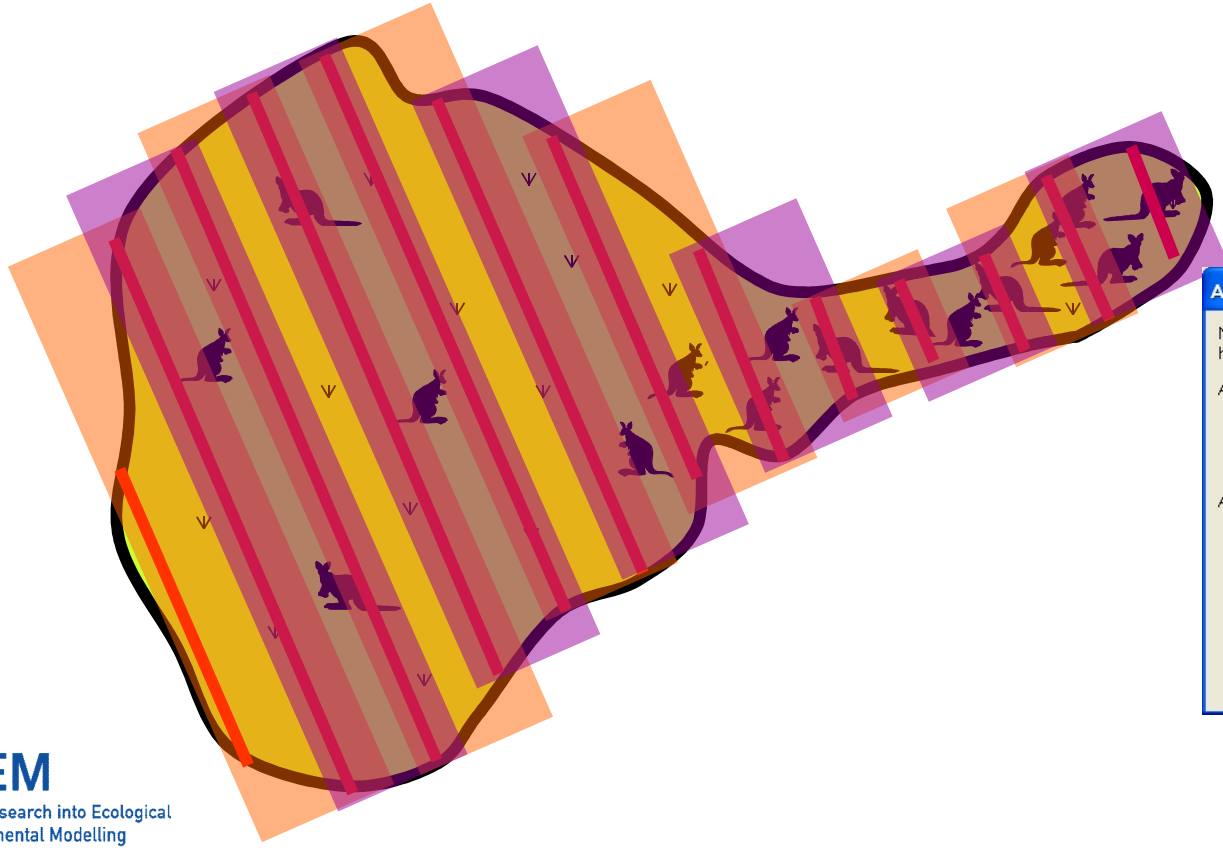
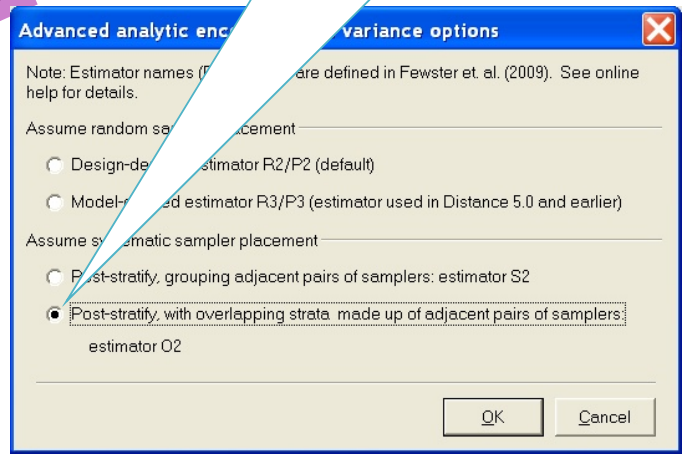
Overlapping strata are even better, as you get a larger sample size of post-strata



Choose this option



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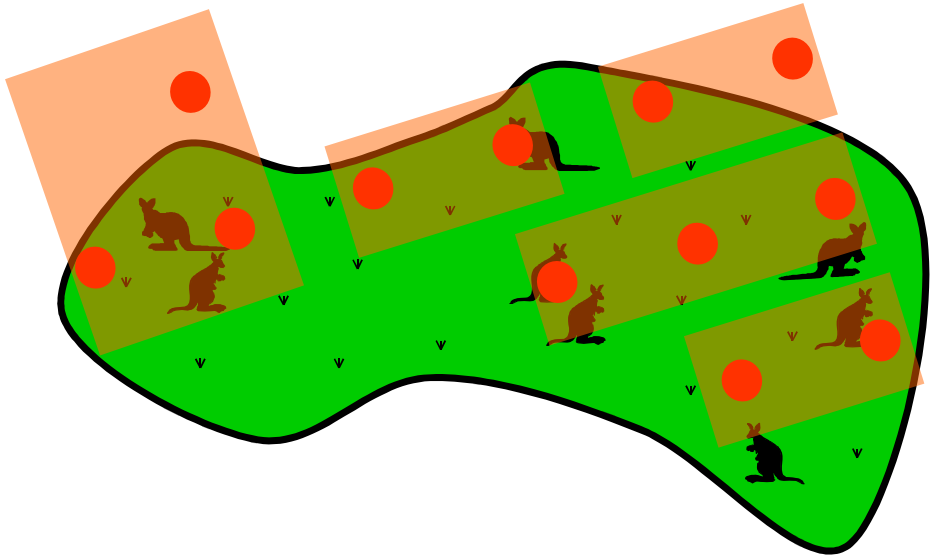
Systematic point transect surveys

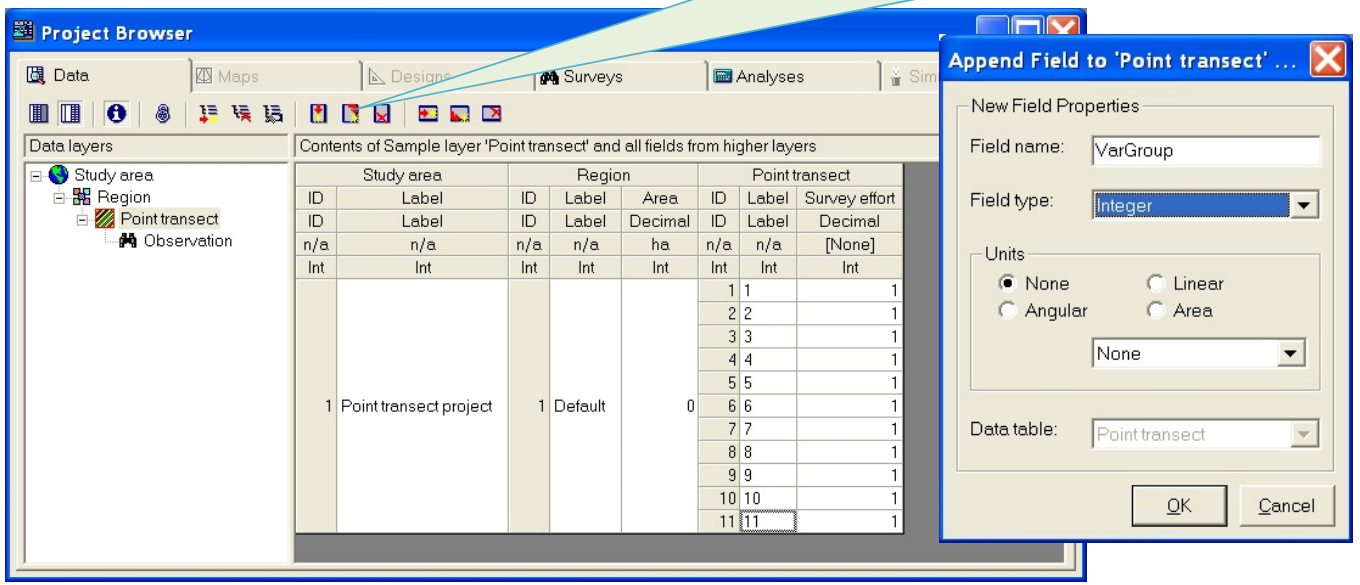
Less of an issue (no problem of different line lengths), but can similarly group into strata of two or three adjacent points for encounter rate variance if required.



However, it is harder to do in Distance – need to manually post-stratify.

Can only do non-overlapping post-stratification this way.

Add new field VarGroup into the Point transect layer (i.e., the sample layer)



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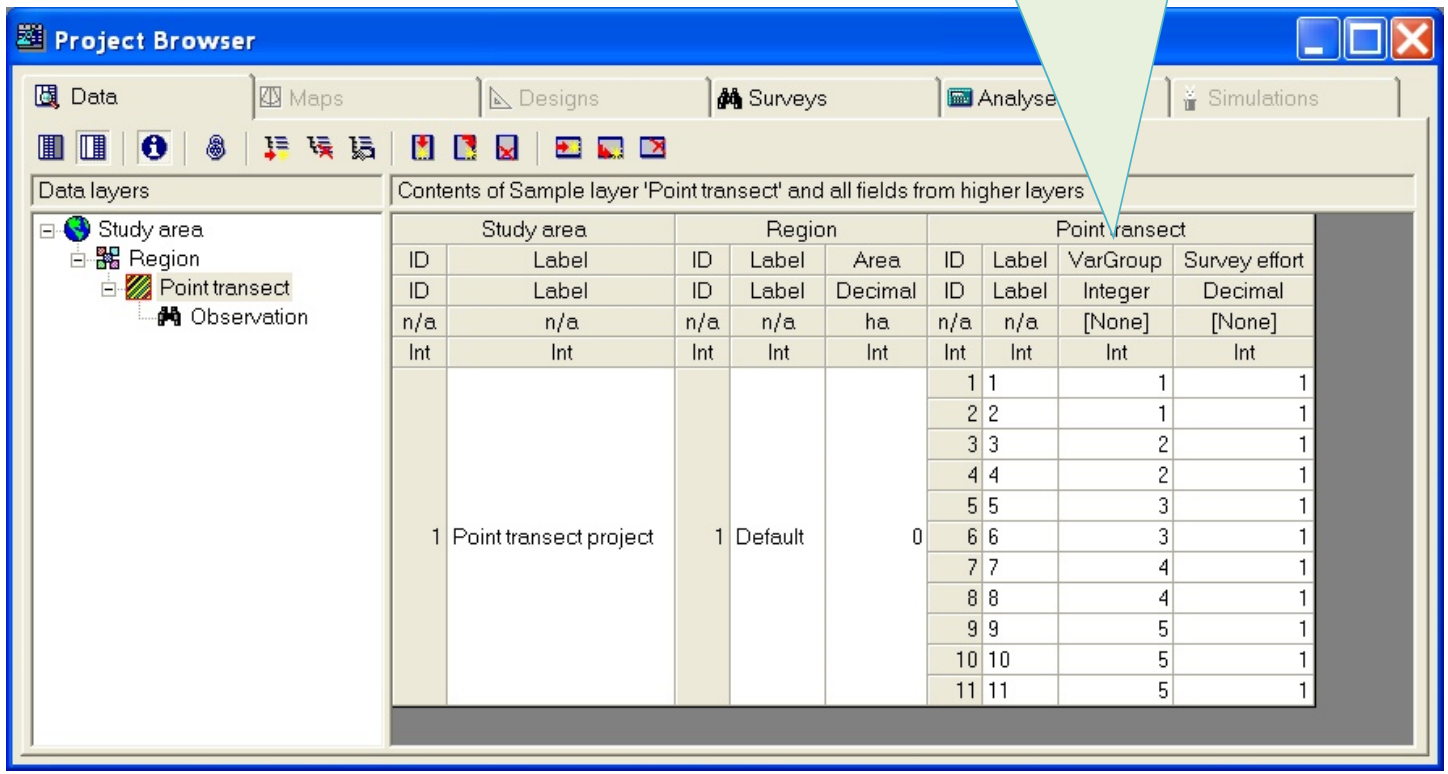
Enter values into VarGroup so that it groups together points 1 and 2, 3 and 4, etc



Study area		Region			Point transect			
ID	Label	ID	Label	Area	ID	Label	VarGroup	Survey effort
ID	Label	ID	Label	Decimal	ID	Label	Integer	Decimal
n/a	n/a	n/a	n/a	ha	n/a	n/a	[None]	[None]
Int	Int	Int	Int	Int	Int	Int	Int	Int
1	Point transect project	1	Default	0	1	1	1	1
					2	2	1	1
					3	3	2	1
					4	4	2	1
					5	5	3	1
					6	6	3	1
					7	7	4	1
					8	8	4	1
					9	9	5	1
					10	10	5	1
					11	11	5	1

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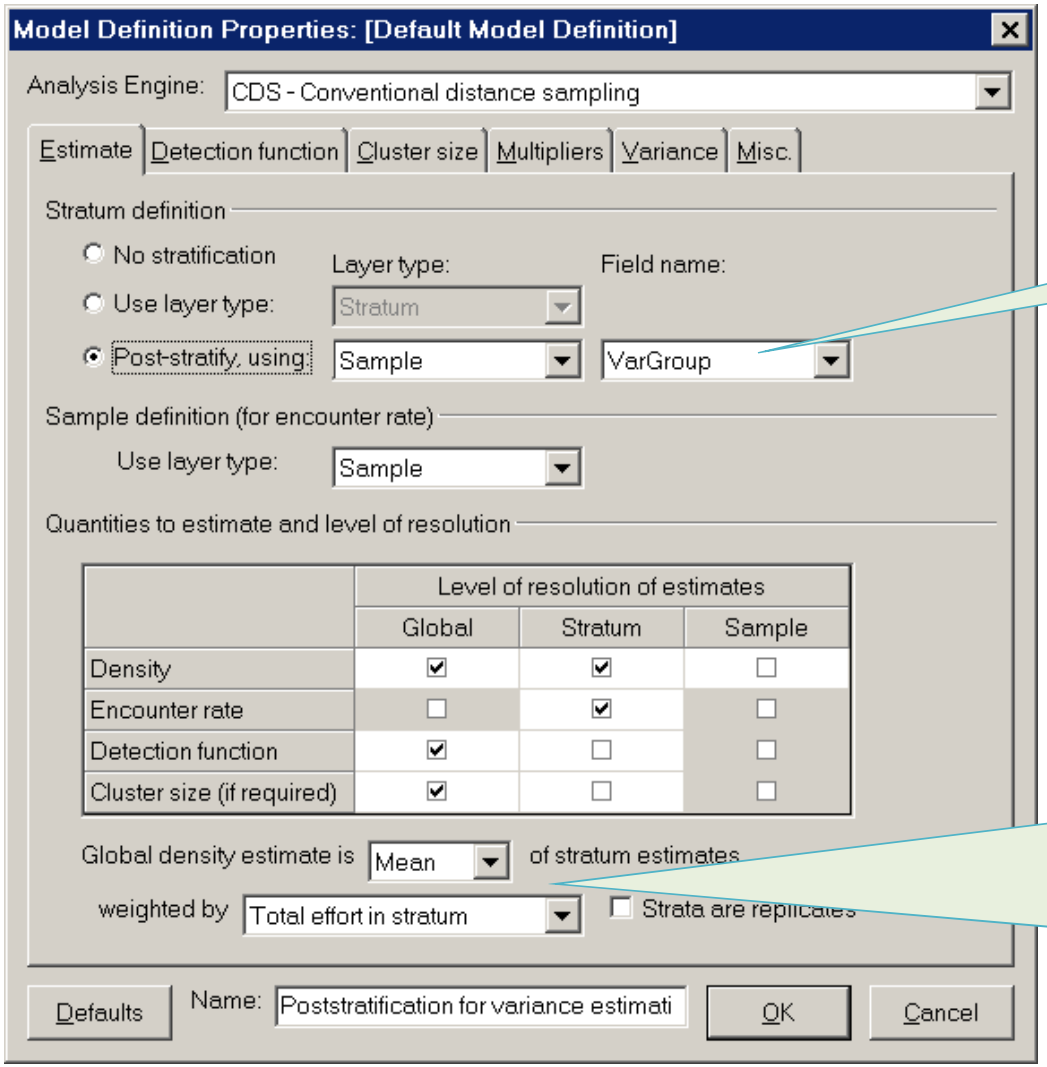

Post-stratify on VarGroup

Encounter rate estimated at Stratum level, everything else Global. Global density is Mean weighted by Effort.

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