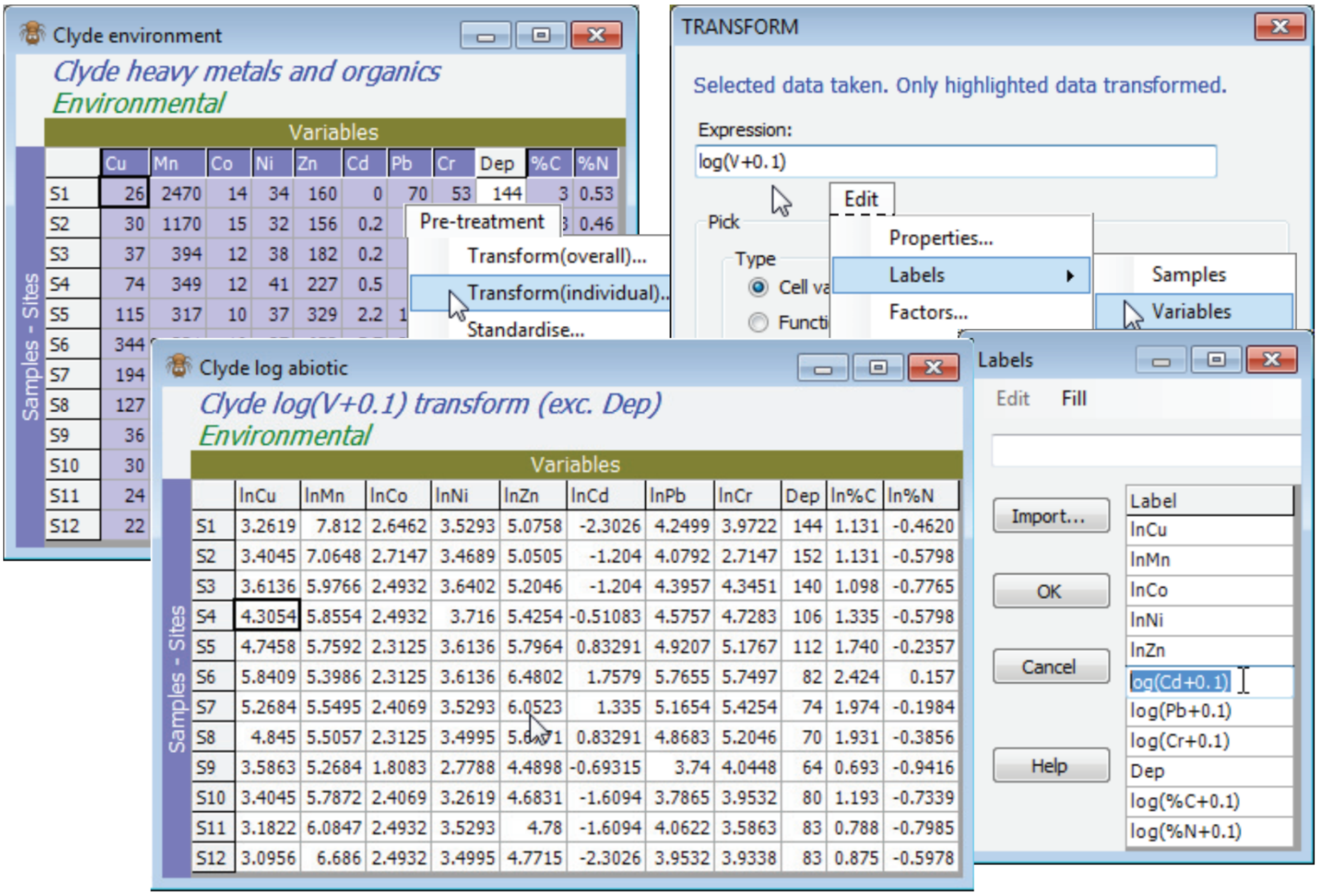
Missing data estimation (Clyde study)

Transformation options for the Clyde environmental matrix, Clyde environment, are discussed in more detail in the following (PCA) section, but the tool to carry out separate transforms on sets of variables, **Pre-Treatment>Transform(individual)**, rather than transforming the whole array, **Pre-treatment>Transform(overall)**, was met in Section 4, applied to the environmental data from the Ekofisk oil-field study. Here, all heavy metals and organics (10 of the 11 variables) will benefit from log transformation, to reduce their right-skewness and so bring these continuous variables closer to normality across the sites (in so far as that can be judged from only 12 samples!). Thus, highlight all variables except Water Depth (*Dep*) and take **Pre-treatment>Transform(individual)**>(Expression: log(V+0.1)) & (✓Rename variables), renaming the result Clyde log abiotic. Give the variables in this sheet shorter names (e.g. lnCu, lnMn etc) with **Edit>Labels>Variables**.



Clyde environment

Clyde heavy metals and organics
Environmental

Variables

	Cu	Mn	Co	Ni	Zn	Cd	Pb	Cr	Dep	%C	%N
S1	26	2470	14	34	160	0	70	53	144	3	0.53
S2	30	1170	15	32	156	0.2				3	0.46
S3	37	394	12	38	182	0.2					
S4	74	349	12	41	227	0.5					
S5	115	317	10	37	329	2.2	1				
S6	344										
S7	194										
S8	127										
S9	36										
S10	30										
S11	24										
S12	22										

TRANSFORM

Selected data taken. Only highlighted data transformed.

Expression: log(V+0.1)

Clyde log abiotic

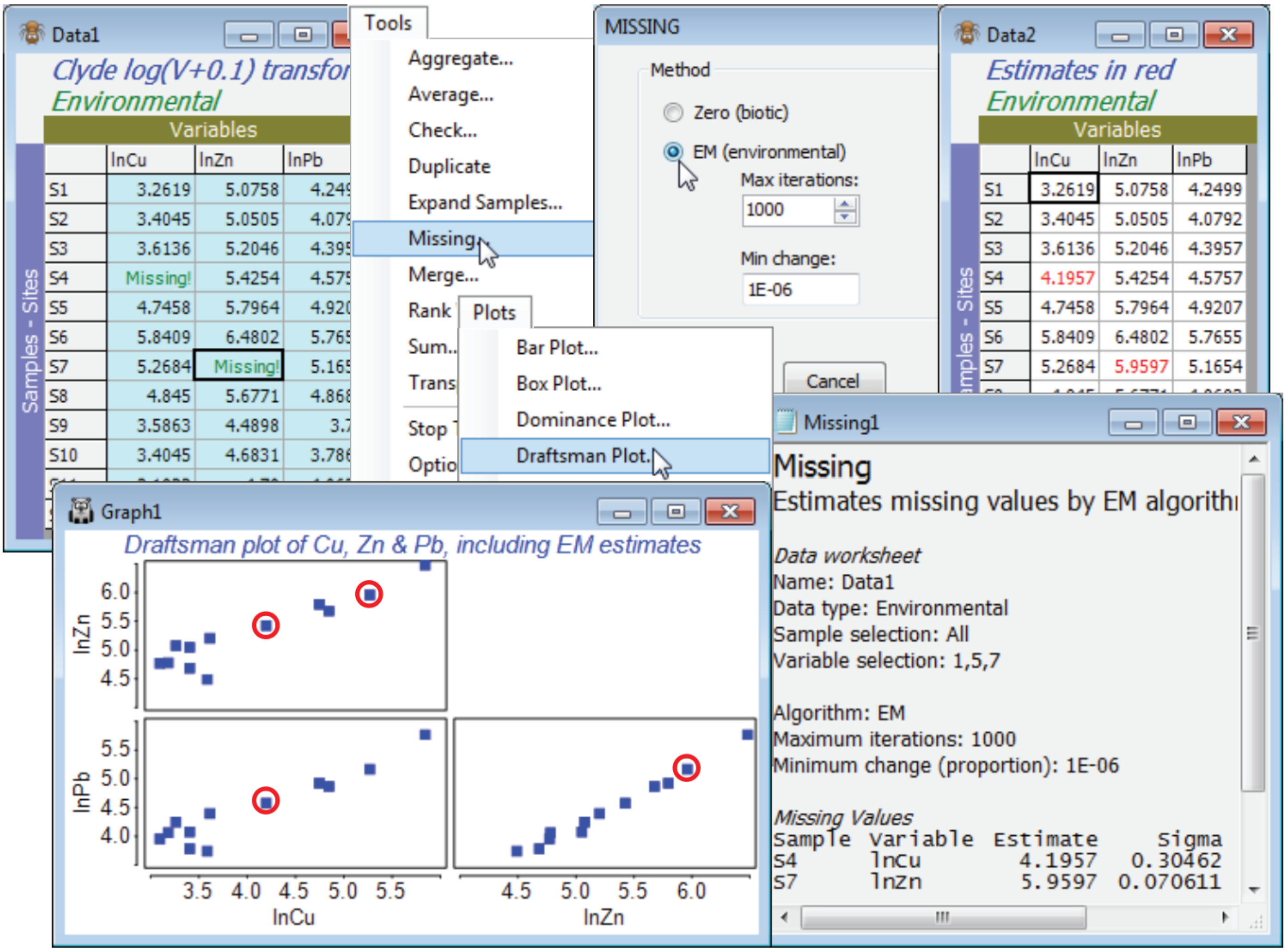
Clyde log(V+0.1) transform (exc. Dep)
Environmental

Variables

	lnCu	lnMn	lnCo	lnNi	lnZn	lnCd	lnPb	lnCr	Dep	ln%C	ln%N
S1	3.2619	7.812	2.6462	3.5293	5.0758	-2.3026	4.2499	3.9722	144	1.131	-0.4620
S2	3.4045	7.0648	2.7147	3.4689	5.0505	-1.204	4.0792	2.7147	152	1.131	-0.5798
S3	3.6136	5.9766	2.4932	3.6402	5.2046	-1.204	4.3957	4.3451	140	1.098	-0.7765
S4	4.3054	5.8554	2.4932	3.716	5.4254	-0.51083	4.5757	4.7283	106	1.335	-0.5798
S5	4.7458	5.7592	2.3125	3.6136	5.7964	0.83291	4.9207	5.1767	112	1.740	-0.2357
S6	5.8409	5.3986	2.3125	3.6136	6.4802	1.7579	5.7655	5.7497	82	2.424	0.157
S7	5.2684	5.5495	2.4069	3.5293	6.0523	1.335	5.1654	5.4254	74	1.974	-0.1984
S8	4.845	5.5057	2.3125	3.4995	5.6[illegible]71	0.83291	4.8683	5.2046	70	1.931	-0.3856
S9	3.5863	5.2684	1.8083	2.7788	4.4898	-0.69315	3.74	4.0448	64	0.693	-0.9416
S10	3.4045	5.7872	2.4069	3.2619	4.6831	-1.6094	3.7865	3.9532	80	1.193	-0.7339
S11	3.1822	6.0847	2.4932	3.5293	4.78	-1.6094	4.0622	3.5863	83	0.788	-0.7985
S12	3.0956	6.686	2.4932	3.4995	4.7715	-2.3026	3.9532	3.9338	83	0.875	-0.5978

Label
lnCu
lnMn
lnCo
lnNi
lnZn
log(Cd+0.1)
log(Pb+0.1)
log(Cr+0.1)
Dep
log(%C+0.1)
log(%N+0.1)

Take a copy with **Tools>Duplicate** and from this remove a couple of cells at random – perhaps (S4, lnCu) and hit the delete key, then (S7, lnPb) and delete again. Both cells will now be displayed as Missing!. **Analyse>Draftsman Plot** on this transformed data shows that normality assumptions are probably now acceptable (see the following section) but the above *DpP* criterion for the whole matrix fails badly (*n* = 12, *p* = 11, *m* = 2, so *DpP* = 1.7) and we should not trust the outcome even if **Tools>Missing** converges (it does not, here). The correlation matrix output with the drafts¬man plot does, however, show some very high correlations between e.g. Cu, Pb and Zn, which gives a better basis for prediction than the whole matrix. So, select just these three variables (highlight them then **Select>Highlighted**), and **Tools>Missing** produces credible missing data estimates of 4.18 (S4, ln Cu) and 5.26 (S7, ln Pb), compared with the original 4.31 and 5.17. Note that the ratio *DpP* = 3.3, which is still some way from respectability, but clearly is capable (sometimes at least) of producing useful results. The results window shows that the imprecision (under the assumption that the value is missing at random, of course) is lower for the estimated (S7, Pb) reading than the (S4, Cu) value, though both are rather well determined. The standard deviation of the estimate for (S7, Pb) is about 0.07 and for (S4, Cu) about 0.30, so that rough confidence intervals are (3.6, 4.8) and (5.8, 6.1) respectively. The reason for this difference in precision is clear from the draftsman plot for these three Cu, Zn, Pb variables, on which the respective points are manually circled (the plot window was copied and pasted to Powerpoint with Ctrl-C and Ctrl-V). The linear relationship between Pb and one of the other variables (Pb) is seen to be extremely tight, whereas Cu is not so highly correlated with either Zn or Pb, so there is inevitably greater uncertainty in the interpolation – it is a consequence of the multivariate normality condition that these relationships are estimated as straight lines. The estimates now need to be individually copied (click in the cell and Ctrl-C) and pasted back into the full matrix (Ctrl-V at the cursor). Of course the process is more automatic in less borderline cases, with larger n, when the full matrix can be input to **Tools>Missing**.



Data1

Clyde log(V+0.1) transfor
Environmental

Variables

	lnCu	lnZn	lnPb
S1	3.2619	5.0758	4.249
S2	3.4045	5.0505	4.079
S3	3.6136	5.2046	4.395
S4	Missing!	5.4254	4.575
S5	4.7458	5.7964	4.920
S6	5.8409	6.4802	5.765
S7	5.2684	Missing!	5.165
S8	4.845	5.6771	4.868
S9	3.5863	4.4898	3.7
S10	3.4045	4.6831	3.786

Samples - Sites

MISSING

Method
○ Zero (biotic)
● EM (environmental)
Max iterations: 1000
Min change: 1E-06

Data2

Estimates in red
Environmental

Variables

	lnCu	lnZn	lnPb
S1	3.2619	5.0758	4.2499
S2	3.4045	5.0505	4.0792
S3	3.6136	5.2046	4.3957
S4	4.1957	5.4254	4.5757
S5	4.7458	5.7964	4.9207
S6	5.8409	6.4802	5.7655
S7	5.2684	5.9597	5.1654

Samples - Sites

Missing1

Missing
Estimates missing values by EM algorith

Data worksheet
Name: Data1
Data type: Environmental
Sample selection: All
Variable selection: 1,5,7

Algorithm: EM
Maximum iterations: 1000
Minimum change (proportion): 1E-06

Missing Values
```
Sample  Variable  Estimate     Sigma
S4      lnCu        4.1957   0.30462
S7      lnZn        5.9597  0.070611
```

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