

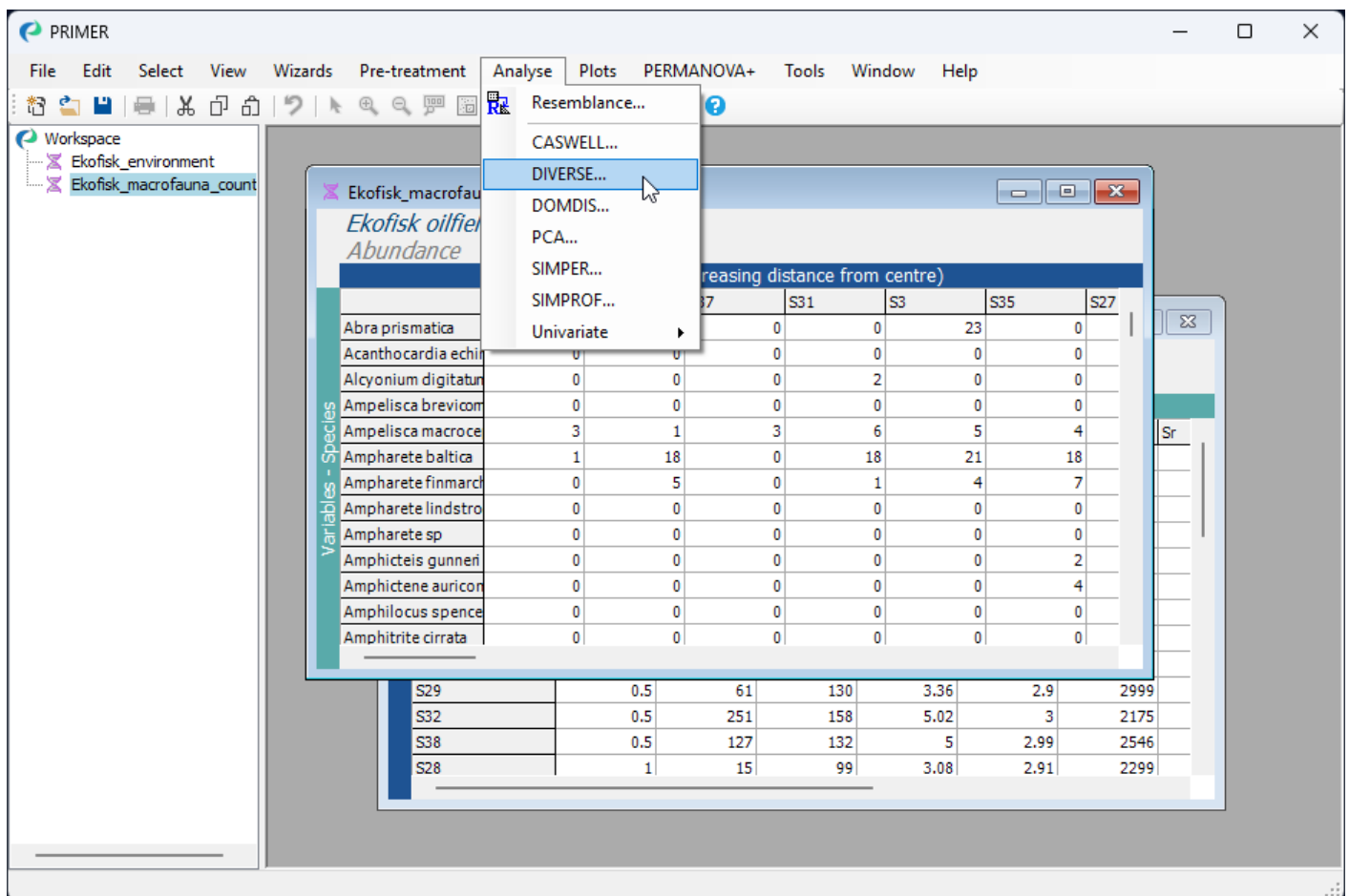
4.10 Example: Ekofisk diversity

To demonstrate the test of association, we shall re-visit a dataset of macrofauna assemblages collected from sites near an oilfield in the North Sea. In this study by [Gray et al. \(1990\)](#), macrofauna were sampled from 39 sites in an approximately 5-spoke radial design, at increasing distances from undersea drilling activities at the Ekofisk oilfield. There were three day-grab samples taken from each site; information from these were combined to yield abundance values for each of $p = 173$ soft-sediment macrofaunal taxa at every site. The macrofauna data are given in the file 'Ekofisk_macrofauna_counts.pri', found in the 'Examples_P8 > Ekofisk_macrofauna' folder. Environmental variables were also obtained at each site, and these, along with the actual distance from the oilfield centre, are given in the file 'Ekofisk_environment.pri'. Open up both of these files in PRIMER, as shown below:

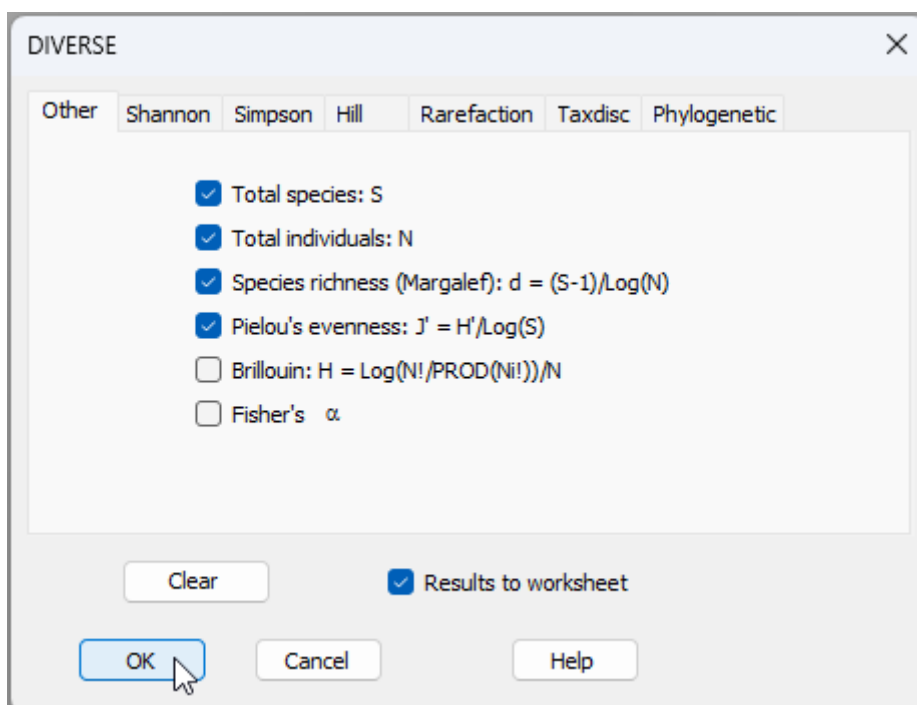
The screenshot shows the PRIMER software interface. The 'Workspace' panel on the left lists the loaded files: 'Ekofisk_environment' and 'Ekofisk_macrofauna_counts'. The main window displays two data sheets. The top sheet, 'Ekofisk_macrofauna_counts', is titled 'Ekofisk oilfield macrofauna Abundance' and shows a table with 'Samples - Sites (increasing distance from centre)'. The bottom sheet, 'Ekofisk_environment', is titled 'Ekofisk sediments Environmental' and shows a table with 'Variables'. The 'Variables' table includes columns for 'Distance', 'THC', 'Redox', '%Mud', 'Phi mean', 'Ba', and 'Sr'.

	Distance	THC	Redox	%Mud	Phi mean	Ba	Sr
S30	0.1	232	80	11.91	3.22	1967	
S36	0.1	443	189	10.95	3.3	1997	
S37	0.1	1896	85	12.29	3.18	1913	
S31	0.15	251	124	7.58	3.11	1922	
S3	0.25	17	142	4.94	3.07	3608	
S35	0.25	56	153	8.3	3.05	3143	
S27	0.33	32	150	3.48	2.96	3096	
S25	0.45	57	168	6.2	3.1	4913	
S26	0.5	39	213	4.34	2.97	2876	
S29	0.5	61	130	3.36	2.9	2999	
S32	0.5	251	158	5.02	3	2175	
S38	0.5	127	132	5	2.99	2546	
S28	1	15	99	3.08	2.91	2299	

Does species richness increase or decrease with increasing distance from the oil platform? Let's start by calculating some simple univariate diversity metrics, such as S = total richness (the number of taxa), along with some others. From the 'Ekofisk_macrofauna_counts' data sheet inside PRIMER, click **Analyse > DIVERSE....**



We can take all of the default options here, but also tick the option to output (\$\checkmark\$Results to worksheet), then click '**OK**'.

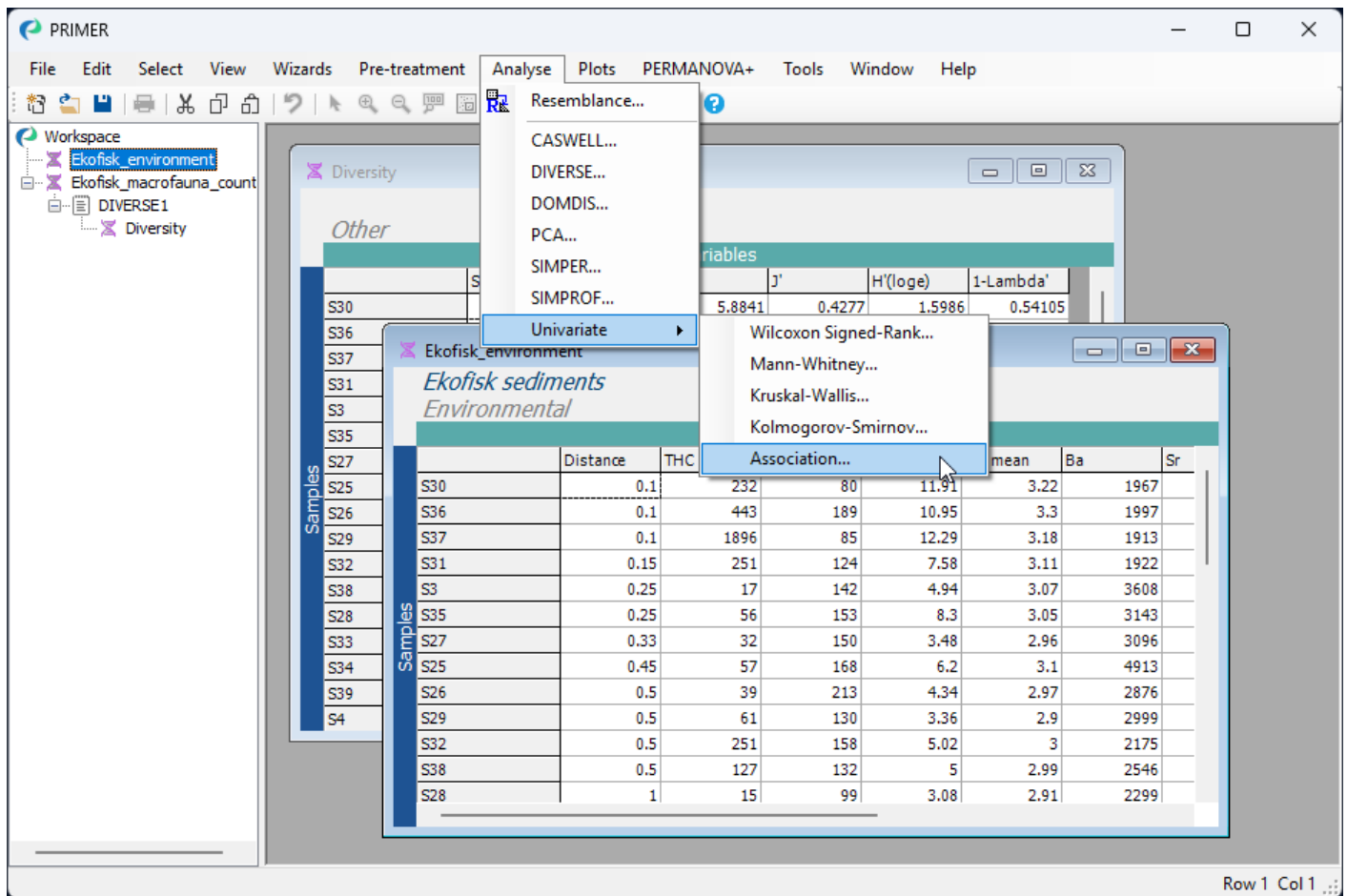


You can (optionally) re-name the resulting data sheet of diversity metrics (called 'Data1') by clicking on that sheet, then click **File > Rename Data** and type a new name 'Diversity', then click '**OK**'. The suite of univariate diversity metrics, calculated on each sampling unit, are now evident in this renamed data sheet, as follows:

Diversity							
Other							
Variables							
	S	N	d	J'	H'(loge)	1-Lambda'	
S30	42	1062	5.8841	0.4277	1.5986	0.54105	
S36	57	935	8.1865	0.48299	1.9528	0.62792	
S37	36	655	5.3974	0.44216	1.5845	0.64462	
S31	59	639	8.9785	0.63938	2.6071	0.80374	
S3	61	437	9.8685	0.78896	3.2433	0.92831	
S35	52	426	8.4236	0.82548	3.2617	0.94227	
S27	57	316	9.7294	0.83563	3.3785	0.95188	
S25	59	471	9.4235	0.8	3.262	0.93514	
S26	56	382	9.2508	0.87054	3.5042	0.96012	
S29	44	196	8.1468	0.81988	3.1026	0.93605	
S32	59	294	10.205	0.83873	3.4199	0.94969	
S38	64	478	10.211	0.81486	3.3889	0.95031	
S28	57	329	9.6617	0.84102	3.4003	0.95228	
S33	56	313	9.5715	0.84779	3.4127	0.95189	
S34	58	416	9.4517	0.84942	3.449	0.95712	
S39	62	252	11.032	0.85956	3.5475	0.96414	
S4	50	276	8.7182	0.8534	3.3385	0.95046	

Run the test of association

Now, let's run the test of association. We wish to test the null hypothesis of 'no association' between species richness (the variable called 'S' in the 'Diversity' data sheet) and distance from the oil platform's drilling activity (the variable called 'Distance' in the 'Ekofisk_environment' data sheet). From the 'Ekofisk_environment' data sheet, click **Analyse > Univariate > Association....**



Complete the relevant information required for this test into the resulting dialog window, as shown below, then click '**OK**'.

Test of Association

Worksheet 1 (active):
Ekofisk_environment

Worksheet 2:
Diversity

Measure of association:
Spearman

Max permutations:
9999

Alternative hypothesis:

☐ Positive association

☐ Negative association

☒ Either a positive or negative association (two-tailed)

Variable 1:
Distance

Variable 2:
S

☐ Within levels of a factor
Dist#

Output:

☐ Results to worksheet

☒ Output scatter plot

Output values of test-statistic under permutation:

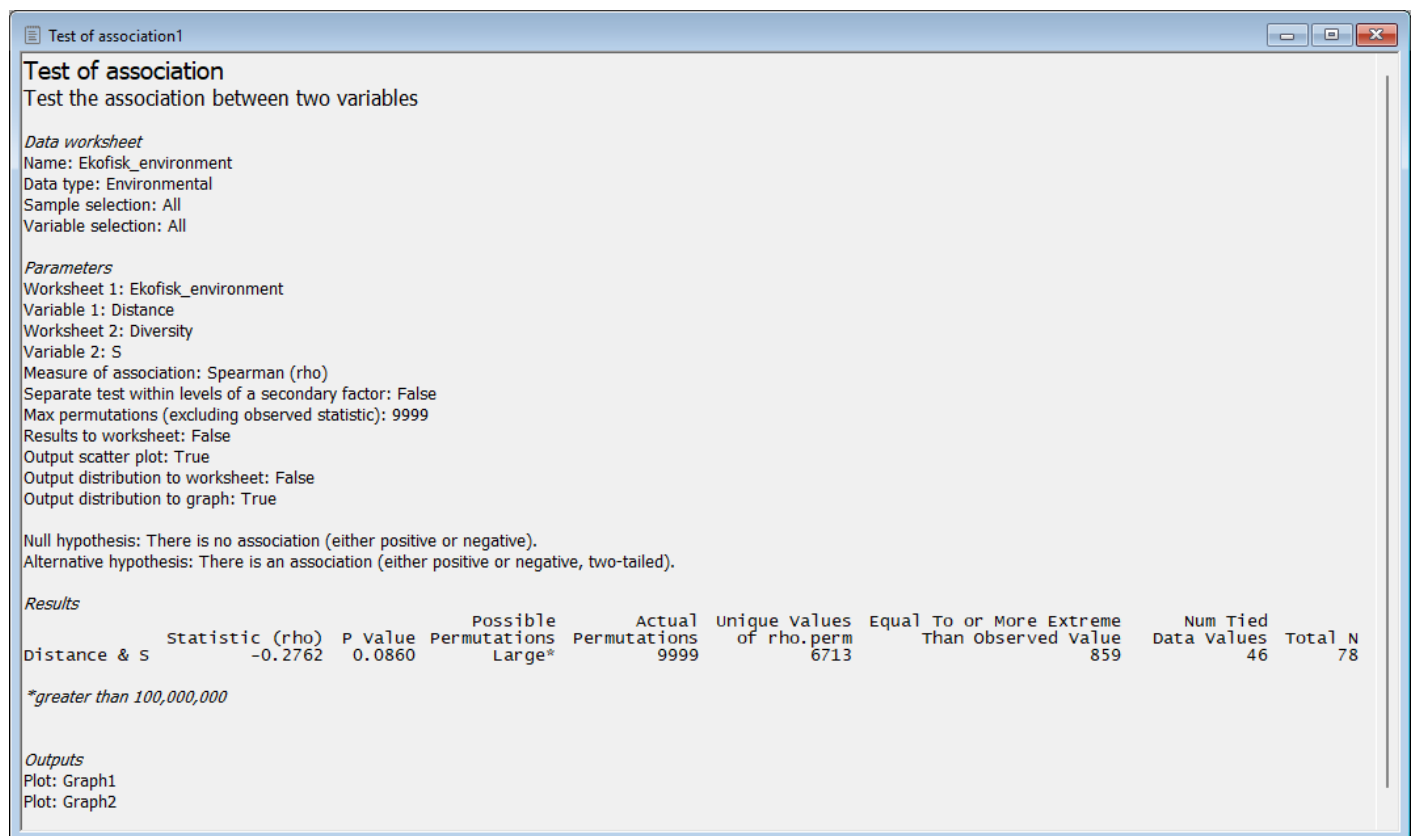
☐ to worksheet

☒ to graph (histogram)

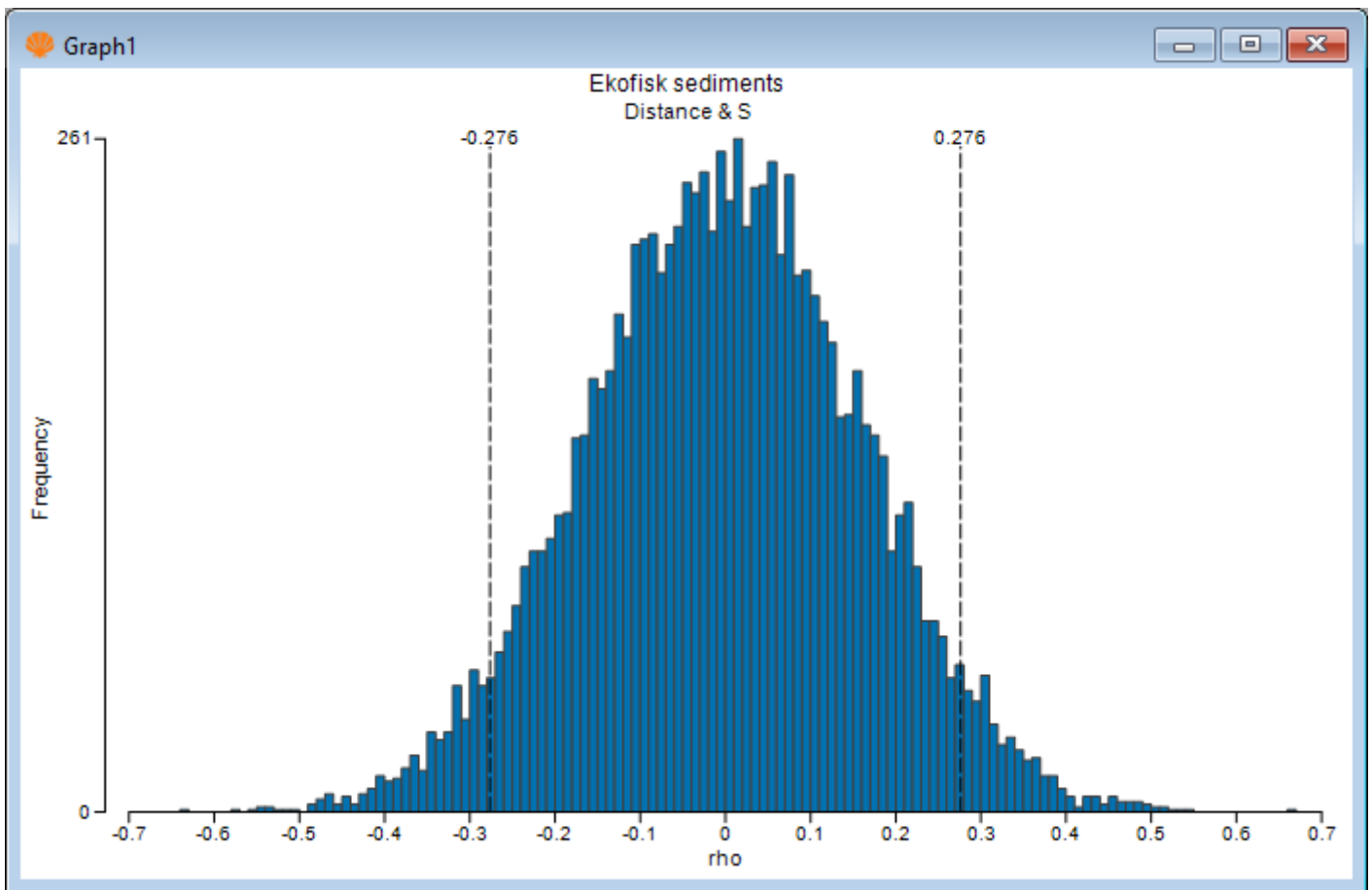
OK **Cancel** **Help**

Results of the test of association

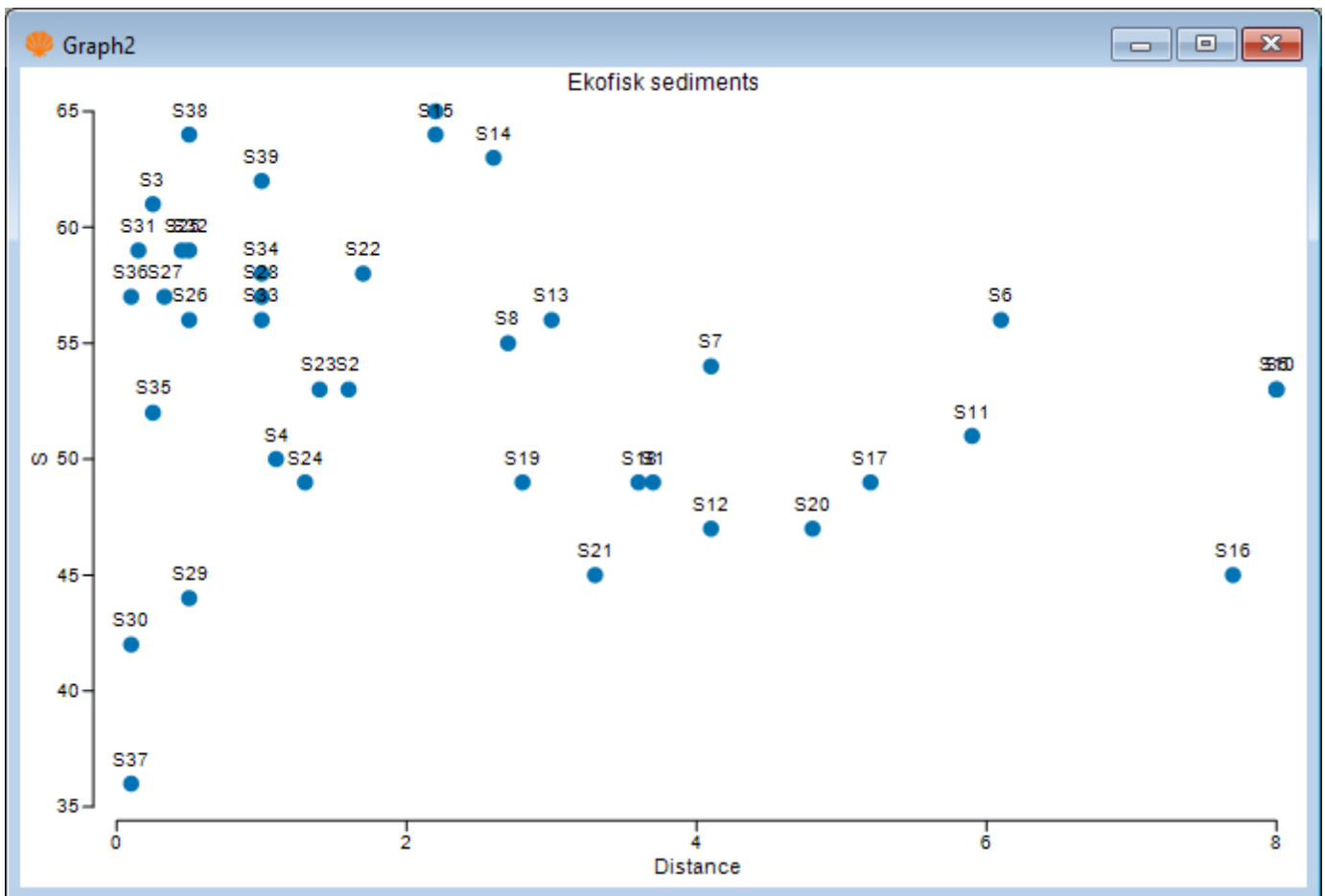
You will see the following output (called 'Test of association1' in the Explorer tree window).



Additional output for this example includes two graphics. First, there is a histogram of the values of the test statistic (here, Spearman's rank correlation, $\rho = \rho_{\{S\}}$) obtained under permutation ('Graph1'), viz:



Second, there is a scatterplot of the two variables ('Graph2'), where whatever variable was provided as 'Variable 1' in the dialog will be the x-axis, and the variable named as 'Variable 2' will be the y-axis, as shown here:



Interestingly, although some samples close to the platform (i.e., S37, S30 and S29) had quite low values for species richness compared to most other sites, there is nevertheless a negative rank correlation measured between species richness and distance from the oil platform ($\rho_{\{S\}} = -0.2762$); however, this was not statistically significant overall ($P > 0.08$) according to the test. Indeed, in many practical ecological applications, univariate diversity measures may or may not show a very strong directional pattern of response to environmental impact. In contrast, multivariate analyses of community structure, holistically, will tend to pick up significant effects that can then be characterised in terms of simultaneous changes in relative occurrences and/or abundances across a suite of component species.

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