Reconstruction of Holocene sea-levels using diatom- and pollen-based microfossil transfer functions, west coast of Scotland, UK

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Reconstruction of Holocene sea-levels using diatom- and pollen-based microfossil transfer functions, west coast of Scotland, UK

Volume 2:

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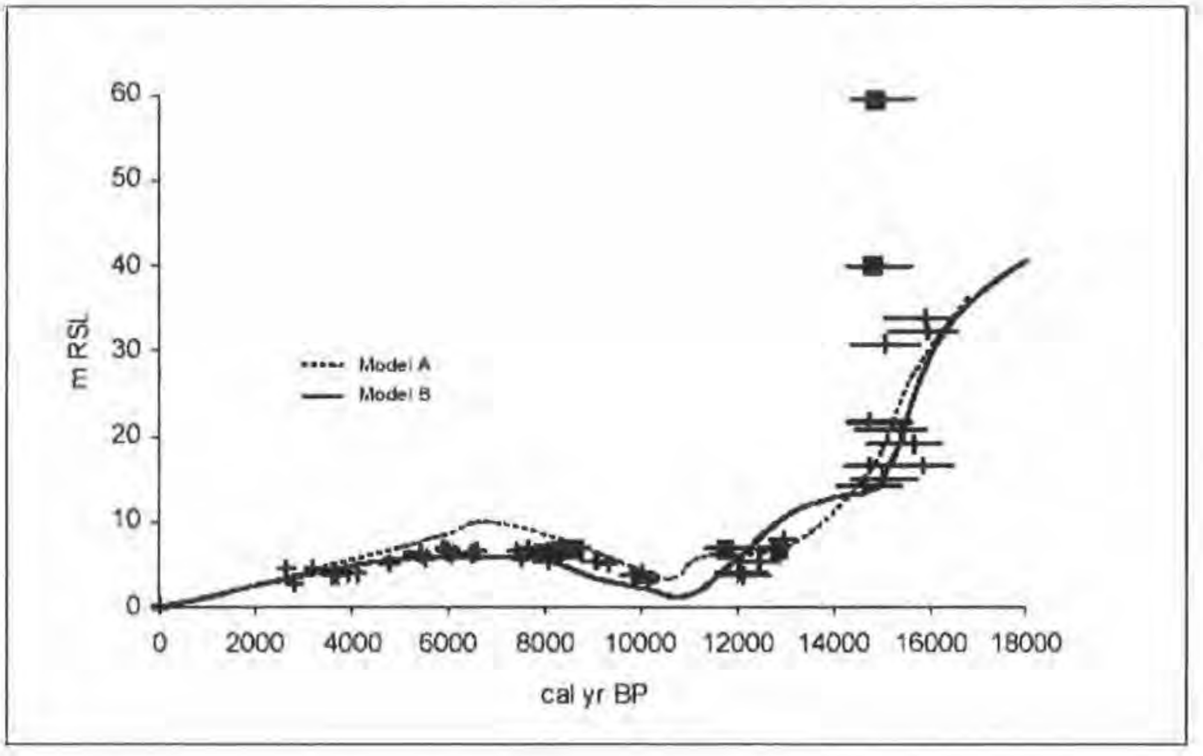
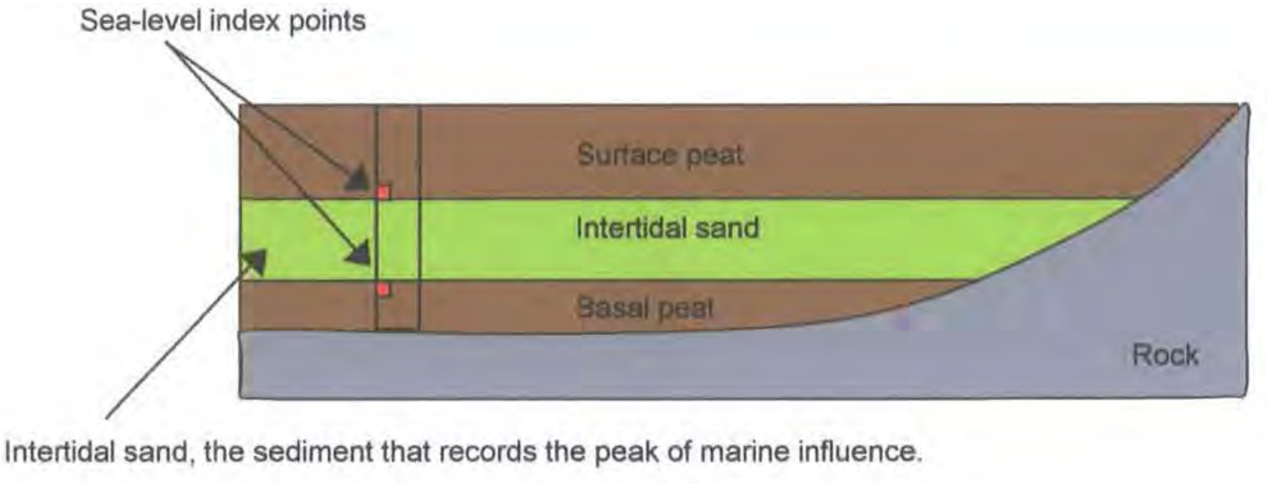


Figure 1.2 Observations and model predictions of relative sea-level change 16000 cal yr BP to present. Age error bars for sea-level index points indicate the maximum and minimum calibrated ages and the vertical bar depicts the median calibrated age. The vertical error calculation includes the sum of all the quantified or estimated height errors (see table 1 in Shennan *et al.*, 2003). Relative sea-level must lie at or below limiting dates, shown as solid symbols ■. Model predictions come from: (A) the modified version of Lambeck (1995) described in Shennan *et al.* (2000); and (B) the modified version of Peltier *et al.* (2002) described as model 3 in Shennan *et al.* (2002).



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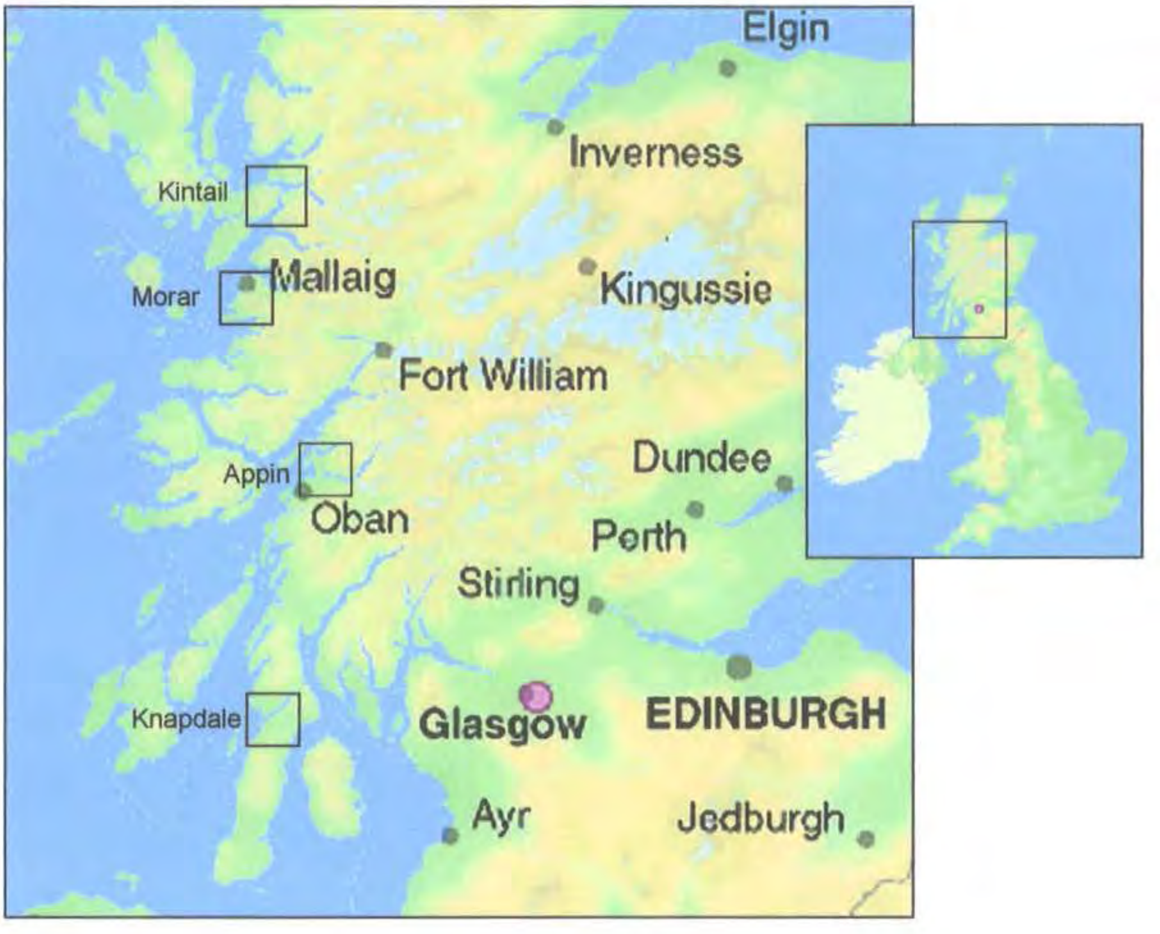

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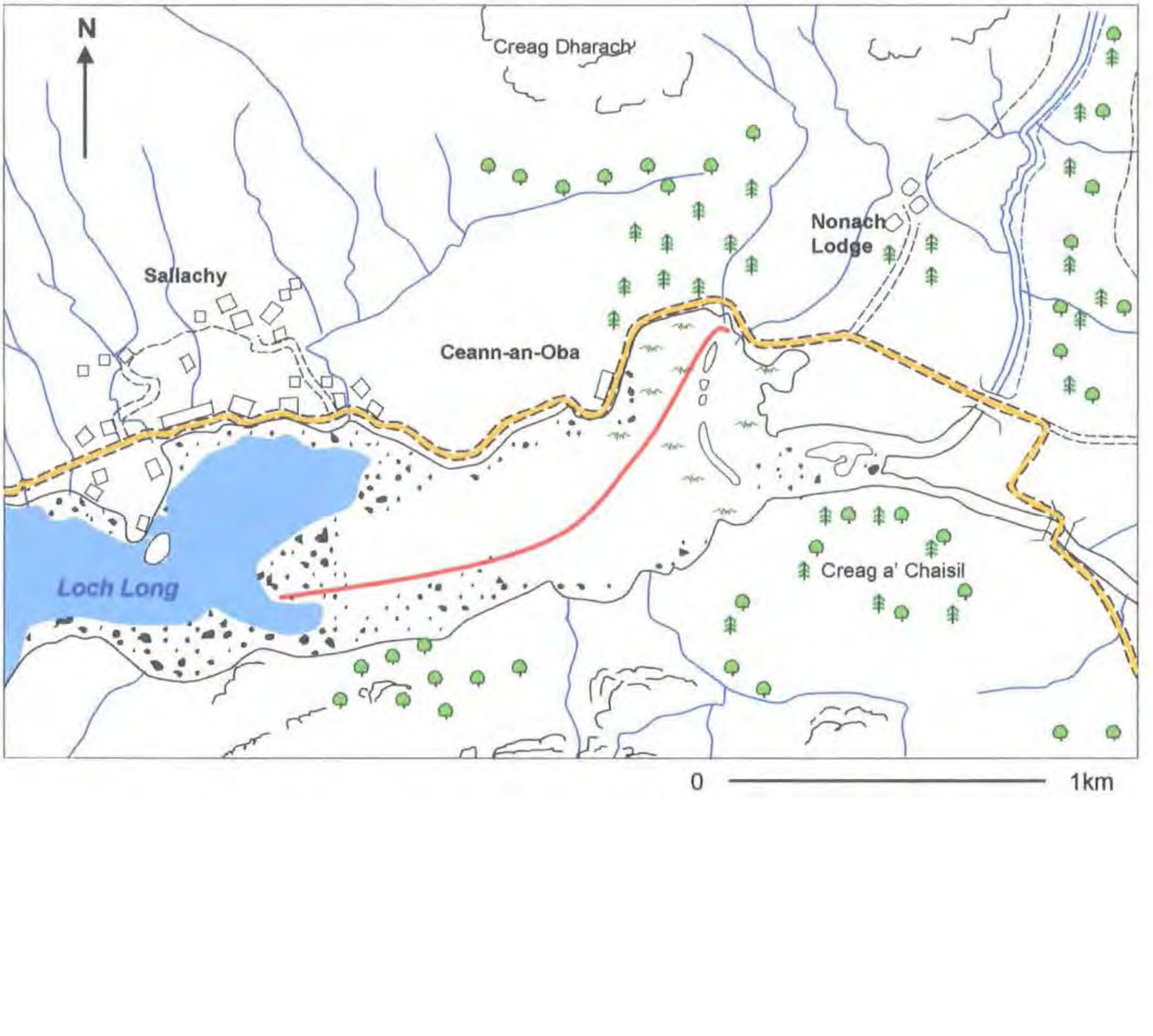


Figure 2.3. The Nonach field site. The location of the sample transect is shown on the tidal marsh as a red line.

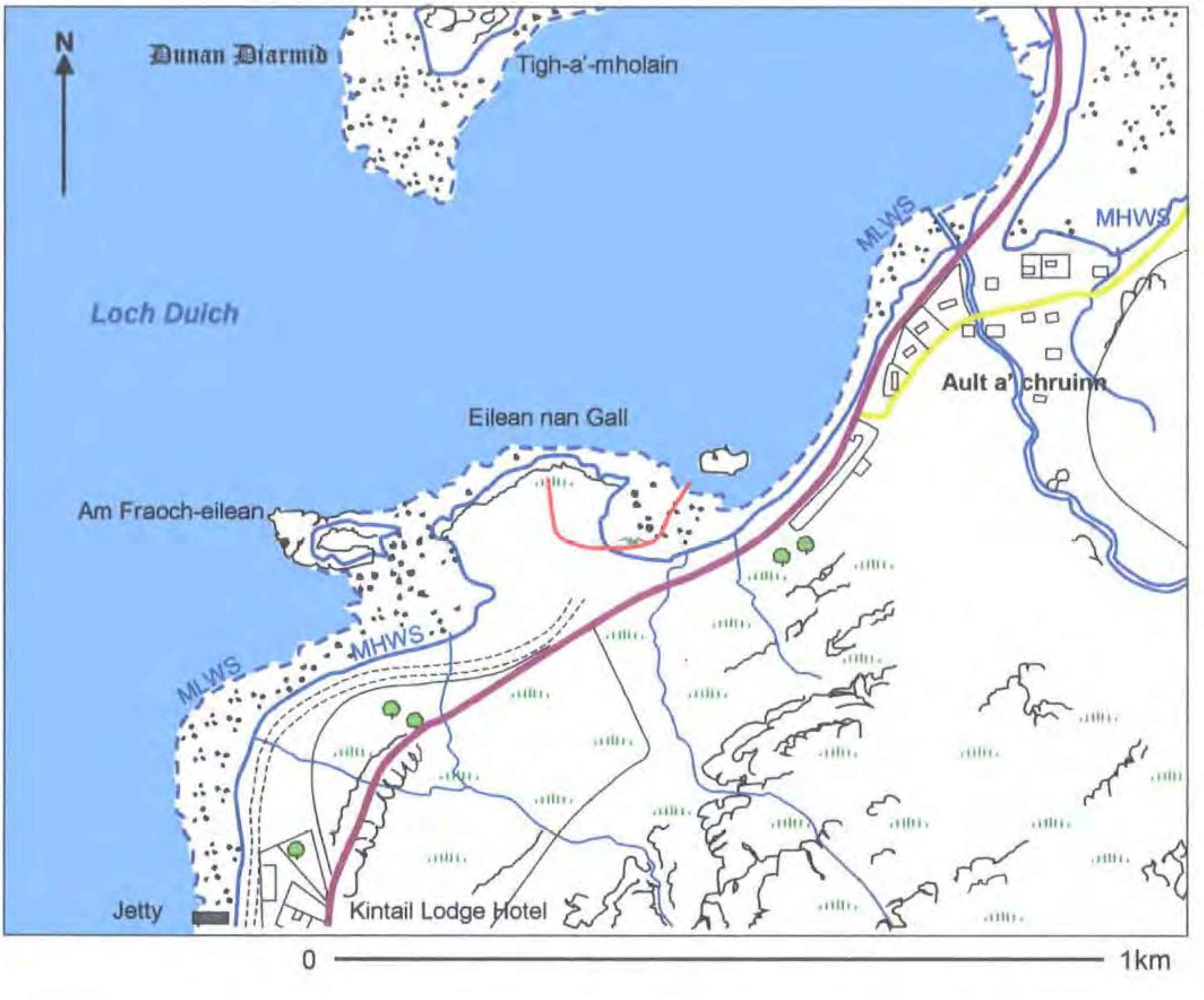
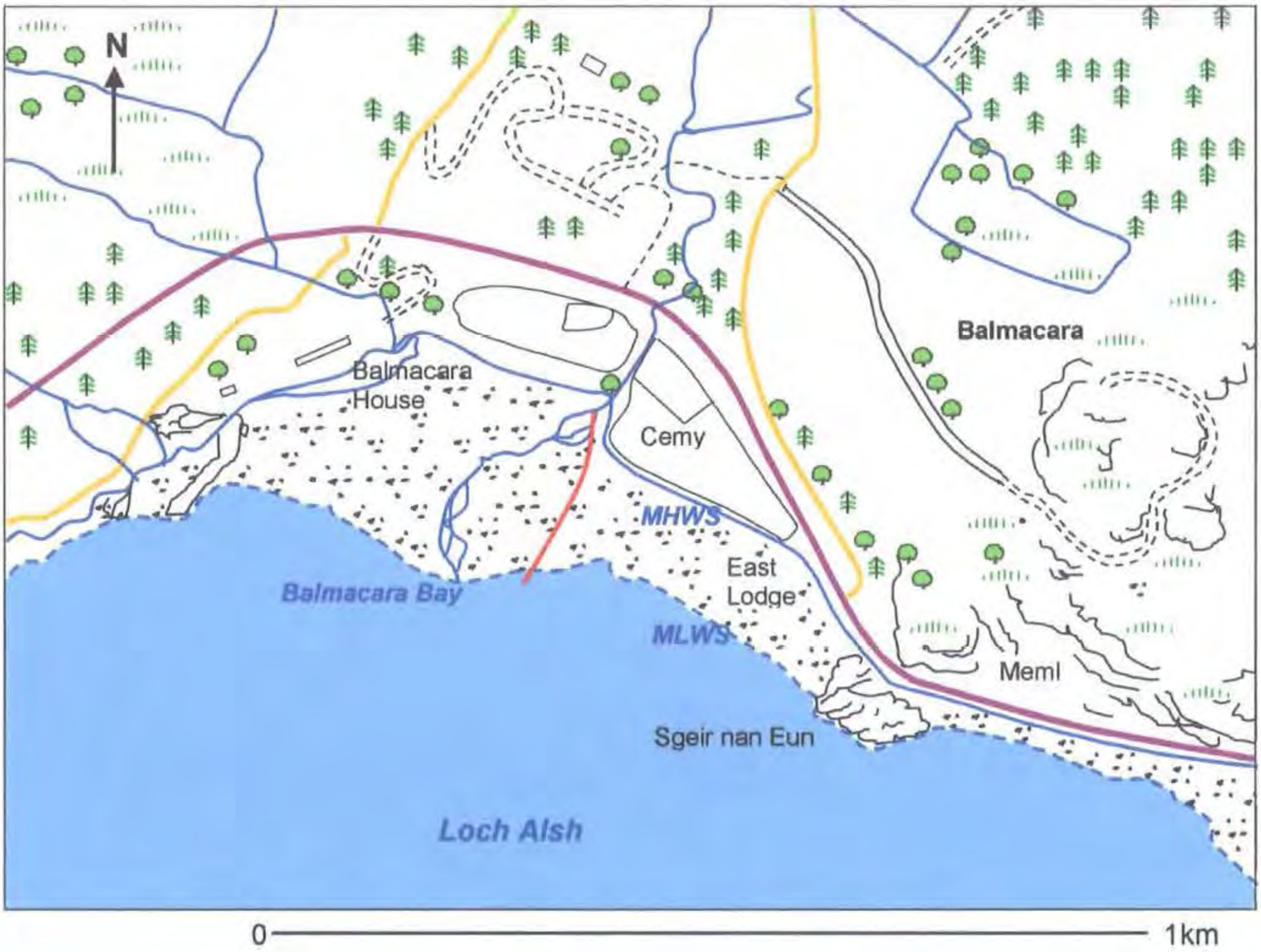


Figure 2.4. Eilean nan Gall field site. The location of the sample transect is shown on the tidal marsh as a red line.



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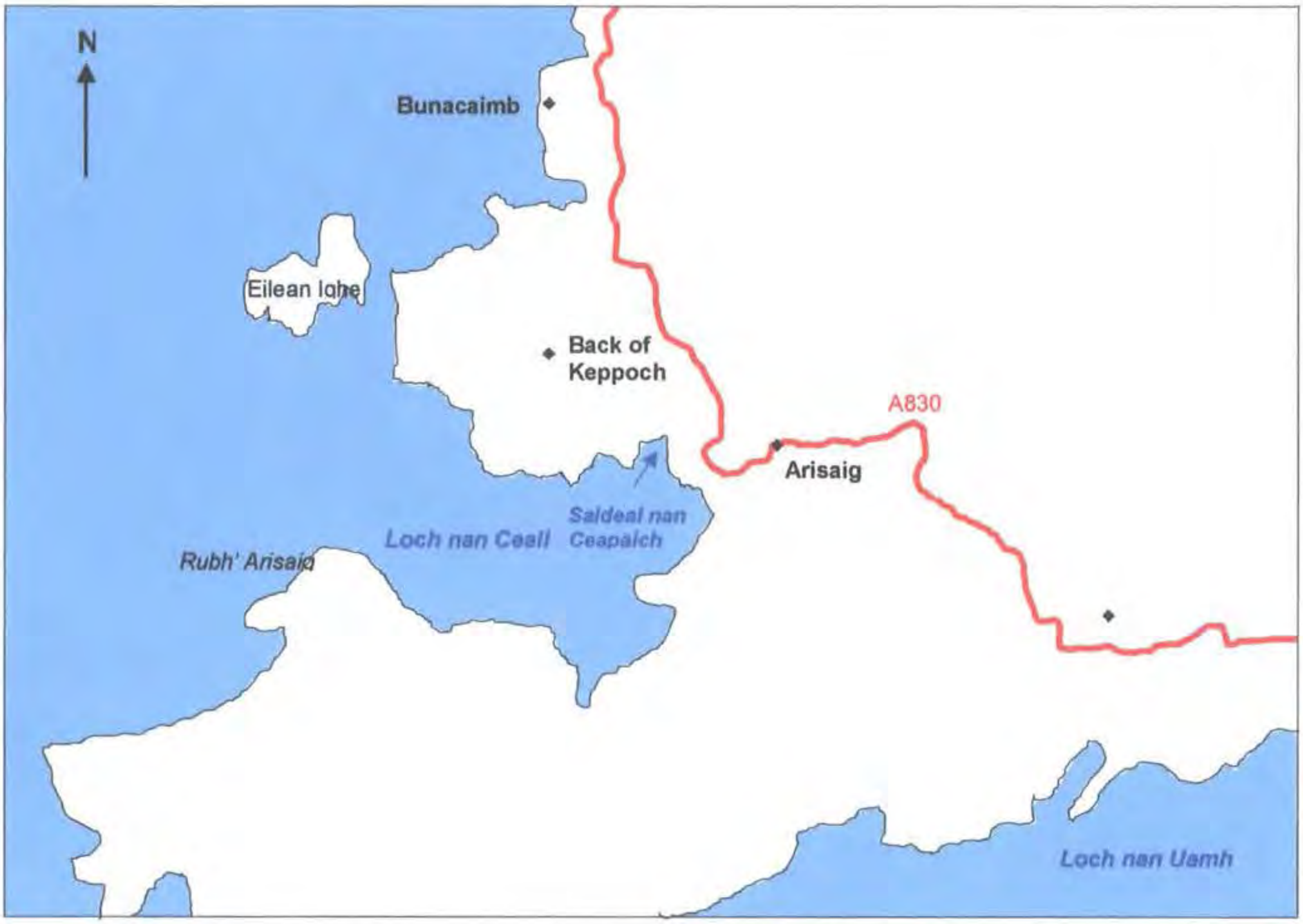
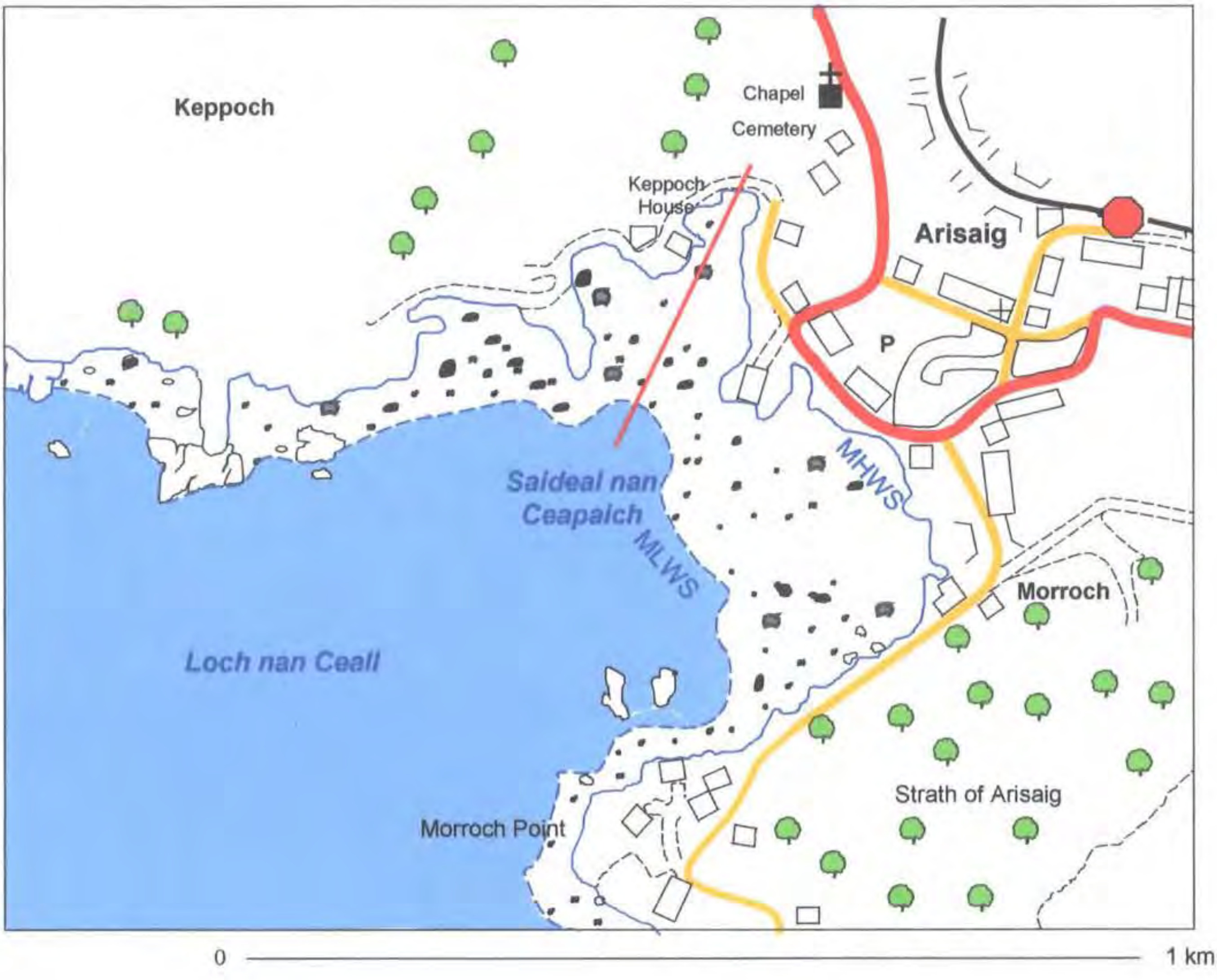


Figure 2.6. The Morar area and the location of the Saideal nan Ceapaich field site.



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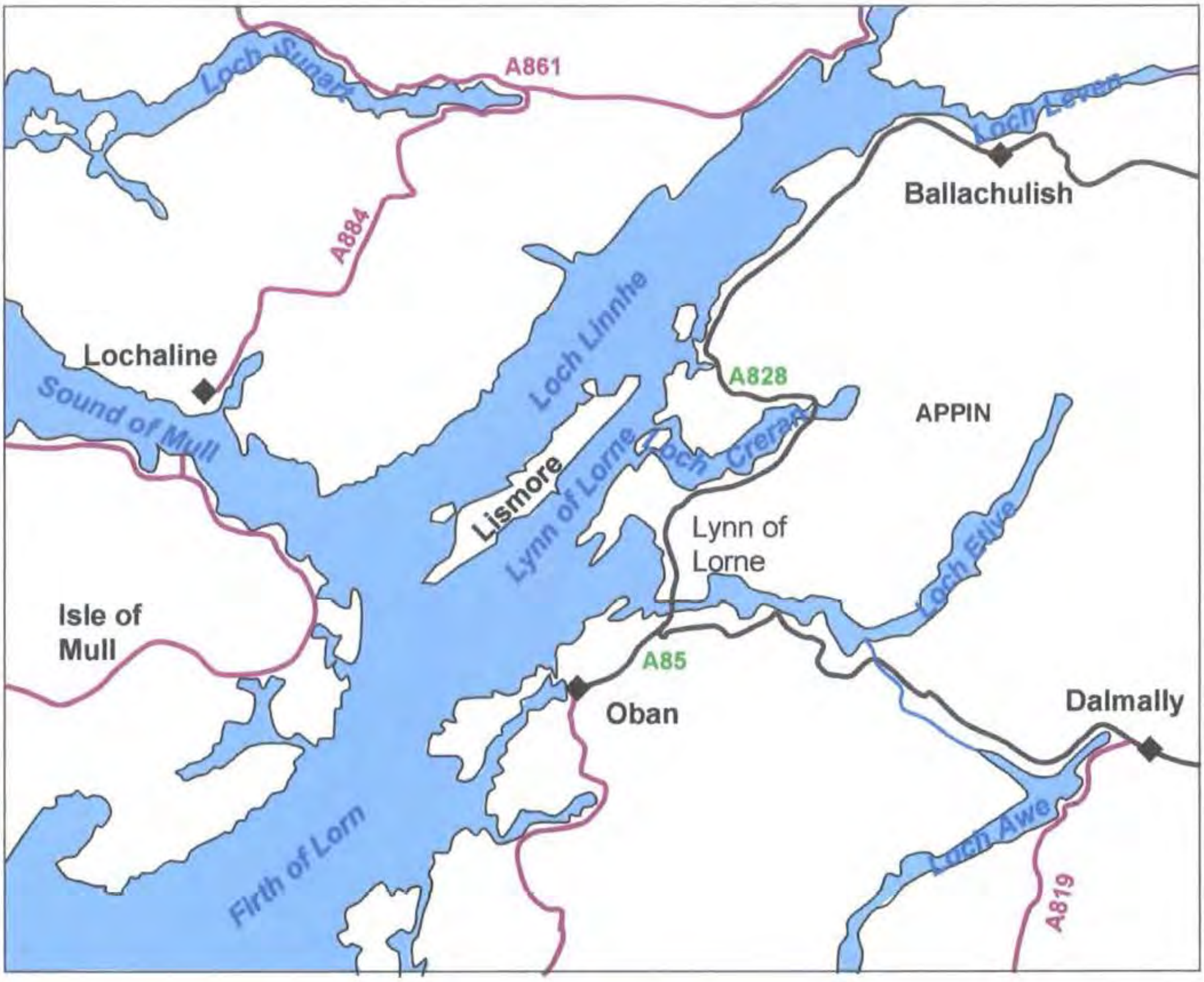

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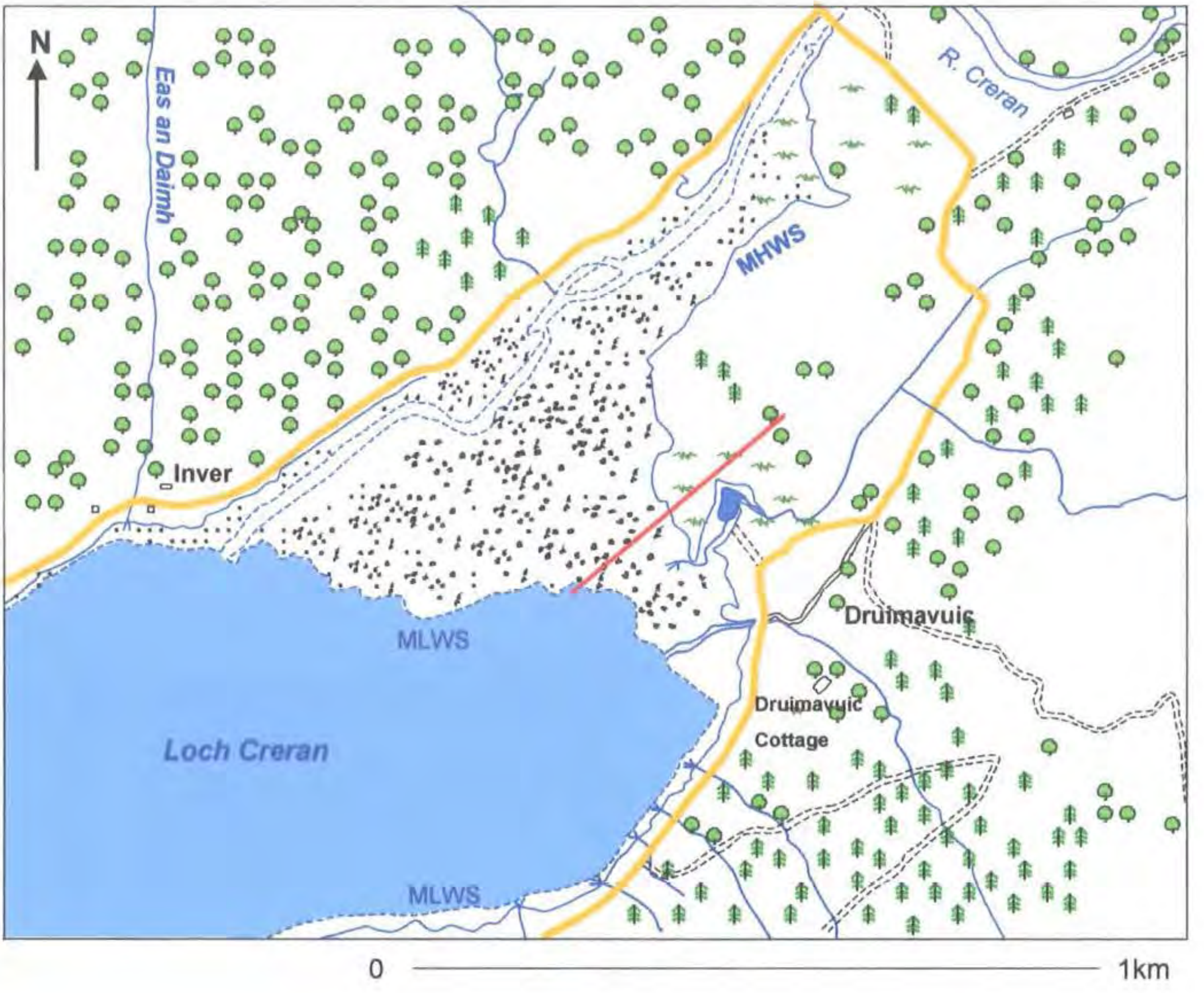

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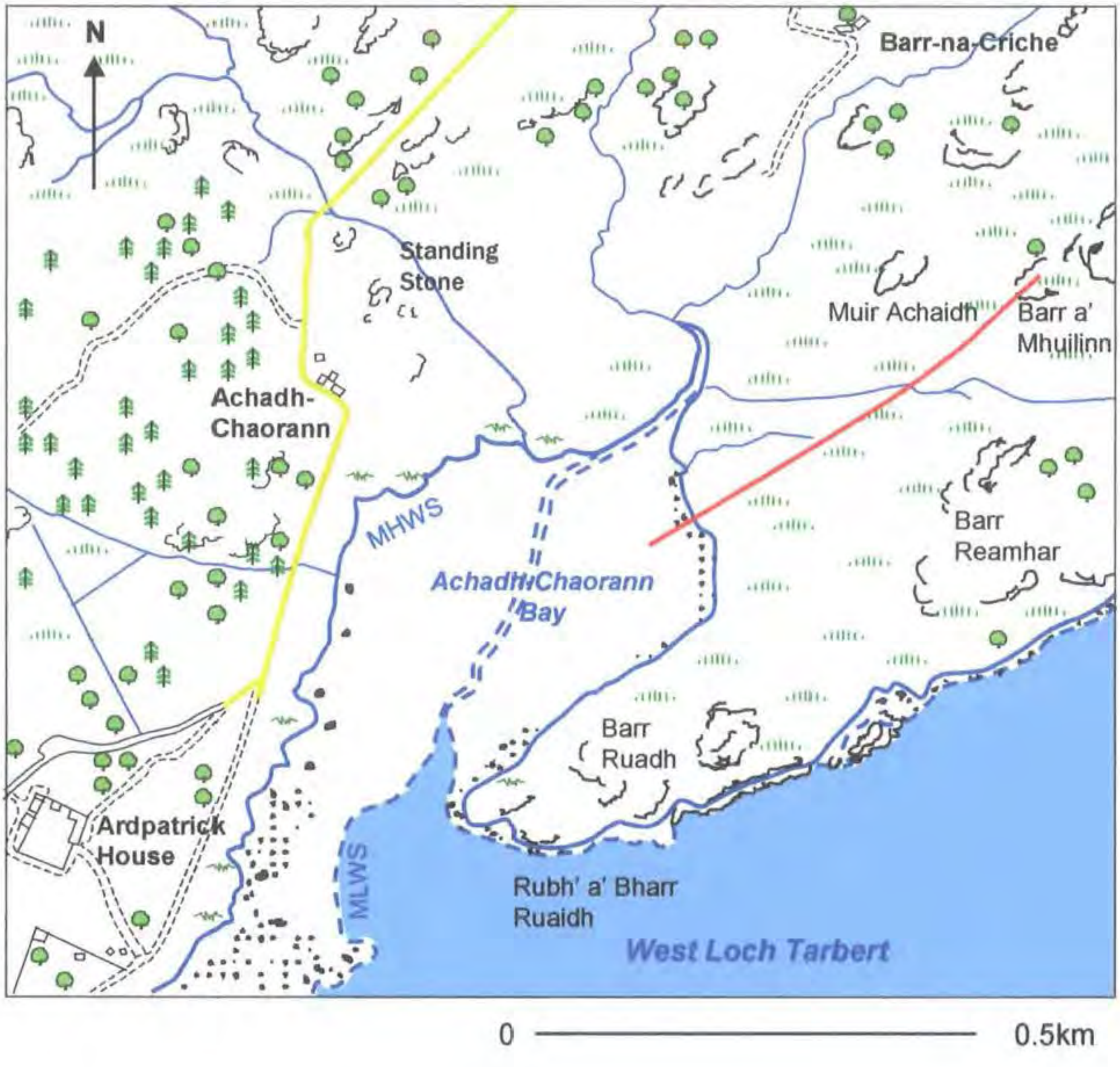


Figure 2.11. The Barr-na-Criche field site. The location of the sample transect is shown on the tidal marsh as a red line.

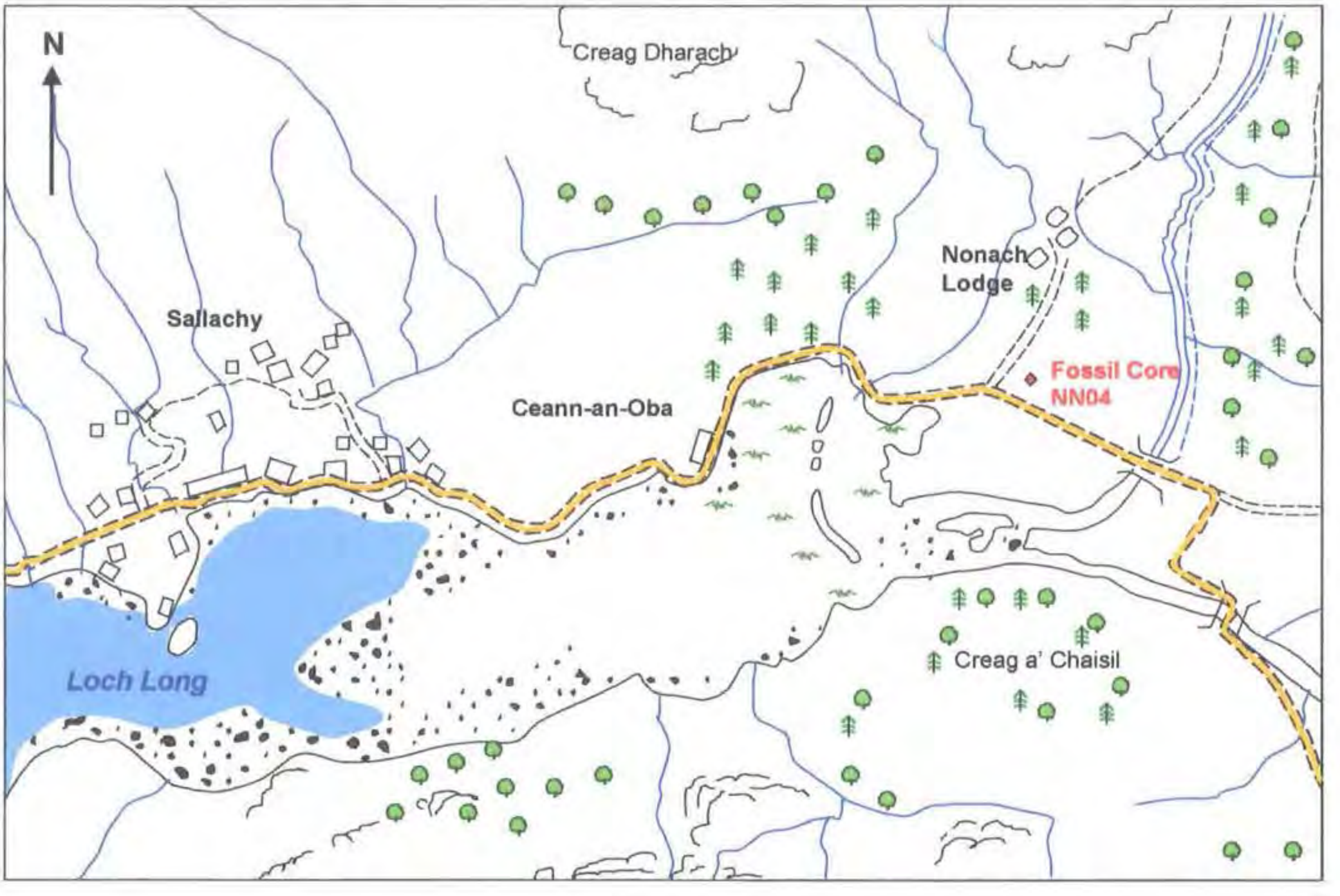


Figure 2.12. The Nonach field site. The location of the fossil core NN04 is shown as a red diamond and annotated accordingly.

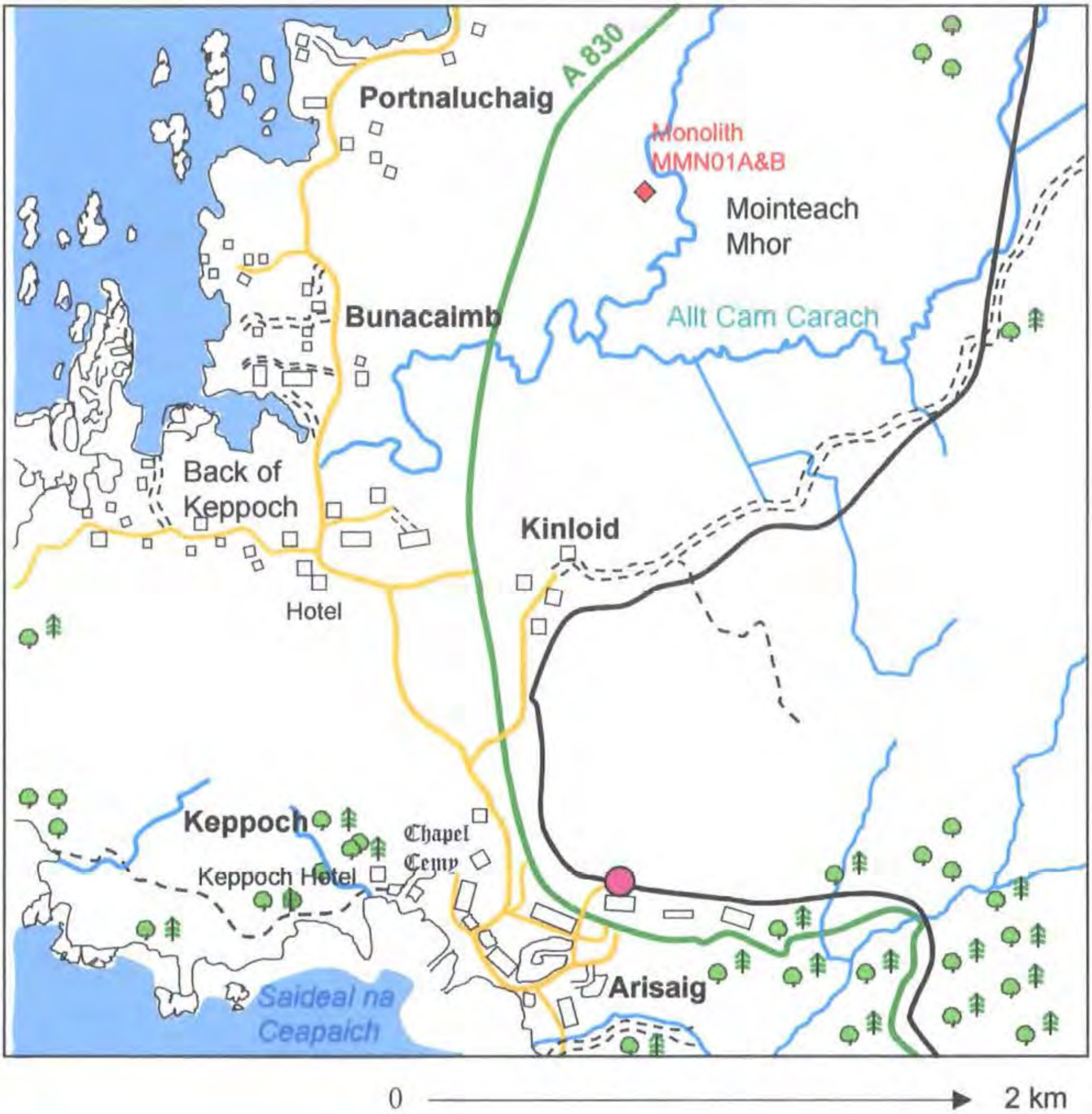


Figure 2.13 Location of monoliths MMN01A & B at Mointeach Mhor North, Morar.

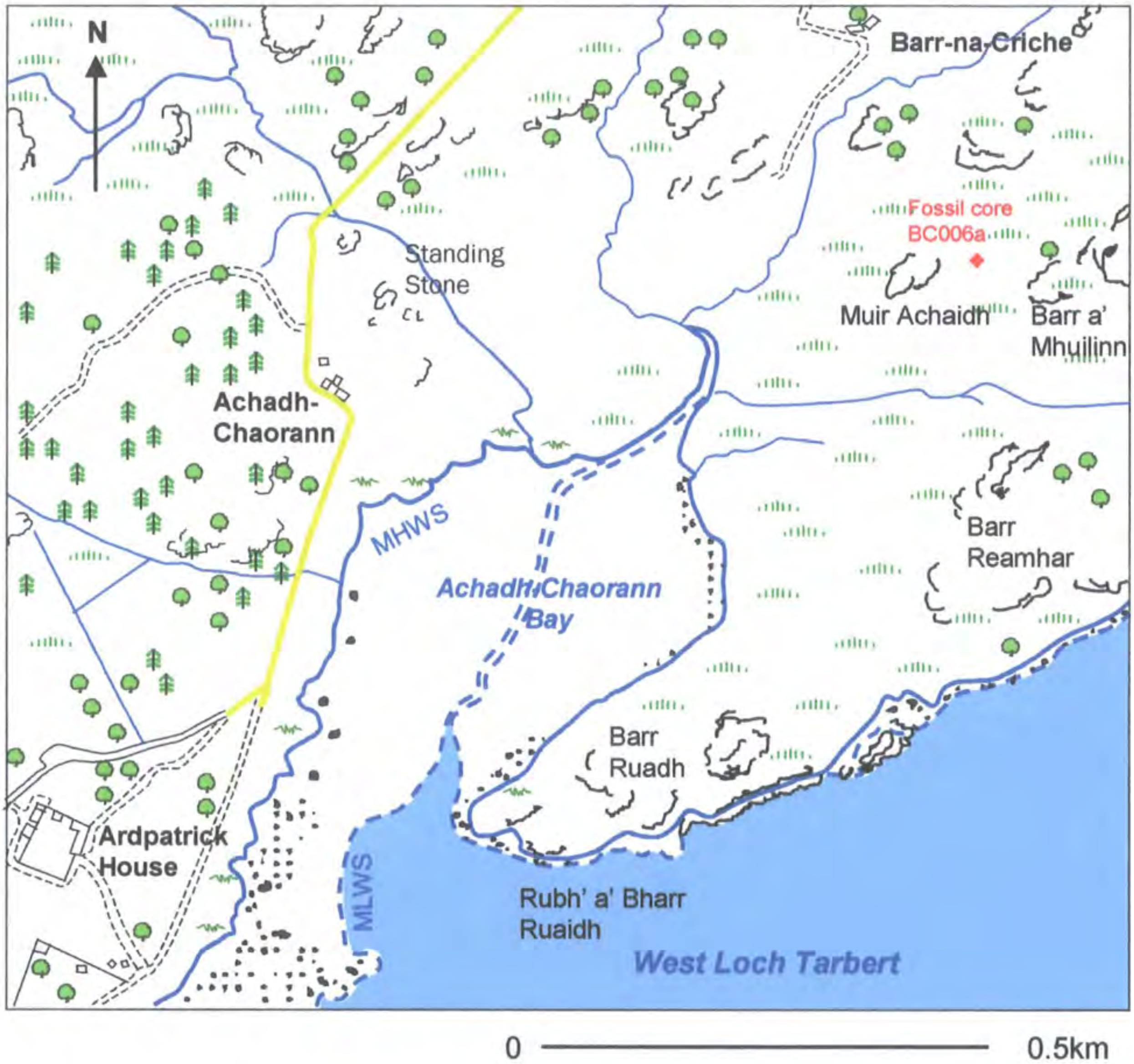


Figure 2.14. The Barr-na-Criche field site. The location of the fossil core BC006a is shown as a red diamond and annotated accordingly.

Field Site	Nearest tidal prediction	LAT	LON	MHWS	MHWN	MLWN	MLWS	MTL
Balmacara	Kyle of Lochalsh	5717	543	2.57	1.17	-0.53	-1.93	0.32
Eilean nan Gall	Dornie Bridge	5717	531	2.62	1.12	-0.58	-1.98	0.3
Nonach	Dornie Bridge	5717	531	2.62	1.12	-0.58	-1.98	0.3
Saideal nan Ceapaich	Mallaig	5700	550	2.38	1.18	-0.52	-1.92	0.28
Loch Creran	Port Appin	5633	525	2.25	1.15	-0.05	-1.15	0.55
Barr-na-Criche	East Loch Tarbert	5552	524	1.78	1.28	-0.52	-1.32	0.31

Table 2.1. Summary of the tidal predictions for the ports nearest to the field sites. The tidal predictions have been transformed into mOD from the Admiralty Tide Tables (1986) by Shennan (*pers comm.*).

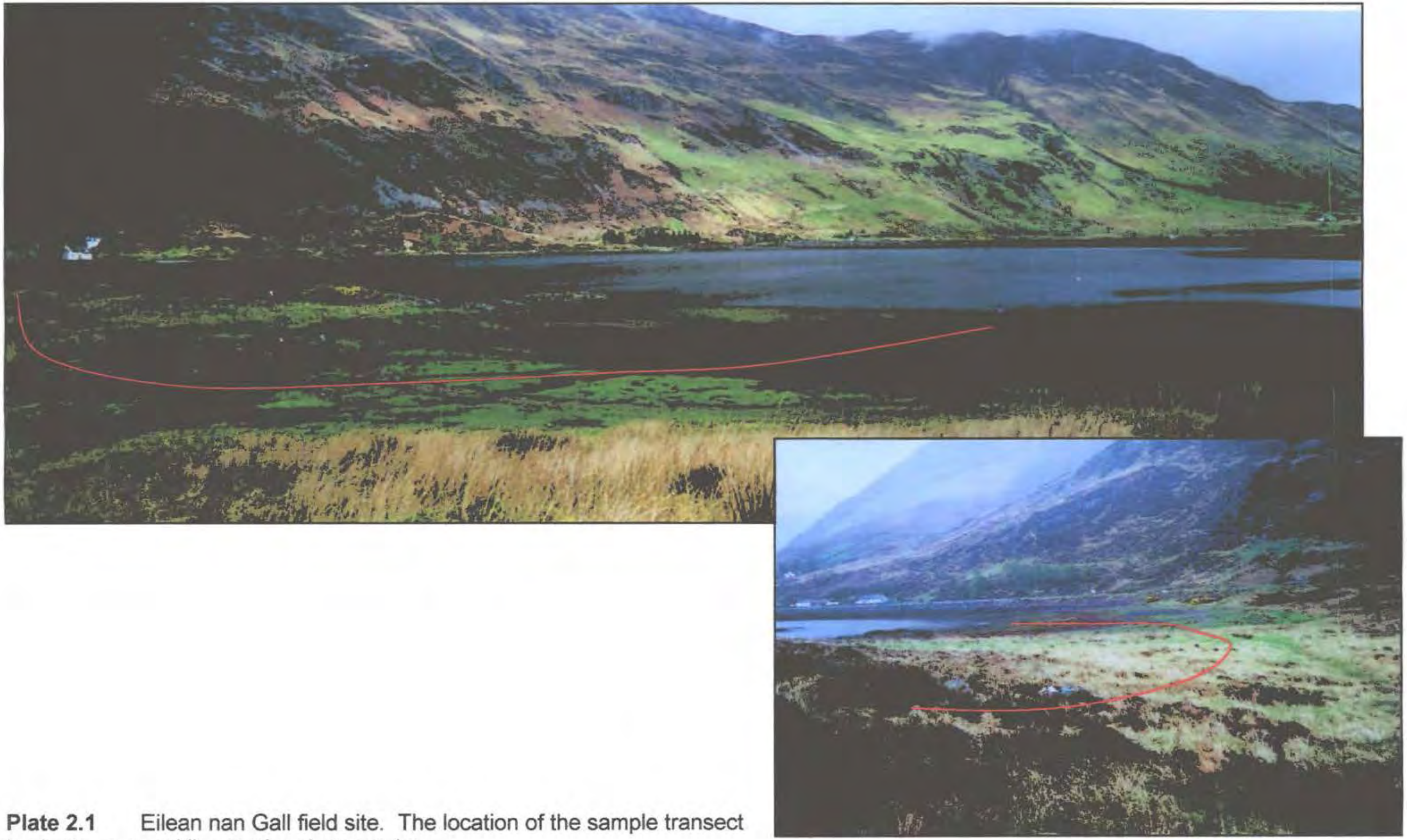


Plate 2.1 Eilean nan Gall field site. The location of the sample transect Is shown as a red line on the photographs.

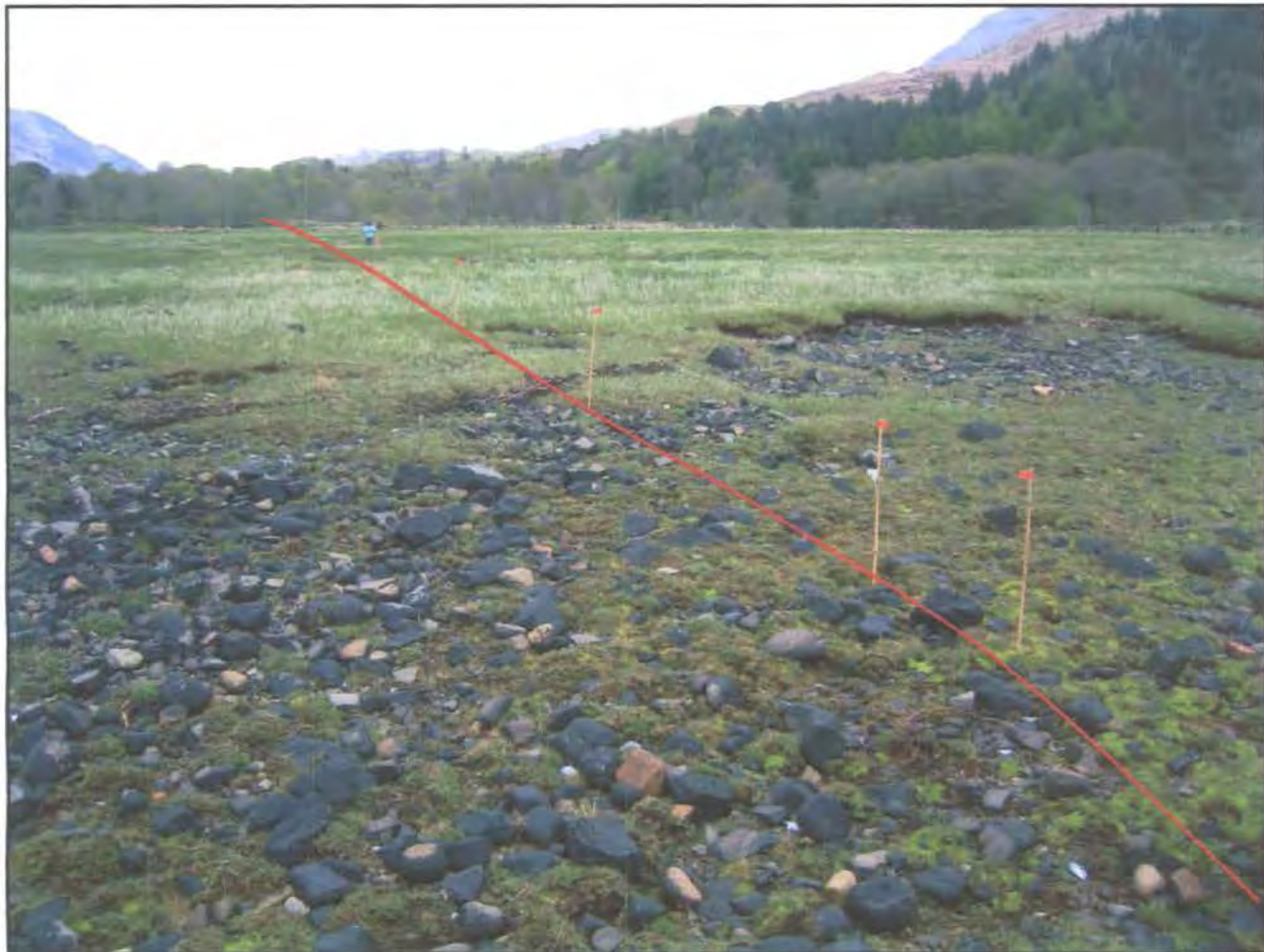


Plate 2.2 Loch Creran field site. The location of the sample transect Is shown as a red line on the photographs.

Plate 2.3 Barr-na-Criche field site. The location of the sample transect is shown as a red line on the photograph.

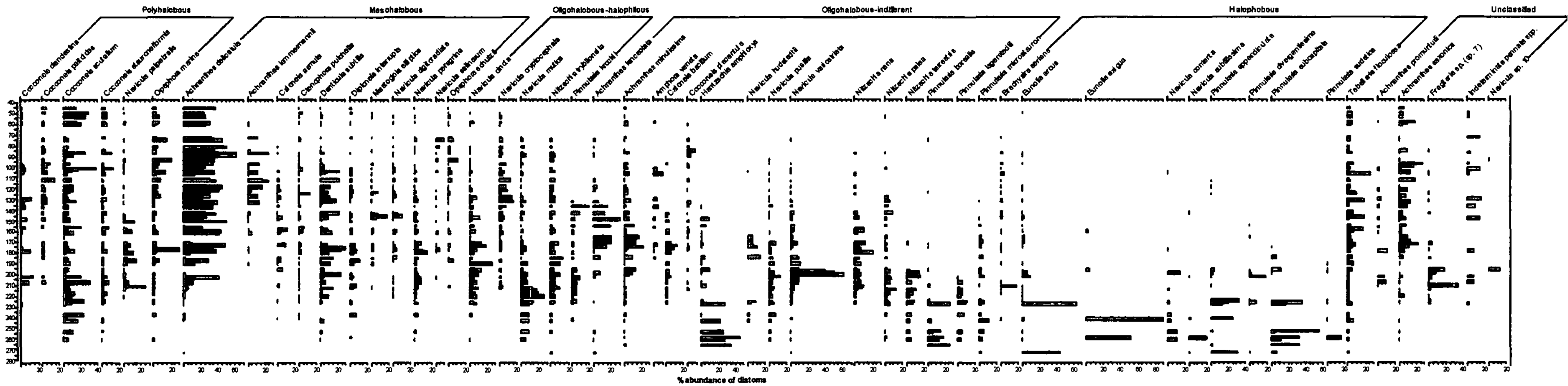
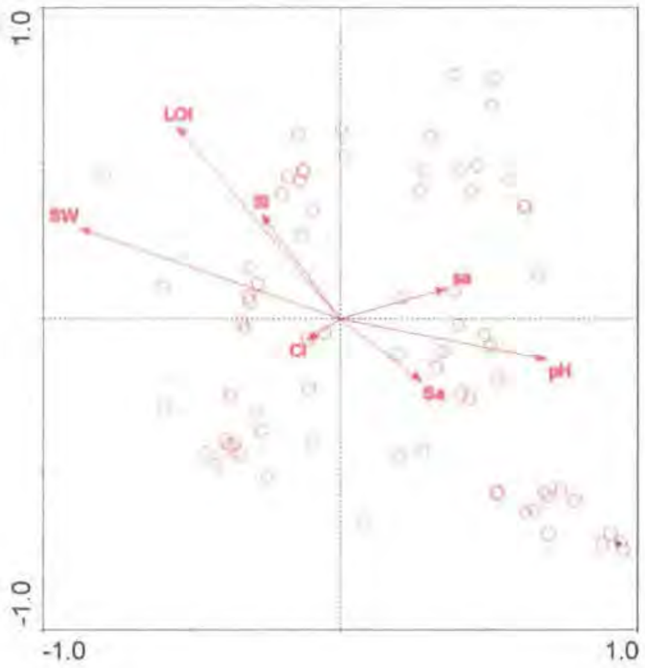


Figure 4.1 Regional diatom training set, dominant diatom species exceeding 10% of the total are shown. Species are ordered according to their salinity tolerance. The diatom samples are ordered on the y-axis according to the elevation (SWLI) of the assemblage and the histograms show the percentage abundance of each of the diatom species.



Key:

	SW	- Standardised Water Level Index
	LOI	- Loss on Ignition
	Ph	- pH
	sa	- Salinity
	Sa	- Sand
	Si	- Silt
	Cl	- Clay

Figure 4.2 CCA Ordination diagram for samples and environmental variables for the regional diatom training set.

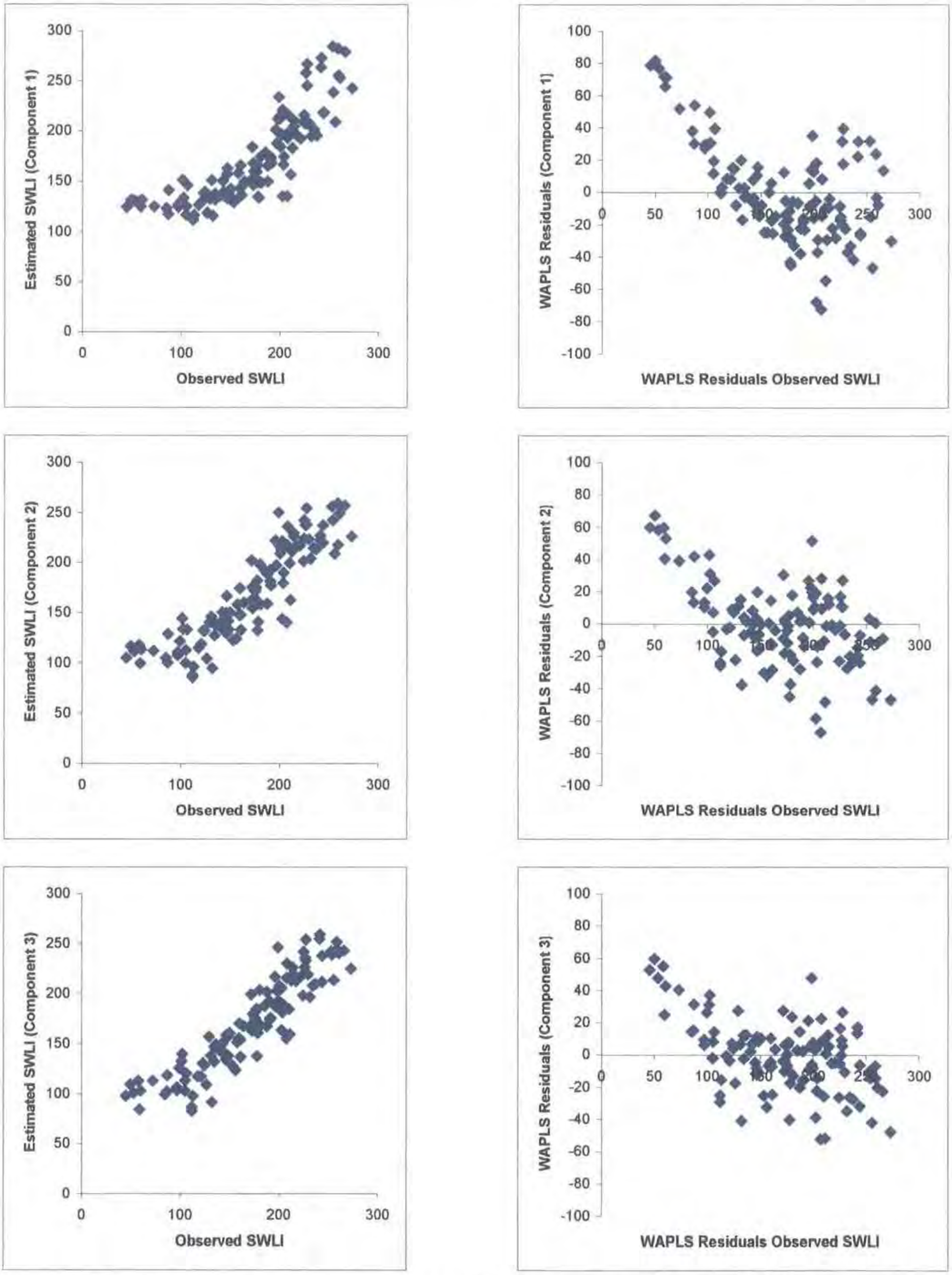


Figure 4.3 Regression results for the regional diatom training set using WAPLS components 1 – 3 are shown on the left and the associated regression residuals are shown on the right.

Figure 4.4 Kintail diatom training set, dominant diatom species exceeding 2% of the total are shown. Species are ordered according to their salinity tolerance. The diatom samples are ordered on the y-axis according to their elevation (SWLI) and the histograms show the percentage abundance of each of the dominant diatom species.

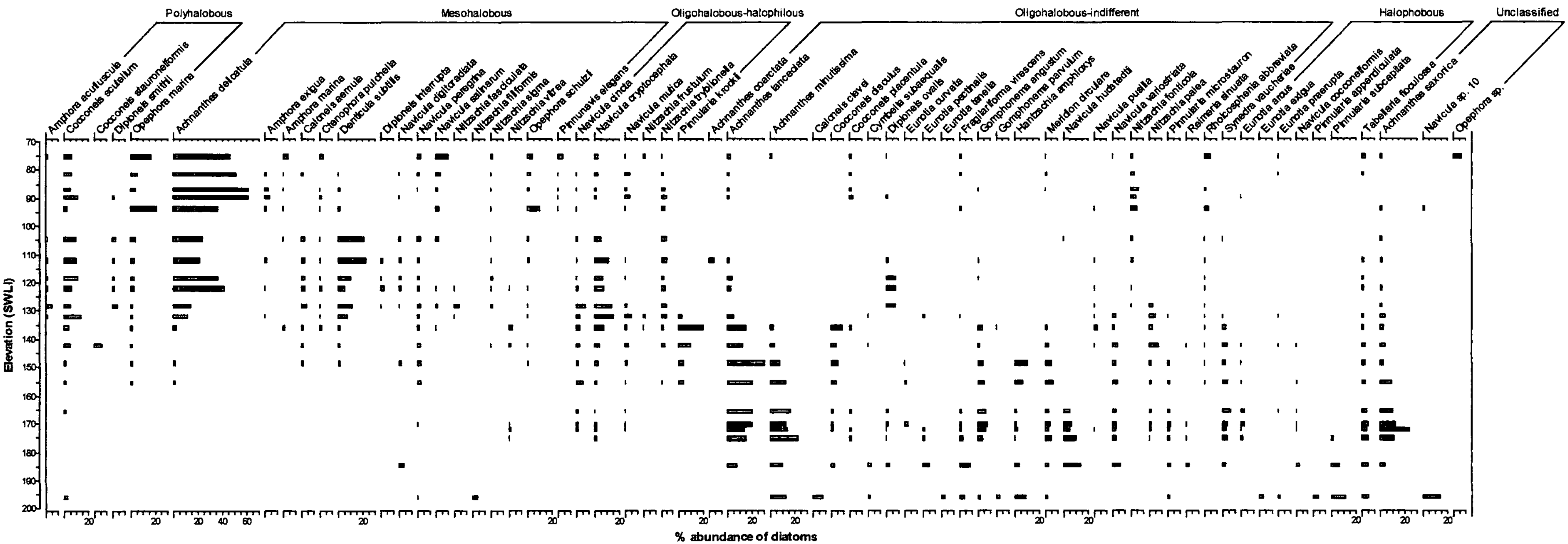


Figure 4.5 Morar diatom training set, dominant diatom species exceeding 2% of the total are shown. Species are ordered according to their salinity tolerance. The diatom samples are ordered on the y-axis according to their elevation (SWLI) and the histograms show the percentage abundance of each of the dominant diatom species.

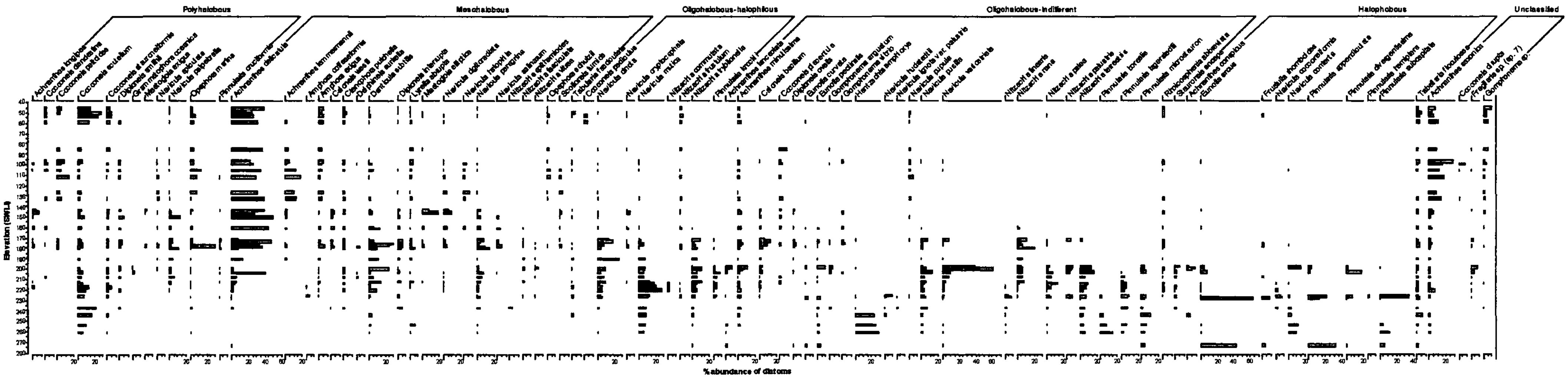
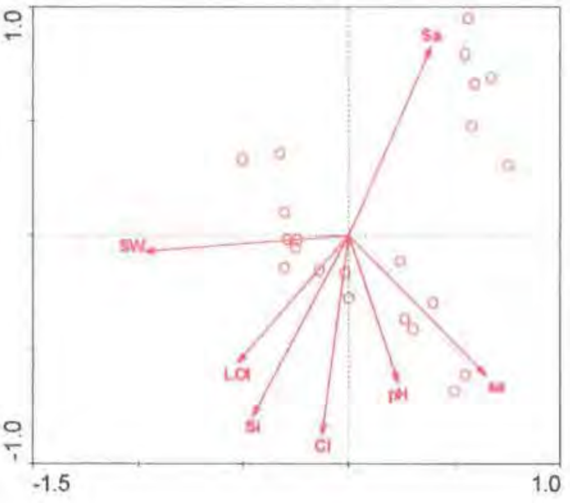
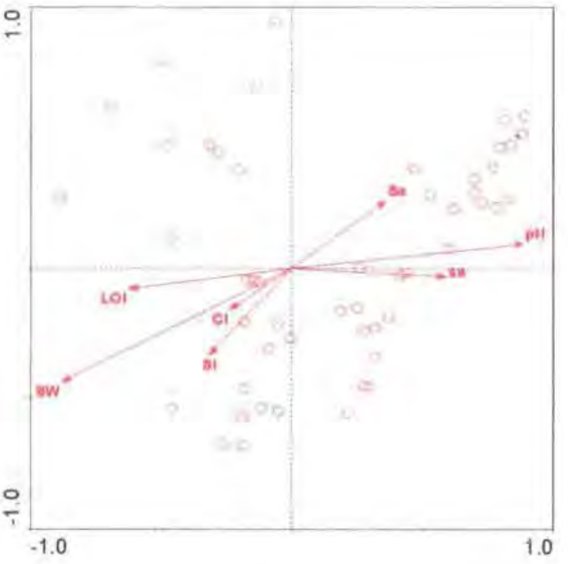


Figure 4.6 Argyll diatom training set, dominant diatom species exceeding 2% of the total are shown. Species are ordered according to their salinity tolerance. The diatom samples are ordered on the y-axis according to their elevation (SWLI) and the histograms show the percentage abundance of each of the dominant diatom species.

a) Morar



b) Argyll



Key:

SW	- Standardised Water Level Index
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Ph	- pH
sa	- Salinity
Sa	- Sand
Si	- Silt
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Figure 4.7 CCA Ordination diagram for samples and environmental variables for the diatom training sets.

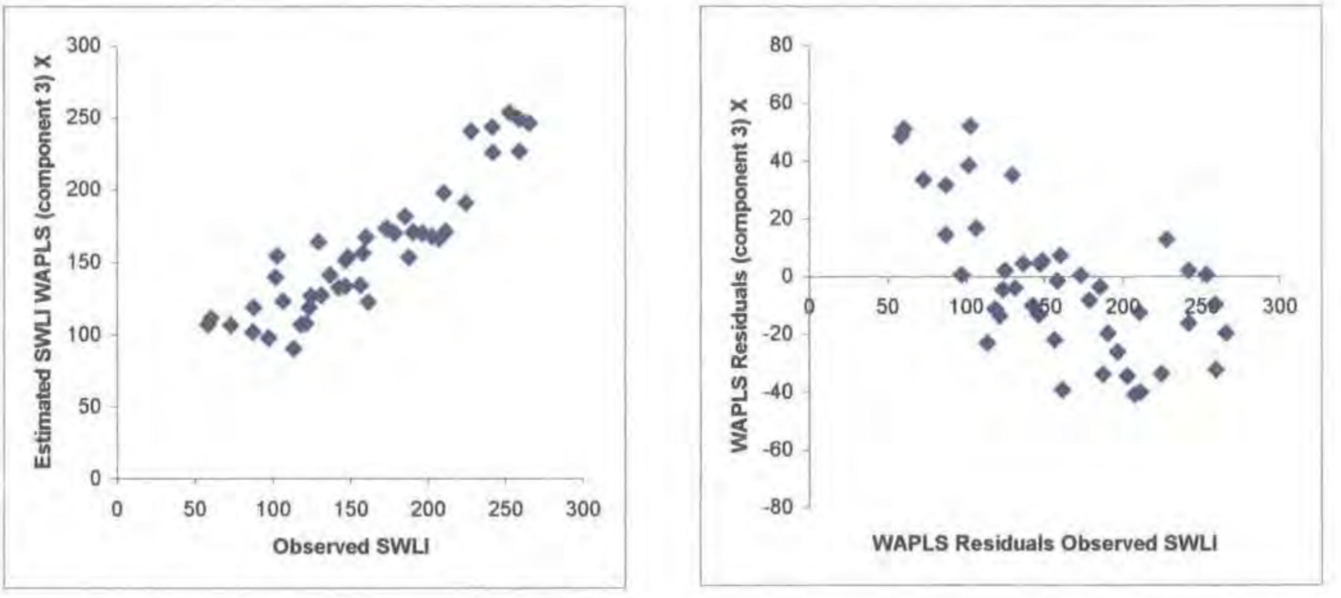


Figure 4.8 Regression results for the Kintail diatom training set using WAPLS component 3 are shown on the left and the associated regression residuals are shown on the right.

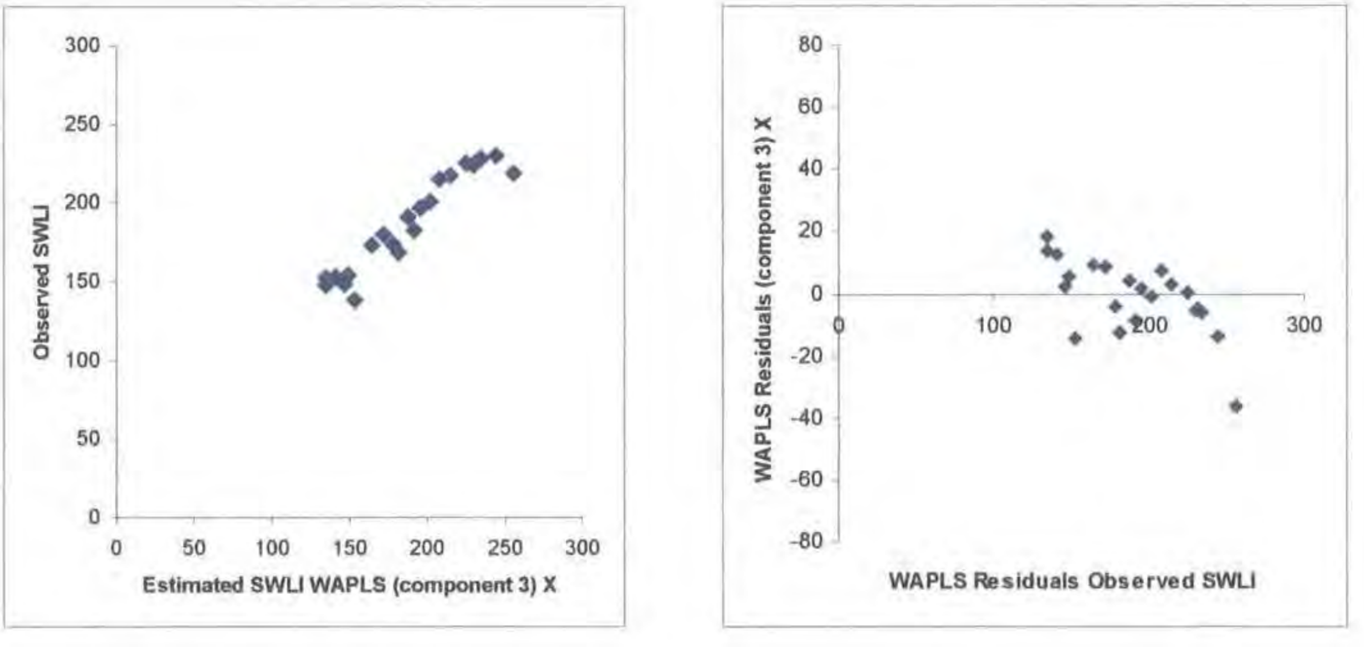
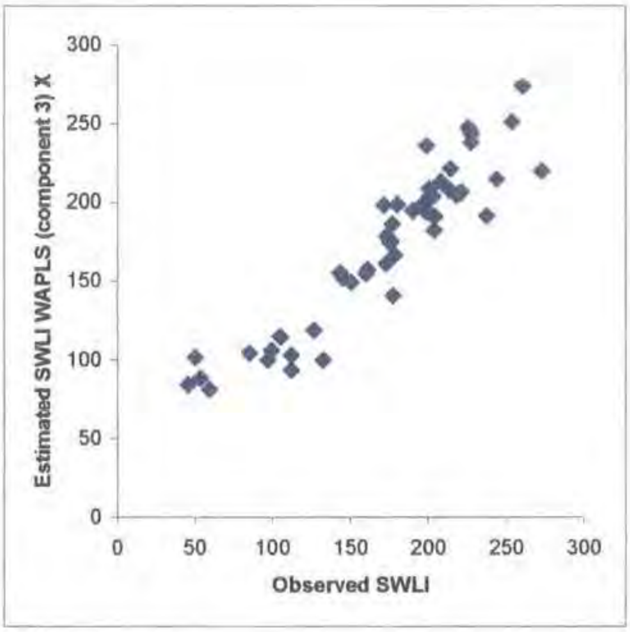


Figure 4.9 Regression results for the Morar diatom training set using WAPLS component 3 are shown on the left and the associated regression residuals are shown on the right.



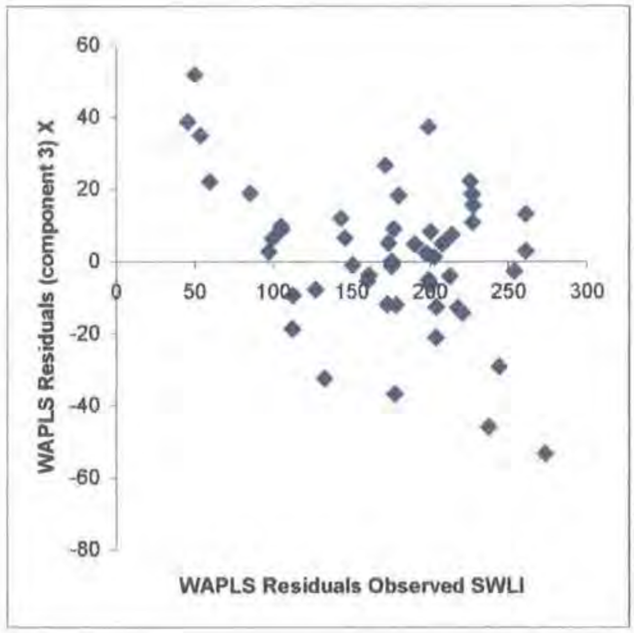


Figure 4.10 Regression results for the Argyll diatom training set using WAPLS component 3 are shown on the left and the associated regression residuals are shown on the right.

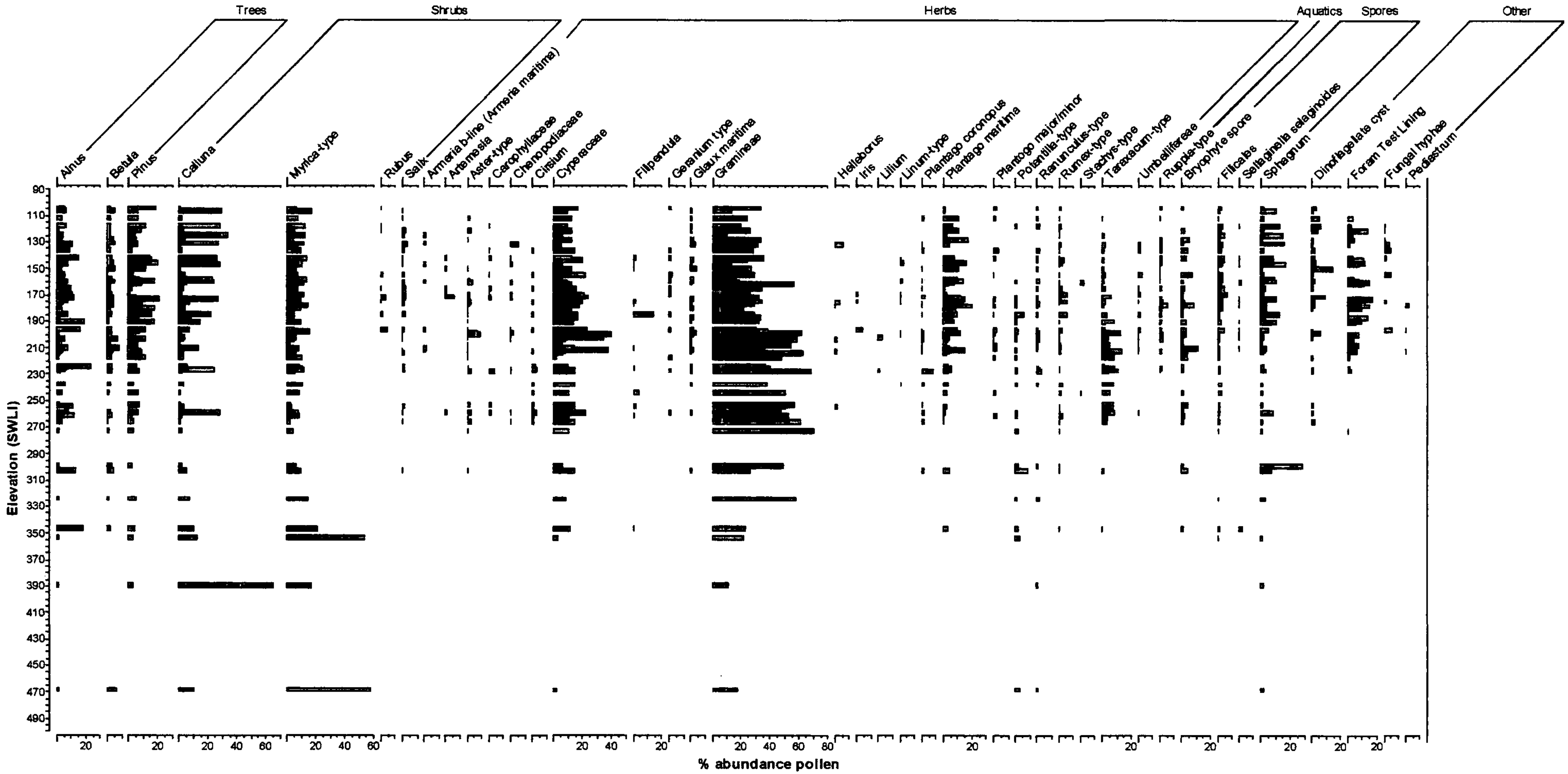


Figure 4.11 Regional pollen training set, dominant pollen species exceeding 5% of the total are shown and species are ordered according to their life form. The pollen samples are ordered on the y-axis according to their elevation (SWLI) and the histograms show the percentage abundance of each of the pollen species.

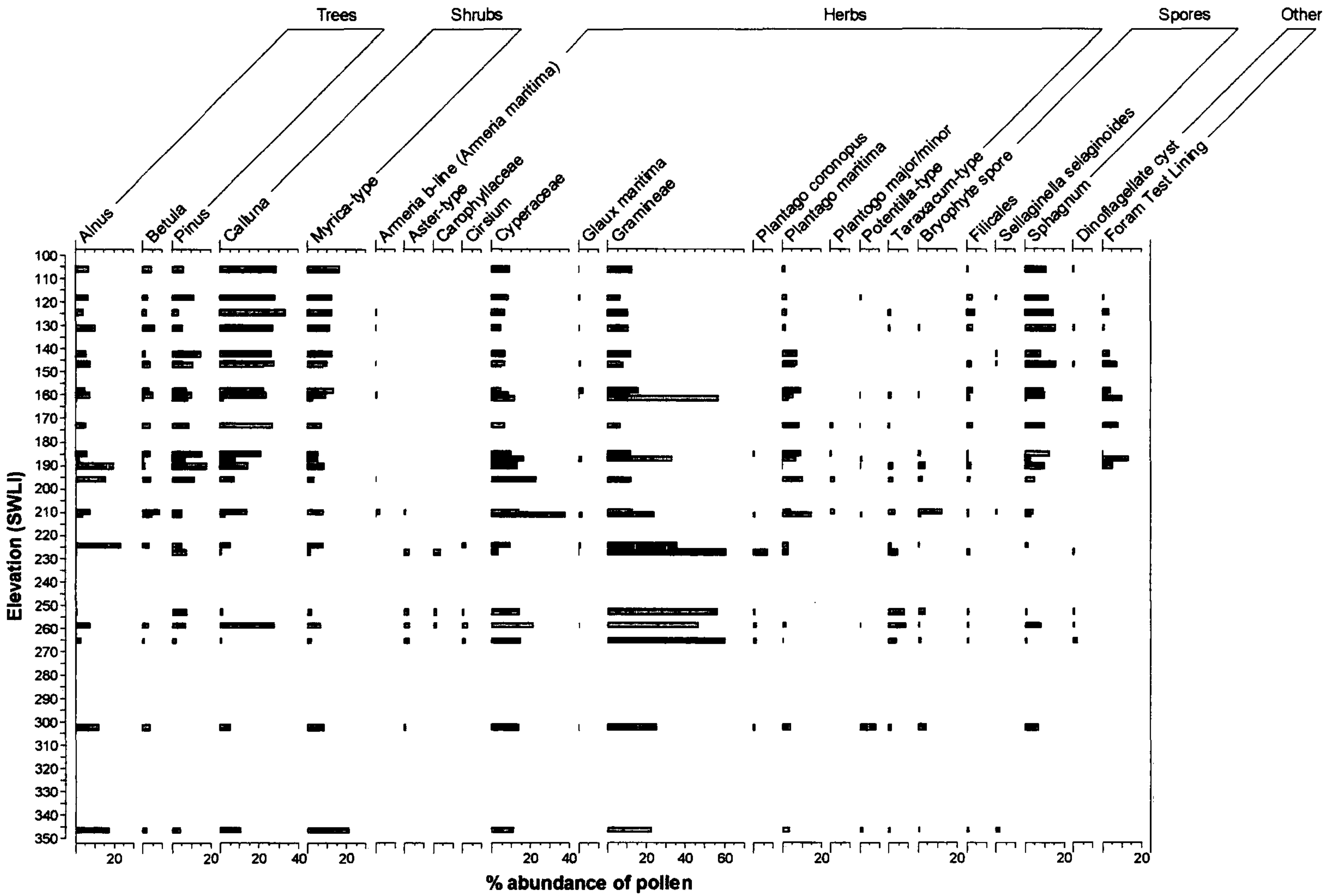


Figure 4.12 Kintaill pollen training set, dominant pollen species exceeding 2% of the total are shown and species are ordered according to their life form. The pollen samples are ordered on the y-axis according to their elevation (SWLI) and the histograms show the percentage abundance of each of the pollen species.

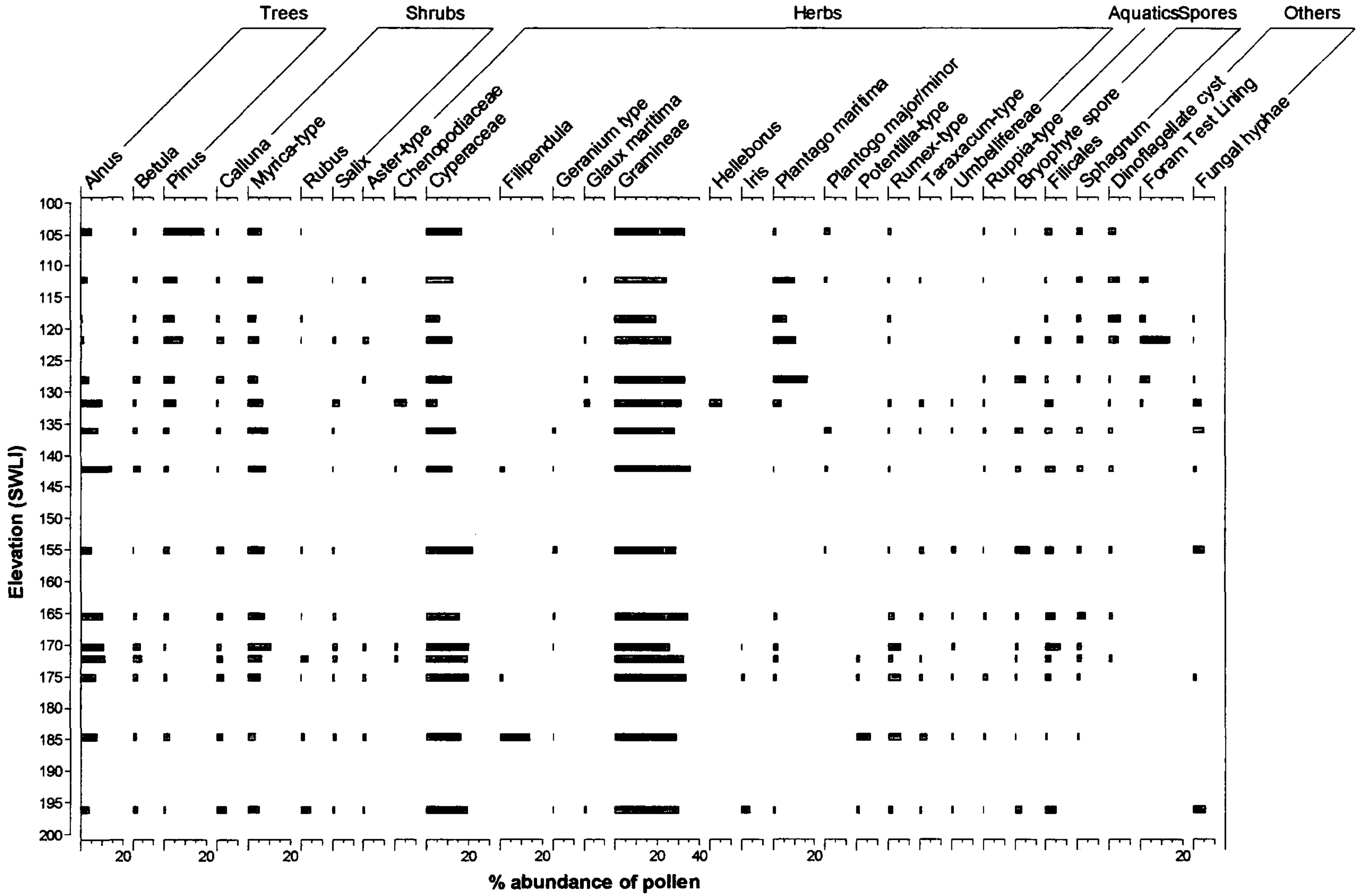


Figure 4.13 Morar pollen training set, dominant pollen species exceeding 2% of the total are shown and species are ordered according to their life form. The pollen samples are ordered on the y-axis according to their elevation (SWLI) and the histograms show the percentage abundance of each of the pollen species.

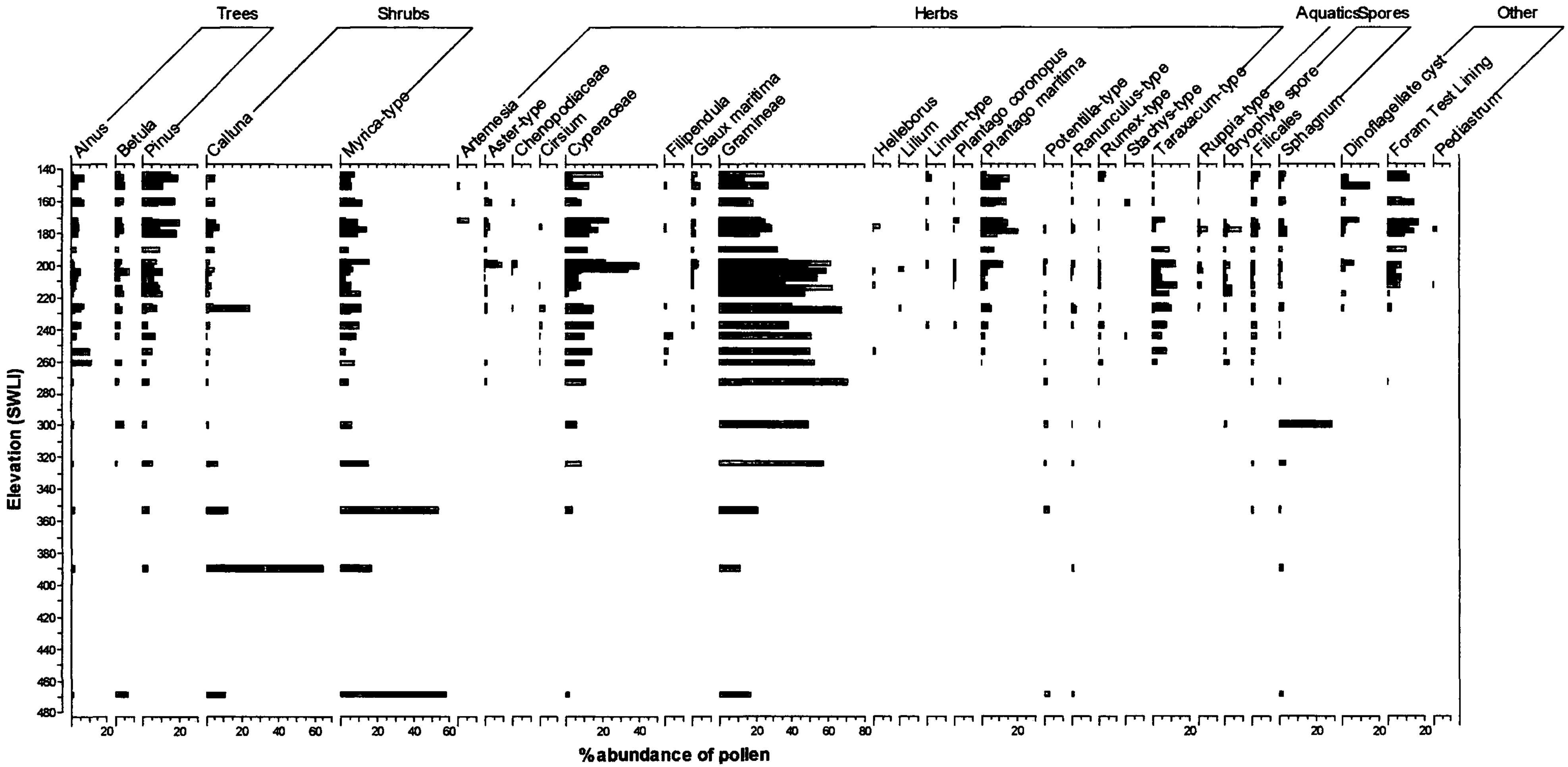


Figure 4.14 Argyll pollen training set, dominant pollen species exceeding 2% of the total are shown and species are ordered according to their life form. The pollen samples are ordered on the y-axis according to their elevation (SWLI) and the histograms show the percentage abundance of each of the pollen species.

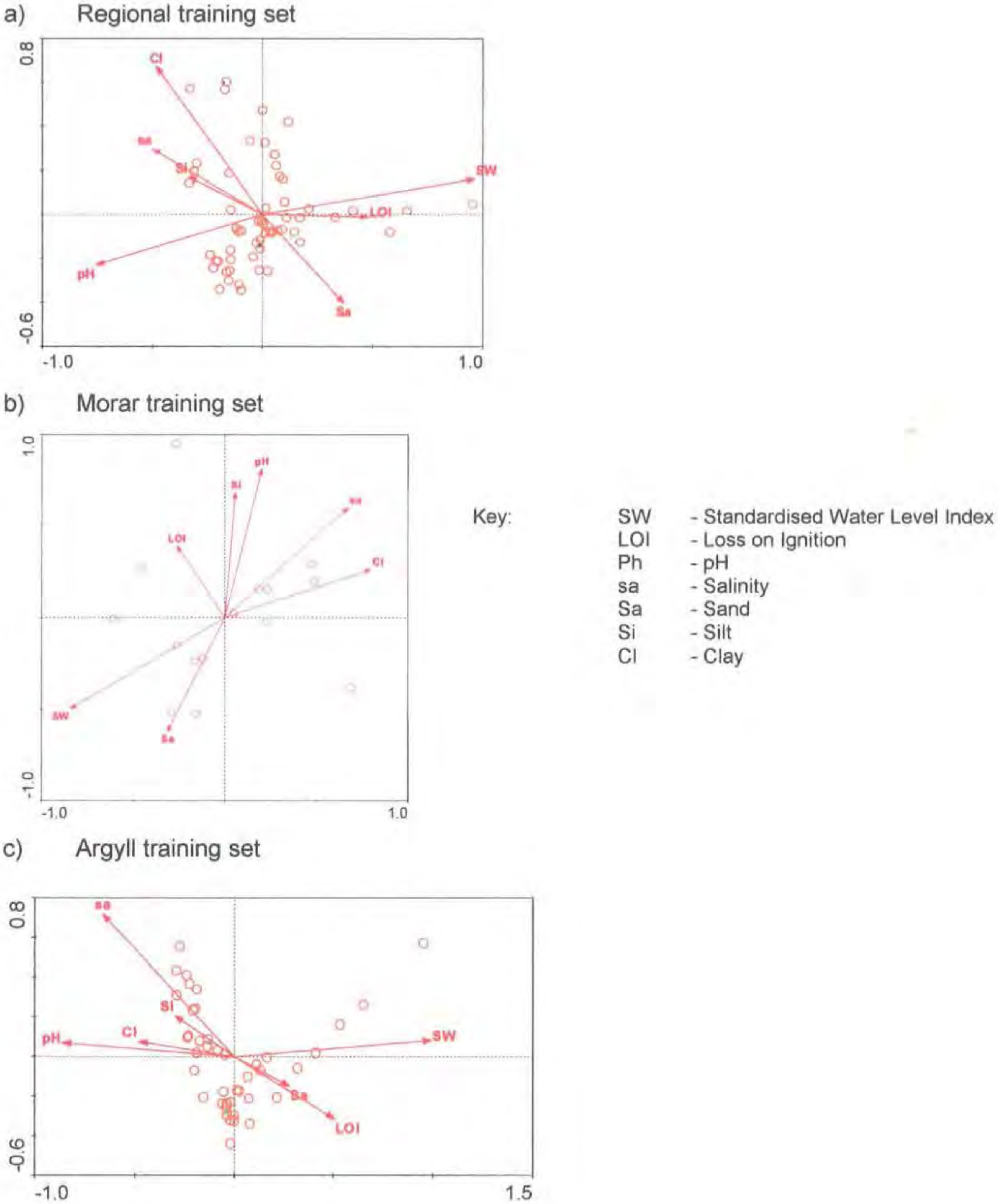
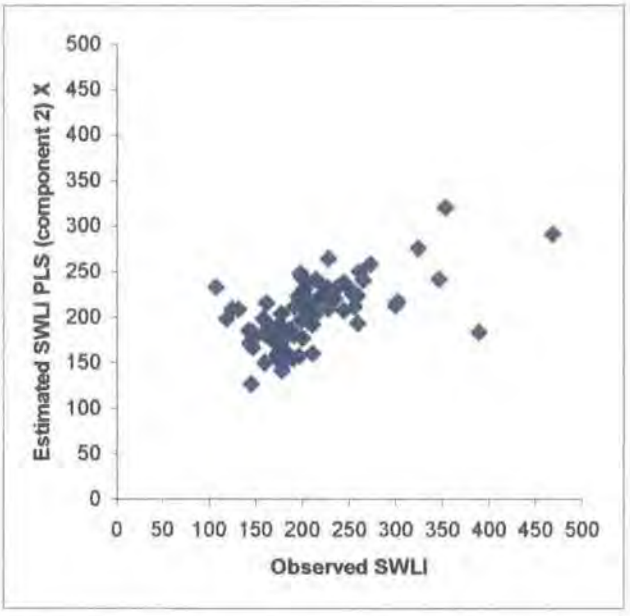


Figure 4.15 CCA Ordination diagram for samples and environmental variables for the pollen training sets.



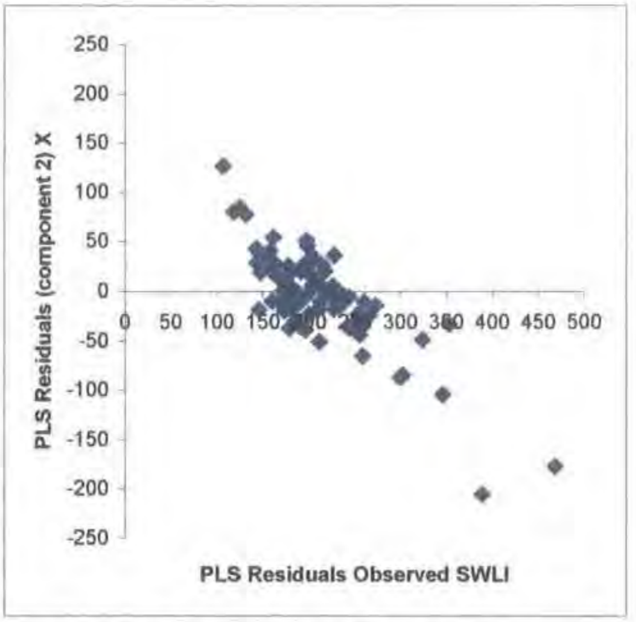
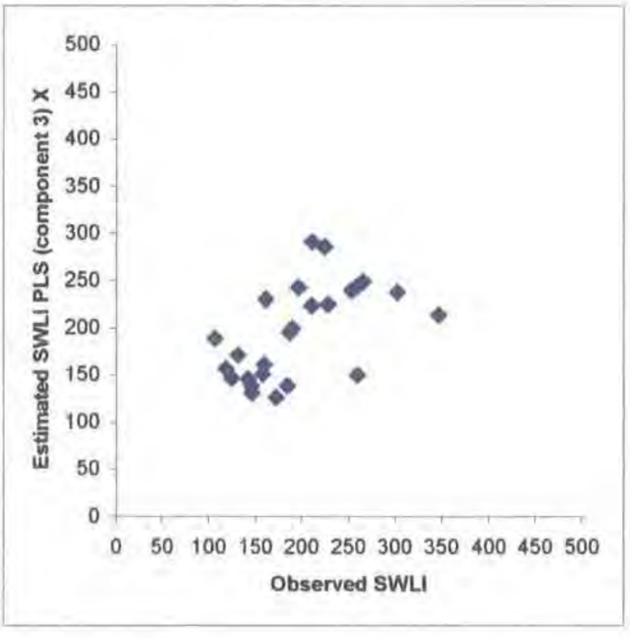


Figure 4.16 Regression results for the regional pollen training set using PLS component 2 are shown on the left and the associated regression residuals are shown on the right.



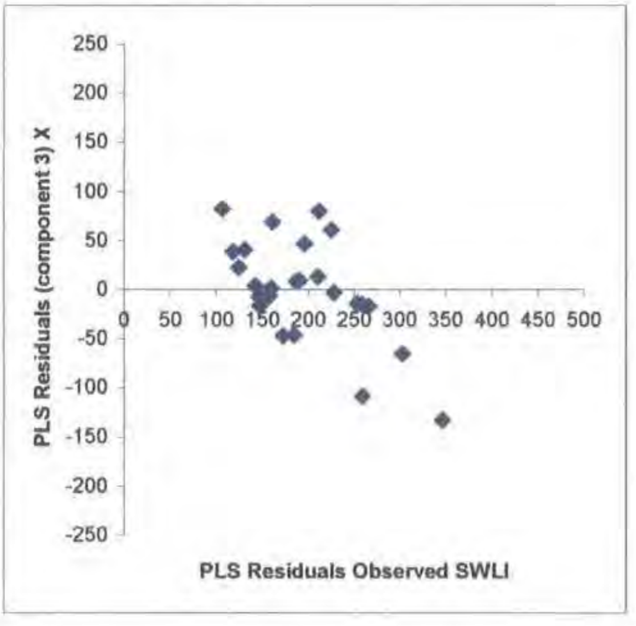
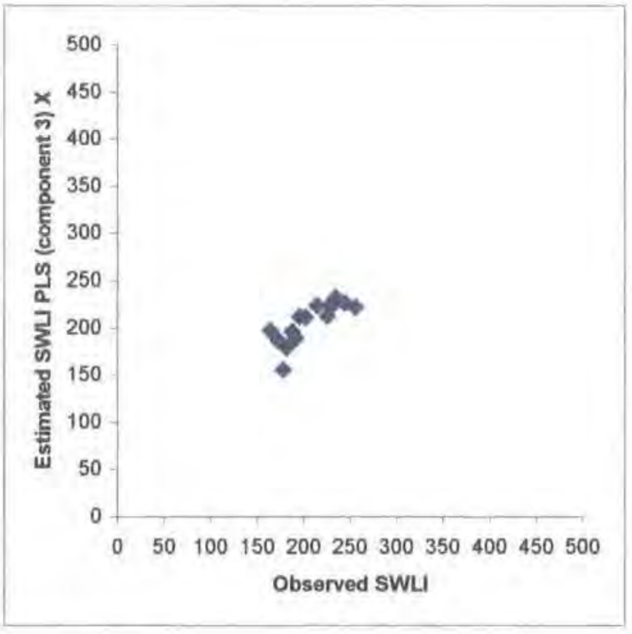


Figure 4.17 Regression results for the Kintail pollen training set using PLS component 3 are shown on the left and the associated regression residuals are shown on the right.



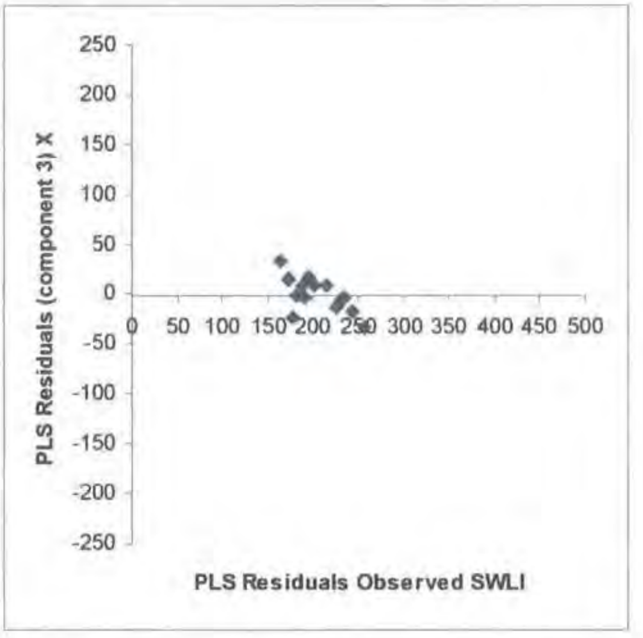
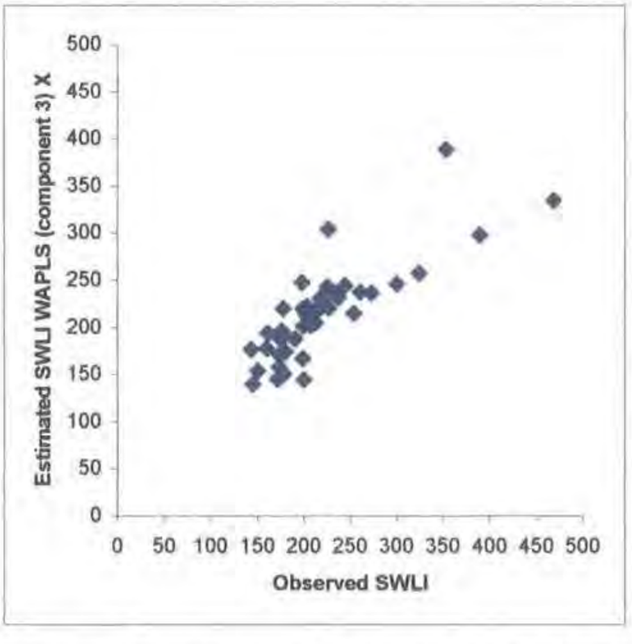


Figure 4.18 Regression results for the Morar pollen training set using PLS component 3 are shown on the left and the associated regression residuals are shown on the right.



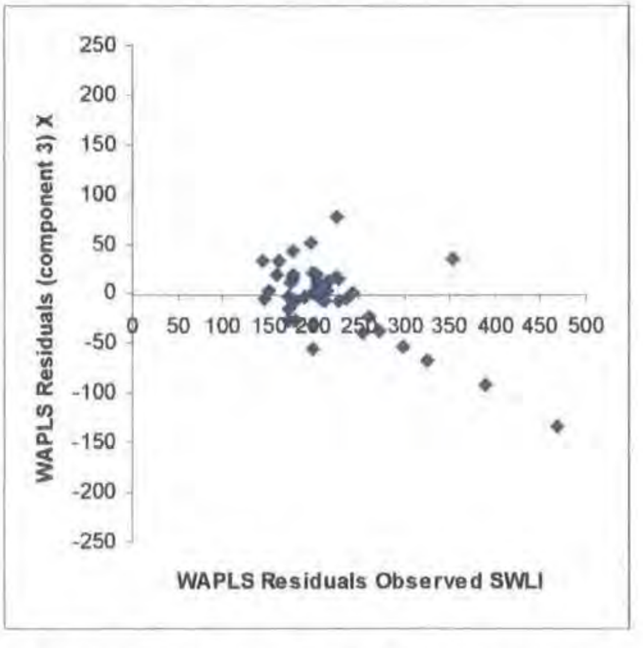


Figure 4.19 Regression results for the Argyll pollen training set using WAPLS component 3 are shown on the left and the associated regression residuals are shown on the right.

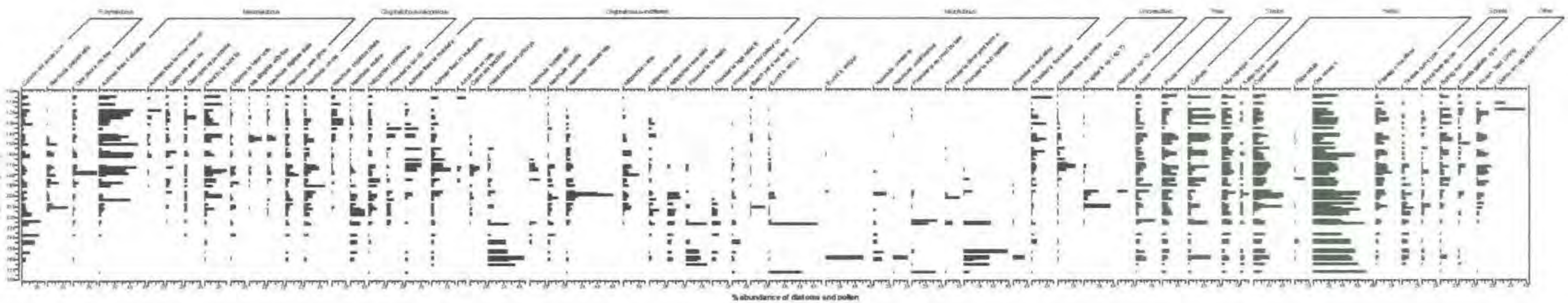


Figure 4.20 Regional multi-proxy training set, dominant species exceeding 10% of the total are shown. Species are ordered according to their salinity tolerance or life form. The samples are ordered on the y-axis according to their elevation (SWLI) and the histograms show the percentage abundance of the diatom and pollen species. Diatoms are shown in black and pollen in green.

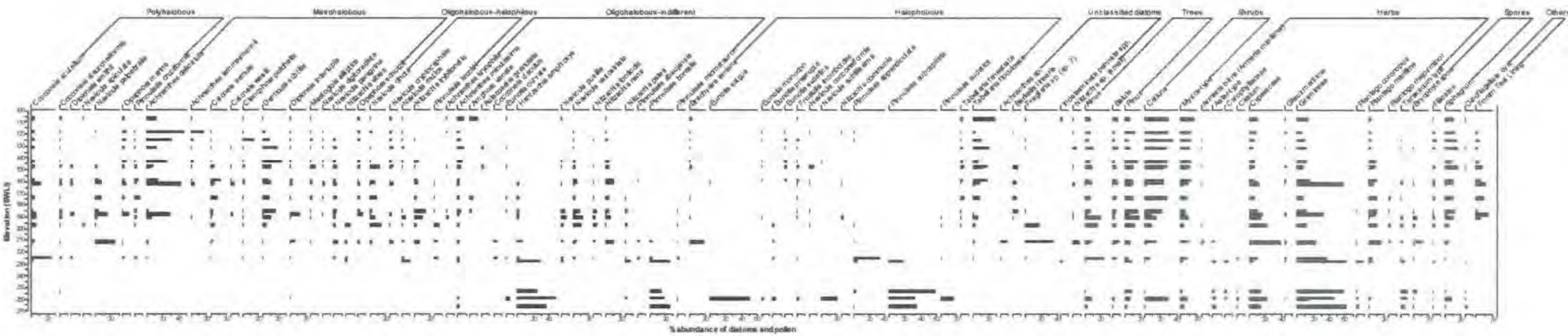


Figure 4.21 Kintail multi-proxy training set, dominant species exceeding 2% of the total are shown. Species are ordered according to their salinity tolerance or life form. The samples are ordered on the y-axis according to their elevation (SWLI) and the histograms show the percentage abundance of the diatom and pollen species. Diatoms are shown in black and pollen in green.

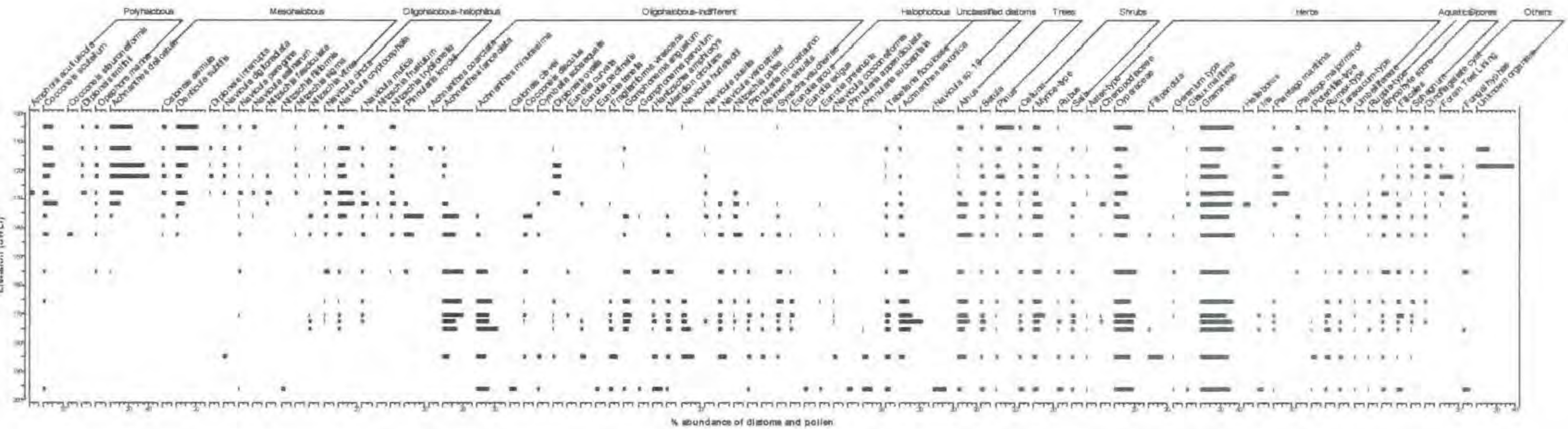


Figure 4.22 Morar multi-proxy training set, dominant species exceeding 2% of the total are shown. Species are ordered according to their salinity tolerance or life form. The samples are ordered on the y-axis according to their elevation (SWLI) and the histograms show the percentage abundance of the diatom and pollen species. Diatoms are shown in black and pollen in green.

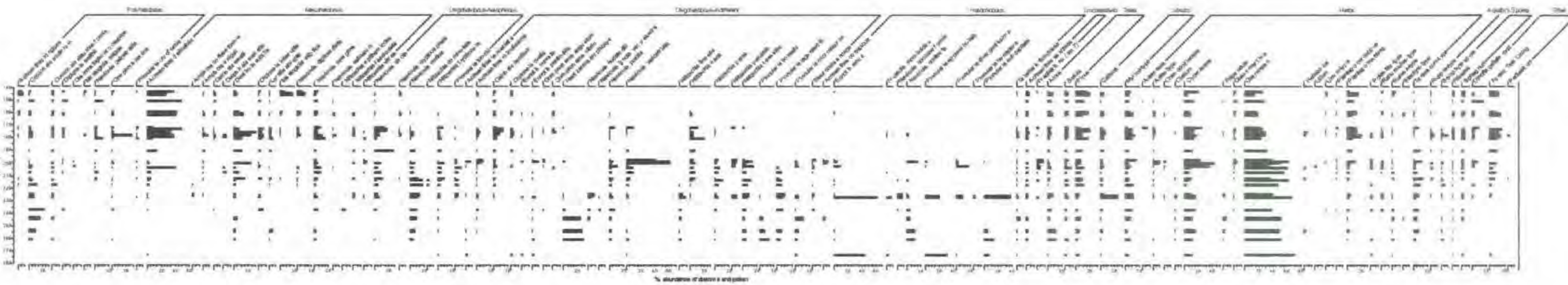
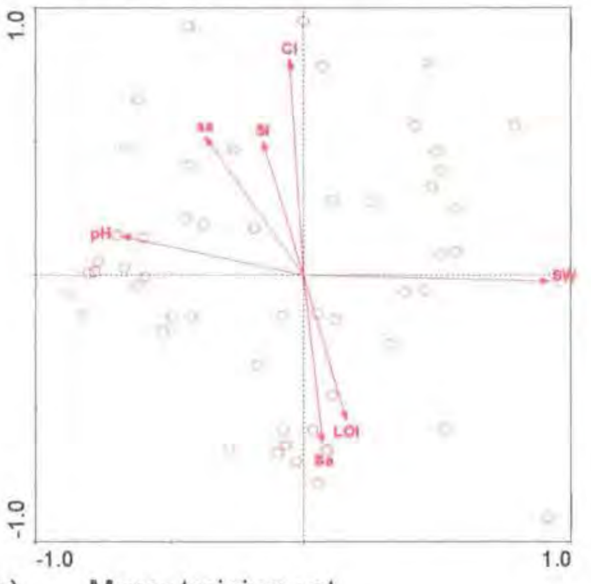
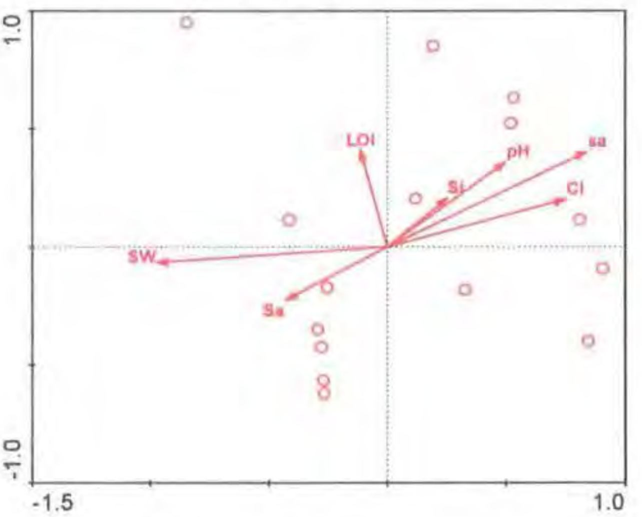


Figure 4.23 Argyll multi-proxy training set, dominant species exceeding 2% of the total are shown. Species are ordered according to their salinity tolerance or life form. The samples are ordered on the y-axis according to their elevation (SWLI) and the histograms show the percentage abundance of the diatom and pollen species. Diatoms are shown in black and pollen in green.

a) Regional training set



b) Morar training set



c) Argyll training set

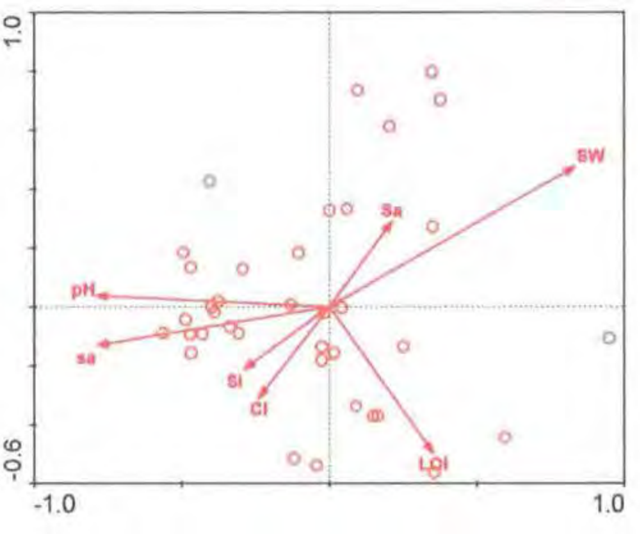


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Figure 4.24 CCA Ordination diagram for samples and environmental variables for the multi-proxy training sets.

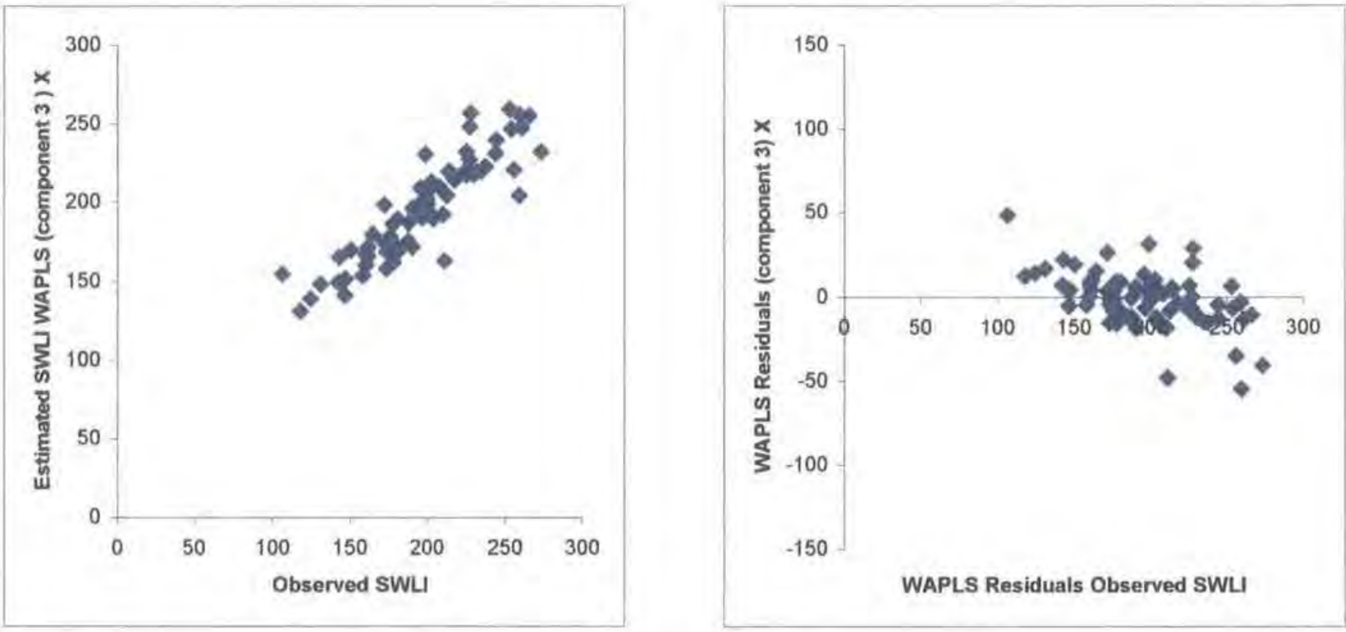


Figure 4.25 Regression results for the regional multi-proxy training set using WAPLS component 3 are shown on the left and the associated regression residuals are shown on the right.

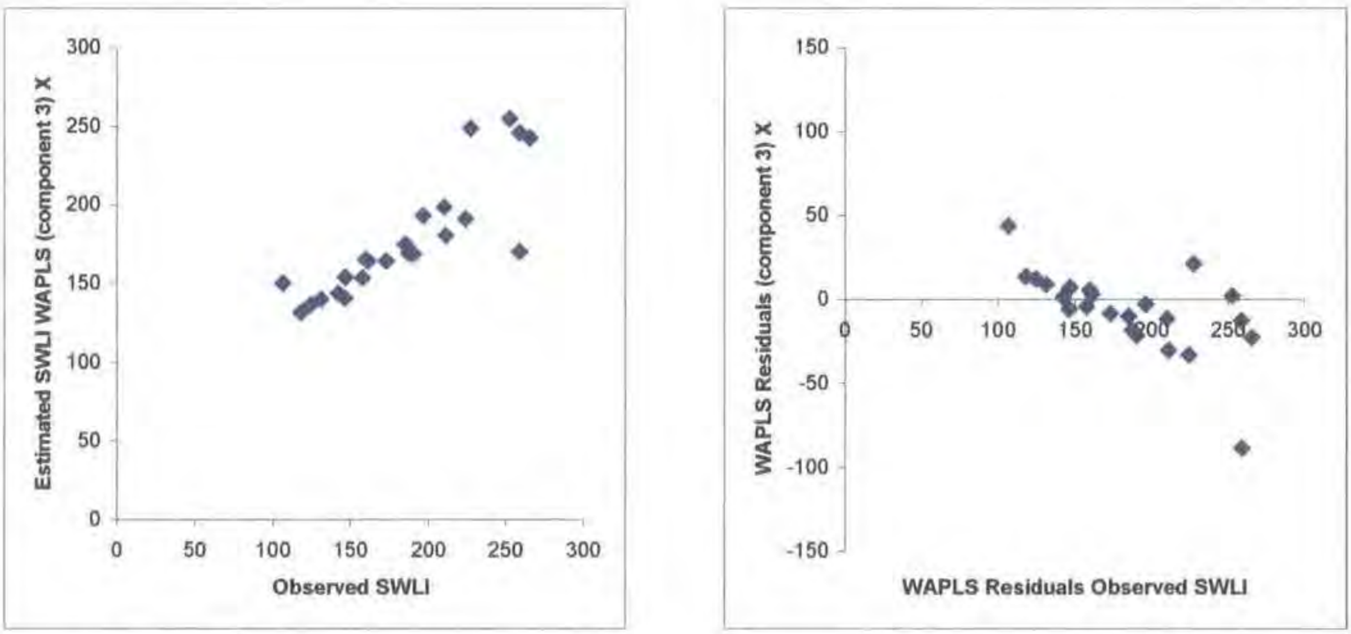
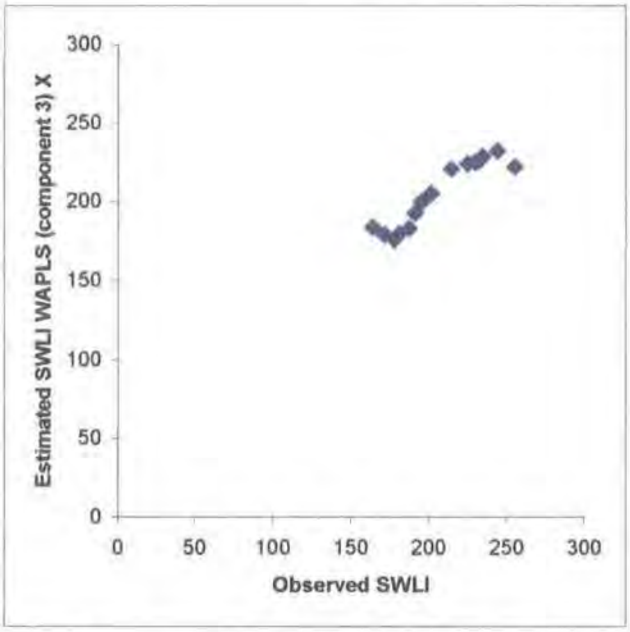


Figure 4.26 Regression results for the Kintail multi-proxy training set using WAPLS component 3 are shown on the left and the associated regression residuals are shown on the right.



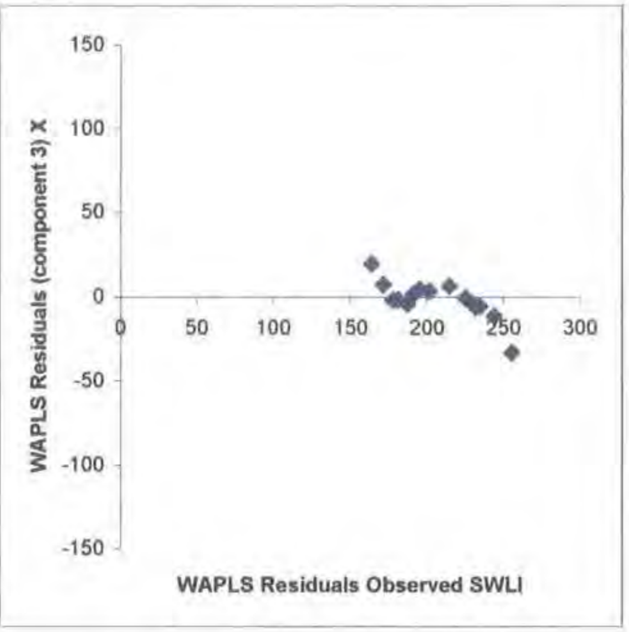
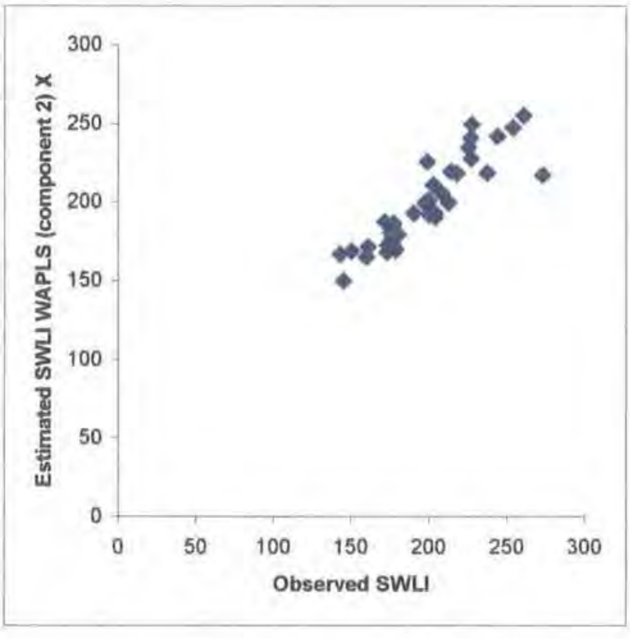


Figure 4.27 Regression results for the Morar multi-proxy training set using WAPLS component 3 are shown on the left and the associated regression residuals are shown on the right.



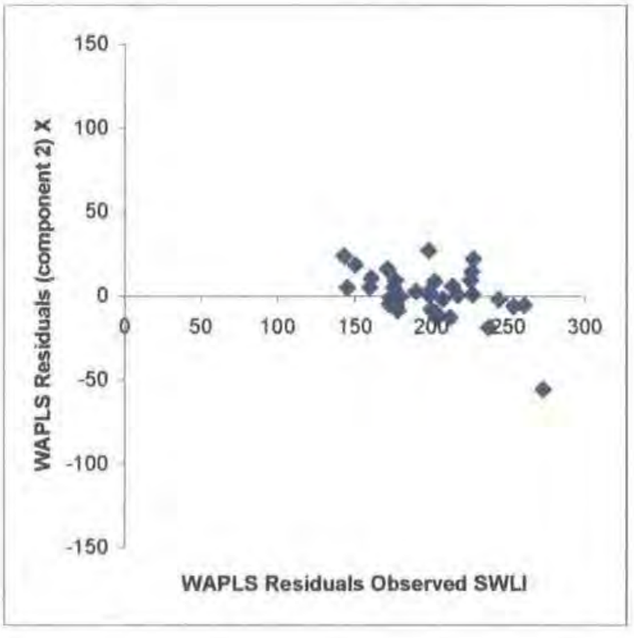


Figure 4.28 Regression results for the Argyll multi-proxy training set using WAPLS component 2 are shown on the left and the associated regression residuals are shown on the right.

Training Set Name	Environmental Variable	DCCA axis 1 length (SD units) diatoms	DCCA axis 1 length (SD units) pollen	DCCA axis 1 length (SD units) diatoms and pollen
Regional	SWLI	4.12	1.57	2.64
Kintail	SWLI	6.78	1.52	2.66
Morar	SWLI	4.48	1.52	2.36
Argyll	SWLI	4.95	2.05	2.38

Table 4.1 Detrended Canonical Correspondence Analysis results.

pH	0.18					
LOI	-0.19	-0.29				
% Sand	-0.44	0.19	-0.41			
% Silt	0.33	-0.19	0.48	-0.98		
% Clay	0.66	-0.12	0.14	-0.87	0.76	
SWLI	-0.48	-0.47	0.59	-0.07	0.17	-0.22
	Salinity	**pH**	**LOI**	**% Sand**	**% Silt**	**% Clay**

Table 4.2 Correlation matrices for environmental variables from the regional diatom training set.

Axes	**1**	**2**	**3**	**4**	**Total inertia**
Eigenvalues:	0.57	0.38	0.31	0.28	7.63
Species-environment correlations:	0.95	0.89	0.86	0.88	
Cumulative percentage variance					
of species data:	7.4	12.5	16.5	20.3	
of species-environment relation:	28.8	48.4	64.3	78.8	
Sum of all eigenvalues:					7.63
Sum of all canonical eigenvalues:					1.96

Table 4.3 CCA results showing summary of eigenvalues for the regional diatom training set.

Training Set Name	Explained Variance (%)	Unexplained Variance (%)
Regional diatom training set	26	74
Kintail diatom training set	11	89
Morar diatom training set	51	49
Argyll diatom training set	34	66
Regional pollen Training Set	28	73
Kintail pollen Training Set	16	84
Morar pollen Training Set	53	47
Argyll pollen Training Set	37	63
Regional multi-proxy training set	28	72
Kintail multi-proxy training set	18	82
Morar multi-proxy training set	43	57
Argyll multi-proxy training set	38	62

Table 4.4 Summary of the results of CCA analysis listing the percentage of explained and unexplained variance.

Model Number	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
1	WAPLS Component 1 for SWLI	27.07	0.75	0.69	30.02	0.70	30.59
	WAPLS Component 2 for SWLI	18.86	0.88	0.79	24.85	0.79	26.43
	WAPLS Component 3 for SWLI	13.97	0.93	0.84	21.84	0.83	24.83
	WAPLS Component 4 for SWLI	11.35	0.96	0.85	20.77	0.85	23.88
	WAPLS Component 5 for SWLI	9.13	0.97	0.87	19.65	0.87	23.32
2	Weighted averaging model (inverse deshrinking) for SWLI	27.07	0.75	0.69	29.94	0.70	30.55
	Weighted averaging model (classical deshrinking) for SWLI	31.25	0.75	0.70	33.56	0.70	33.68
	Weighted averaging model (tolerance downweighted, inverse deshrinking) for SWLI	21.51	0.84	0.74	27.87	0.74	29.48
	Weighted averaging model (tolerance downweighted, classical deshrinking) for SWLI	23.44	0.84	0.74	29.21	0.74	30.24

Table 4.5 Summary of the transfer function performance statistics for the regional diatom training set. WA-PLS component 3 is the chosen model.

Paper	r^2
Gasse *et al.* (1995)	0.77 to 0.92
Campeau *et al.* (1999)	0.87 to 0.89
Zong and Horton (1999)	0.65 to 0.72
Gehrels (2000)	0.77 to 0.85
Sawai *et al.* (2004)	0.88 to 0.94

Table 4.6 List of r^2 values from other studies.

a) Morar

pH	0.61					
LOI	-0.04	0.41				
% Sand	-0.22	-0.48	-0.91			
% Silt	0.16	0.48	0.93	-0.99		
% Clay	0.43	0.41	0.75	-0.90	0.85	
SWLI	-0.49	-0.16	0.49	-0.40	0.45	0.16
	Salinity	**pH**	**LOI**	**% Sand**	**% Silt**	**% Clay**

b) Argyll

pH	0.42					
LOI	-0.34	-0.56				
% Sand	-0.21	0.40	-0.53			
% Silt	0.24	-0.38	0.52	-0.99		
% Clay	0.28	-0.23	0.37	-0.91	0.88	
SWLI	-0.44	-0.80	0.59	-0.39	0.38	0.23
	Salinity	**pH**	**LOI**	**% Sand**	**% Silt**	**% Clay**

Table 4.7 Correlation matrices for environmental variables for the local diatom training sets.

a) Kintail diatom training set

Axes	1	2	3	4	Total inertia
Eigenvalues:	0.70	0.88	0.61	0.52	6.52
Species-environment correlations:	0.92	0.00	0.00	0.00	
Cumulative percentage variance					
of species data:	10.70	24.30	33.60	41.50	
of species-environment relation:	100.00	0.00	0.00	0.00	
Sum of all eigenvalues					6.52
Sum of all canonical eigenvalues					0.70

b) Morar diatom training set

Axes	1	2	3	4	Total inertia
Eigenvalues:	0.69	0.41	0.32	0.23	3.52
Species-environment correlations:	0.99	0.95	0.86	0.931	
Cumulative percentage variance					
of species data:	19.6	31.3	40.4	46.9	
of species-environment relation:	38.5	61.4	79.4	92.1	
Sum of all eigenvalues:					3.52
Sum of all canonical eigenvalues:					1.79

c) Argyll diatom training set

Axes	1	2	3	4	Total inertia
Eigenvalues:	0.70	0.43	0.38	0.29	6.21
Species-environment correlations:	0.97	0.90	0.88	0.86	
Cumulative percentage variance					
of species data:	11.20	18.10	24.10	28.80	
of species-environment relation:	33.6	53	69.8	84.5	
Sum of all eigenvalues					6.21
Sum of all canonical eigenvalues					2.11

Table 4.8 CCA results showing summary of eigenvalues for the diatom training sets.

Training Set Name	No of samples	Component	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
Regional diatoms	116	3	WAPLS Component 3 for SWLI	13.97	0.93	0.84	21.84	0.83	24.83
Kintail diatoms	43	3	WAPLS Component 3 for SWLI	11.23	0.96	0.82	24.19	0.82	27.79
Morar diatoms	22	3	WAPLS Component 3 for SWLI	2.76	0.99	0.93	10.28	0.91	12.46
Argyll diatoms	51	3	WAPLS Component 3 for SWLI	9.97	0.97	0.86	21.13	0.87	24.06

Table 4.9 Summary of the transfer function performance statistics for the diatom training sets for each model chosen. The results are shown in full in appendix 4.1.

a) Regional training set

pH	0.33					
LOI	-0.32	-0.46				
% Sand	-0.58	-0.18	-0.01			
% Silt	0.43	0.20	0.08	-0.96		
% Clay	0.79	0.20	-0.21	-0.86	0.71	
SWLI	-0.34	-0.81	0.49	0.25	-0.26	-0.29
	Salinity	**pH**	**LOI**	**% Sand**	**% Silt**	**% Clay**

b) Morar training set

pH	0.55					
LOI	-0.22	0.30				
% Sand	-0.38	-0.44	-0.69			
% Silt	0.21	0.47	0.79	-0.96		
% Clay	0.65	0.21	0.22	-0.74	0.52	
SWLI	-0.87	-0.55	0.06	0.57	-0.39	-0.78
	Salinity	**pH**	**LOI**	**% Sand**	**% Silt**	**% Clay**

c) Argyll training set

pH	0.58					
LOI	-0.52	-0.57				
% Sand	-0.32	-0.13	-0.19			
% Silt	0.36	0.15	0.17	-0.99		
% Clay	0.43	0.37	-0.06	-0.88	0.85	
SWLI	-0.60	-0.87	0.51	0.23	-0.23	-0.44
	Salinity	**pH**	**LOI**	**% Sand**	**% Silt**	**% Clay**

Table 4.10 Correlation matrices for environmental variables for the pollen training sets.

a) Regional training set

Axes	1	2	3	4	Total inertia
Eigenvalues:	0.17	0.13	0.07	0.07	1.90
Species-environment correlations:	0.88	0.79	0.61	0.77	
Cumulative percentage variance					
of species data:	9.00	15.70	19.50	22.90	
of species-environment relation:	32.50	56.80	70.60	83.00	
Sum of all eigenvalues					1.90
Sum of all canonical eigenvalues					0.53

b) Kintail training set

Axes	1	2	3	4	Total inertia
Eigenvalues:	0.16	0.25	0.09	0.08	0.96
Species-environment correlations:	0.76	0.00	0.00	0.00	
Cumulative percentage variance					
of species data:	16.30	42.90	52.20	61.00	
of species-environment relation:	100.00	0.00	0.00	0.00	
Sum of all eigenvalues:					0.96
Sum of all canonical eigenvalues:					0.16

c) Morar training set

Axes	1	2	3	4	Total inertia
Eigenvalues:	0.24	0.14	0.11	0.06	1.21
Species-environment correlations:	0.87	0.91	0.94	0.76	
Cumulative percentage variance					
of species data:	19.8	31.2	40.6	45.5	
of species-environment relation:	37.5	59.1	76.7	86.1	
Sum of all eigenvalues:					1.21
Sum of all canonical eigenvalues:					0.64

d) Argyll training set

Axes	1	2	3	4	Total inertia
Eigenvalues:	0.19	0.14	0.06	0.04	1.39
Species-environment correlations :	0.92	0.89	0.84	0.82	
Cumulative percentage variance					
of species data:	13.80	24.20	28.60	31.60	
of species-environment relation:	37.30	65.30	77.10	85.40	
Sum of all eigenvalues:					1.39
Sum of all canonical eigenvalues:					0.52

Table 4.11 CCA results showing summary of eigenvalues for the pollen training sets.

Training Set Name	No of samples	Component	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
Regional pollen	82	2	PLS Component 2 for SWLI	39.44	0.56	0.34	48.19	0.36	50.89
Kintail pollen	25	3	PLS Component 3 for SWLI	34.63	0.66	0.30	52.92	0.31	57.61
Morar pollen	15	3	PLS Component 3 for SWLI	6.49	0.94	0.59	17.97	0.65	18.44
Argyll pollen	42	3	WAPLS Component 3 for SWLI	18.74	0.92	0.59	42.20	0.67	43.29

Table 4.12 Summary of the performance statistics for the chosen transfer function model for each of the pollen training sets. A table of the results for each model is shown in Appendix 4.1.

a) Regional training set

pH	0.30					
LOI	-0.26	-0.16				
% Sand	-0.55	-0.06	-0.10			
% Silt	0.42	0.10	0.16	-0.96		
% Clay	0.75	0.03	-0.11	-0.87	0.71	
SWLI	-0.37	-0.65	0.18	0.13	-0.17	-0.11
	Salinity	**pH**	**LOI**	**% Sand**	**% Silt**	**% Clay**

b) Morar training set

pH	0.58					
LOI	-0.14	0.33				
% Sand	-0.37	-0.48	-0.76			
% Silt	0.22	0.50	0.82	-0.97		
% Clay	0.63	0.28	0.35	-0.77	0.58	
SWLI	-0.85	-0.59	-0.03	0.58	-0.44	-0.76
	Salinity	**pH**	**LOI**	**% Sand**	**% Silt**	**% Clay**

c) Argyll training set

pH	0.55					
LOI	-0.42	-0.33				
% Sand	-0.30	-0.05	-0.27			
% Silt	0.35	0.07	0.25	-0.99		
% Clay	0.35	0.17	0.11	-0.89	0.85	
SWLI	-0.79	-0.68	0.28	0.24	-0.24	-0.30
	Salinity	**pH**	**LOI**	**% Sand**	**% Silt**	**% Clay**

Table 4.13 Correlation matrices for environmental variables from the multi-proxy training sets.

a) Regional training set

Axes	1	2	3	4	Total inertia
Eigenvalues:	0.31	0.21	0.18	0.10	3.47
Species-environment correlations:	0.95	0.85	0.90	0.78	
Cumulative percentage variance					
of species data:	9.00	15.10	20.20	23.00	
of species-environment relation:	31.40	52.90	70.50	80.30	
Sum of all eigenvalues:					3.47
Sum of all canonical eigenvalues:					0.99

b) Kintail training set

Axes	1	2	3	4	Total inertia
Eigenvalues:	0.45	0.51	0.33	0.21	2.47
Species-environment correlations:	0.93	0.00	0.00	0.00	
Cumulative percentage variance					
of species data:	18.00	38.60	51.80	60.10	
of species-environment relation:	100.00	0.00	0.00	0.00	
Sum of all eigenvalues:					2.47
Sum of all canonical eigenvalues:					0.45

c) Morar training set

Axes	1	2	3	4	Total inertia
Eigenvalues:	0.37	0.21	0.17	0.12	1.76
Species-environment correlations:	0.97	0.94	0.93	0.85	
Cumulative percentage variance					
of species data:	21.10	32.80	42.40	49.20	
of species-environment relation:	37.10	57.80	74.70	86.50	
Sum of all eigenvalues					1.76
Sum of all canonical eigenvalues					1.00

d) Argyll training set

Axes	1	2	3	4	Total inertia
Eigenvalues:	0.35	0.23	0.17	0.11	2.62
Species-environment correlations:	0.96	0.92	0.80	0.83	
Cumulative percentage variance					
of species data:	13.30	22.00	28.50	32.80	
of species-environment relation:	34.80	57.60	74.70	85.70	
Sum of all eigenvalues:					2.62
Sum of all canonical eigenvalues:					1.00

Table 4.14 CCA results showing summary of eigenvalues for the multi-proxy training sets.

Training Set Name	No of samples	Component	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
Regional multi-proxy	75	3	WAPLS Component 3 for SWLI	6.10	0.97	0.82	15.66	0.81	17.90
Kintail multi-proxy	23	3	WAPLS Component 3 for SWLI	5.06	0.99	0.73	25.00	0.74	26.40
Morar multi-proxy	15	3	WAPLS Component 3 for SWLI	1.21	1.00	0.87	10.51	0.88	11.65
Argyll multi-proxy	37	2	WAPLS Component 2 for SWLI	7.34	0.95	0.80	14.42	0.80	15.93

Table 4.15 Summary of the performance statistics for the chosen transfer function model for each of the multi-proxy training sets. A table of the results for each model is shown in Appendix 4.1.

Training Set Name	No of samples	Component	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
Regional diatoms	116	3	WAPLS Component 3 for SWLI	13.97	0.93	0.84	21.84	0.83	24.83
Kintail diatoms	43	3	WAPLS Component 3 for SWLI	11.23	0.96	0.82	24.19	0.82	27.79
Morar diatoms	22	3	WAPLS Component 3 for SWLI	2.76	0.99	0.93	10.28	0.91	12.46
Argyll diatoms	51	3	WAPLS Component 3 for SWLI	9.97	0.97	0.86	21.13	0.87	24.06
Regional pollen	82	2	PLS Component 2 for SWLI	39.44	0.56	0.34	48.19	0.36	50.89
Kintail pollen	25	3	PLS Component 3 for SWLI	34.63	0.66	0.30	52.92	0.31	57.61
Morar pollen	15	3	PLS Component 3 for SWLI	6.49	0.94	0.59	17.97	0.65	18.44
Argyll pollen	42	3	WAPLS Component 3 for SWLI	18.74	0.92	0.59	42.20	0.67	43.29
Regional multi-proxy	75	3	WAPLS Component 3 for SWLI	6.10	0.97	0.82	15.66	0.81	17.90
Kintail multi-proxy	23	3	WAPLS Component 3 for SWLI	5.06	0.99	0.73	25.00	0.74	26.40
Morar multi-proxy	15	3	WAPLS Component 3 for SWLI	1.21	1.00	0.87	10.51	0.88	11.65
Argyll multi-proxy	37	2	WAPLS Component 2 for SWLI	7.34	0.95	0.80	14.42	0.80	15.93

Table 4.16 Summary of the performance statistics for the chosen transfer function models for each of the training sets.

Multi-proxy Training Set Name	No of samples	Component	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
Regional Diatom and pollen	75	3	WAPLS Component 3 for SWLI	6.10	0.97	0.82	15.66	0.81	17.90
Regional Diatoms	75	3	WAPLS Component 3 for SWLI	8.11	0.95	0.78	17.51	0.78	20.35
Regional Pollen	75	2	WAPLS Component 2 for SWLI	18.39	0.76	0.58	24.40	0.61	24.73

Table 4.17 Summary of the performance statistics for the most appropriate models for the multi-proxy training set and diatom and pollen training sets comprising just the diatom and pollen samples present in the multi-proxy training set.

APPENDIX 4.1 Transfer function results.

Regional Diatom Training Set

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
	Component 1	WAPLS Component 1 for SWLI	27.07	0.75	0.69	30.02	0.70	30.59
	Component 2	WAPLS Component 2 for SWLI	18.86	0.88	0.79	24.85	0.79	26.43
1	Component 3	WAPLS Component 3 for SWLI	13.97	0.93	0.84	21.84	0.83	24.83
	Component 4	WAPLS Component 4 for SWLI	11.35	0.96	0.85	20.77	0.85	23.88
	Component 5	WAPLS Component 5 for SWLI	9.13	0.97	0.87	19.65	0.87	23.32

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
	WA_Inv	Weighted averaging model (inverse deshrinking) for SWLI	27.07	0.75	0.69	29.94	0.70	30.55
2	WA_Cla	Weighted averaging model (classical deshrinking) for SWLI	31.25	0.75	0.70	33.56	0.70	33.68
	WATOL_Inv	Weighted averaging model (tolerance downweighted, inverse deshrinking) for SWLI	21.51	0.84	0.74	27.87	0.74	29.48
	WATOL_Cla	Weighted averaging model (tolerance downweighted, classical deshrinking) for SWLI	23.44	0.84	0.74	29.21	0.74	30.24

Kintail Diatom Training Set

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
	Component 1	WAPLS Component 1 for SWLI	27.04	0.77	0.68	32.07	0.69	34.27
	Component 2	WAPLS Component 2 for SWLI	16.18	0.92	0.79	25.76	0.80	28.93
1	Component 3	WAPLS Component 3 for SWLI	11.23	0.96	0.82	24.19	0.82	27.79
	Component 4	WAPLS Component 4 for SWLI	8.29	0.98	0.86	21.54	0.85	26.32
	Component 5	WAPLS Component 5 for SWLI	6.05	0.99	0.87	20.79	0.86	26.39

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
	WA_Inv	Weighted averaging model (inverse deshrinking) for SWLI	27.04	0.77	0.68	31.94	0.68	33.43
	WA_Cla	Weighted averaging model (classical deshrinking) for SWLI	30.76	0.77	0.69	35.71	0.69	36.12
2	WATOL_Inv	Weighted averaging model (tolerance downweighted, inverse deshrinking) for SWLI	24.10	0.82	0.70	31.30	0.69	34.67
	WATOL_Cla	Weighted averaging model (tolerance downweighted, classical deshrinking) for SWLI	26.63	0.82	0.70	33.90	0.70	35.97

Morar Diatom Training Set

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
	Component 1	WAPLS Component 1 for SWLI	8.67	0.94	0.84	15.00	0.84	15.64
	Component 2	WAPLS Component 2 for SWLI	4.38	0.99	0.89	12.75	0.89	13.68
1	Component 3	WAPLS Component 3 for SWLI	2.76	0.99	0.93	10.28	0.91	12.46
	Component 4	WAPLS Component 4 for SWLI	1.56	1.00	0.93	10.17	0.92	12.29
	Component 5	WAPLS Component 5 for SWLI	0.99	1.00	0.93	10.05	0.92	12.18

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
	WA_Inv	Weighted averaging model (inverse deshrinking) for SWLI	8.67	0.94	0.86	14.01	0.88	13.81
	WA_Cla	Weighted averaging model (classical deshrinking) for SWLI	8.92	0.94	0.86	13.75	0.88	13.48
2	WATOL_Inv	Weighted averaging model (tolerance downweighted, inverse deshrinking) for SWLI	6.38	0.97	0.89	12.21	0.91	14.48
	WATOL_Cla	Weighted averaging model (tolerance downweighted, classical deshrinking) for SWLI	6.47	0.97	0.89	11.98	0.91	14.30

Argyll Diatom Training Set

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
1	Component 1	WAPLS Component 1 for SWLI	24.46	0.81	0.74	28.69	0.75	29.51
	Component 2	WAPLS Component 2 for SWLI	15.73	0.92	0.82	23.66	0.82	26.20
	Component 3	WAPLS Component 3 for SWLI	9.97	0.97	0.86	21.13	0.87	24.06
	Component 4	WAPLS Component 4 for SWLI	7.34	0.98	0.87	20.13	0.87	23.87
	Component 5	WAPLS Component 5 for SWLI	5.18	0.99	0.88	19.90	0.88	24.33

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
2	WA_Inv	Weighted averaging model (inverse deshrinking) for SWLI	24.46	0.81	0.74	28.73	0.73	30.22
	WA_Cla	Weighted averaging model (classical deshrinking) for SWLI	27.18	0.81	0.74	31.48	0.74	32.19
	WATOL_Inv	Weighted averaging model (tolerance downweighted, inverse deshrinking) for SWLI	14.58	0.93	0.80	25.44	0.80	30.02
	WATOL_Cla	Weighted averaging model (tolerance downweighted, classical deshrinking) for SWLI	15.10	0.93	0.81	24.84	0.80	29.82

Regional Pollen Training Set

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
	Component 1	PLS Component 1 for SWLI	47.30	0.36	0.17	54.82	0.19	55.71
	Component 2	PLS Component 2 for SWLI	39.44	0.56	0.34	48.19	0.36	50.89
1	Component 3	PLS Component 3 for SWLI	37.91	0.59	0.33	49.26	0.32	54.01
	Component 4	PLS Component 4 for SWLI	36.32	0.62	0.23	57.29	0.27	58.28
	Component 5	PLS Component 5 for SWLI	35.65	0.64	0.19	58.96	0.24	61.21
Model	**Code**	**Name**	**RMSE**	**R2**	**Jack R2**	**Jack RMSEP**	**Boot R2**	**Boot RMSEP**
	PCAR_01	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 1	59.12	0.00	0.61	62.69	0.55	64.85
	PCAR_02	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 2	52.52	0.21	0.09	57.46	0.09	60.09
2	PCAR_03	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 3	46.94	0.37	0.22	52.68	0.22	56.13
	PCAR_04	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 4	46.31	0.39	0.23	52.42	0.25	54.43
	PCAR_05	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 5	40.73	0.53	0.35	47.96	0.32	52.47
Model	**Code**	**Name**	**RMSE**	**R2**				
	PCAR_01	Principal Components Regression model for SWLI using axes 1 - 1	57.59	0.05				
	PCAR_02	Principal Components Regression model for SWLI using axes 1 - 2	48.94	0.32				
3	PCAR_03	Principal Components Regression model for SWLI using axes 1 - 3	42.05	0.49				
	PCAR_04	Principal Components Regression model for SWLI using axes 1 - 4	39.35	0.56				
	PCAR_05	Principal Components Regression model for SWLI using axes 1 - 5	39.35	0.56				

Kintail Pollen Training Set

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
	Component 1	PLS Component 1 for SWLI	46.71	0.38	0.27	51.12	0.29	52.14
	Component 2	PLS Component 2 for SWLI	37.36	0.60	0.35	48.84	0.37	50.86
1	Component 3	PLS Component 3 for SWLI	34.63	0.66	0.30	52.92	0.31	57.61
	Component 4	PLS Component 4 for SWLI	32.76	0.70	0.11	68.96	0.20	69.13
	Component 5	PLS Component 5 for SWLI	28.02	0.78	0.05	81.47	0.16	77.25

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
	PCAR_01	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 1	54.46	0.16	0.07	58.44	0.16	59.96
	PCAR_02	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 2	44.43	0.44	0.28	51.11	0.33	53.01
2	PCAR_03	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 3	40.62	0.53	0.36	48.39	0.40	50.74
	PCAR_04	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 4	36.76	0.62	0.40	46.49	0.41	50.33
	PCAR_05	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 5	35.92	0.63	0.40	46.79	0.38	55.50

Model	Code	Name	RMSE	R2
	PCAR_01	Principal Components Regression model for SWLI using axes 1 - 1	49.44	0.31
	PCAR_02	Principal Components Regression model for SWLI using axes 1 - 2	44.29	0.44
3	PCAR_03	Principal Components Regression model for SWLI using axes 1 - 3	38.93	0.57
	PCAR_04	Principal Components Regression model for SWLI using axes 1 - 4	35.80	0.64
	PCAR_05	Principal Components Regression model for SWLI using axes 1 - 5	35.80	0.64

Morar Pollen Training Set

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
	Component 1	PLS Component 1 for SWLI	17.58	0.59	0.39	21.53	0.47	22.02
	Component 2	PLS Component 2 for SWLI	9.67	0.88	0.60	17.50	0.61	19.18
1	Component 3	PLS Component 3 for SWLI	6.49	0.94	0.59	17.97	0.65	18.44
	Component 4	PLS Component 4 for SWLI	3.67	0.98	0.72	14.93	0.72	16.91
	Component 5	PLS Component 5 for SWLI	2.70	0.99	0.80	12.35	0.74	16.42

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
	PCAR_01	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 1	25.17	0.17	0.08	48.41	0.11	51.19
	PCAR_02	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 2	20.16	0.46	0.18	27.54	0.42	43.05
2	PCAR_03	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 3	16.55	0.64	0.39	21.64	0.54	40.40
	PCAR_04	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 4	14.25	0.73	0.49	21.26	0.52	43.39
	PCAR_05	Imbrie & Kipp Factor Analysis Regression model for SWLI using axes 1 - 5	13.78	0.75	0.51	19.37	0.38	47.79

Model	Code	Name	RMSE	R2
	PCAR_01	Principal Components Regression model for SWLI using axes 1 - 1	23.38	0.28
	PCAR_02	Principal Components Regression model for SWLI using axes 1 - 2	16.50	0.64
3	PCAR_03	Principal Components Regression model for SWLI using axes 1 - 3	13.94	0.74
	PCAR_04	Principal Components Regression model for SWLI using axes 1 - 4	11.79	0.82
	PCAR_05	Principal Components Regression model for SWLI using axes 1 - 5	9.66	0.88

Argyll Pollen Training Set

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
1	WA_Inv	Weighted averaging model (inverse deshrinking) for SWLI	26.50	0.84	0.69	37.29	0.70	40.84
	WA_Cla	Weighted averaging model (classical deshrinking) for SWLI	29.00	0.84	0.70	36.42	0.71	39.82
	WATOL_Inv	Weighted averaging model (tolerance downweighted, inverse deshrinking) for SWLI	23.04	0.88	0.67	38.84	0.72	41.99
	WATOL_Cla	Weighted averaging model (tolerance downweighted, classical deshrinking) for SWLI	24.62	0.88	0.68	37.91	0.73	40.72
Model	**Code**	**Name**	**RMSE**	**R2**	**Jack R2**	**Jack RMSEP**	**Boot R2**	**Boot RMSEP**
2	Component 1	WAPLS Component 1 for SWLI	26.50	0.84	0.69	37.30	0.72	40.99
	Component 2	WAPLS Component 2 for SWLI	21.78	0.89	0.66	38.35	0.70	40.83
	Component 3	WAPLS Component 3 for SWLI	18.74	0.92	0.59	42.20	0.67	43.29
	Component 4	WAPLS Component 4 for SWLI	16.72	0.93	0.56	44.75	0.64	45.66
	Component 5	WAPLS Component 5 for SWLI	14.92	0.95	0.47	50.39	0.62	48.35
Model	**Code**	**Name**	**RMSE**	**R2**	**Jack R2**	**Jack RMSEP**	**Boot R2**	**Boot RMSEP**
3	Component 1	PLS Component 1 for SWLI	26.22	0.84	0.58	43.61	0.55	53.52
	Component 2	PLS Component 2 for SWLI	25.44	0.85	0.67	37.88	0.69	41.91
	Component 3	PLS Component 3 for SWLI	23.48	0.87	0.65	39.44	0.69	41.73
	Component 4	PLS Component 4 for SWLI	22.39	0.88	0.66	38.45	0.68	42.40
	Component 5	PLS Component 5 for SWLI	21.88	0.89	0.55	44.80	0.67	44.84

Regional Multi-proxy Training Set

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
1	WA_Inv	Weighted averaging model (inverse deshrinking) for SWLI	14.16	0.86	0.76	18.16	0.75	19.45
	WA_Cla	Weighted averaging model (classical deshrinking) for SWLI	15.31	0.86	0.77	18.73	0.76	19.72
	WATOL_Inv	Weighted averaging model (tolerance downweighted, inverse deshrinking) for SWLI	13.98	0.86	0.65	22.39	0.73	22.49
	WATOL_Cla	Weighted averaging model (tolerance downweighted, classical deshrinking) for SWLI	15.08	0.86	0.65	24.00	0.73	22.91
Model	**Code**	**Name**	**RMSE**	**R2**	**Jack R2**	**Jack RMSEP**	**Boot R2**	**Boot RMSEP**
2	Component 1	WAPLS Component 1 for SWLI	14.16	0.86	0.76	18.26	0.75	19.47
	Component 2	WAPLS Component 2 for SWLI	8.40	0.95	0.80	16.65	0.79	18.53
	Component 3	WAPLS Component 3 for SWLI	6.10	0.97	0.82	15.66	0.81	17.90
	Component 4	WAPLS Component 4 for SWLI	4.79	0.98	0.83	15.33	0.81	17.97
	Component 5	WAPLS Component 5 for SWLI	3.92	0.99	0.83	15.55	0.81	18.45
Model	**Code**	**Name**	**RMSE**	**R2**	**Jack R2**	**Jack RMSEP**	**Boot R2**	**Boot RMSEP**
3	Component 1	PLS Component 1 for SWLI	19.23	0.73	0.69	20.68	0.69	21.28
	Component 2	PLS Component 2 for SWLI	14.98	0.84	0.71	20.20	0.72	20.76
	Component 3	PLS Component 3 for SWLI	12.80	0.88	0.72	19.73	0.74	20.30
	Component 4	PLS Component 4 for SWLI	10.68	0.92	0.75	18.65	0.76	19.98
	Component 5	PLS Component 5 for SWLI	9.29	0.94	0.77	18.13	0.77	19.83

Kintail Multi-proxy Training Set

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
1	WA_Inv	Weighted averaging model (inverse deshrinking) for SWLI	16.16	0.88	0.63	29.13	0.65	29.81
	WA_Cla	Weighted averaging model (classical deshrinking) for SWLI	17.21	0.88	0.63	30.36	0.65	30.43
	WATOL_Inv	Weighted averaging model (tolerance downweighted, inverse deshrinking) for SWLI	17.73	0.86	0.67	27.75	0.69	29.31
	WATOL_Cla	Weighted averaging model (tolerance downweighted, classical deshrinking) for SWLI	19.13	0.86	0.67	30.00	0.70	29.68
Model	**Code**	**Name**	**RMSE**	**R2**	**Jack R2**	**Jack RMSEP**	**Boot R2**	**Boot RMSEP**
2	Component 1	WAPLS Component 1 for SWLI	16.16	0.88	0.63	29.07	0.64	30.16
	Component 2	WAPLS Component 2 for SWLI	8.18	0.97	0.73	25.32	0.74	26.87
	Component 3	WAPLS Component 3 for SWLI	5.06	0.99	0.73	25.00	0.74	26.40
	Component 4	WAPLS Component 4 for SWLI	3.41	0.99	0.68	27.15	0.71	27.55
	Component 5	WAPLS Component 5 for SWLI	2.27	1.00	0.58	31.53	0.68	28.84
Model	**Code**	**Name**	**RMSE**	**R2**	**Jack R2**	**Jack RMSEP**	**Boot R2**	**Boot RMSEP**
3	Component 1	PLS Component 1 for SWLI	23.72	0.75	0.63	28.64	0.65	29.10
	Component 2	PLS Component 2 for SWLI	11.13	0.94	0.78	22.35	0.77	23.97
	Component 3	PLS Component 3 for SWLI	8.61	0.97	0.77	22.98	0.78	23.78
	Component 4	PLS Component 4 for SWLI	6.16	0.98	0.76	23.46	0.77	23.99
	Component 5	PLS Component 5 for SWLI	4.92	0.99	0.76	23.37	0.77	24.15

Morar Multi-proxy Training Set

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
1	WA_Inv	Weighted averaging model (inverse deshrinking) for SWLI	6.20	0.95	0.83	11.47	0.84	12.20
	WA_Cla	Weighted averaging model (classical deshrinking) for SWLI	6.37	0.95	0.84	11.24	0.84	11.81
	WATOL_Inv	Weighted averaging model (tolerance downweighted, inverse deshrinking) for SWLI	5.39	0.96	0.88	9.71	0.86	13.45
	WATOL_Cla	Weighted averaging model (tolerance downweighted, classical deshrinking) for SWLI	5.50	0.96	0.89	9.48	0.86	13.21

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
2	Component 1	WAPLS Component 1 for SWLI	6.20	0.95	0.81	12.34	0.83	13.02
	Component 2	WAPLS Component 2 for SWLI	2.79	0.99	0.88	10.72	0.88	11.88
	Component 3	WAPLS Component 3 for SWLI	1.21	1.00	0.87	10.51	0.88	11.65
	Component 4	WAPLS Component 4 for SWLI	0.57	1.00	0.88	10.36	0.88	11.63
	Component 5	WAPLS Component 5 for SWLI	0.28	1.00	0.88	10.32	0.88	11.62

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
3	Component 1	PLS Component 1 for SWLI	12.50	0.79	0.68	15.64	0.68	16.64
	Component 2	PLS Component 2 for SWLI	4.09	0.98	0.81	12.23	0.78	14.14
	Component 3	PLS Component 3 for SWLI	2.10	0.99	0.84	11.47	0.81	13.59
	Component 4	PLS Component 4 for SWLI	1.18	1.00	0.86	10.81	0.82	13.34
	Component 5	PLS Component 5 for SWLI	0.79	1.00	0.87	10.63	0.82	13.22

Argyll Multi-proxy Training Set

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
1	WA_Inv	Weighted averaging model (inverse deshrinking) for SWLI	10.88	0.88	0.77	14.96	0.79	15.84
	WA_Cla	Weighted averaging model (classical deshrinking) for SWLI	11.59	0.88	0.78	15.39	0.80	15.72
	WATOL_Inv	Weighted averaging model (tolerance downweighted, inverse deshrinking) for SWLI	8.42	0.93	0.74	16.06	0.81	19.37
	WATOL_Cla	Weighted averaging model (tolerance downweighted, classical deshrinking) for SWLI	8.74	0.93	0.74	16.03	0.81	19.17

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
2	Component 1	WAPLS Component 1 for SWLI	10.88	0.88	0.77	14.97	0.78	16.09
	Component 2	WAPLS Component 2 for SWLI	7.34	0.95	0.80	14.42	0.80	15.93
	Component 3	WAPLS Component 3 for SWLI	5.10	0.97	0.78	15.52	0.80	16.76
	Component 4	WAPLS Component 4 for SWLI	3.40	0.99	0.76	16.50	0.79	17.34
	Component 5	WAPLS Component 5 for SWLI	1.97	1.00	0.75	17.12	0.79	17.53

Model	Code	Name	RMSE	R2	Jack R2	Jack RMSEP	Boot R2	Boot RMSEP
3	Component 1	PLS Component 1 for SWLI	15.14	0.77	0.70	17.19	0.71	17.95
	Component 2	PLS Component 2 for SWLI	11.69	0.86	0.74	15.95	0.75	16.85
	Component 3	PLS Component 3 for SWLI	9.59	0.91	0.74	16.36	0.76	17.27
	Component 4	PLS Component 4 for SWLI	7.94	0.94	0.75	15.82	0.77	17.44
	Component 5	PLS Component 5 for SWLI	6.59	0.96	0.76	16.00	0.78	17.83

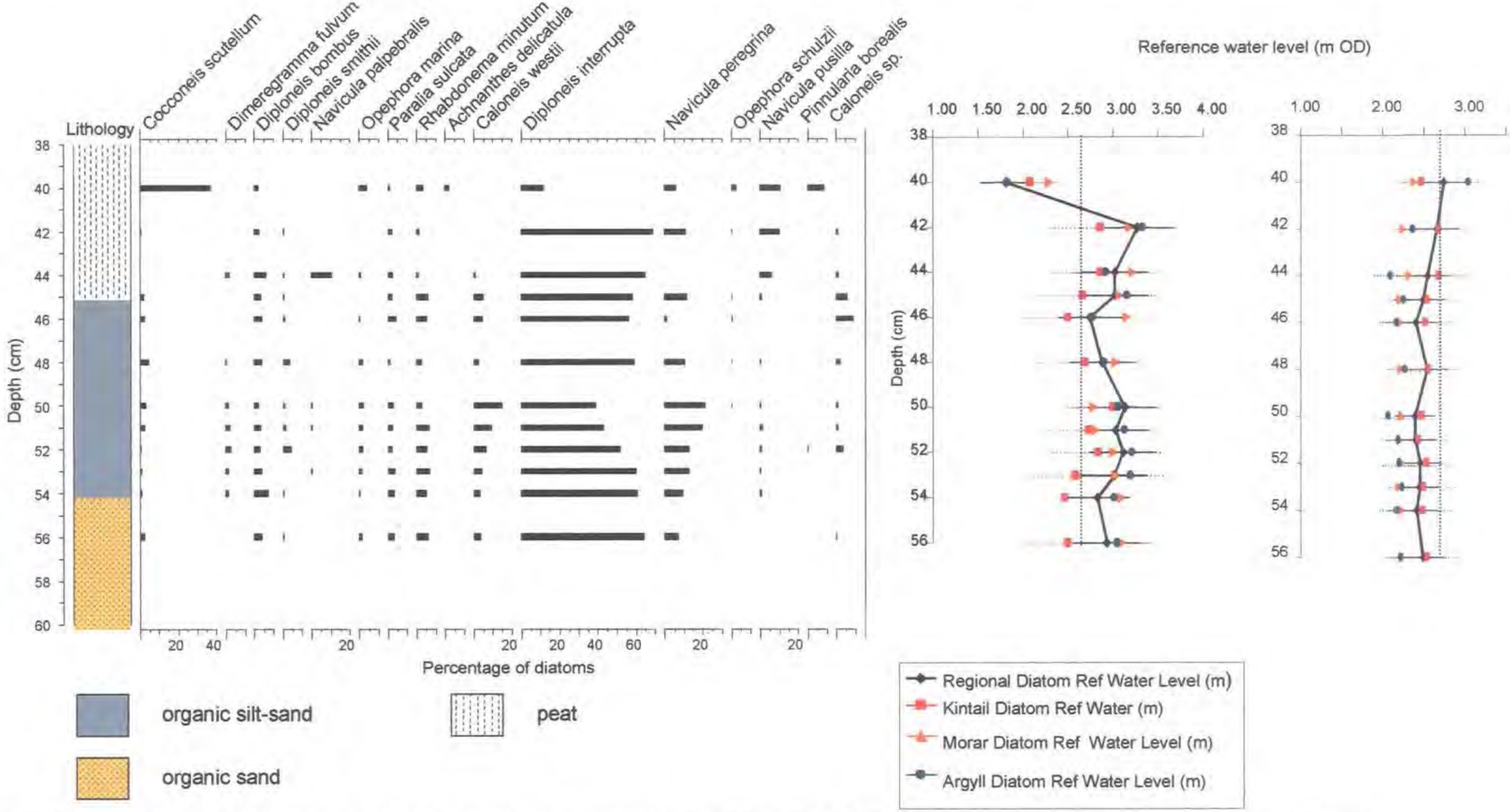


Figure 5.1 Summary of the results of the diatom RWL reconstruction showing the transfer function inferred values of RWL for core NN04. The diatom training set reconstructions are shown to the immediate right of the diatom diagram and the training sets containing only the samples in the multi-proxy training set are shown on the far right. The grey vertical line shows MHWS at the location of the nearest tidal prediction.

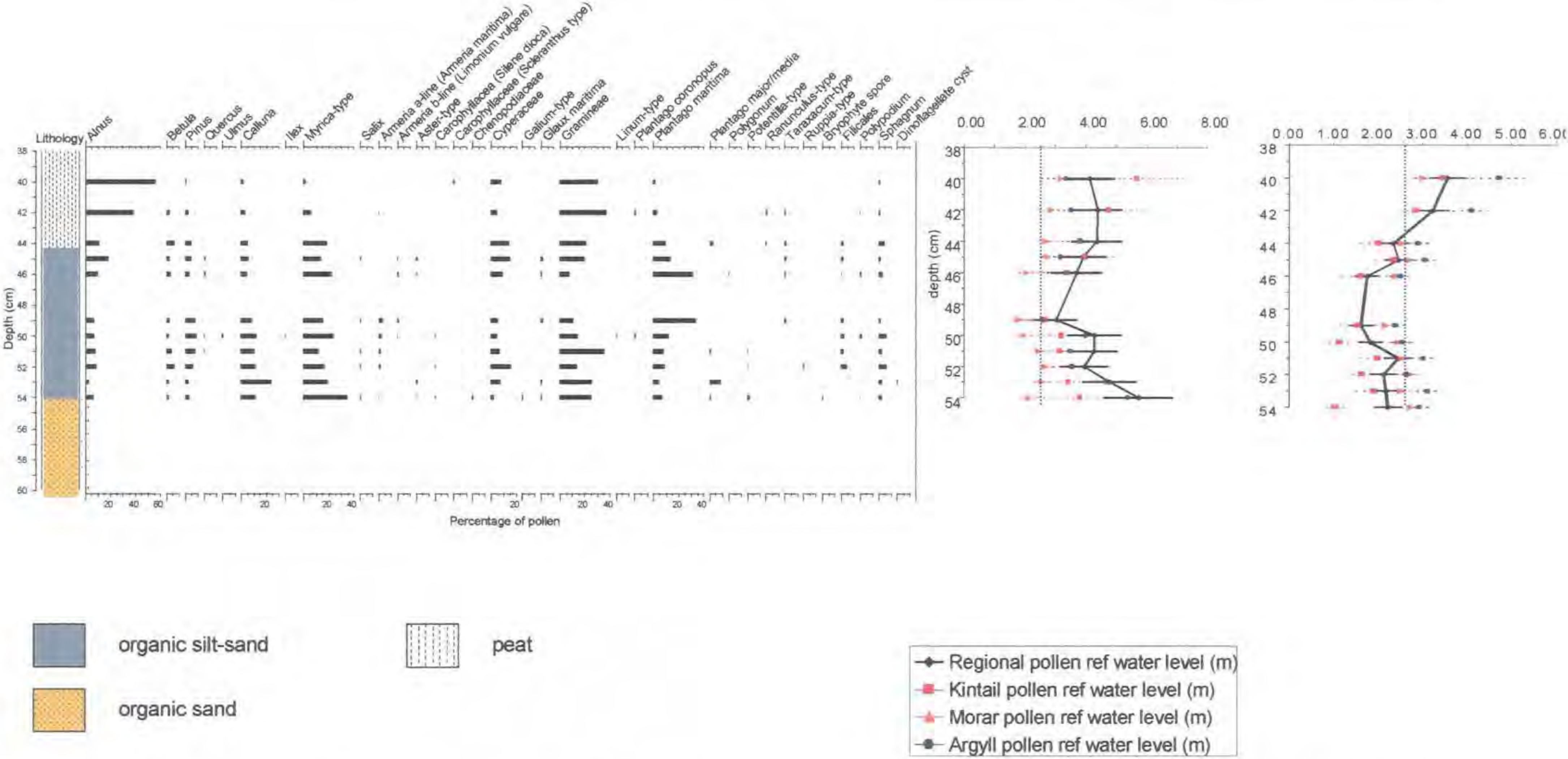


Figure 5.2 Summary of the results of the pollen RWL reconstruction showing the transfer function inferred values of RWL for core NN04. The pollen training set reconstructions are shown to the immediate right of the pollen diagram and the training sets containing only the samples in the multi-proxy training set are shown to the far right. The grey vertical line shows MHWS at the location of the nearest tidal prediction.

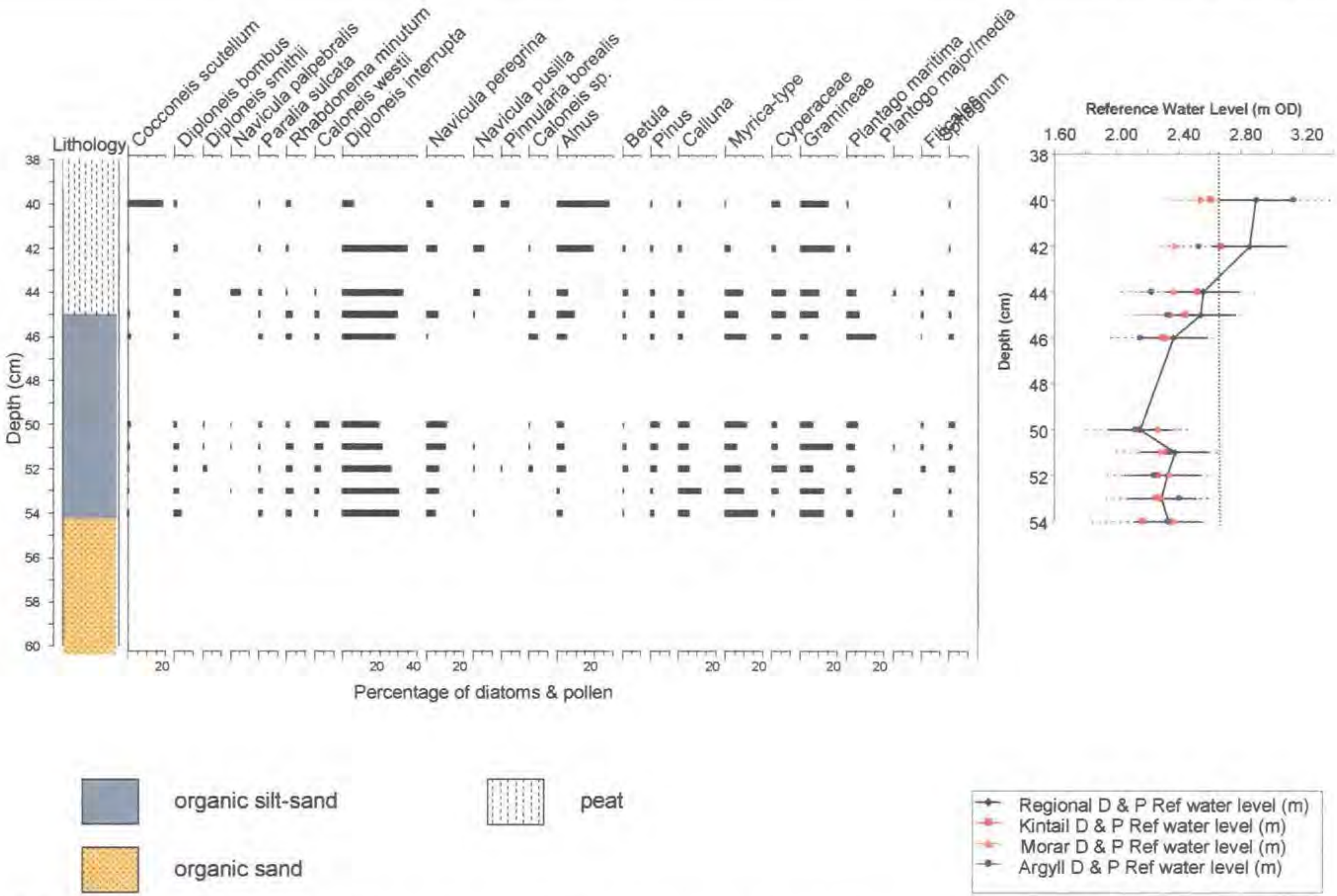
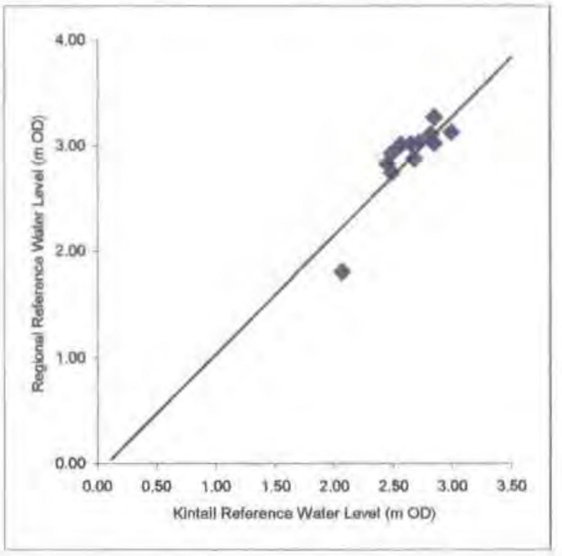
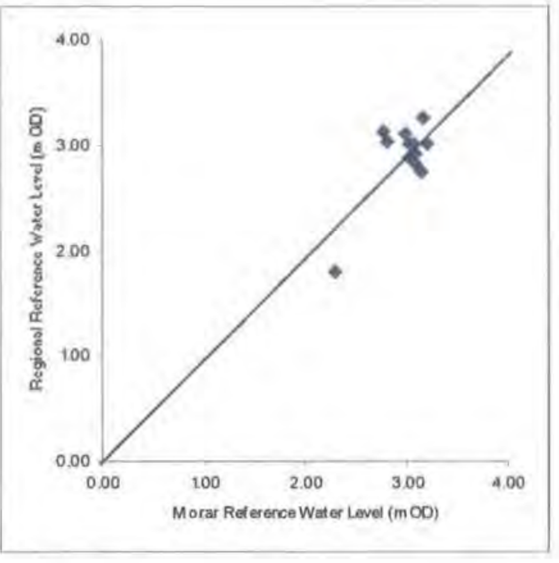


Figure 5.3 Summary of the results of the multi-proxy RWL reconstruction showing the transfer function inferred values of RWL for core NN04. The multi-proxy training set reconstructions are shown to the immediate right of the microfossil diagram. The grey vertical line shows MHWS at the location of the nearest tidal prediction.





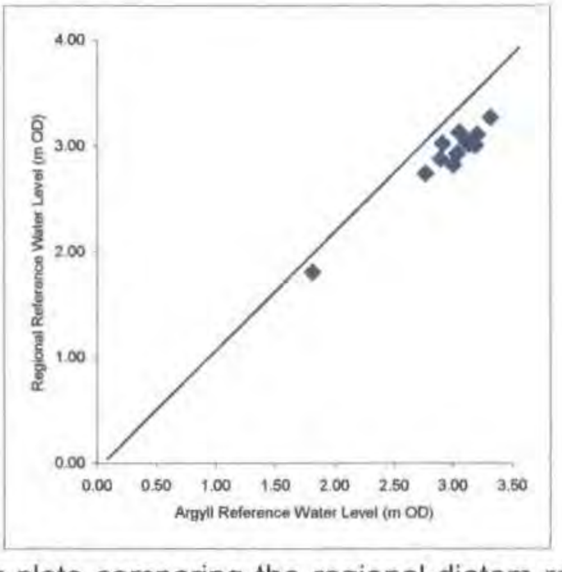


Figure 5.4 Scatter plots comparing the regional diatom reference water level reconstruction with the local reconstructions for core NN04.

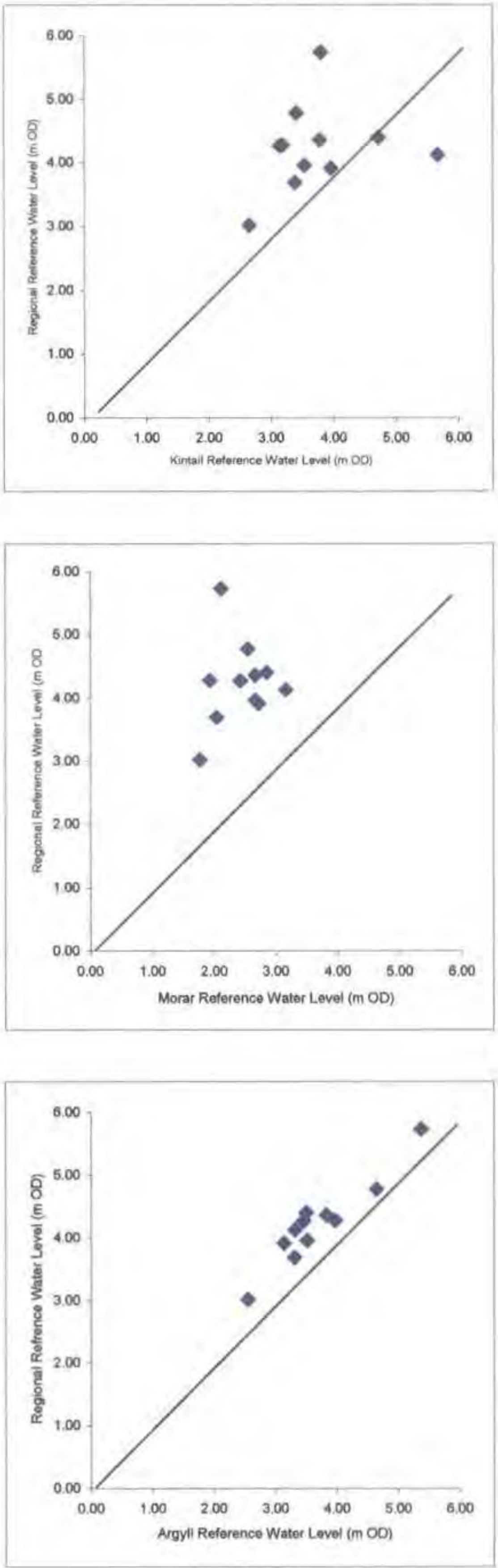
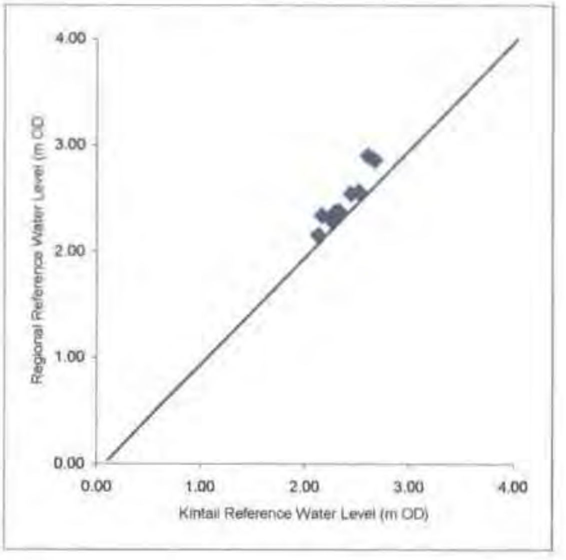
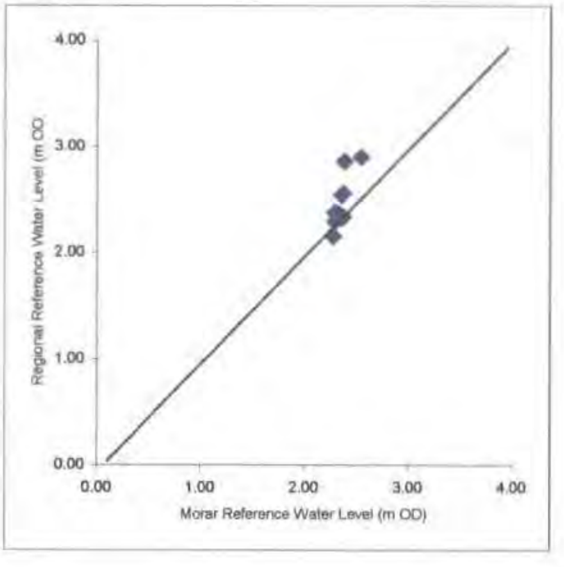


Figure 5.5 Scatter plots comparing the regional pollen reference water level reconstruction with the local reconstructions for core NN04.





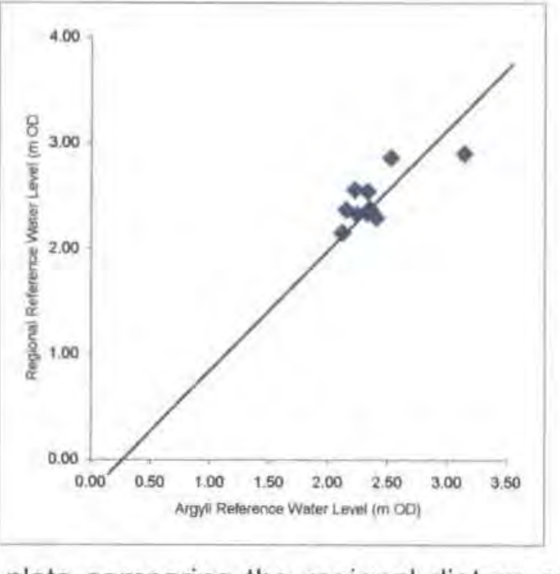


Figure 5.6 Scatter plots comparing the regional diatom and pollen reference water level reconstruction with the local reconstructions for core NN04.

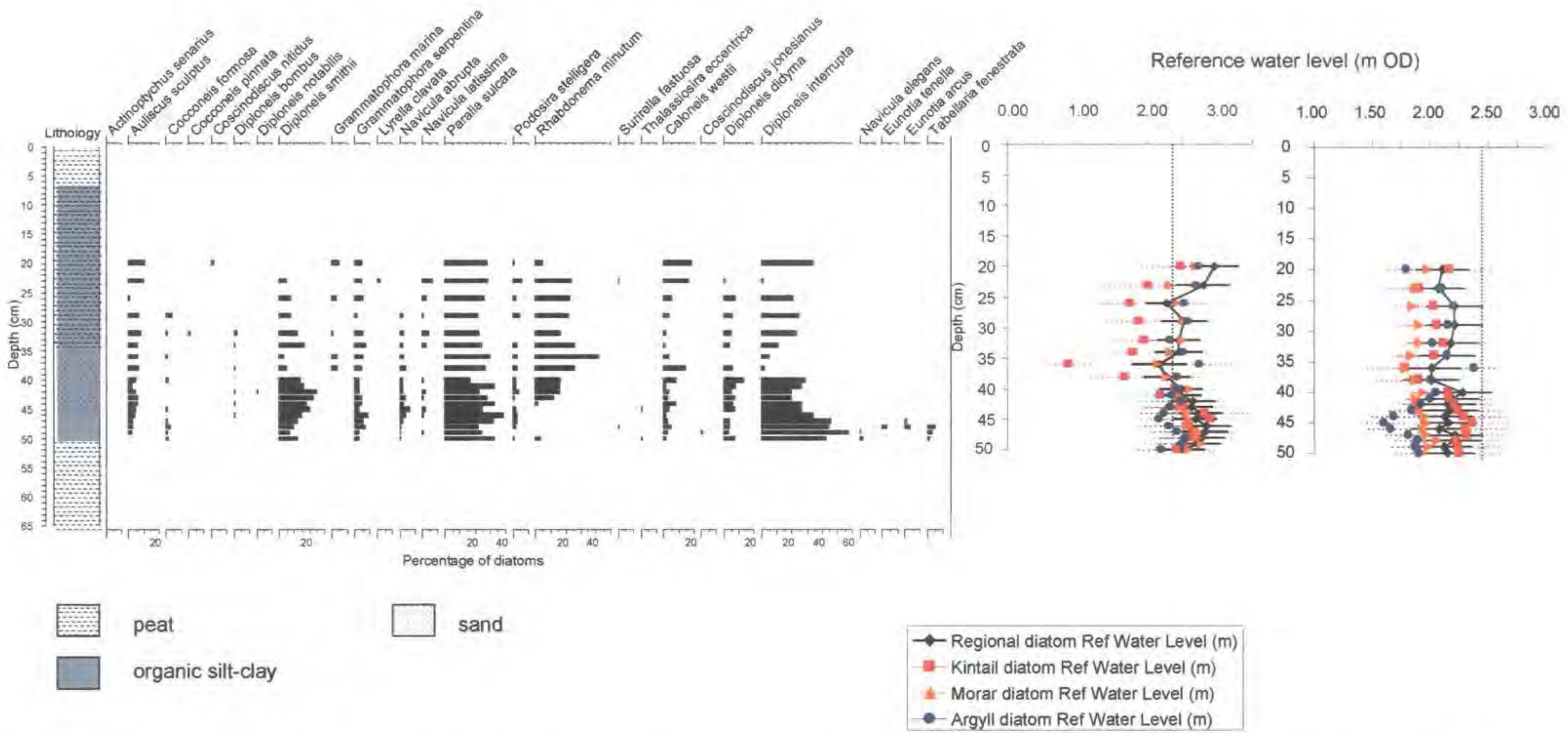


Figure 5.7 Summary of the results of the diatom RWL reconstructions showing the transfer function inferred values of RWL for monolith MMN01A&B. The diatom training sets reconstructions are shown to the immediate right of the diatom diagram and the diatom training sets containing only the samples in the multi-proxy training set are shown to the far right. The grey vertical line shows MHWS at the location of the nearest tidal prediction.

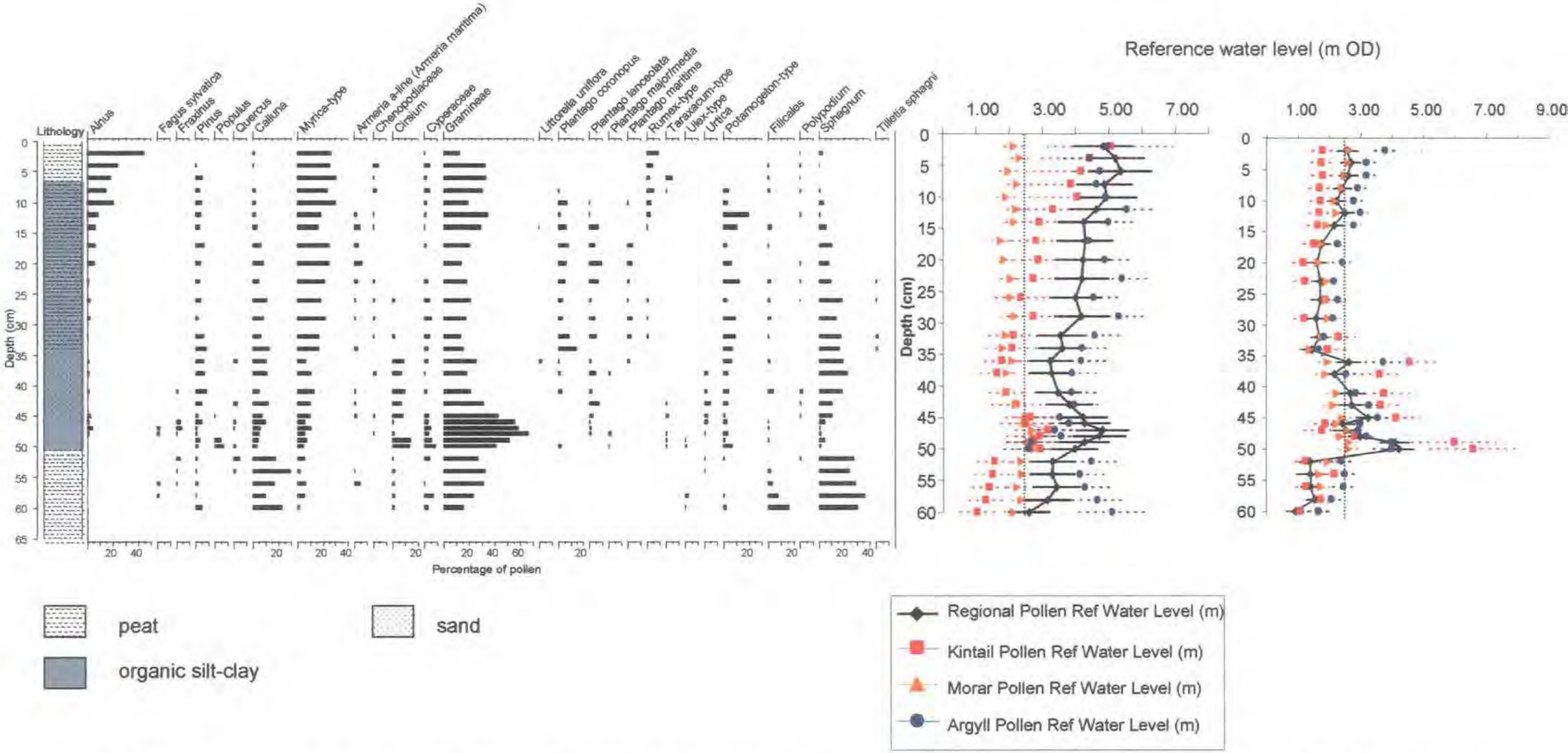


Figure 5.8 Summary of the results of the pollen RWL reconstruction showing the transfer function inferred values of RWL for monolith MMN01A&B. The pollen training set reconstructions are shown to the immediate right of the pollen diagram and the training sets containing only the samples in the multi-proxy training set are shown to the far right. The grey vertical line shows MHWS at the location of the nearest tidal prediction.

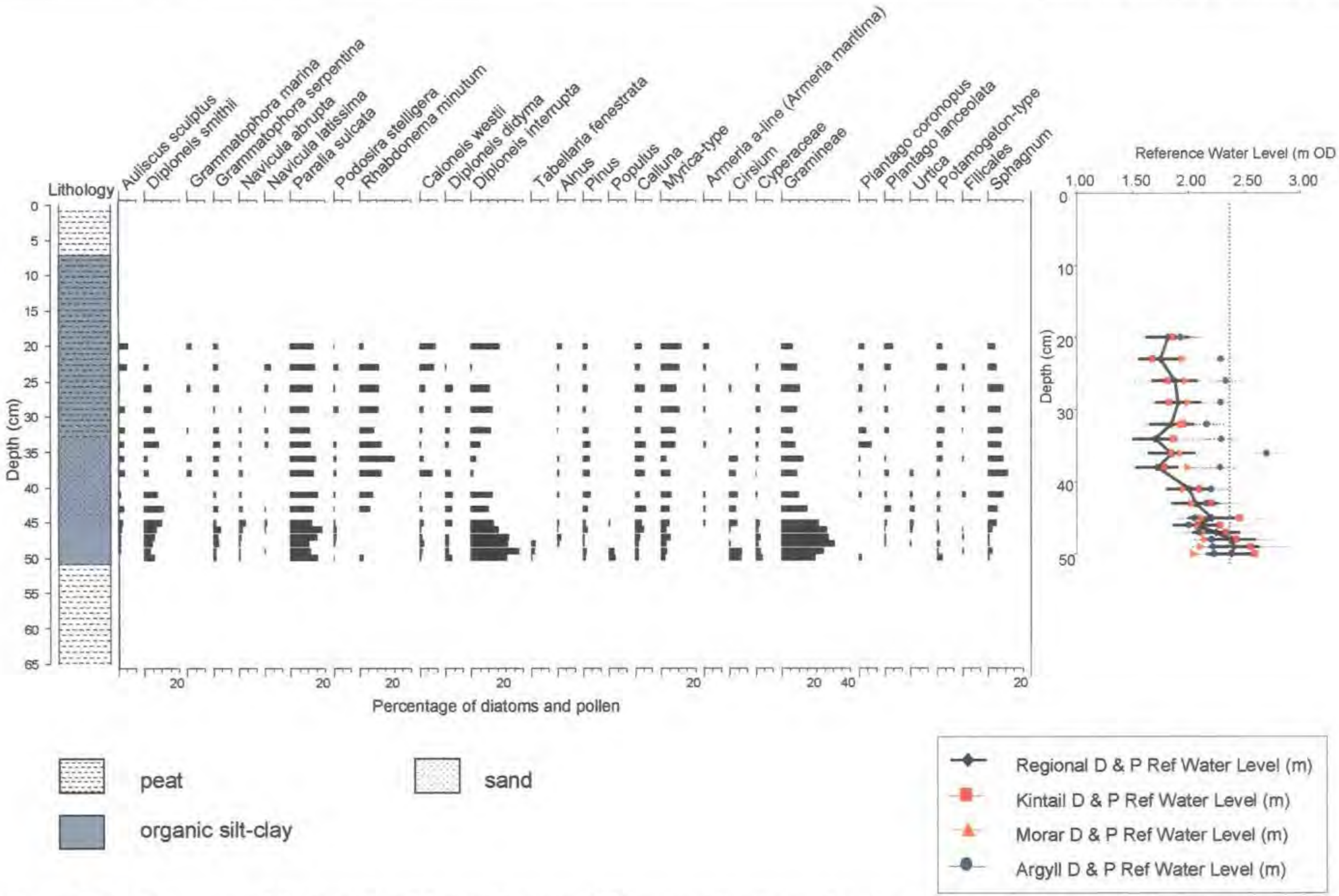


Figure 5.9 Summary of the results of the multi-proxy RWL reconstructions showing the transfer function inferred values of RWL for monolith MMN01A&B. The multi-proxy training sets are shown to the right of the microfossil diagram. The grey vertical line shows MHWS at the location of the nearest tidal prediction.

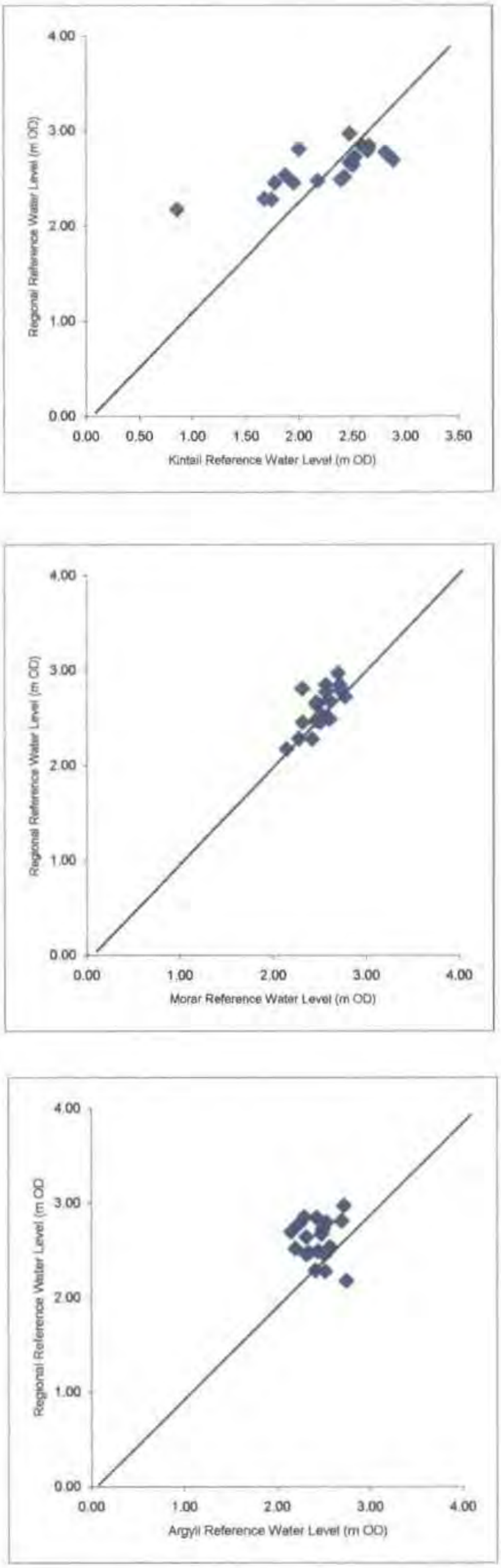


Figure 5.10 Scatter plots comparing the regional diatom reference water level reconstruction with the local reconstructions for monoliths MMN01A & B.

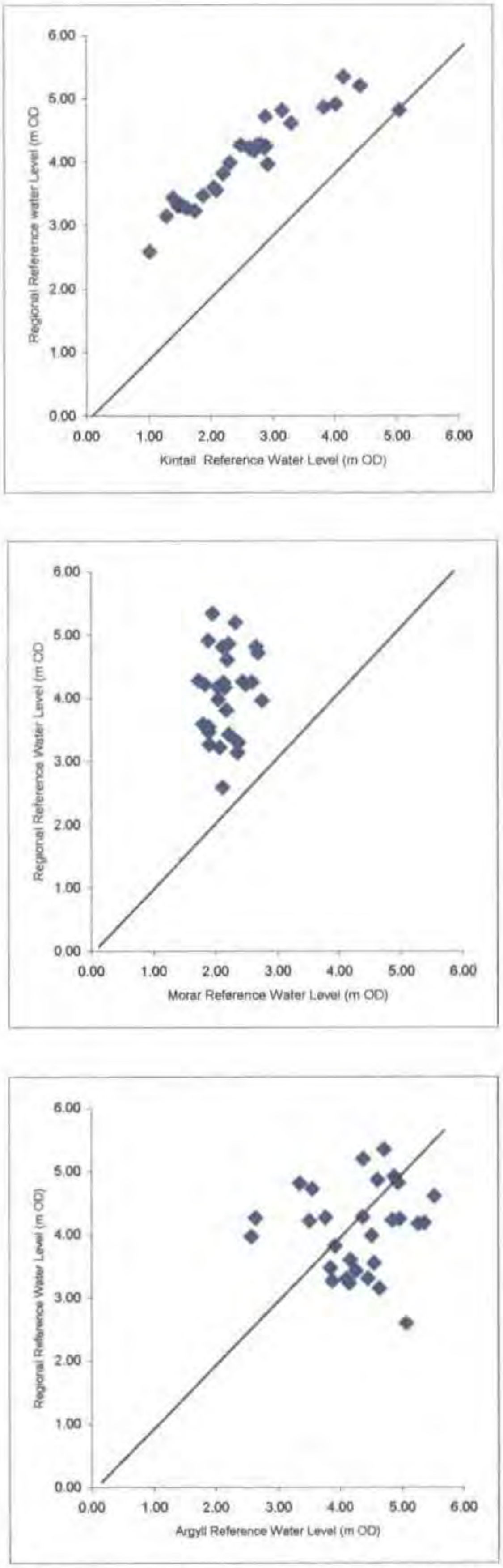


Figure 5.11 Scatter plots comparing the regional pollen reference water level reconstruction with the local reconstructions for monoliths MMN01 A & B.

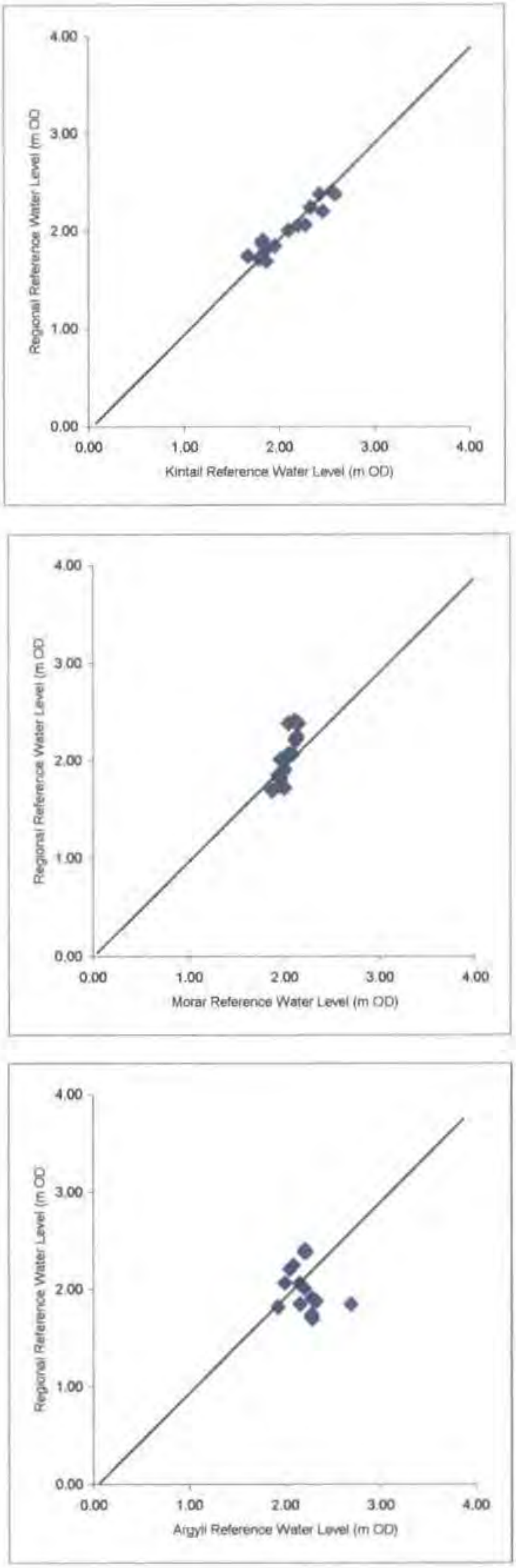


Figure 5.12 Scatter plots comparing the regional diatom and pollen reference water level reconstruction with the local reconstructions for monolith MMN01 A & B.

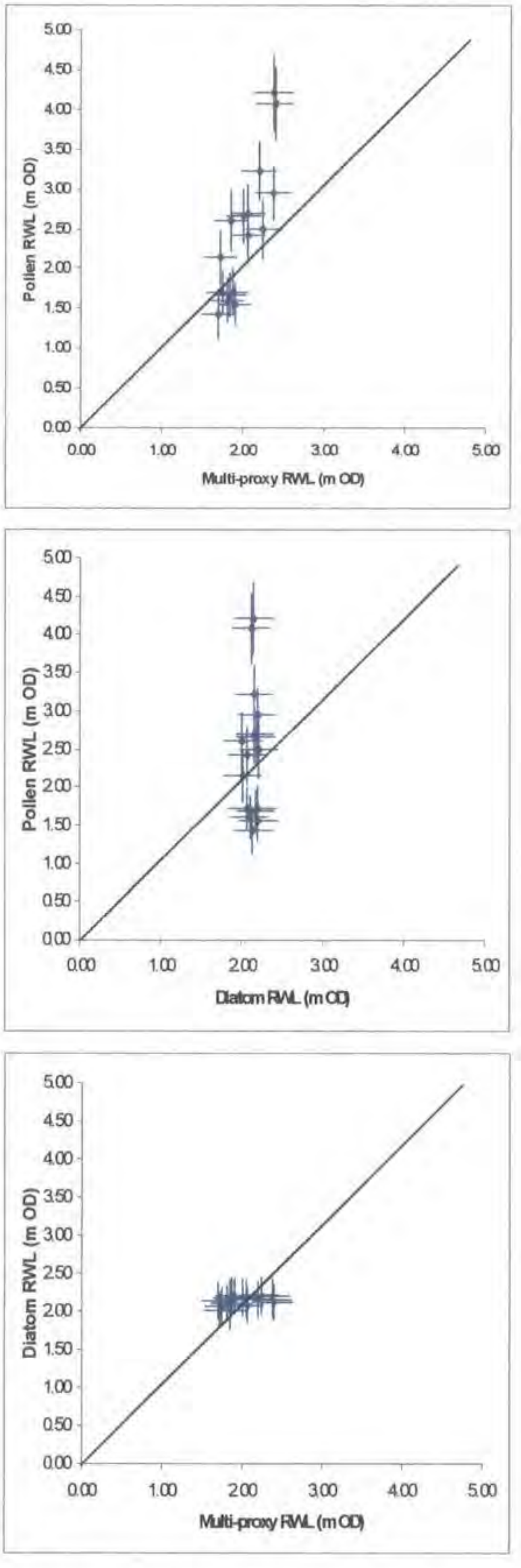


Figure 5.13 Bi-plots comparing the RWL reconstruction values produced for the regional diatom, pollen and multi-proxy training sets using only the samples within the multi-proxy training set to allow direct comparison.

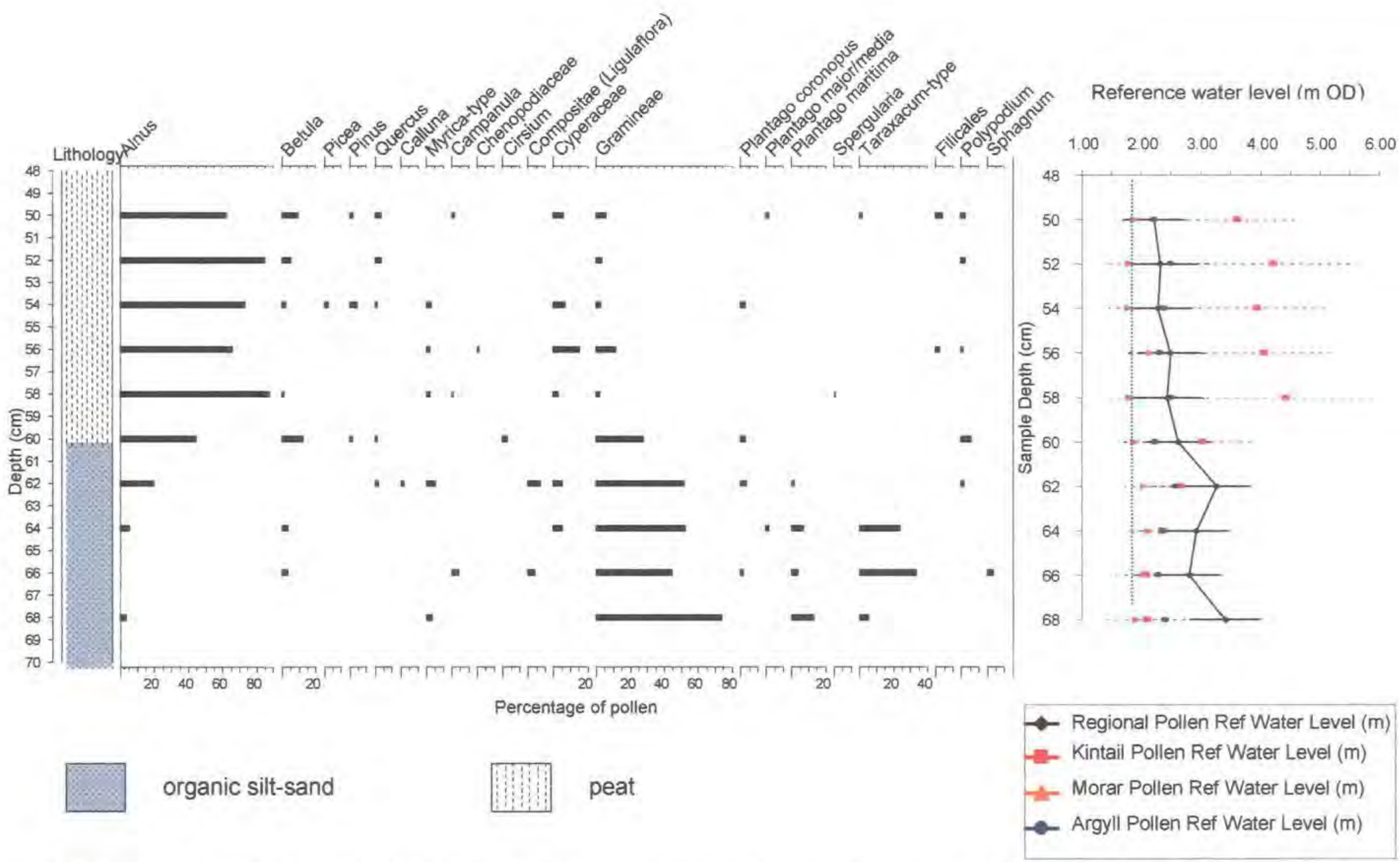
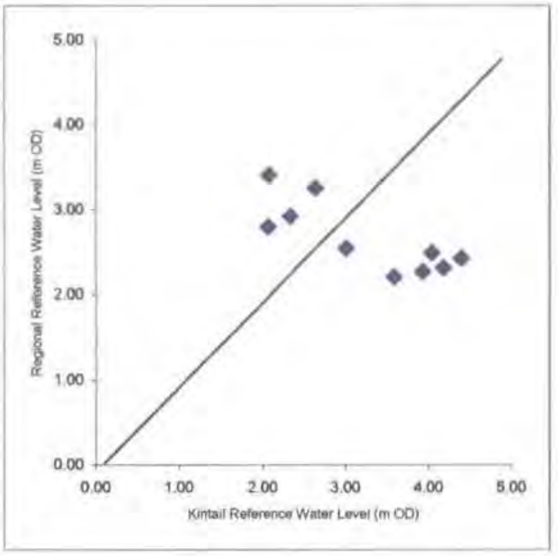
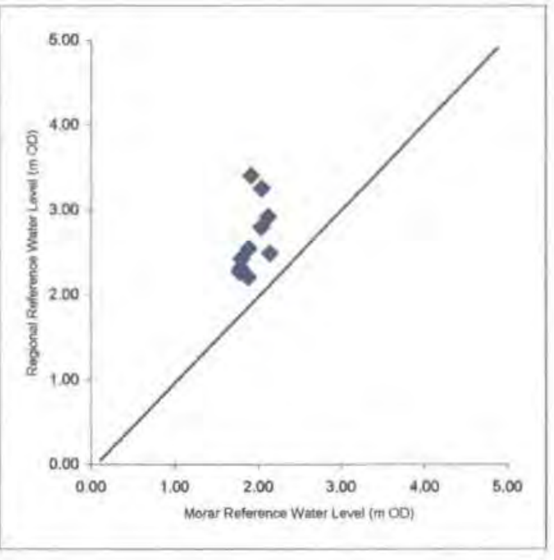


Figure 5.14 Summary of the results of the pollen RWL reconstructions showing the transfer function inferred values of RWL for core BC006a. The pollen training set reconstructions are shown to the immediate right of the pollen diagram. The grey vertical line shows MHWS at the location of the nearest tidal prediction.





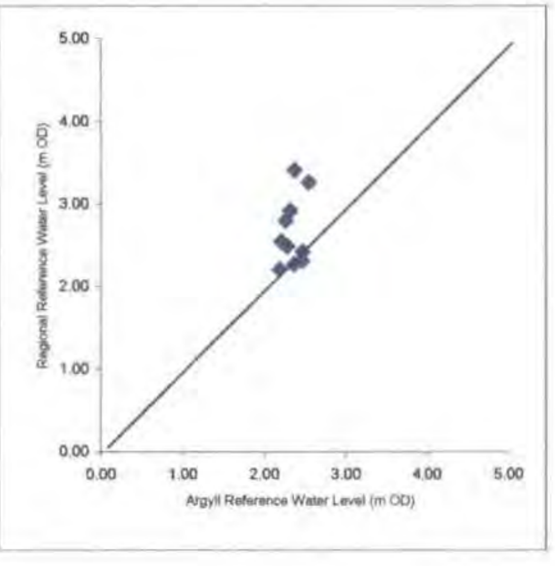


Figure 5.15 Scatter plots comparing the regional pollen reference water level reconstruction with the local reconstructions for core BC006a.

Core	Training Set	Microfossil	No. of microfossils in fossil dataset	Modern analogues (%)
NN04	Regional	Diatom	65	89.2
NN04	Kintail	Diatom	65	83.1
NN04	Morar	Diatom	65	58.5
NN04	Argyll	Diatom	65	72.3
NN04	Regional	Pollen	33	87.9
NN04	Kintail	Pollen	33	75.8
NN04	Morar	Pollen	33	78.8
NN04	Argyll	Pollen	33	81.8
NN04	Regional	Diatom and pollen	91	92.3
NN04	Kintail	Diatom and pollen	91	79.1
NN04	Morar	Diatom and pollen	91	72.5
NN04	Argyll	Diatom and pollen	91	81.3

Core	Training Set	Microfossil	No. of microfossils in fossil dataset	Modern analogues (%)
MMN01	Regional	Diatom	26	73.1
MMN01	Kintail	Diatom	26	53.8
MMN01	Morar	Diatom	26	57.7
MMN01	Argyll	Diatom	26	57.7
MMN01	Regional	Pollen	45	68.9
MMN01	Kintail	Pollen	45	55.6
MMN01	Morar	Pollen	45	62.2
MMN01	Argyll	Pollen	45	71.1
MMN01	Regional	Diatom and pollen	65	78.5
MMN01	Kintail	Diatom and pollen	65	60.0
MMN01	Morar	Diatom and pollen	65	64.6
MMN01	Argyll	Diatom and pollen	65	67.7

Core	Training Set	Microfossil	No. of microfossils in fossil dataset	Modern analogues (%)
BC006a	Regional	Pollen	21	76.2
BC006a	Kintail	Pollen	21	71.4
BC006a	Morar	Pollen	21	71.4
BC006a	Argyll	Pollen	21	71.4

Table 5.1 Lists the number of microfossils recorded in the fossil cores and the percentages of microfossils also found in the modern training set (% of modern analogues).

Core	Training Set	Microfossil	No. of microfossils in fossil dataset	Modern analogues (%)
NN04	Regional	Diatom	65	87.7
NN04	Kintail	Diatom	65	76.9
NN04	Morar	Diatom	65	56.9
NN04	Argyll	Diatom	65	67.7
NN04	Regional	Pollen	33	75.8
NN04	Kintail	Pollen	33	69.7
NN04	Morar	Pollen	33	66.7
NN04	Argyll	Pollen	33	78.8

Core	Training Set	Microfossil	No. of microfossils in fossil dataset	Modern analogues (%)
MMN01	Regional	Diatom	26	73.1
MMN01	Kintail	Diatom	26	46.2
MMN01	Morar	Diatom	26	50.0
MMN01	Argyll	Diatom	26	50.0
MMN01	Regional	Pollen	42	73.8
MMN01	Kintail	Pollen	42	54.8
MMN01	Morar	Pollen	42	59.5
MMN01	Argyll	Pollen	42	66.7

Table 5.2 Lists the number of microfossils recorded in the fossil cores and the percentages of microfossils also found in the modern training sets (% of modern analogues) for the diatoms and pollen samples within the multi-proxy training sets.

APPENDIX 5.1 - Stratigraphy

Site: Nonach, Core NN04

Altitude m OD	Corrected depth, cm	Observed depth, cm	Description nig, straf, sic, elas, lim
3.97 – 3.96		0 – 1	In-situ sphagnum (substratum confusum)
3.96 – 3.52		1 - 45	3 0 2 0 0 Sh2 $Th^2$2 Ag+ Dark brown herbaceous peat with occasional silt.
3.52 – 3.45		45 - 52	3 0 2 0 0 Ag1 As1 Th^2+ Sh2 Brown organic silt and sand.
3.45 – 3.32		52 - 65	3 0 2 0 0 As3 Ag+ Dl+ Gg+ Brown organic silt sand with occasional woody fragments and gravel.

Site: Mointeach Mhor, Core MMN01/AB

Altitude m OD	Corrected depth, cm	Observed depth, cm	Description nig, straf, sic, elas, lim
9.37 – 9.30		0 – 7	3 0 2 0 0 Sh3 $Th^2$1 Very dark brown soft wet humified peat with rootlets and visible organic fragments.
9.30 – 9.04		7 - 33	2 0 2 0 0 Sh3 $Th^2$1 Ga+ Dark brown humified peat with frequent rootlets and occasional sand.
9.04 – 8.92		33 – 45	3 0 2 0 0 Sh3 Ga1 Ag+ Th^2+ Organic sand with silt and occasional rootlets.
8.92 – 8.87		45 - 50	3 0 2 0 0 Sh 2 Ag 1 Th^2 1 As+ Organic silt clay with organic fragments and rootlets.
8.87 – 8.72		50 - 65	3 0 2 0 0 Sh 3 Th^2 1 Very dark brown humified peat with large organic fragments and rootlets.

Site: Barr na Criche, Core BC006a

Altitude m OD	Corrected depth, cm	Observed depth, cm	Description nig, straf, sic, elas, lim
3.34 – 3.11		37 - 60	3 0 2 0 – Sh 3, Th ^{3}1 Humified herbaceous peat.
3.11 – 2.92		60 - 79	2 0 2 0 0 Sh 1, Ag 2, Ga 1, Th^{3}+ Slightly laminated organic silt and sand with herbaceous rootlets.
2.92 – 2.84		79 - 87	2 0 2 0 0 Ga 4, Ag +, Gg +, Sh +, Th^{3}+ Slightly organic sand with rare rootlets, silty towards top, gravel at base. (Core ended on gravel).

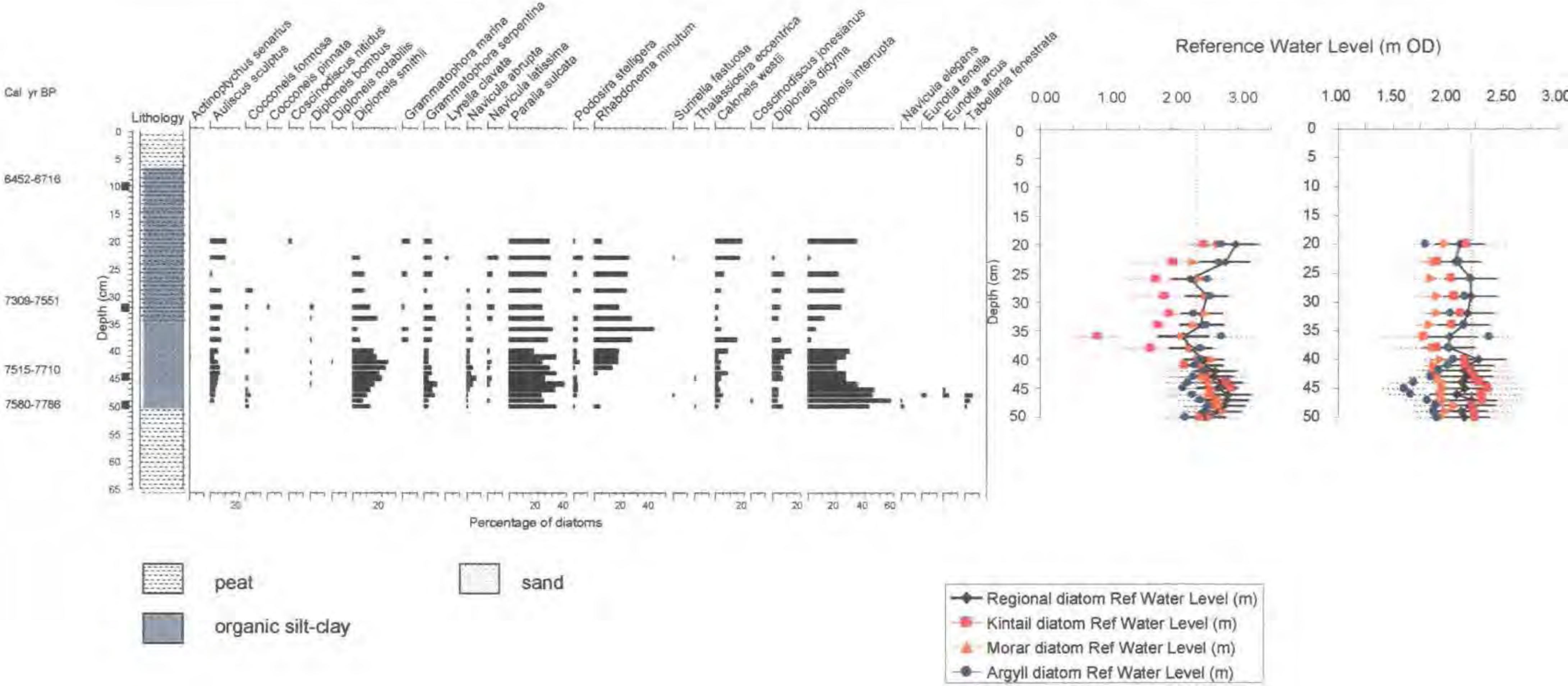


Figure 6.1 Summary of the results of the diatom-inferred reference water level reconstruction for fossil monolith sample MMN01A & B. The depths of the sea-level index sample points are shown as black squares and the associated radiocarbon ages are shown adjacent to the lithology. The RWL reconstruction for the regional diatom training set is shown to the immediate right of the diatom diagram and the RWL reconstruction for diatom training set samples from the multi-proxy training set are shown on the far right. The dotted vertical line indicates the approximate position of the predicted MHWS at Mallaig (2.38 m OD)

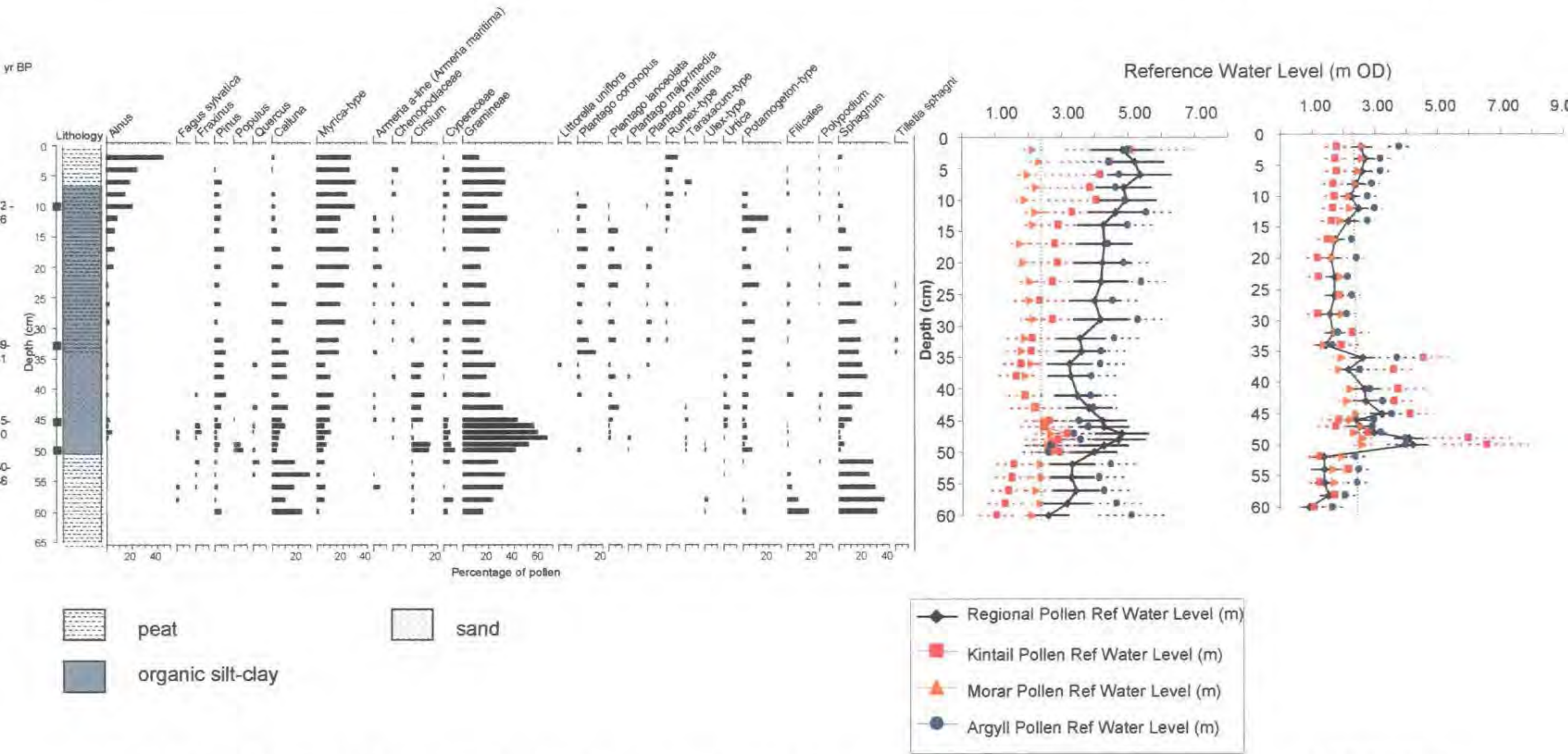


Figure 6.2 Summary of the results of the pollen-based reference water level reconstruction for fossil monolith sample MMN01A & B. The depths of the sea-level index sample points are shown as black squares and the associated radiocarbon ages are shown adjacent to the lithology. The RWL reconstruction for the regional pollen training set is shown to the immediate right of the pollen diagram and the RWL reconstruction for pollen training set samples from the multi-proxy training set are shown on the far right. The dotted vertical line indicates the approximate position of the predicted MHWS at Mallaig (2.38 m OD).

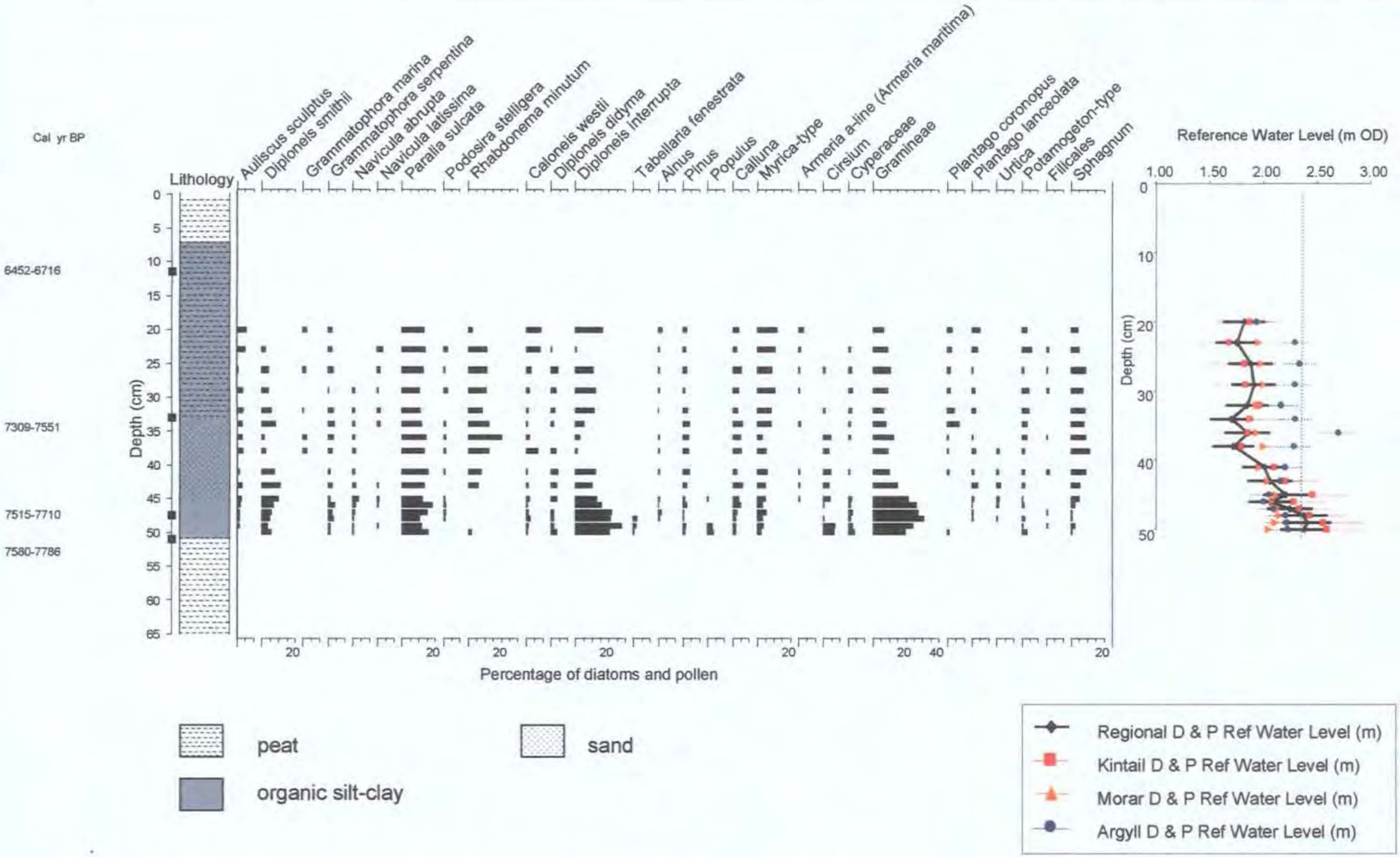


Figure 6.3 Summary of the results of the multi-proxy-based reference water level reconstruction for fossil monolith sample MMN01A & B. The depths of the sea-level index sample points are shown as black squares and the associated radiocarbon ages are shown adjacent to the lithology. The dotted vertical line indicates the approximate position of the predicted MHWS at Mallaig (2.38 m OD).

Training Set Name	No of samples	Name	RMSE	R2	Boot R2	RMSEP (Boot)	RMSEP (m OD) Nonach	Mointeach Mhor North	Barr-na-Criche
Regional diatoms	116	WAPLS Component 3 for SWLI	13.97	0.93	0.83	24.83	0.58	0.52	0.36
Kintail diatoms	43	WAPLS Component 3 for SWLI	11.23	0.96	0.82	27.79	0.64	0.58	0.41
Morar diatoms	22	WAPLS Component 3 for SWLI	2.76	0.99	0.91	12.46	0.29	0.26	0.18
Argyll diatoms	51	WAPLS Component 3 for SWLI	9.97	0.97	0.87	24.06	0.56	0.51	0.35
Regional pollen	82	PLS Component 2 for SWLI	39.44	0.56	0.36	50.89	1.18	1.07	0.75
Kintail pollen	25	PLS Component 3 for SWLI	34.63	0.66	0.31	57.61	1.34	1.21	0.85
Morar pollen	15	PLS Component 3 for SWLI	6.49	0.94	0.65	18.44	0.43	0.39	0.27
Argyll pollen	42	WAPLS Component 3 for SWLI	18.74	0.92	0.67	43.29	1.00	0.91	0.64
Regional multi-proxy	75	WAPLS Component 3 for SWLI	6.10	0.97	0.81	17.90	0.42	0.38	0.26
Kintail multi-proxy	23	WAPLS Component 3 for SWLI	5.06	0.99	0.74	26.40	0.61	0.55	0.39
Morar multi-proxy	15	WAPLS Component 3 for SWLI	1.21	1.00	0.88	11.65	0.27	0.24	0.17
Argyll multi-proxy	37	WAPLS Component 2 for SWLI	7.34	0.95	0.80	15.93	0.37	0.33	0.23

Table 6.1 For each transfer function model that was considered the best model, the RMSEP in SWLI units has been converted into m OD for each of the fossil sample sites taking into account the local tidal parameters.

Multi-proxy Training Set Name	No of samples	Name	RMSE	R2	Boot R2	Boot RMSEP	RMSEP (m OD)		
							Nonach	Mointeach Mhor North	Barr-na-Criche
Regional diatom	75	WAPLS Component 3 for SWLI	8.11	0.95	0.78	20.35	0.47	0.43	0.30
Kintail diatom	23	WAPLS Component 2 for SWLI	7.29	0.98	0.71	27.91	0.65	0.59	0.41
Morar diatom	15	WAPLS Component 3 for SWLI	1.56	1.00	0.87	11.22	0.26	0.24	0.16
Argyll diatom	37	WAPLS Component 3 for SWLI	6.61	0.96	0.76	18.92	0.44	0.40	0.28
Regional pollen	75	WAPLS Component 2 for SWLI	18.39	0.76	0.61	24.73	0.57	0.52	0.36
Kintail pollen	23	WAPLS Component 3 for SWLI	13.98	0.91	0.55	35.71	0.83	0.75	0.53
Morar pollen	15	WAPLS Component 3 for SWLI	3.53	0.98	0.76	16.99	0.39	0.36	0.25
Argyll pollen	37	WAPLS Component 3 for SWLI	6.55	0.96	0.74	17.93	0.42	0.38	0.26

Table 6.2 For each transfer function model that was considered the best model for the training sets containing only samples from the multi-proxy training set, the RMSEP in SWLI units has been converted into m OD for each of the fossil sample sites taking into account the local tidal parameters.

Site	Lab code	14C age BP and error		Elevation (m oD)	Indicative meaning (m)	Median, maximum, minimum calibrated age (yr BP)			Relative sea level and error		Sea-level tendency
Mointeach Mhor North MMN01	AA54113	5771	47	9.27	2.73	6575	6716	6452	6.54	0.2	Negative
Mointeach Mhor North MMN01	AA54112	6499	47	9.04	2.58	7394	7551	7309	6.46	0.2	Negative
Mointeach Mhor North MMN01	AA54111	6786	49	8.91	2.18	7635	7710	7515	6.73	0.2	Positive
Mointeach Mhor North MMN01	AA54110	6836	59	8.87	2.28	7671	7786	7580	6.59	0.2	Positive

Table 6.3 Sea-level index points from Arisaig area (Shennan *et al.*, 2005).

		Regional Training Set		Kintail Training Set		Morar Training set		Argyll Training Set	
Diatom	Sample depth (cm)	RWL (m)	Error (m)	RWL (m)	Error (m)	RWL (m)	Error (m)	RWL (m)	Error (m)
	32	2.45	0.32	1.95	0.53	2.51	0.19	2.32	0.33
	34	2.45	0.34	1.78	0.56	2.32	0.17	2.51	0.37
	46	2.85	0.35	2.59	0.66	2.57	0.23	2.30	0.40
	50	2.52	0.32	2.42	0.60	2.58	0.25	2.20	0.35

		Regional Training Set		Kintail Training Set		Morar Training set		Argyll Training Set	
Pollen	Sample depth (cm)	RWL (m)	Error (m)	RWL (m)	Error (m)	RWL (m)	Error (m)	RWL (m)	Error (m)
	10	4.92	0.94	4.02	1.56	1.89	0.28	4.88	0.80
	32	3.55	0.74	2.10	0.74	1.89	0.24	4.55	0.82
	34	3.60	0.74	2.06	0.74	1.80	0.24	4.17	0.85
	46	4.27	0.77	2.49	0.87	2.44	0.44	3.77	0.59
	50	3.96	0.72	2.92	0.87	2.75	0.38	2.57	0.82

		Regional Training Set		Kintail Training Set		Morar Training set		Argyll Training Set	
Multi-proxy	Sample depth (cm)	RWL (m)	Error (m)	RWL (m)	Error (m)	RWL (m)	Error (m)	RWL (m)	Error (m)
	32	1.85	0.20	1.95	0.33	1.93	0.12	2.16	0.17
	34	1.70	0.20	1.86	0.33	1.87	0.13	2.29	0.17
	46	2.07	0.20	2.27	0.34	2.08	0.13	2.00	0.17
	50	2.38	0.23	2.59	0.37	2.04	0.13	2.22	0.18

Sea-level Index Points	Sample depth (cm)	RWL (m)	Error (m)
	10	2.73	0.2
	33	2.58	0.2
	46	2.18	0.2
	50	2.28	0.2

Table 6.4 Shows the results of the diatom, pollen and multi-proxy RWL reconstructions and associated error terms and the RWL and error terms for the sea-level index (SLI) points from Mointeach Mhor North (after Shennan *et al.*, 2005).

		Regional Training Set		Kintail Training Set		Morar Training set		Argyll Training Set	
Diatom	Sample depth (cm)	RWL (m)	Error (m)	RWL (m)	Error (m)	RWL (m)	Error (m)	RWL (m)	Error (m)
	32	2.18	0.23	2.10	0.38	1.90	0.13	2.01	0.19
	34	2.14	0.24	2.02	0.38	1.83	0.13	2.13	0.20
	46	2.07	0.23	2.29	0.39	1.93	0.13	1.65	0.19
	50	2.15	0.23	2.23	0.38	1.92	0.14	1.88	0.20

		Regional Training Set		Kintail Training Set		Morar Training set		Argyll Training Set	
Pollen	Sample depth (cm)	RWL (m)	Error (m)	RWL (m)	Error (m)	RWL (m)	Error (m)	RWL (m)	Error (m)
	10	2.21	0.29	1.68	0.45	2.18	0.21	2.74	0.28
	32	1.67	0.27	2.26	0.54	1.73	0.26	1.80	0.23
	34	1.42	0.30	1.91	0.61	1.35	0.30	1.62	0.24
	46	2.41	0.37	1.83	0.51	2.20	0.23	2.93	0.23
	50	4.21	0.47	6.54	1.46	2.59	0.27	3.94	0.54

Sea-level Index Points	Sample depth (cm)	RWL (m)	Error (m)
	10	2.73	0.2
	33	2.58	0.2
	46	2.18	0.2
	50	2.28	0.2

Table 6.5 Shows the results of the diatom and pollen RWL reconstructions for the samples within the multi-proxy training set and associated error terms and the RWL and error terms for the sea-level index (SLI) points from Mointeach Mhor North (after Shennan *et al.*, 2005).