



UCL



**UK Upland Waters Monitoring Network (UKUWMN)
Llyn Llagi, Llyn Cwm Mynach, Afon Hafren and Afon Gwy
Annual Summary Progress Report. April 13 - March 14**

E. M. Shilland, L. Irvine, K. Millidine & I. A. Malcolm

March 2014

**UK UPLAND WATERS MONITORING NETWORK (UKUWMN) –
CONTRACT 22 01 249**

**LLYN LLAGI, LLYN CWM MYNACH, AFON HAFREN AND AFON
GWY**

ANNUAL SUMMARY PROGRESS REPORT April 2013 - March 2014

**REPORT TO THE WELSH ASSEMBLY GOVERNMENT AND
NATURAL RESOURCES WALES**

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March 2014

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Cover photo: Afon Gwy, July 2013. All photographs © Ewan Shilland

3 Llyn Llagi



Figure 1 Llyn Llagi. Looking down on the lake during sampling, 23rd July 2013.

3.1 Summary Overview

Chemical and biological sample collection, analysis and data collation, quality control and archiving proceeded without any problems at Llyn Llagi during the period from April 2013 to March 2014.

3.2 Water Chemistry

Samples were collected by CEH in early June, September and December 2013, delivered to the analytical laboratories on schedule and have been analysed, quality controlled and

archived in the UKUWMN central chemistry database at CEH Lancaster. March 2014 samples have been collected and are in the process of being analysed.

3.3 Sediment Traps

Sediment traps were recovered and replaced on the 23rd of July 2013 by a team from ENSIS. Diatoms in the sediment retrieved from the traps are currently being analysed.

3.4 Thermistors

Lake top and bottom thermistors and the thermistor chain were removed and replaced on the 23rd of July 2013 by a team from ENSIS. All had functioned well during the previous year and the data were added to the ENSIS and MS thermistor water temperature database.

3.5 Epilithic Diatoms

Epilithic diatoms were retrieved by a team from ENSIS from three sampling points around the lake on the 23rd of July 2013. The samples have been made into slides and are currently in the process of being analysed.

3.6 Macroinvertebrates

Aquatic macroinvertebrates were sampled on the 17th April 2013 by a team from QMuL. Five 1 minute kick samples were performed. The samples were counted and the data sent to ENSIS Ltd. The data is in the process of being quality screened before being added to the UKUWMN biological database at ENSIS.

3.7 Fish

Fish surveying was performed on the 1st October 2013 by the Game and Wildlife Conservation Trust. The data have been forwarded to ENSIS Ltd. After quality screening the data will be added to the UKUWMN biological database at ENSIS.

3.8 Aquatic Macrophytes

Aquatic macrophytes were surveyed by a team from ENSIS on 23rd of July 2013 using both UKUWMN and CSM standard methodologies. Data will be added to the ENSIS biological database after microscope confirmation of bryophyte identifications.

3.9 Data Management and Reporting

No problems or hiatus occurred with the collation and transfer of data within methodological programmes, or to the UKUWMN databases, during the reporting period.

Work on the 2012-2013 annual report is nearly finished and it should be uploaded to the UKUWMN web page in April 2014. The section on Llyn Llagi appears in section 3.11 below.

The UKUWMN website page detailing Llyn Llagi is here:

http://awmn.defra.gov.uk/sites/site_15.php

Further publications from the contract period utilizing UKUWMN data from Llyn Llagi are detailed in section 3.10 below.

3.10 Llyn Llagi Recent UKUWMN Output

Battarbee, R. W., Simpson, G. L., Shilland, E. M., Flower, R. J., Kreiser, A., Yang, H. & Clarke, G. (2014) Recovery of UK lakes from acidification: An assessment using combined palaeoecological and contemporary diatom assemblage data. *Ecological Indicators*, **37, Part B**, 365-380.

Battarbee, R. W., Shilland, E. M., Kernan, M., Monteith, D. T. & Curtis, C. J. (2014) Recovery of acidified surface waters from acidification in the United Kingdom after twenty years of chemical and biological monitoring (1988–2008). *Ecological Indicators*, **37, Part B**, 267-273.

Curtis, C. J., Battarbee, R. W., Monteith, D. T. & Shilland, E. M. (2014) The future of upland water ecosystems of the UK in the 21st century: A synthesis. *Ecological Indicators*, **37, Part B**, 412-430.

Curtis, C. J. & Simpson, G. L. (2014) Trends in bulk deposition of acidity in the UK, 1988–2007, assessed using additive models. *Ecological Indicators*, **37, Part B**, 274-286.

Garmo, O. A., Skjelkvale, B. L., Wit, H. A., Colombo, L., Curtis, C., Folster, J., Hoffmann, A., Hruska, J., Hogasen, T., Jeffries, D. S., Keller, W. B., Kram, P., Majer, V., Monteith, D. T., Paterson, A. M., Rogora, M., Rzychon, D., Steingruber, S., Stoddard, J., Vuorenmaa, J. & Worsztynowicz, A. (2014) Trends in Surface Water Chemistry in Acidified Areas in Europe and North America from 1990 to 2008. *Water Air and Soil Pollution*, **225**, 1-14.

Helliwell, R. C., Aherne, J., MacDougall, G., Nisbet, T. R., Lawson, D., Cosby, B. J. & Evans, C. D. (2014) Past acidification and recovery of surface waters, soils and ecology in the United Kingdom: Prospects for the future under current deposition and land use protocols. *Ecological Indicators*, **37, Part B**, 381-395.

Malcolm, I. A., Bacon, P. J., Middlemas, S. J., Fryer, R. J., Shilland, E. M. & Collen, P. (2014) Relationships between hydrochemistry and the presence of juvenile brown trout

(*Salmo trutta*) in headwater streams recovering from acidification. *Ecological Indicators*, **37**, Part B, 351-364.

Monteith, D. T., Evans, C. D., Henrys, P. A., Simpson, G. L. & Malcolm, I. A. (2014) Trends in the hydrochemistry of acid-sensitive surface waters in the UK 1988–2008. *Ecological Indicators*, **37**, Part B, 287-303.

Murphy, J. F., Winterbottom, J. H., Orton, S., Simpson, G. L., Shilland, E. M. & Hildrew, A. G. (2014) Evidence of recovery from acidification in the macroinvertebrate assemblages of UK fresh waters: A 20-year time series. *Ecological Indicators*, **37**, Part B, 330-340.

Stockdale, A., Tipping, E., Fjellheim, A., Garmo, O., A., Hildrew, A. G., Lofts, S., Monteith, D. T., Ormerod, S. J. & Shilland, E. M. (2014) Recovery of macroinvertebrate species richness in acidified upland waters assessed with a field toxicity model. *Ecological Indicators*, **37**, Part B, 341-350.

Shilland, E. M. (2013) 25 Years of the Acid Waters Monitoring Network in Wales. Marine and Freshwater Evidence Workshop, Countryside Council for Wales HQ, Bangor. February 20th 2013.

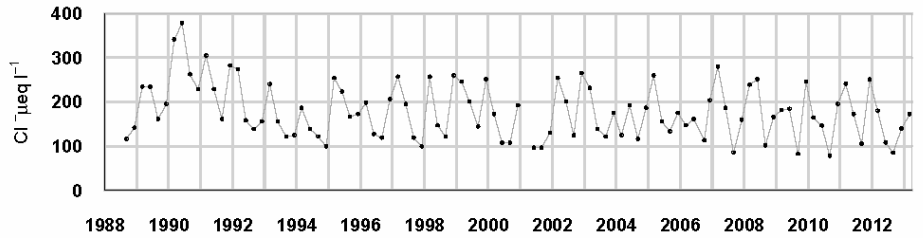
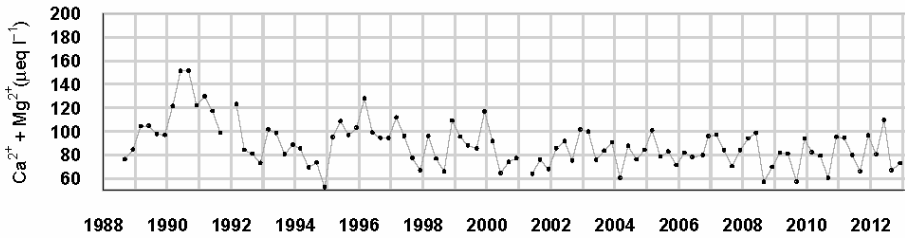
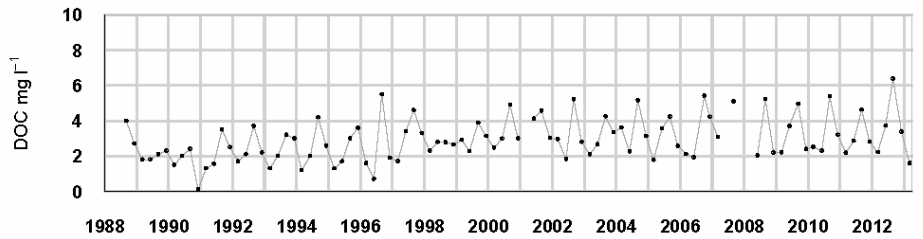
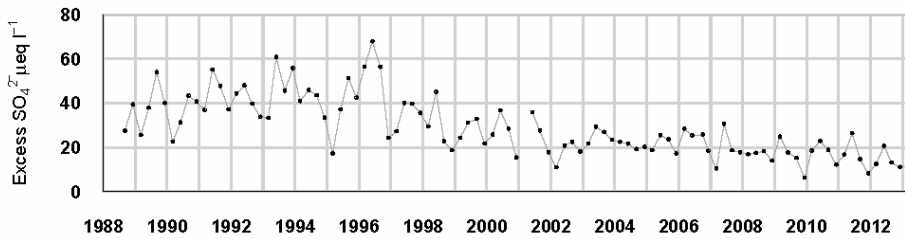
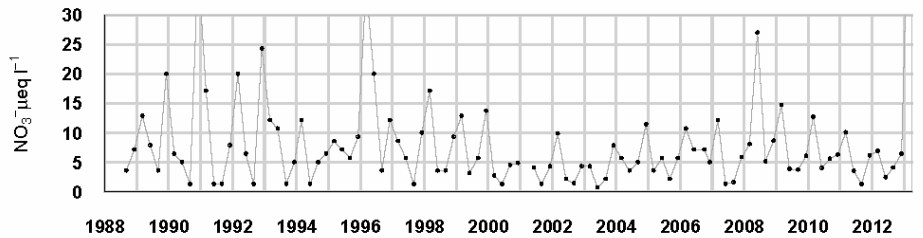
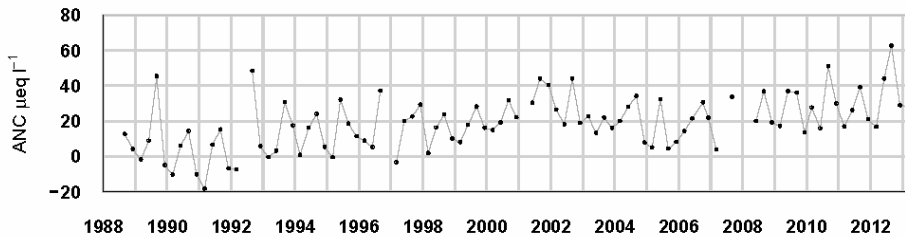
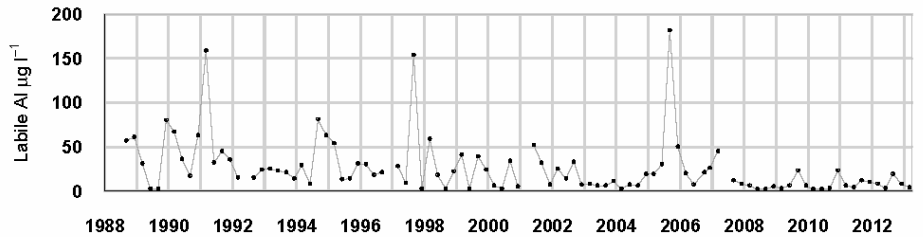
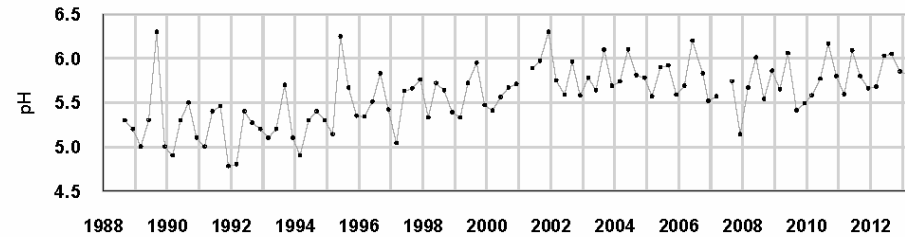
Shilland, E. M., Irvine, L., Malcolm, I. A. & Salgado, J. (2013) The United Kingdom Acid Waters Monitoring Network Data Report for 2011-2012 (year 24). Report to the Department for Environment, Food and Rural Affairs (Contract EPG 1/3/160). 1-250. ENSIS Ltd. Environmental Change Research Centre, University College London, London.

Velle, G., Telford, R. J., Curtis, C. J., Eriksson, L., Fjellheim, A., Frolova, M., Fölster, J., Grudule, N., Halvorsen, G. A., Hildrew, A., Hoffmann, A., Indriksone, I., Kamasová, L., Kopáček, J., Orton, S., Krám, P., Monteith, D. T., Senoo, T., Shilland, E. M., Stuchlík, E., Wiklund, M. L., de Wit, H. & Skjelkvåle, B. L. (2013) Biodiversity in freshwaters: temporal trends and response to water chemistry. ICP Waters Report 114/2013, 1-66. NIVA, Norway.

Winterbottom, J. H. & Orton, S. E. (2013) United Kingdom Acid Waters Monitoring Network Invertebrate Survey. Twenty Sixth Year: 2013. Summary of species identification and abundance. 1-13. School of Biological Sciences, Queen Mary University of London, London.

3.11 Llyn Llago Summary Data to March 2013

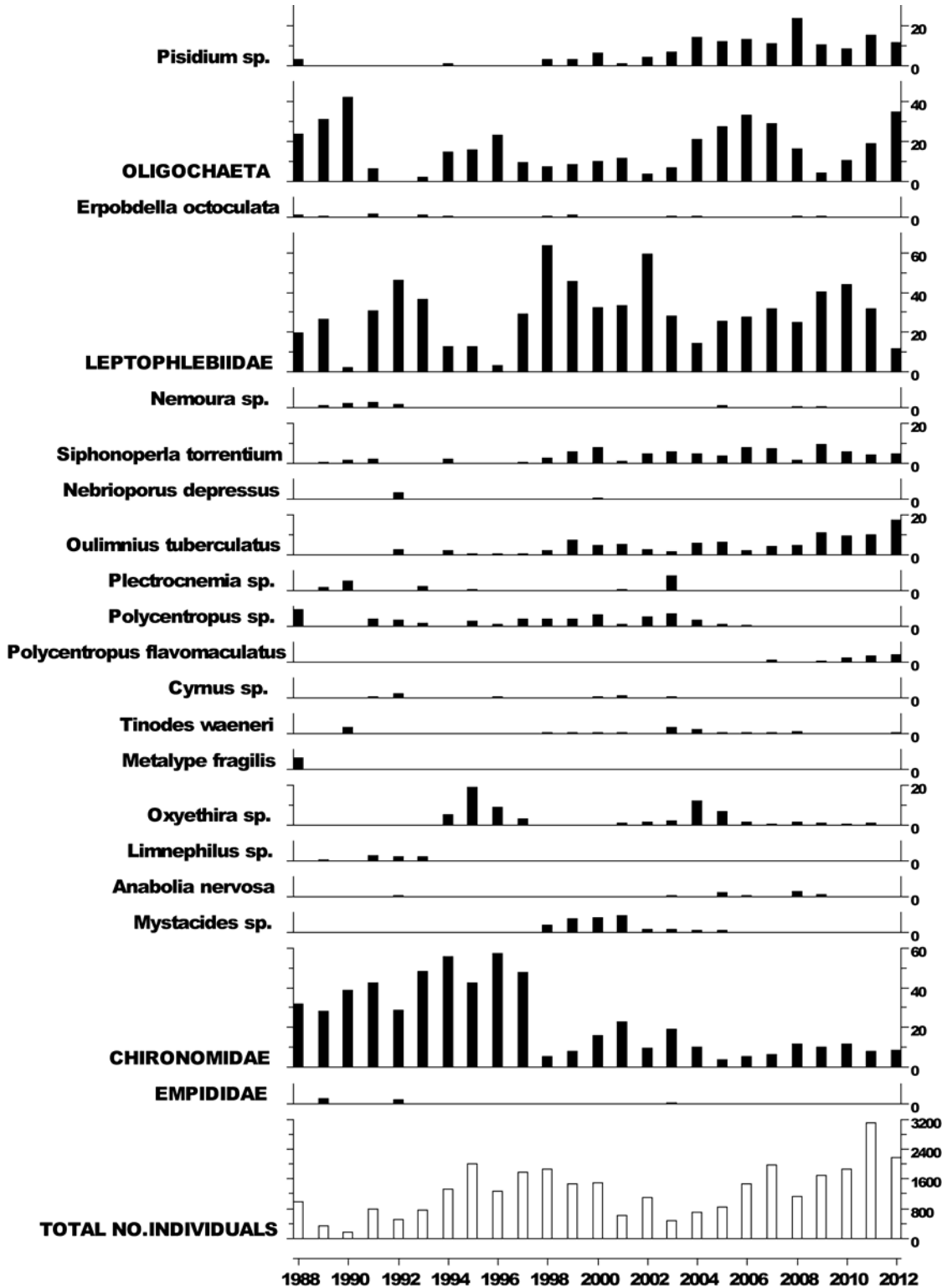
3.11.1 Spot sampled chemistry data



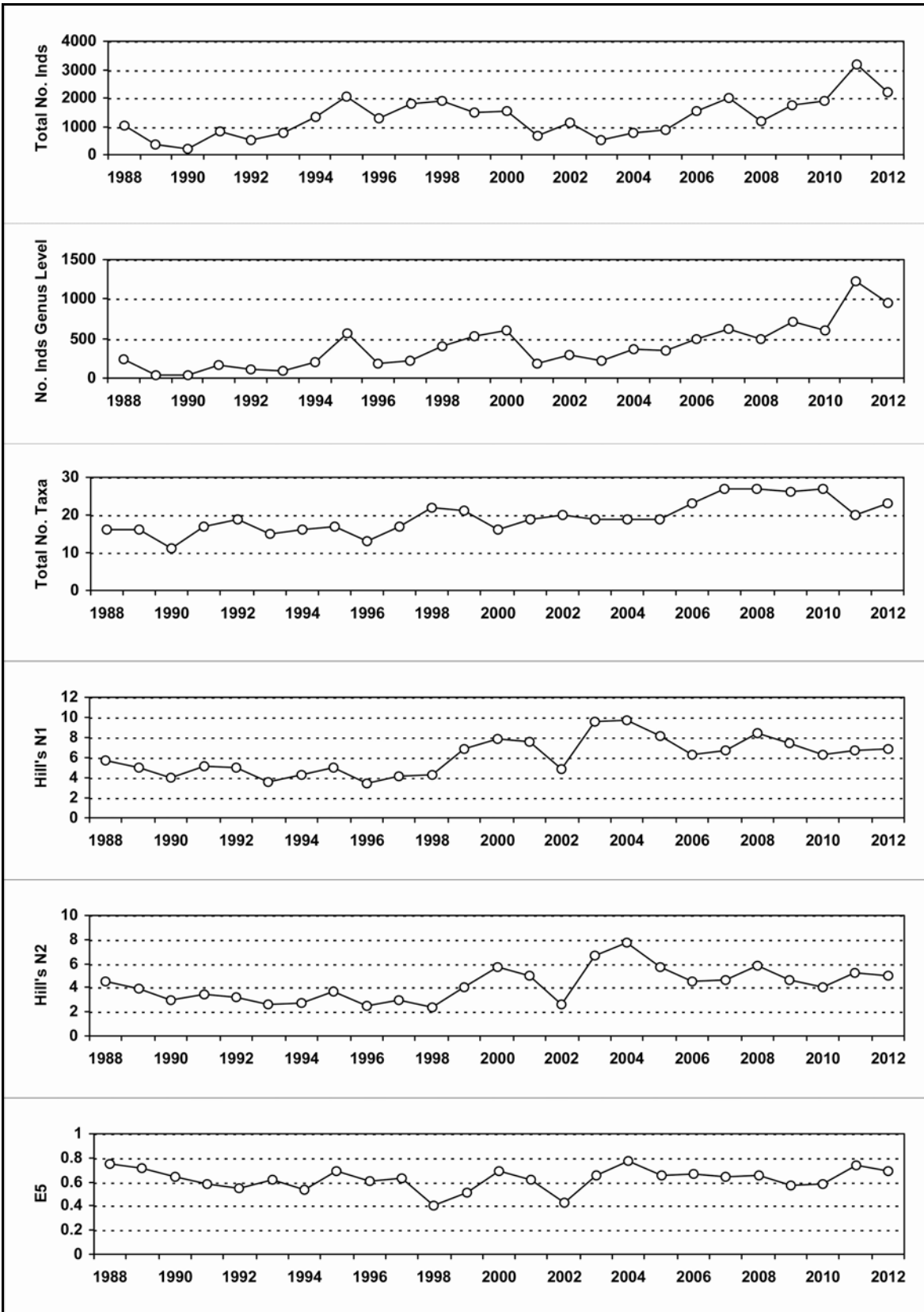
$\mu\text{eq l}^{-1}$, * $\mu\text{g l}^{-1}$, ** mg l^{-1}	pH	ANC	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	*Soluble Al	*Labile Al	Cl ⁻	*SO ₄ ²⁻	xSO ₄ ²⁻	NO ₃ ⁻	**DOC
Mean 1 st 5 yrs	5.23	5.71	56.70	49.69	185.75	3.54	75.37	41.61	219.33	62.91	39.91	10.44	2.13
12-13 mean	5.94	40.95	52.99	30.02	104.55	3.17	30.25	8.50	125.75	27.17	13.98	17.77	3.77
12-13 std dev	0.12	16.18	25.84	4.02	14.00	1.05	12.61	7.33	38.09	4.38	4.50	26.97	1.97

3.11.2 Macroinvertebrate data

3.11.2.1 Percentage abundance summary, Llyn Llgi

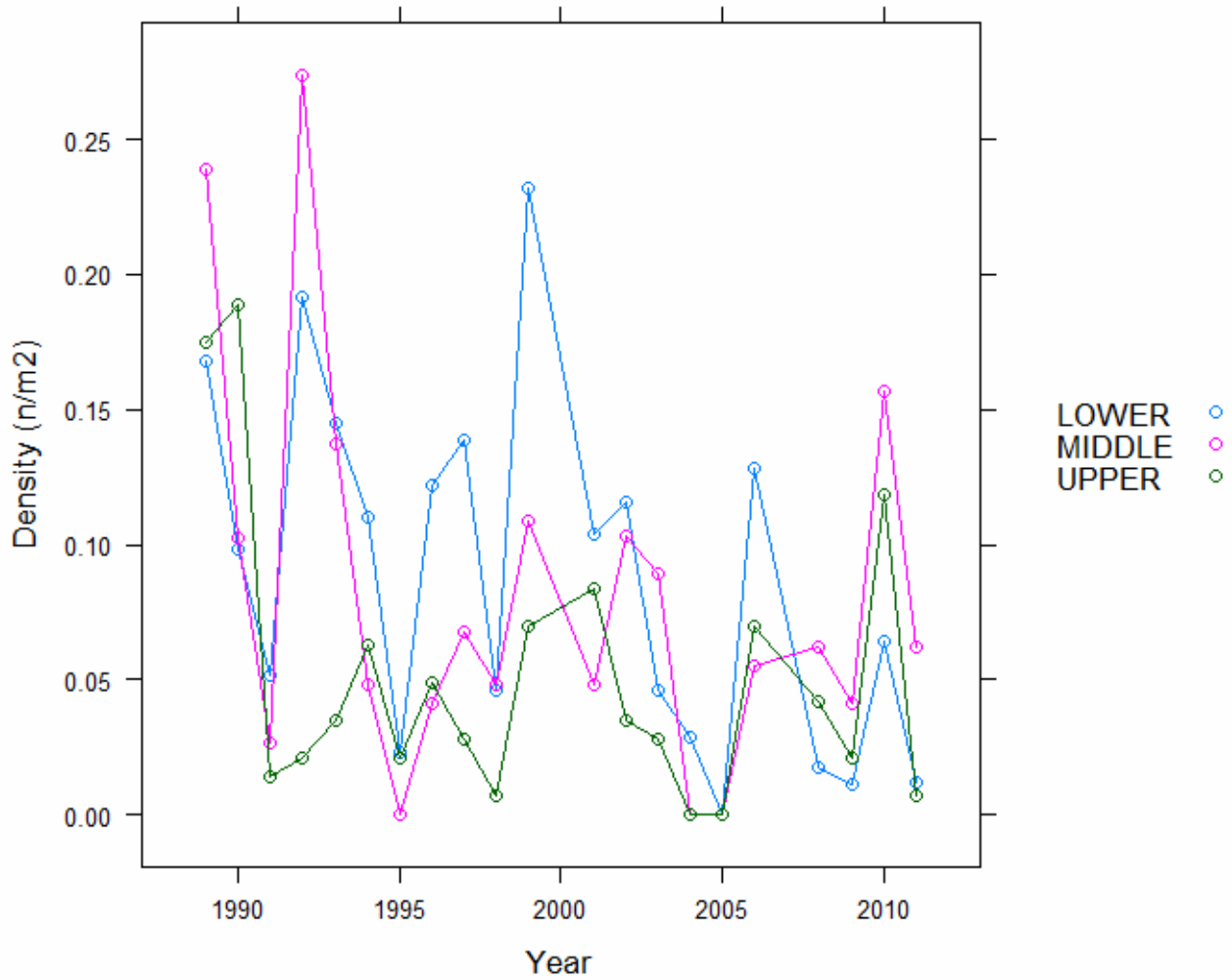


3.11.2.1 Macroinvertebrate summary statistics, Llyn Llago



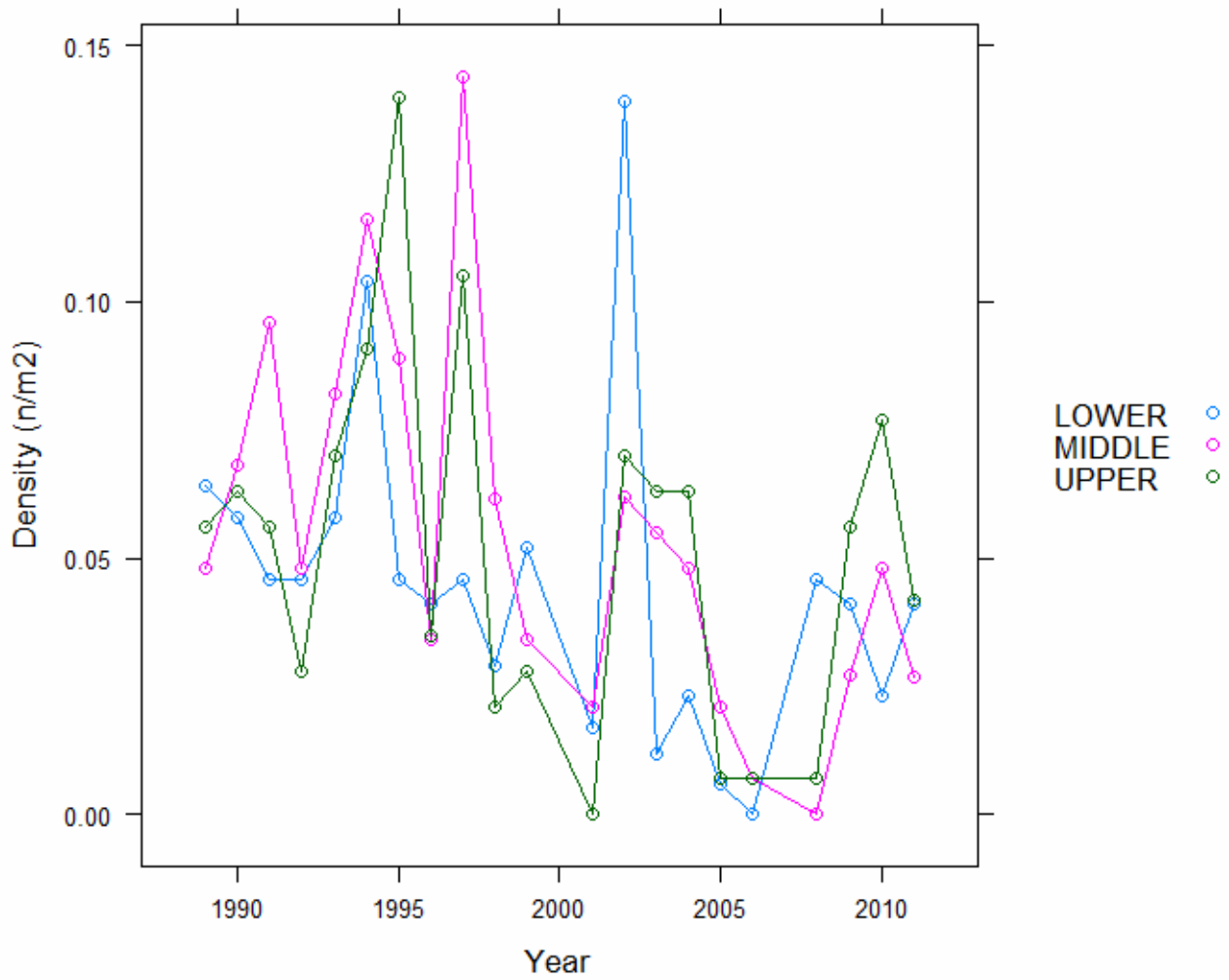
3.11.3 Fish data (for outflow stream)

3.11.3.1 Summary of Trout fry density (numbers m^{-2}), Llyn Llgi



Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

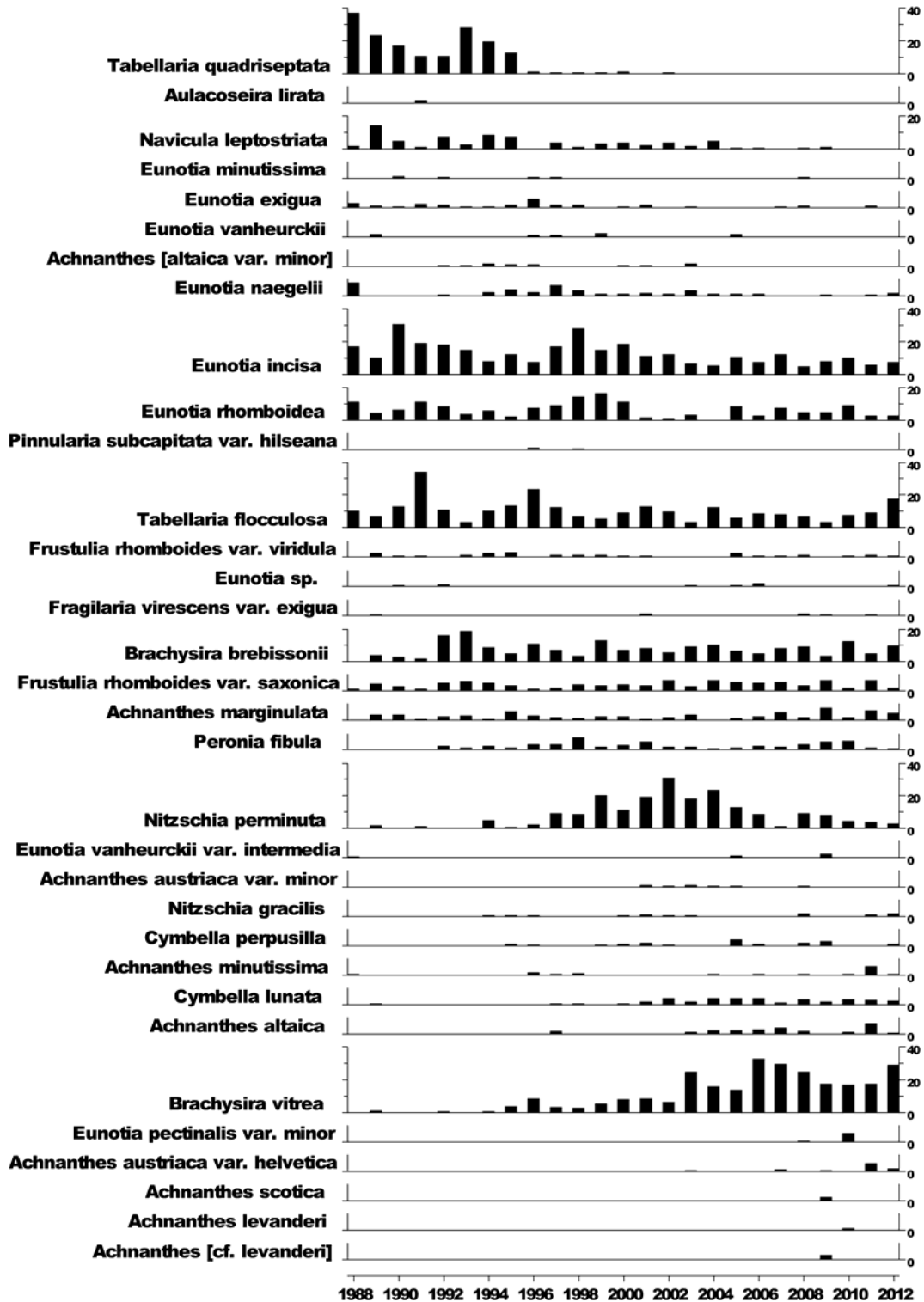
3.11.3.2 Summary of Trout parr density (numbers m⁻²), Llyn Llagi



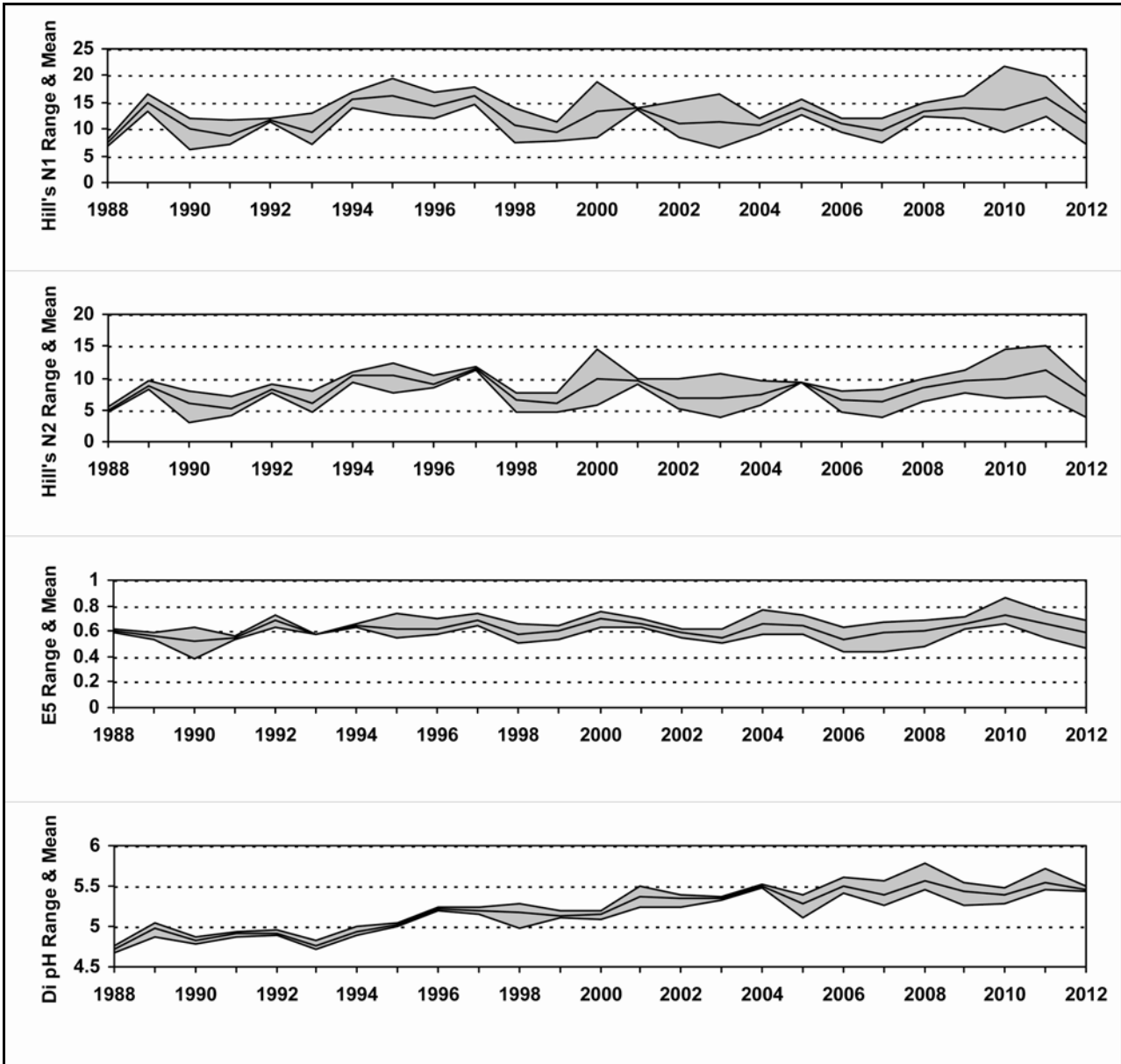
Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

3.11.4 Epilithic diatom data

3.11.4.1 Percentage abundance summary, Llyn Llago

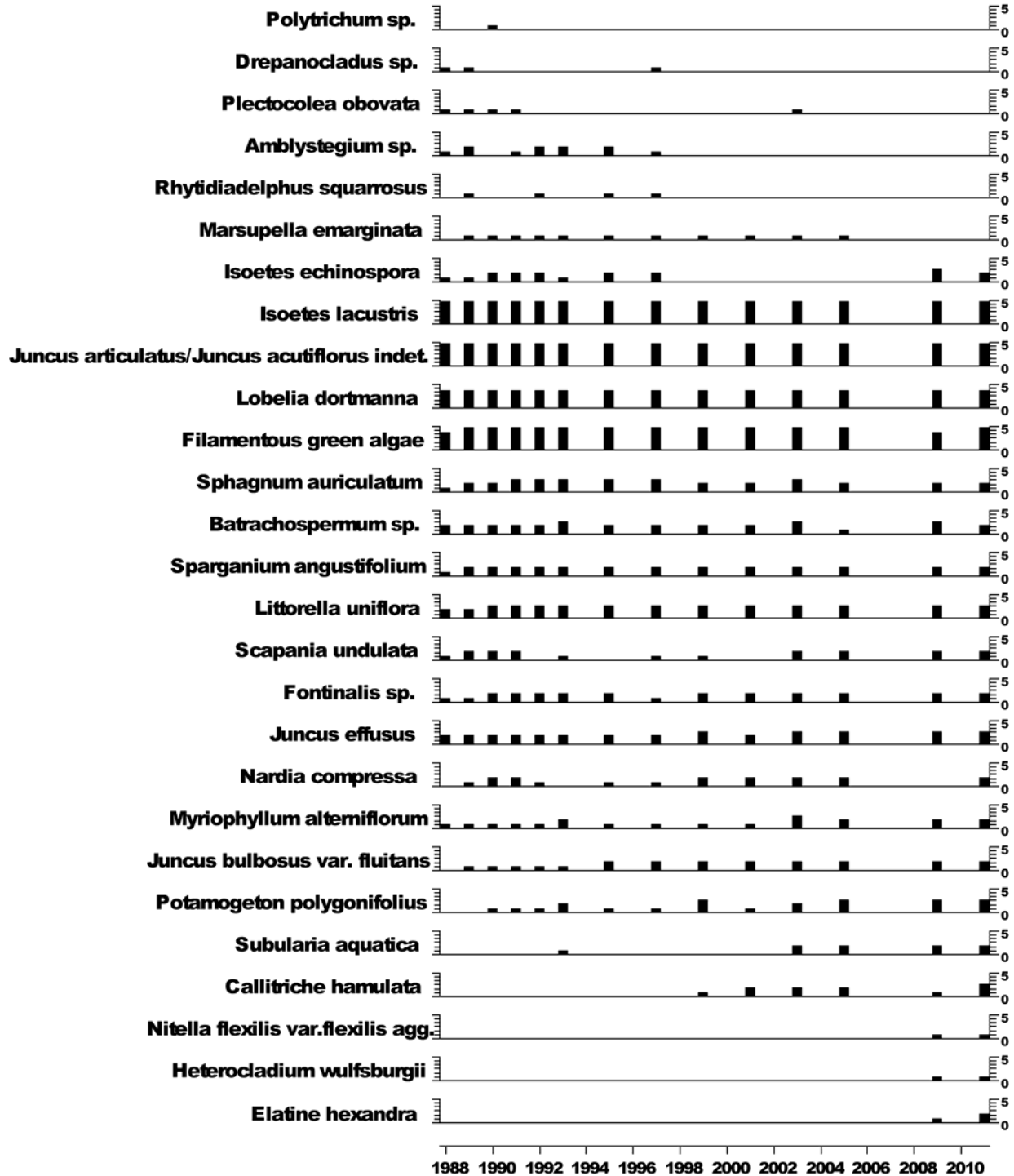


3.11.4.1 Diatom summary statistics, Llyn Llagi



3.11.5 Aquatic macrophyte data, Llyn Llgi

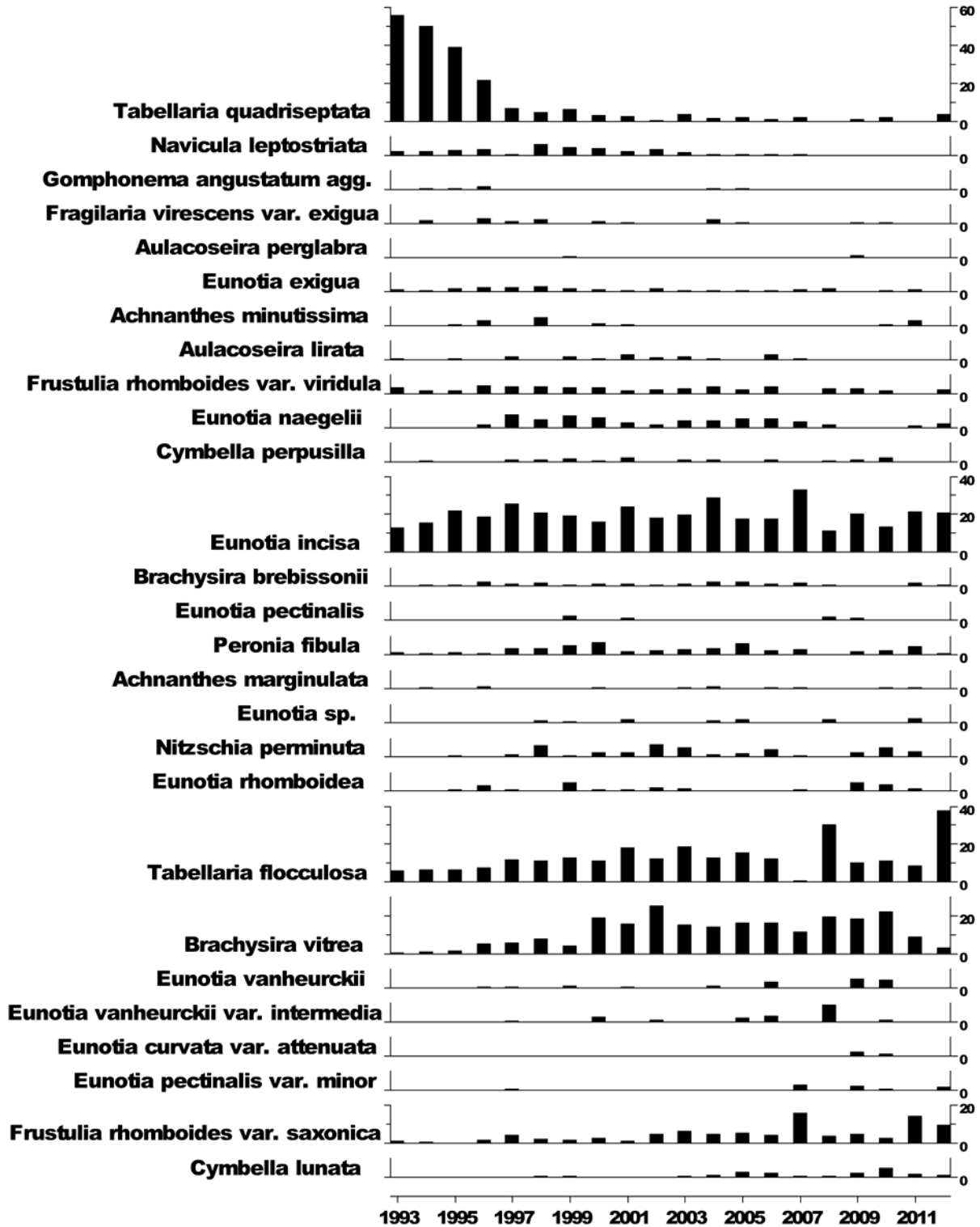
Species Scores (1-5)



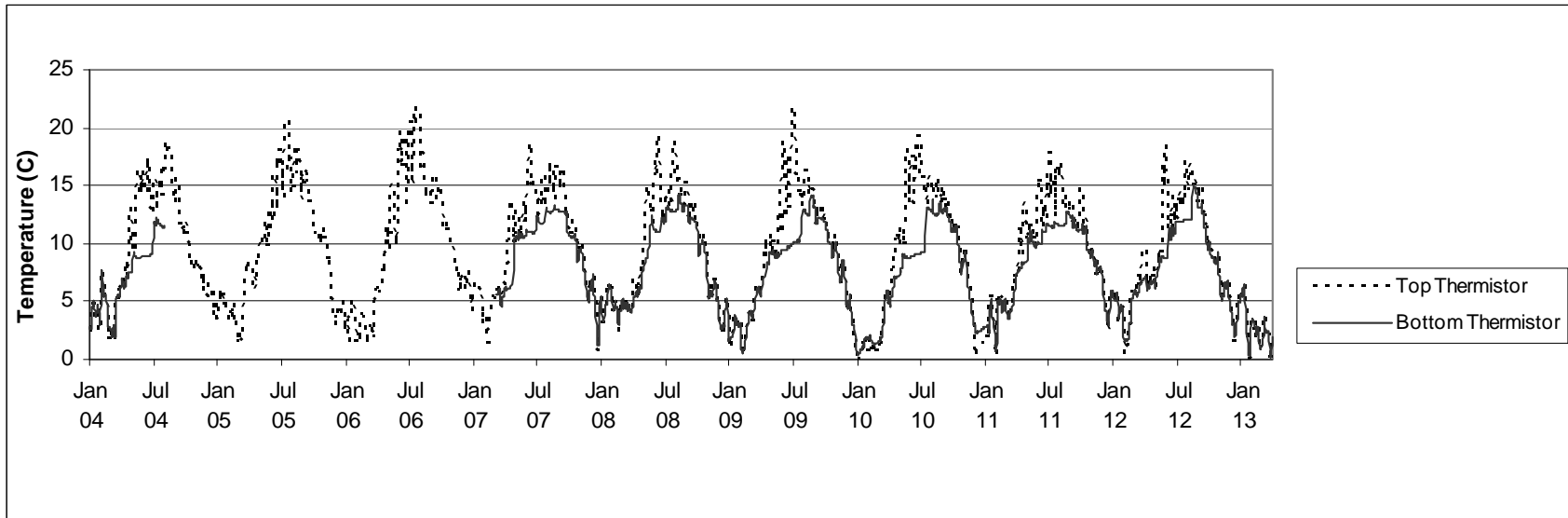
No survey in 2007 due to funding cuts

3.11.6 Sediment trap data, Llyn Llgi

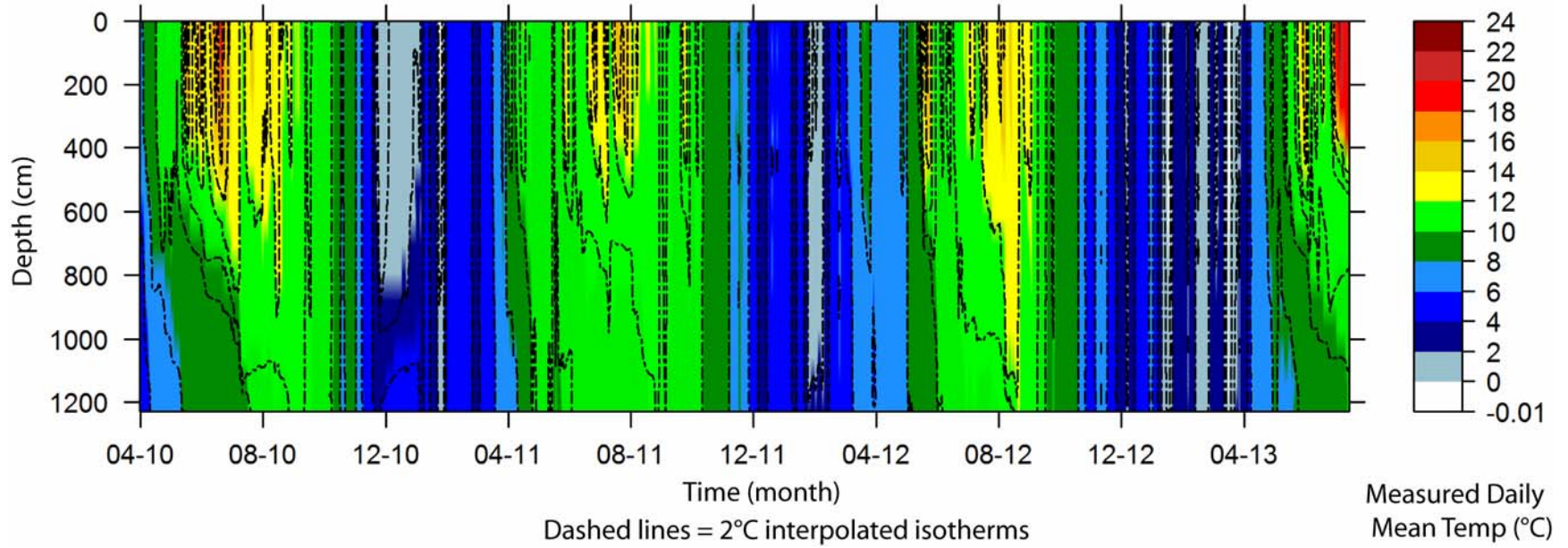
Relative percentage frequency of diatom taxa



3.11.7 Sediment trap thermistor data, Llyn Llagi

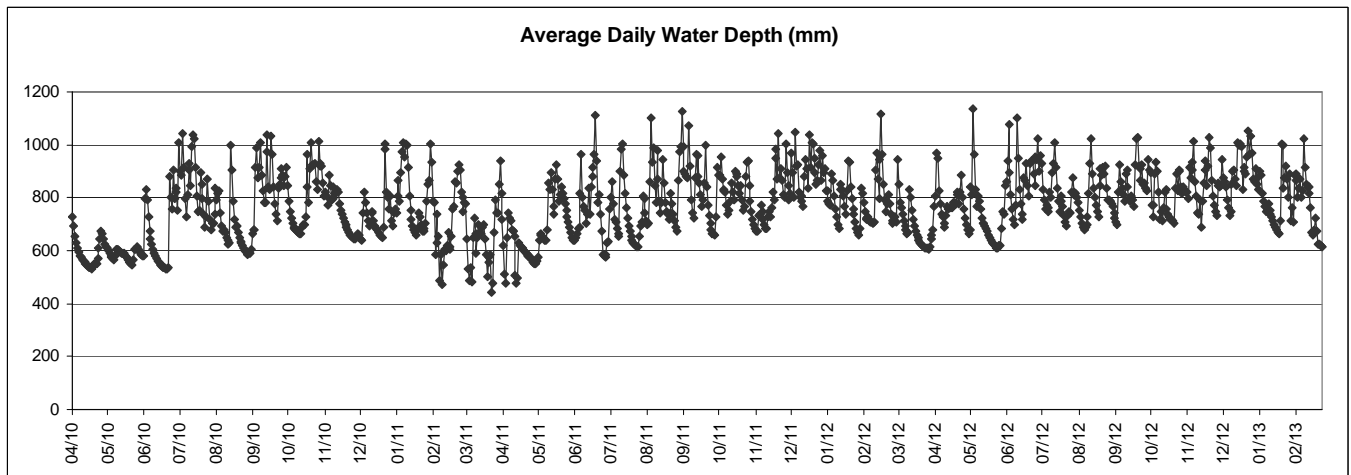
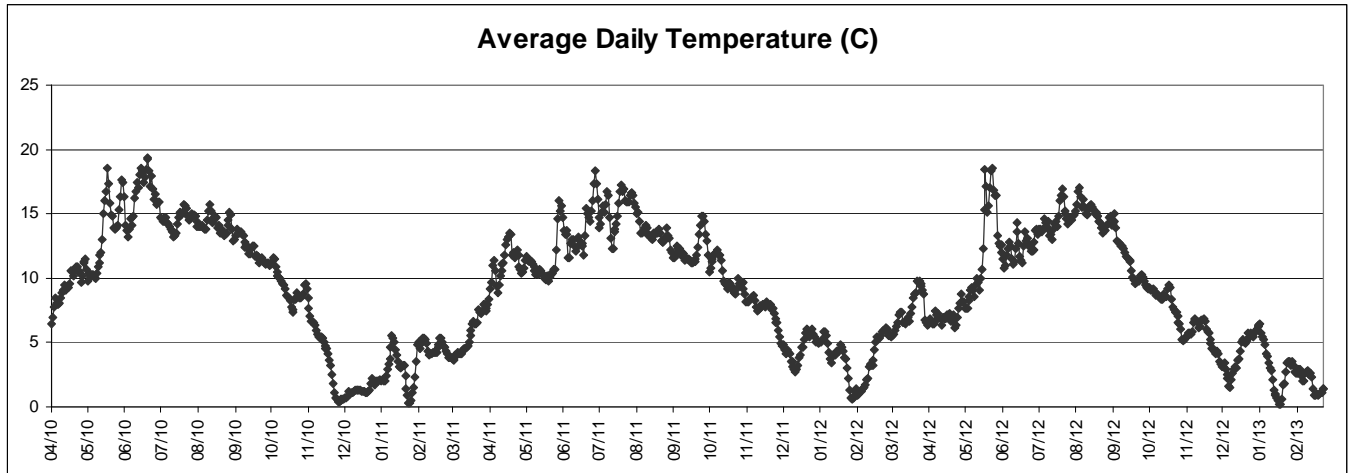


3.11.8 Thermistor chain data, Llyn Llagi

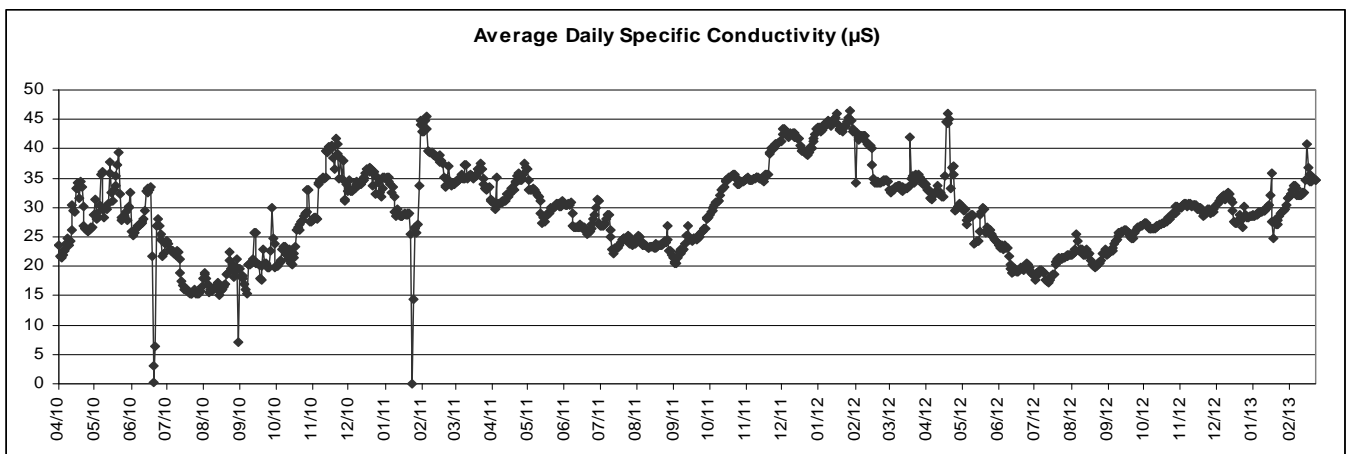
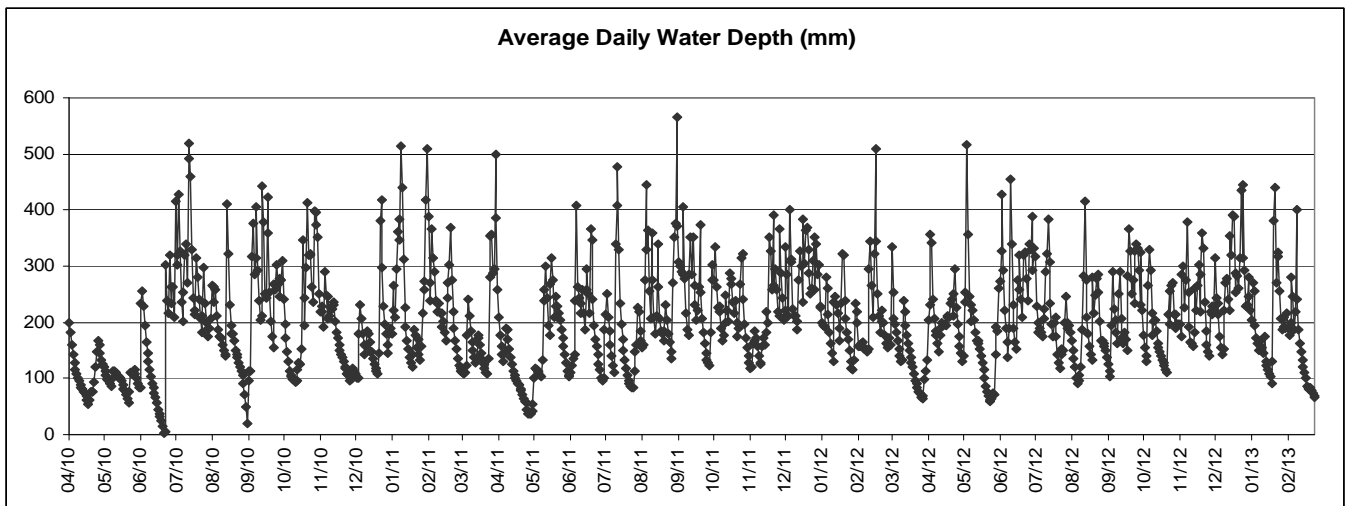
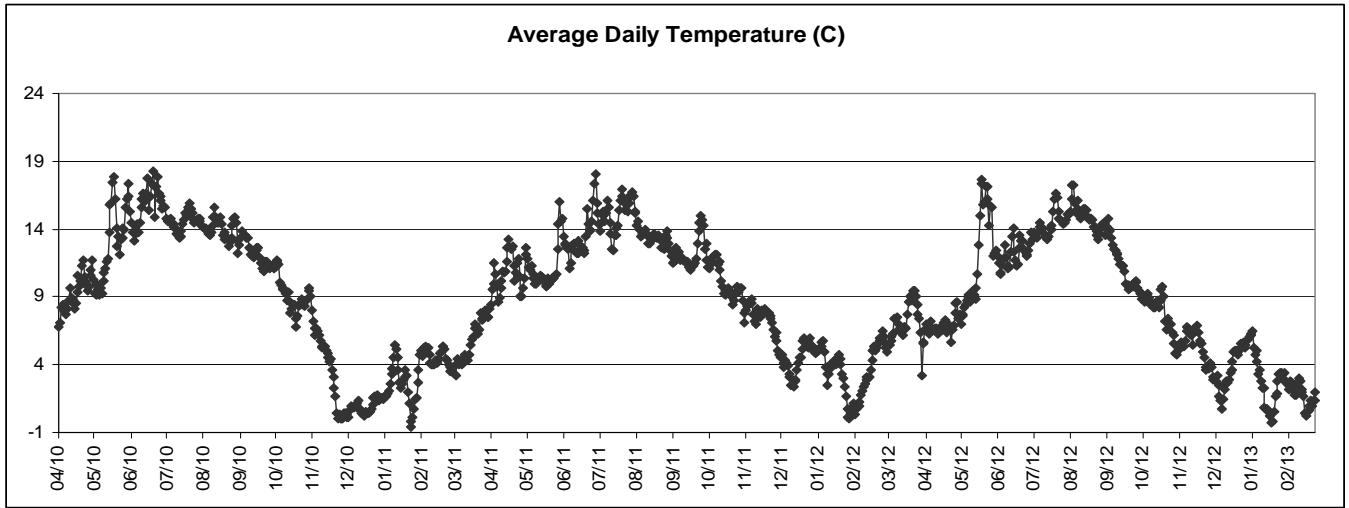


3.11.9 Automatic sensor data, Llyn Llagi

3.11.9.1 Lake sensor data, Llyn Llagi



3.11.9.2 Outflow sensor data, Llyn Llago



4 Llyn Cwm Mynach



Figure 2 Llyn Cwm Mynach. Looking southeast from the north west end of the lake, 22nd July 2013.

4.1 Summary Overview

Chemical and biological sample collection, analysis and data collation, quality control and archiving proceeded without any problems at Llyn Cwm Mynach during the period from April 2013 to March 2014.

4.2 Water Chemistry

Samples were collected by CEH in early June, September and December 2013, delivered to the analytical laboratories on schedule and have been analysed, quality controlled and archived in the UKUWMN central chemistry database at CEH Lancaster. March 2014 samples have been collected and are in the process of being analysed.

4.3 Sediment Traps

Sediment traps were recovered and replaced on the 22nd of July 2013 by a team from ENSIS. Diatoms in the sediment retrieved from the traps are currently being analysed.

4.4 Thermistors

Lake top and bottom thermistors were removed and replaced on the 22nd of July 2013 by a team from ENSIS. Both had functioned well during the previous year and the data were added to the ENSIS thermistor water temperature database. A thermistor chain was also installed on 22nd of July 2013.

4.5 Epilithic Diatoms

Epilithic diatoms were retrieved by a team from ENSIS from three sampling points around the lake on the 22nd of July 2013. The samples have been made into slides and are currently in the process of being analysed.

4.6 Macroinvertebrates

Aquatic macroinvertebrates were sampled on the 17th April 2013 by a team from QMuL. Five 1 minute kick samples were performed. The samples were counted and the data sent to ENSIS Ltd. The data is in the process of being quality screened before being added to the UKUWMN biological database at ENSIS.

4.7 Fish

Fish surveying was performed on the 2nd October 2013 by the Game and Wildlife Conservation Trust. The data have been forwarded to ENSIS Ltd. After quality screening the data will be added to the UKUWMN biological database at ENSIS.

4.8 Aquatic Macrophytes

Aquatic macrophytes were not surveyed at Llyn Cwm Mynach in 2013.

4.9 Data Management and Reporting

No problems or hiatus occurred with the collation and transfer of data within methodological programmes, or to the UKUWMN databases, during the reporting period.

Work on the 2012-2013 annual report is nearly finished and it should be uploaded to the UKUWMN web page in April 2014. The section on Llyn Cwm Mynach appears in section 4.11 below.

The UKUWMN website page detailing Llyn Cwm Mynach is here:

http://awmn.defra.gov.uk/sites/site_16.php

Further publications from the contract period utilizing UKUWMN data from Llyn Cwm Mynach are detailed in section 4.10 below.

4.10 Llyn Cwm Mynach Recent UKUWMN Output

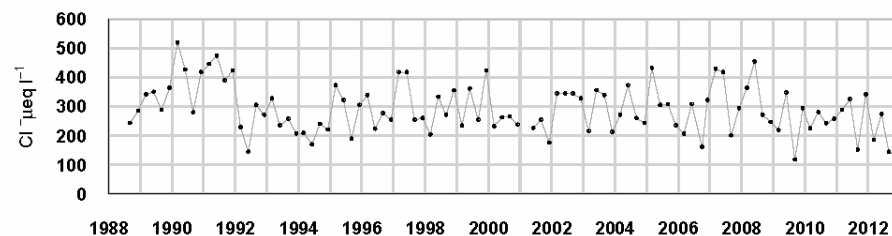
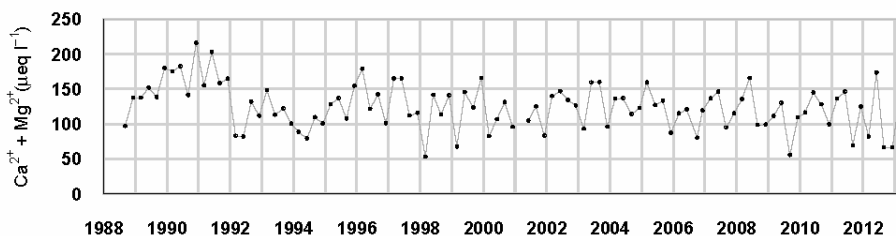
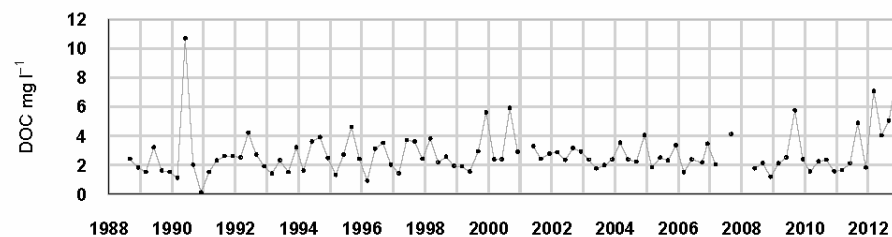
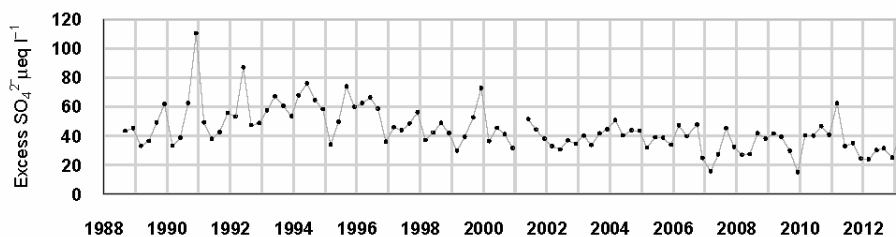
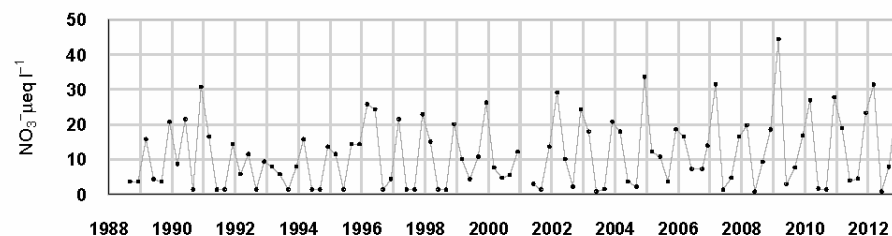
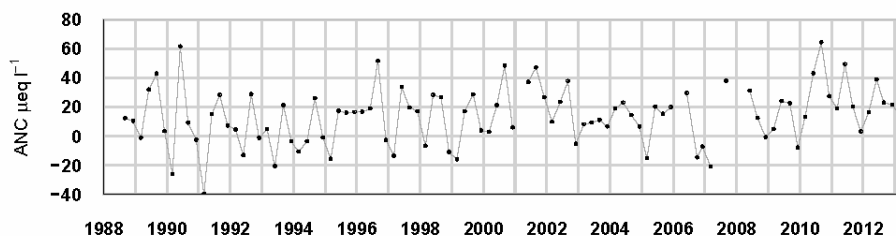
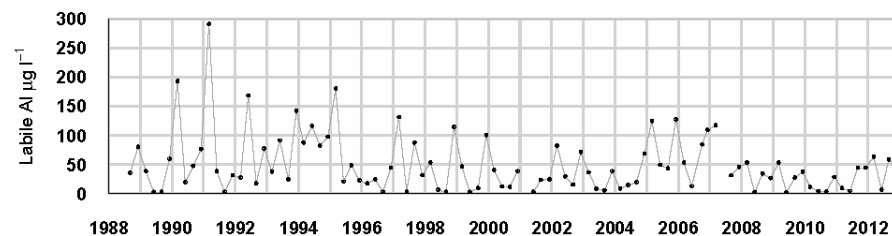
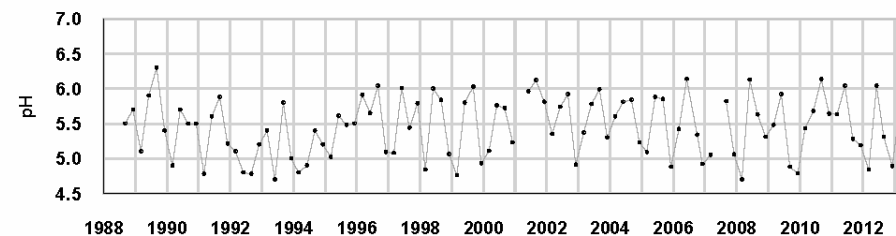
Battarbee, R. W., Shilland, E. M., Kernan, M., Monteith, D. T. & Curtis, C. J. (2014) Recovery of acidified surface waters from acidification in the United Kingdom after twenty years of chemical and biological monitoring (1988–2008). *Ecological Indicators*, **37, Part B**, 267-273.

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- Curtis, C. J., Battarbee, R. W., Monteith, D. T. & Shilland, E. M. (2014) The future of upland water ecosystems of the UK in the 21st century: A synthesis. *Ecological Indicators*, **37, Part B**, 412-430.
- Curtis, C. J. & Simpson, G. L. (2014) Trends in bulk deposition of acidity in the UK, 1988–2007, assessed using additive models. *Ecological Indicators*, **37, Part B**, 274-286.
- Helliwell, R. C., Aherne, J., MacDougall, G., Nisbet, T. R., Lawson, D., Cosby, B. J. & Evans, C. D. (2014) Past acidification and recovery of surface waters, soils and ecology in the United Kingdom: Prospects for the future under current deposition and land use protocols. *Ecological Indicators*, **37, Part B**, 381-395.
- Malcolm, I. A., Bacon, P. J., Middlemas, S. J., Fryer, R. J., Shilland, E. M. & Collen, P. (2014) Relationships between hydrochemistry and the presence of juvenile brown trout (*Salmo trutta*) in headwater streams recovering from acidification. *Ecological Indicators*, **37, Part B**, 351-364.
- Monteith, D. T., Evans, C. D., Henrys, P. A., Simpson, G. L. & Malcolm, I. A. (2014) Trends in the hydrochemistry of acid-sensitive surface waters in the UK 1988–2008. *Ecological Indicators*, **37, Part B**, 287-303.
- Murphy, J. F., Winterbottom, J. H., Orton, S., Simpson, G. L., Shilland, E. M. & Hildrew, A. G. (2014) Evidence of recovery from acidification in the macroinvertebrate assemblages of UK fresh waters: A 20-year time series. *Ecological Indicators*, **37, Part B**, 330-340.
- Stockdale, A., Tipping, E., Fjellheim, A., Garmo, O., A., Hildrew, A. G., Lofts, S., Monteith, D. T., Ormerod, S. J. & Shilland, E. M. (2014) Recovery of macroinvertebrate species richness in acidified upland waters assessed with a field toxicity model. *Ecological Indicators*, **37, Part B**, 341-350.
- Shilland, E. M., Irvine, L., Malcolm, I. A. & Salgado, J. (2013) The United Kingdom Acid Waters Monitoring Network Data Report for 2011-2012 (year 24). Report to the Department for Environment, Food and Rural Affairs (Contract EPG 1/3/160). 1-250. ENSIS Ltd. Environmental Change Research Centre, University College London, London.
- Shilland, E. M. (2013) UK Acid Waters Monitoring Network (UKAWMN) - Contract 22 01 249 Llyn Cwm Mynach, Afon Hafren and Afon Gwy Annual Summary Progress Report April 2012 - March 2013. Report to the Welsh Government, Countryside Council for Wales and Environment Agency, Wales. 1-82. ENSIS Ltd, Environmental Change Research Centre, University College London, London.

Shilland, E. M. (2013) 25 Years of the Acid Waters Monitoring Network in Wales. Marine and Freshwater Evidence Workshop, Countryside Council for Wales HQ, Bangor. February 20th 2013.

4.11 Llyn Cwm Mynach Summary Data to March 2013

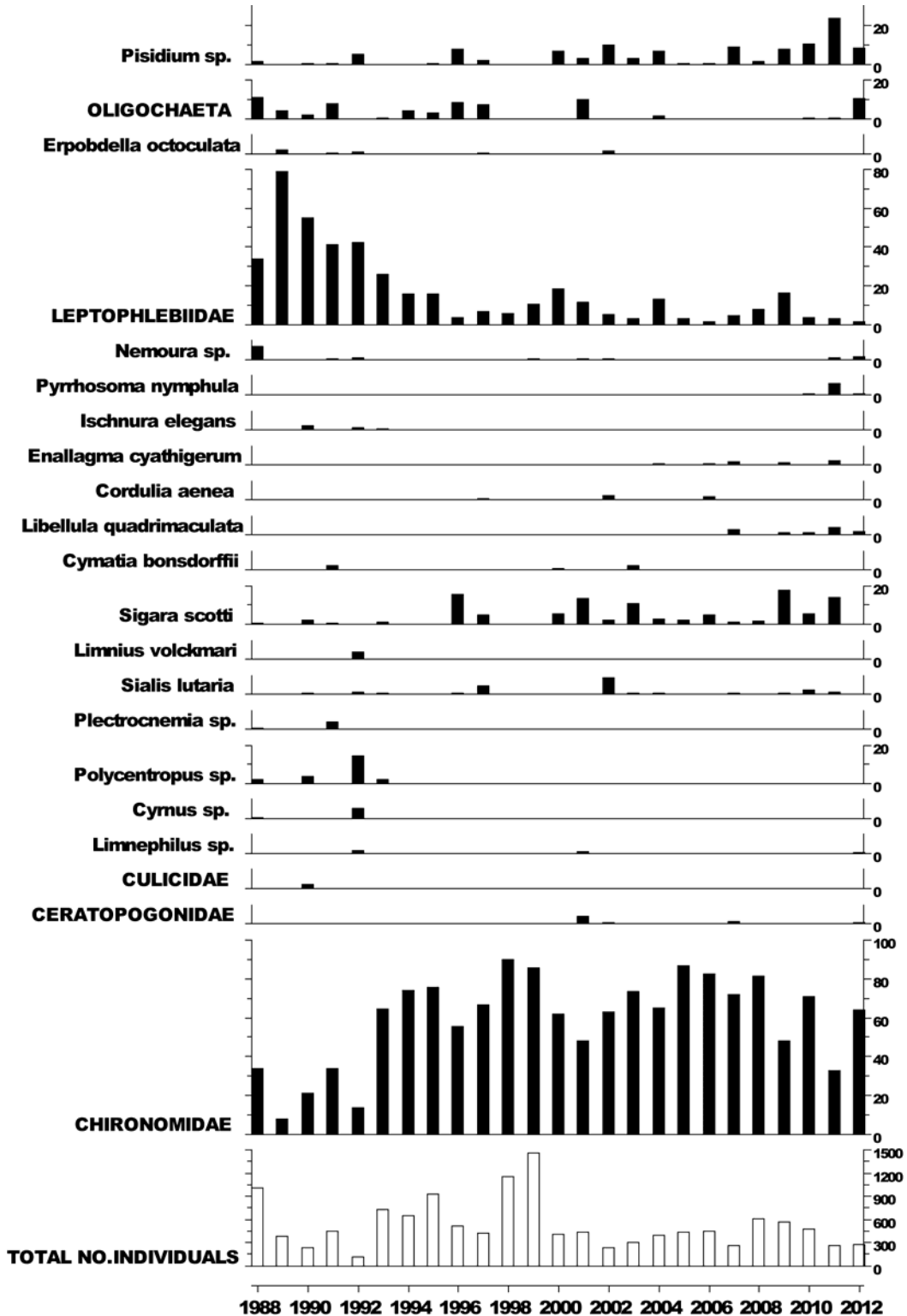
4.11.1 Spot sampled chemistry data



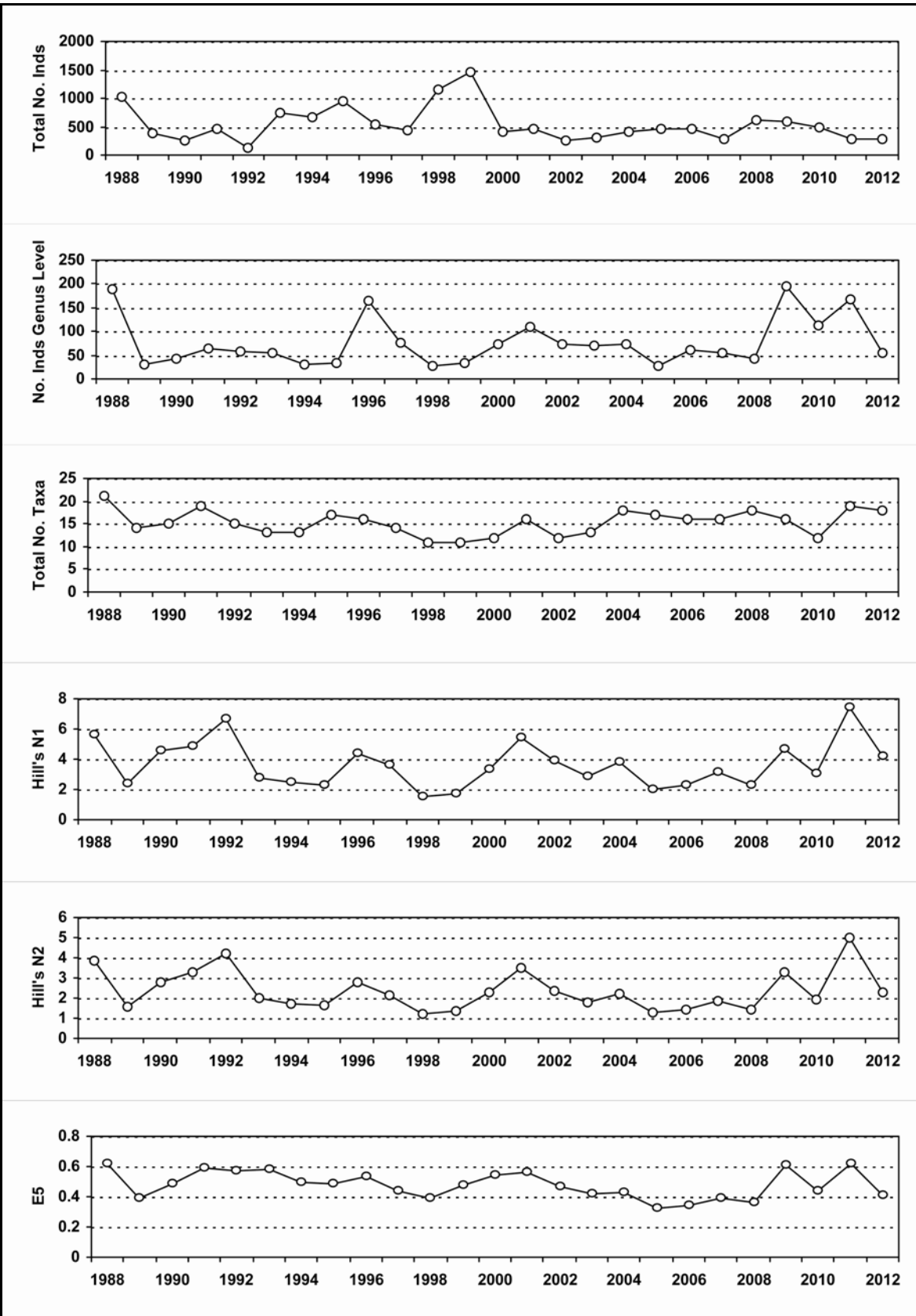
$\mu\text{eq l}^{-1}$, * $\mu\text{g l}^{-1}$, ** mg l^{-1}	pH	ANC	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	*Soluble Al	*Labile Al	Cl ⁻	*SO ₄ ²⁻	xSO ₄ ²⁻	NO ₃ ⁻	**DOC
Mean 1 st 5 yrs	5.35	7.68	77.79	67.45	291.02	3.36	110.75	66.58	337.67	88.32	52.91	9.40	2.50
12-13 mean	5.51	24.30	64.88	47.48	193.68	4.63	111.50	29.25	201.77	52.96	31.80	102.07	4.54
12-13 std dev	0.52	10.54	41.19	16.63	61.32	1.66	90.97	25.79	75.24	13.09	6.68	181.32	2.97

4.11.2 Macroinvertebrate data

4.11.2.1 Percentage abundance summary, Llyn Cwm Mynach

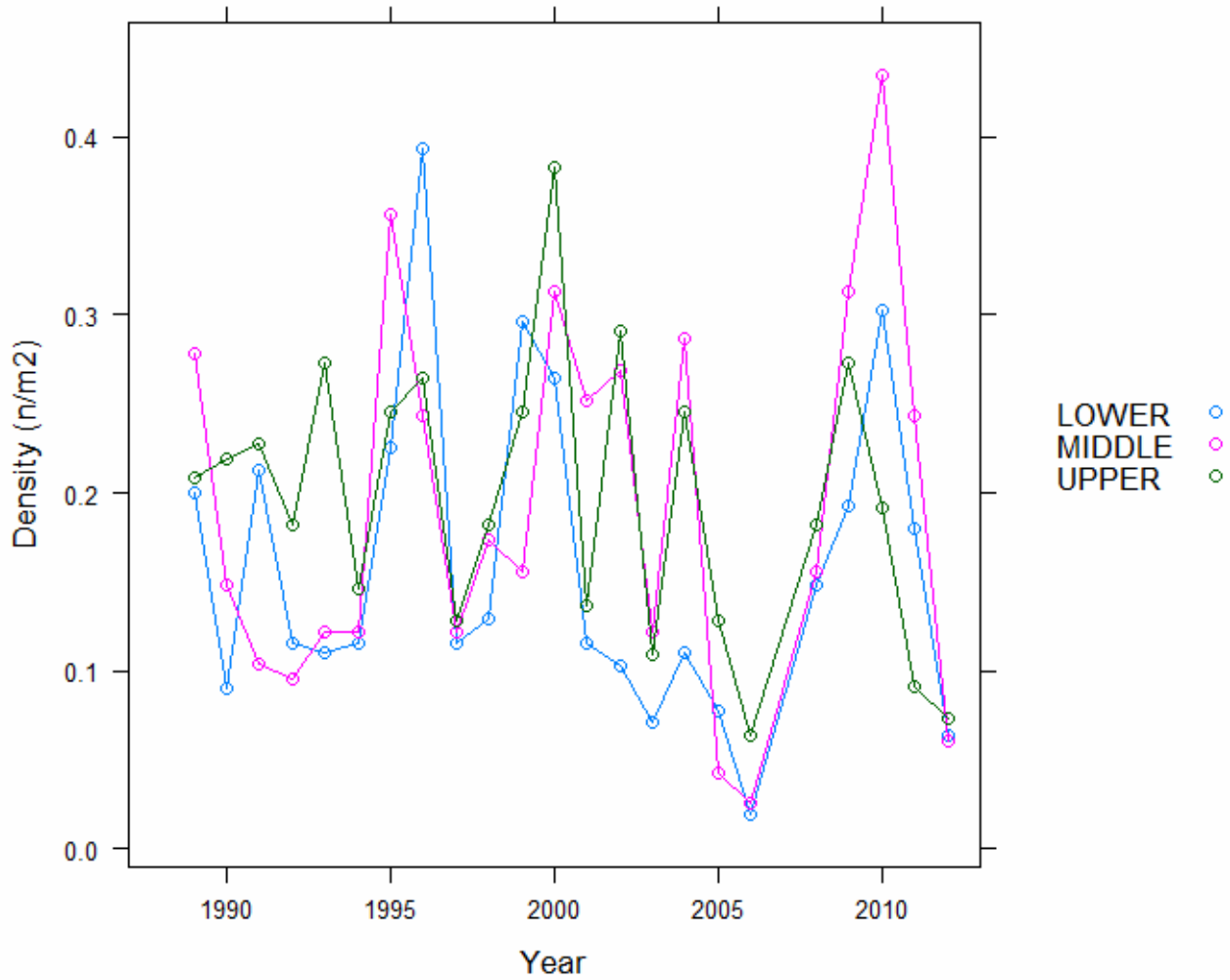


4.11.2.1 Macroinvertebrate summary statistics, Llyn Cwm Mynach



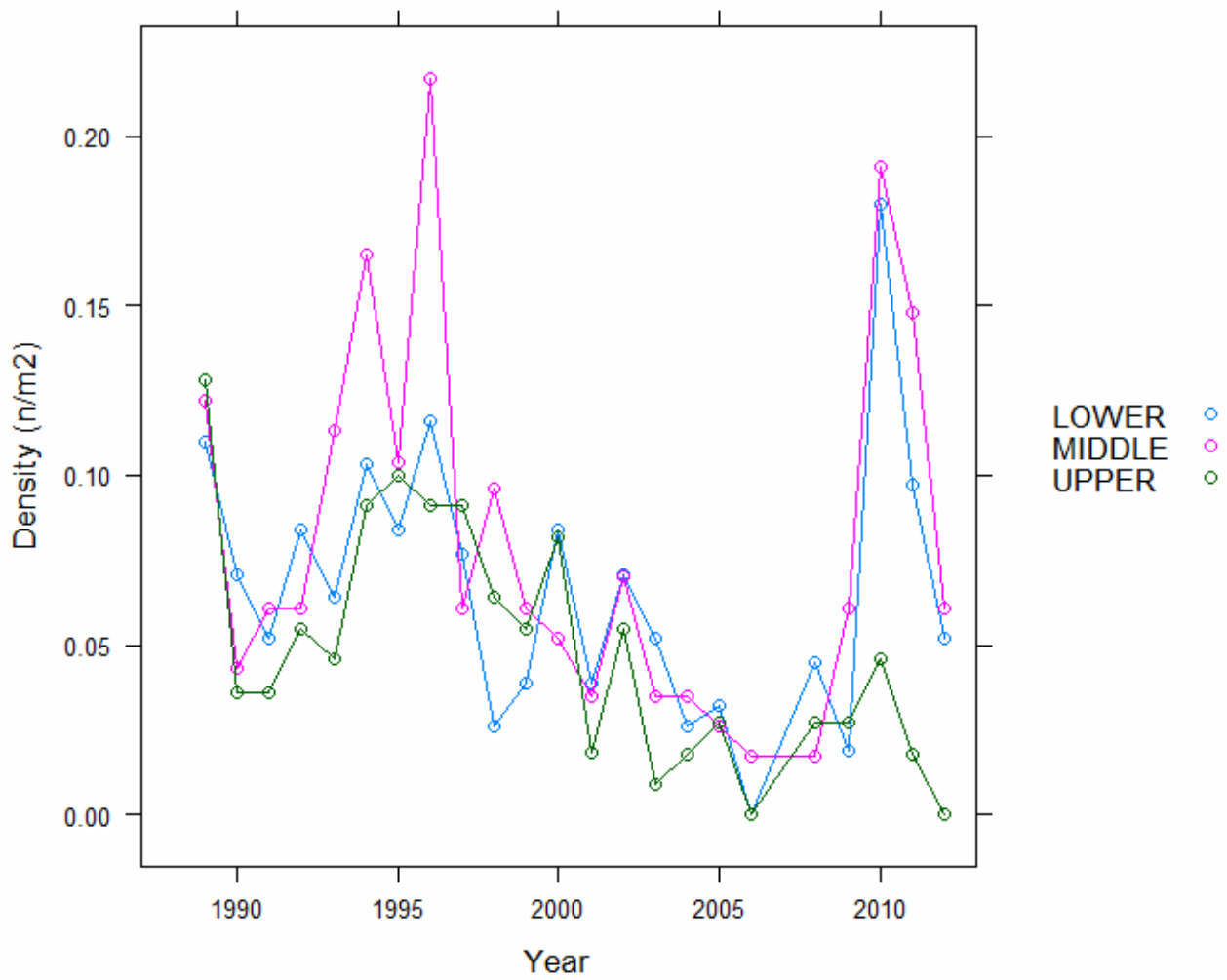
4.11.3 Fish data (for outflow stream)

4.11.3.1 Summary of Trout fry density (numbers m^{-2}), Llyn Cwm Mynach



Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

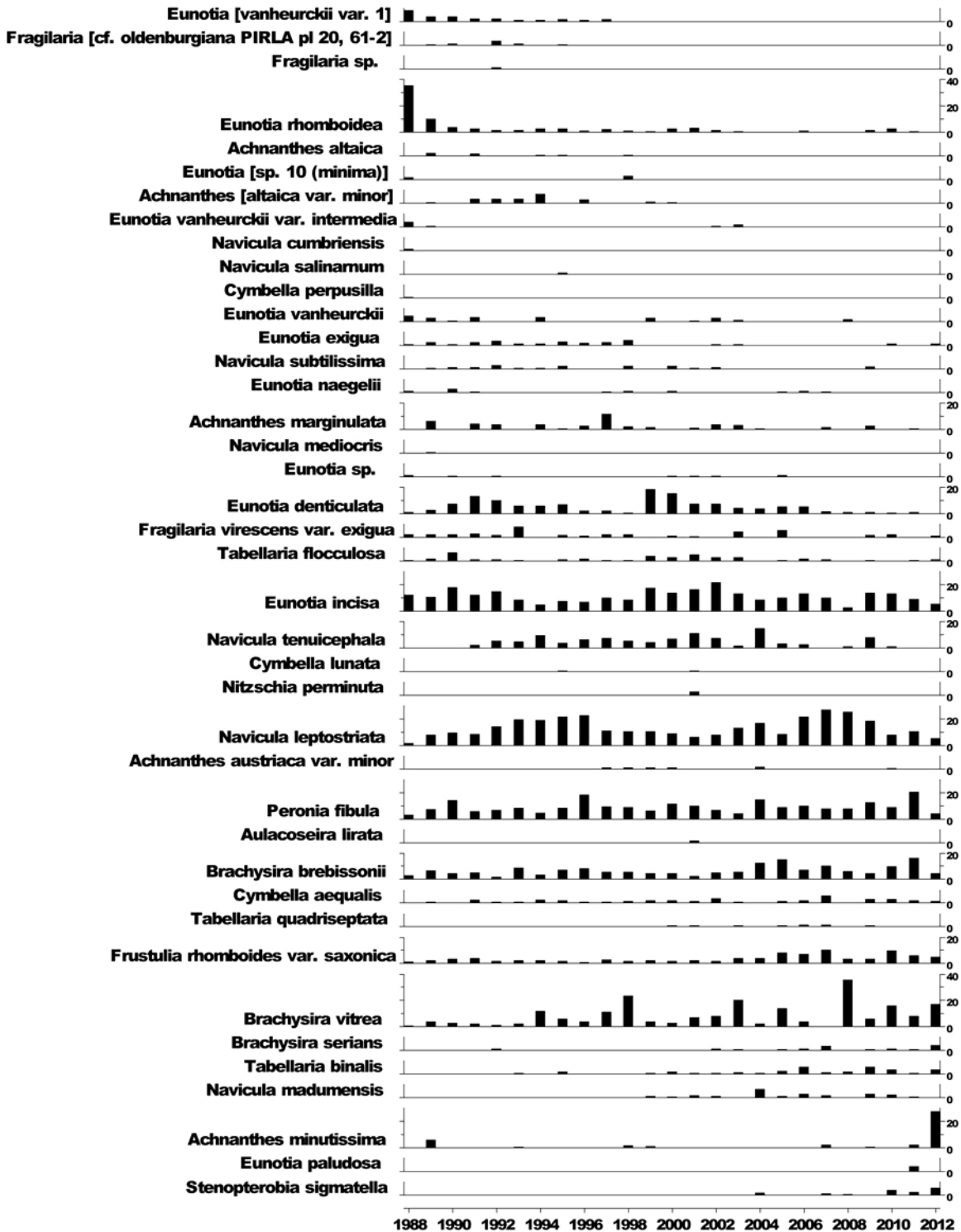
4.11.3.2 Summary of Trout parr density (numbers m⁻²), Llyn Cwm Mynach



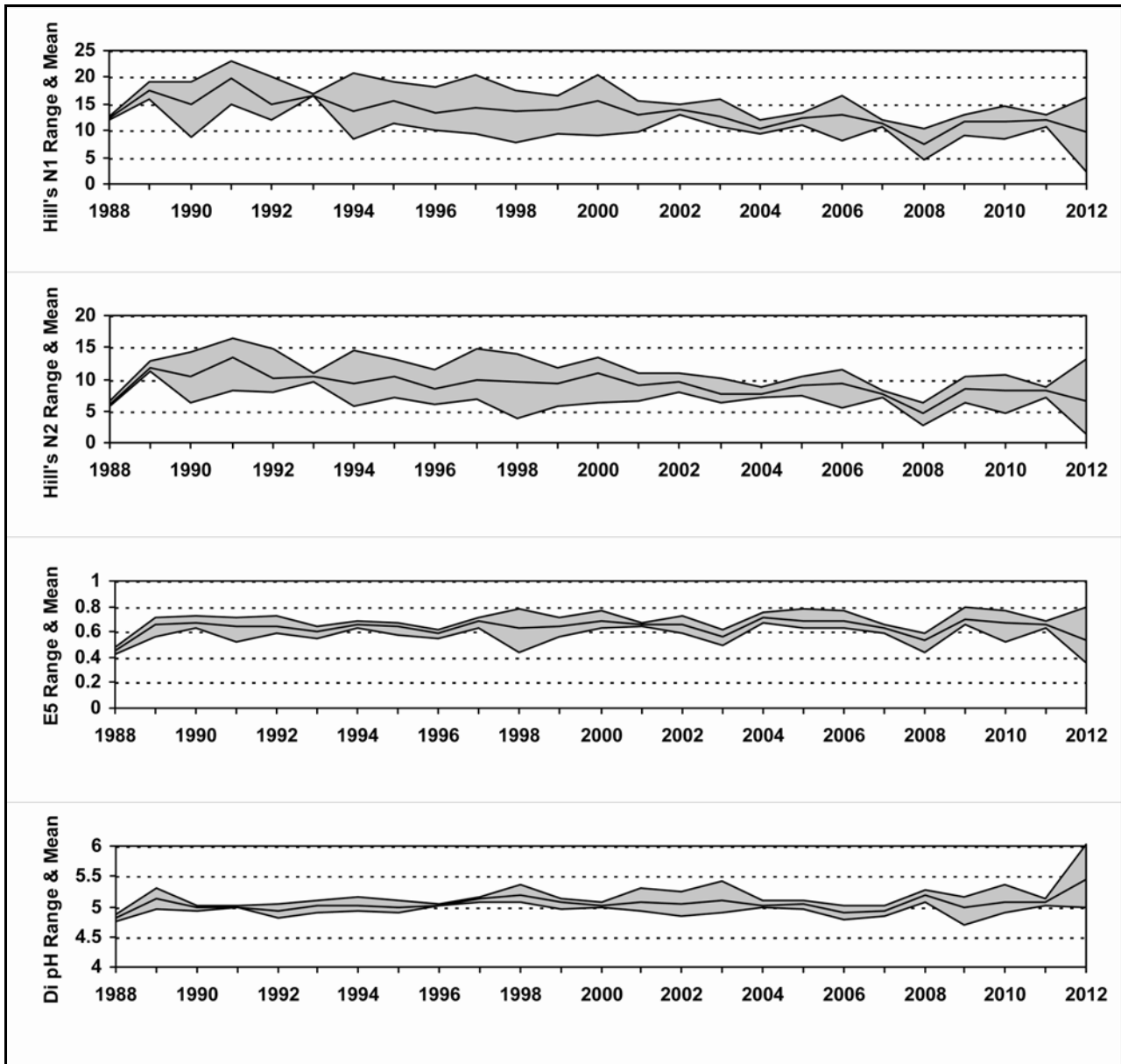
Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

4.11.4 Epilithic diatom data

4.11.4.1 Percentage abundance summary, Llyn Cwm Mynach

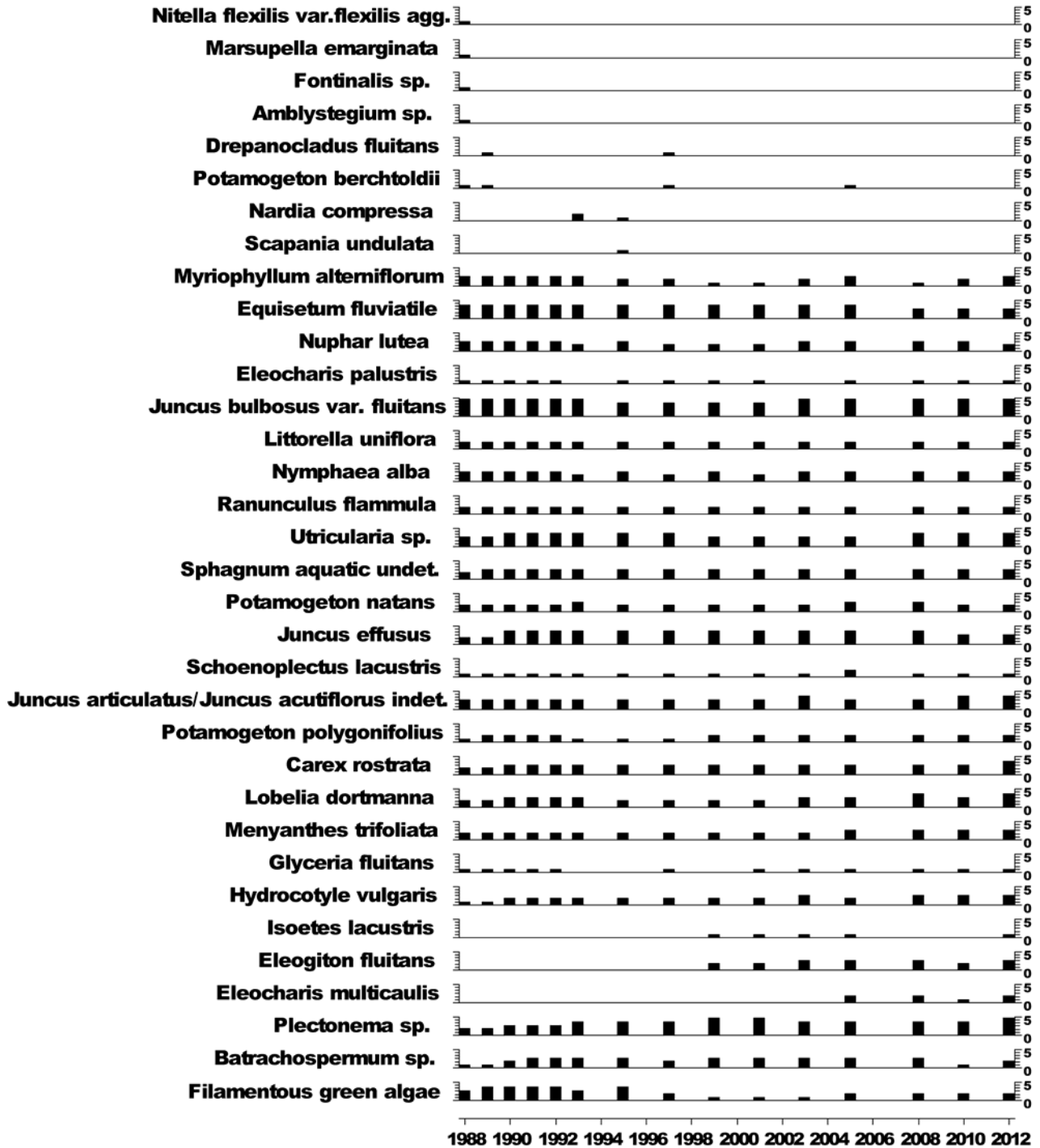


4.11.4.2 Diatom summary statistics, Llyn Cwm Mynach



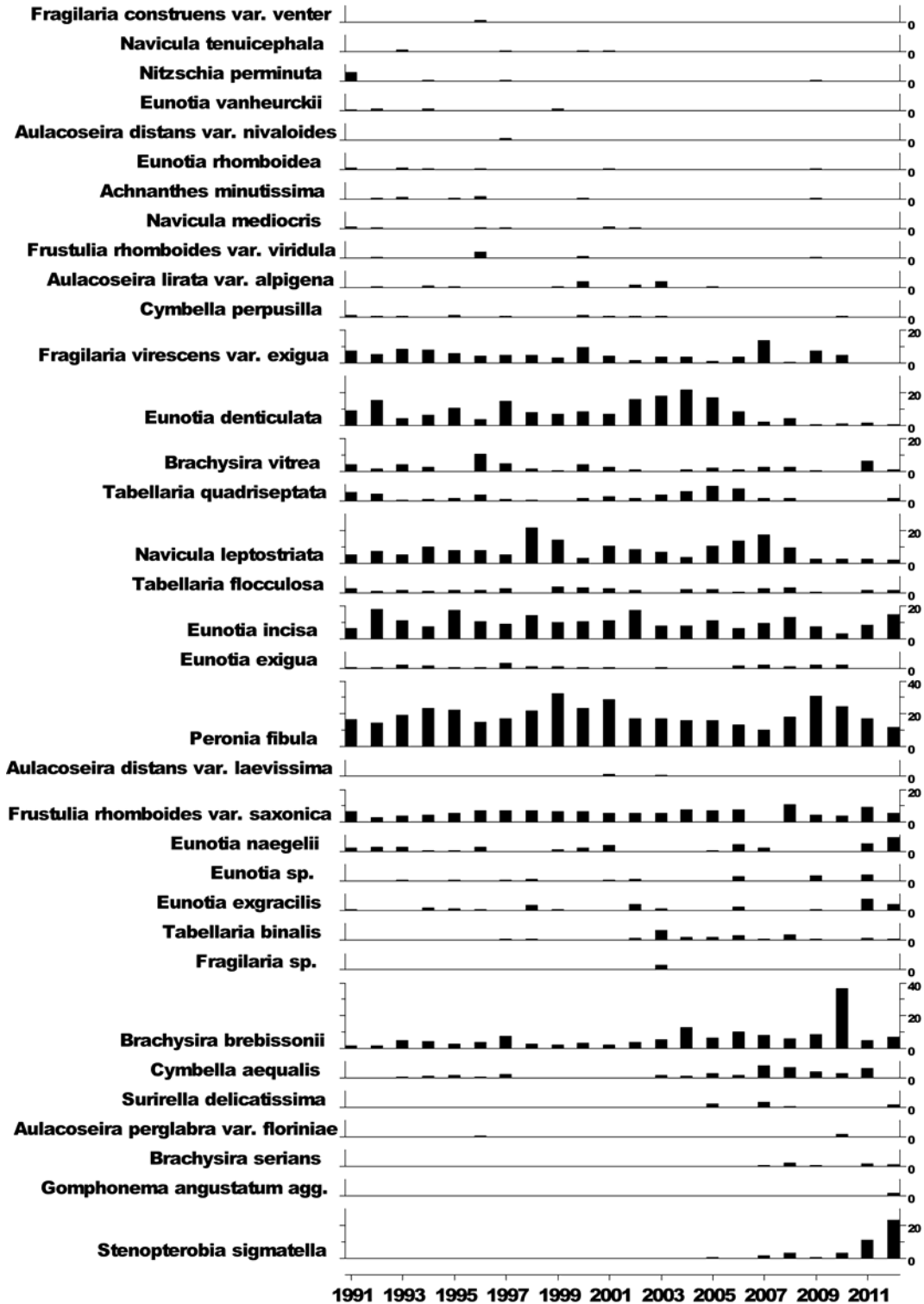
4.11.5 Aquatic macrophyte data, Llyn Cwm Mynach

Species Scores (1-5)

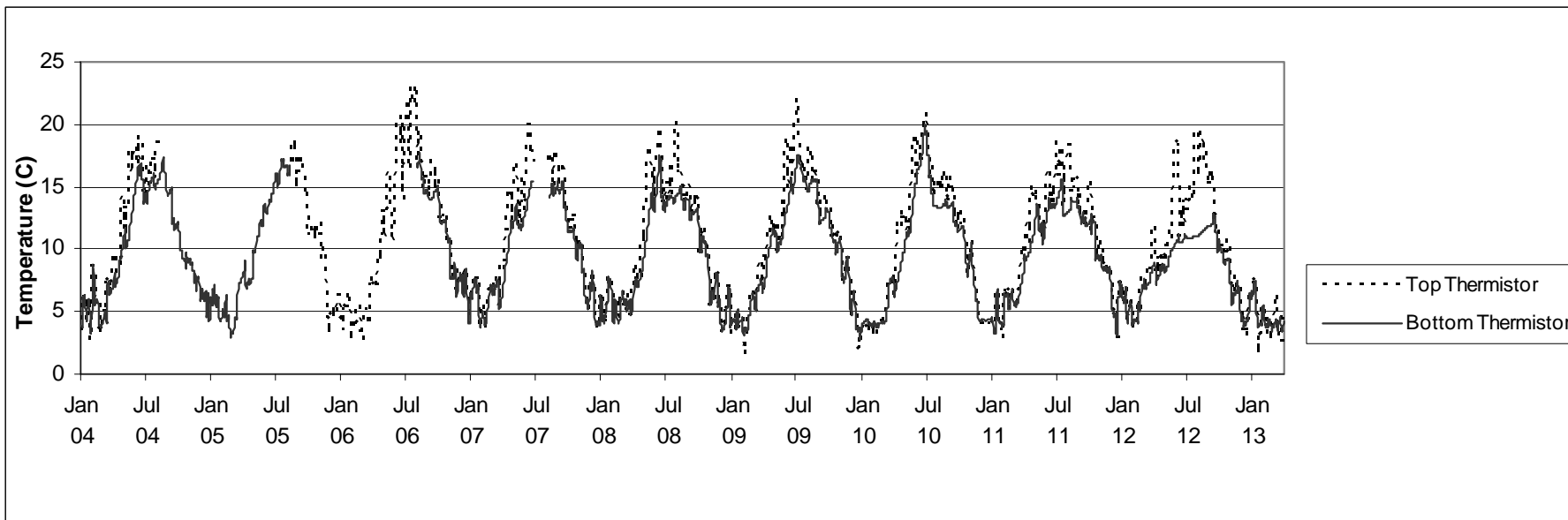


4.11.6 Sediment trap data, Llyn Cwm Mynach

Relative percentage frequency of diatom taxa



4.11.7 Thermistor data, Llyn Cwm Mynach



5 Afon Hafren



Figure 3 Afon Hafren biological survey section 10th July 2013

5.1 Summary Overview

Chemical and biological sample collection, analysis and data collation, quality control and archiving proceeded without any problems at Afon Hafren during the period from April 2013 to March 2014.

5.2 Water Chemistry

Samples were collected by CEH early every month throughout the period April 2013 to March 2014, delivered to the analytical laboratories on schedule and are in the process of being analysed, quality controlled and archived in the UKUWMN central chemistry database at CEH Lancaster.

5.3 Thermistors

The CEH thermistor at Afon Hafren functioned well throughout the period April 2013 to March 2014. Data up to January 2014 have been downloaded, checked and archived in the central ENSIS and MS temperature database.

5.4 Epilithic Diatoms

Epilithic diatoms were retrieved by a team from ENSIS from three sampling points in the stream on the 10th of July 2013. The samples have been made into slides and are currently in the process of being analysed.

5.5 Macroinvertebrates

Aquatic macroinvertebrates were sampled on the 17th April 2013 by a team from QMuL. Five 1 minute kick samples were performed. The samples were counted and the data sent to ENSIS Ltd. The data is in the process of being quality screened before being added to the UKUWMN biological database at ENSIS.

5.6 Fish

Fish surveying was performed on the 3rd October 2013 by a team from the Game and Wildlife Conservation Trust. The data have been forwarded to ENSIS Ltd. After quality screening the data will be added to the UKUWMN biological database at ENSIS.

5.7 Aquatic Macrophytes

Aquatic macrophytes were surveyed by a team from ENSIS on 10th of July 2013. Percentage cover scores were recorded and data will be added to the ENSIS biological database after microscope confirmation of bryophyte identifications.

5.8 Data Management and Reporting

No problems or hiatus occurred with the collation and transfer of data within methodological programmes, or to the UKUWMN databases, during the reporting period.

Work on the 2012-2013 annual report is nearly finished and it should be uploaded to the UKUWMN web page in April 2014. The section on Afon Hafren appears in section 5.10 below.

The UKUWMN website page detailing Afon Hafren can be found here:
http://awmn.defra.gov.uk/sites/site_17.php

Further publications from the contract period utilizing UKUWMN data from Afon Hafren are detailed in section 5.9 below.

5.9 Afon Hafren Recent UKUWMN Output

Battarbee, R. W., Shilland, E. M., Kernan, M., Monteith, D. T. & Curtis, C. J. (2014) Recovery of acidified surface waters from acidification in the United Kingdom after twenty years of chemical and biological monitoring (1988–2008). *Ecological Indicators*, **37, Part B**, 267-273.

Curtis, C. J., Battarbee, R. W., Monteith, D. T. & Shilland, E. M. (2014) The future of upland water ecosystems of the UK in the 21st century: A synthesis. *Ecological Indicators*, **37, Part B**, 412-430.

Curtis, C. J. & Simpson, G. L. (2014) Trends in bulk deposition of acidity in the UK, 1988–2007, assessed using additive models. *Ecological Indicators*, **37, Part B**, 274-286.

Helliwell, R. C., Aherne, J., MacDougall, G., Nisbet, T. R., Lawson, D., Cosby, B. J. & Evans, C. D. (2014) Past acidification and recovery of surface waters, soils and ecology in the United Kingdom: Prospects for the future under current deposition and land use protocols. *Ecological Indicators*, **37, Part B**, 381-395.

Malcolm, I. A., Bacon, P. J., Middlemas, S. J., Fryer, R. J., Shilland, E. M. & Collen, P. (2014) Relationships between hydrochemistry and the presence of juvenile brown trout (*Salmo trutta*) in headwater streams recovering from acidification. *Ecological Indicators*, **37, Part B**, 351-364.

Monteith, D. T., Evans, C. D., Henrys, P. A., Simpson, G. L. & Malcolm, I. A. (2014) Trends in the hydrochemistry of acid-sensitive surface waters in the UK 1988–2008. *Ecological Indicators*, **37, Part B**, 287-303.

Murphy, J. F., Winterbottom, J. H., Orton, S., Simpson, G. L., Shilland, E. M. & Hildrew, A. G. (2014) Evidence of recovery from acidification in the macroinvertebrate assemblages of UK fresh waters: A 20-year time series. *Ecological Indicators*, **37, Part B**, 330-340.

Stockdale, A., Tipping, E., Fjellheim, A., Garmo, +. A., Hildrew, A. G., Lofts, S., Monteith, D. T., Ormerod, S. J. & Shilland, E. M. (2014) Recovery of macroinvertebrate species richness in acidified upland waters assessed with a field toxicity model. *Ecological Indicators*, **37, Part B**, 341-350.

Holmberg, M., Vuorenmaa, J., Posch, M., Forsios, M., Lundin, L., Kleemola, S., Augustaitis, A., Beudert, B., de Wit, H. A., Dirnbock, T., Evans, C. D., Frey, J., Grandin, U., Indriksone, I., Kram, P., Pompei, E., Schulte-Bisping, H., Srybny, A. & Vana, M. (2013) Relationship between critical load exceedances and empirical impact indicators at Integrated Monitoring sites across Europe. *Ecological Indicators*, **24**, 256-265.

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Shilland, E. M. (2013) 25 Years of the Acid Waters Monitoring Network in Wales. Marine and Freshwater Evidence Workshop, Countryside Council for Wales HQ, Bangor. February 20th 2013.

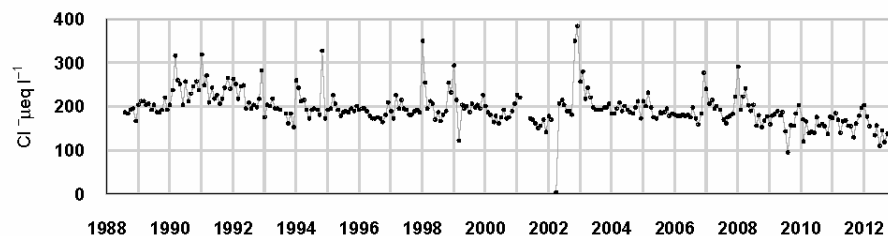
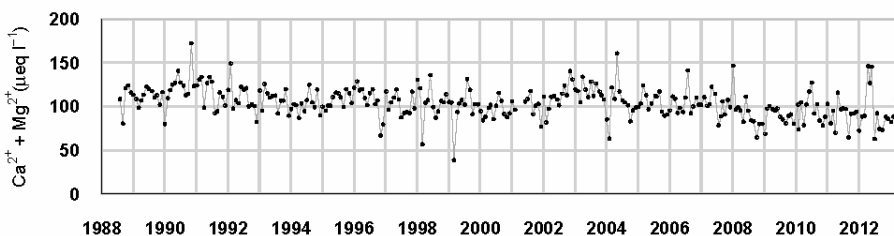
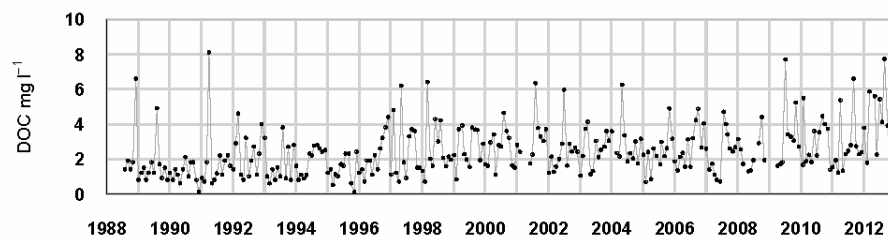
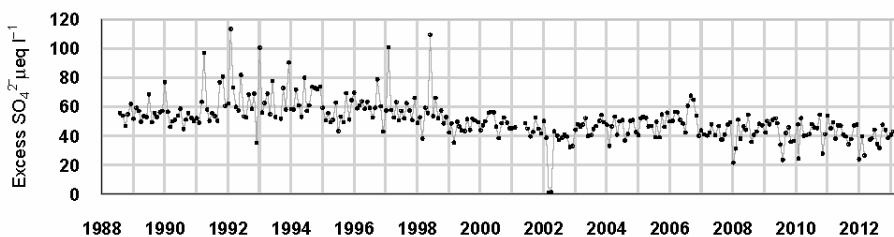
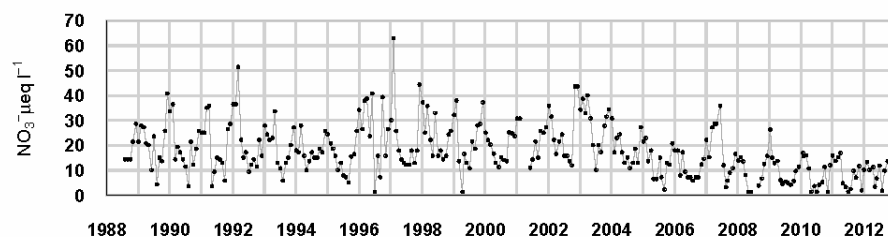
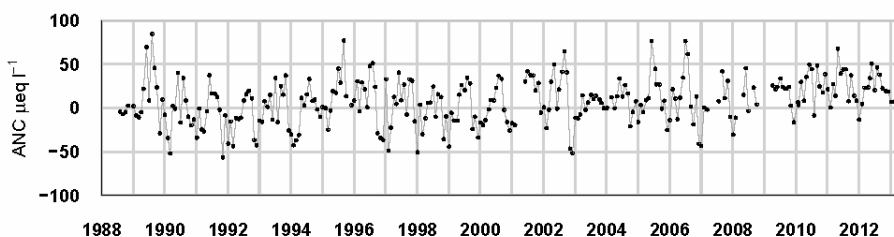
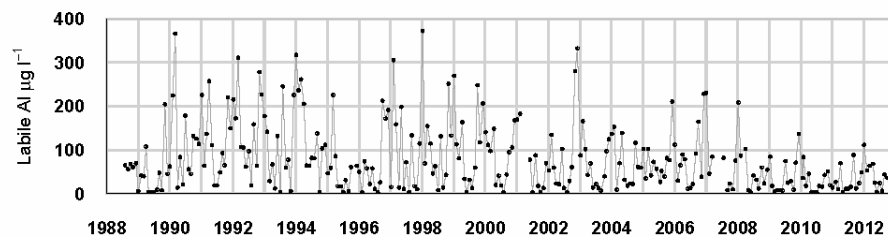
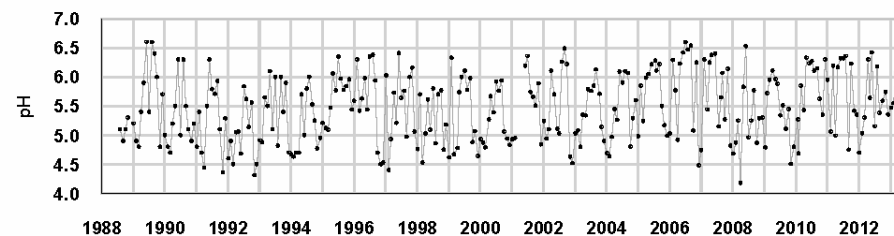
Shilland, E. M. (2013) UK Acid Waters Monitoring Network (UKAWMN) - Contract 22 01 249 Llyn Cwm Mynach, Afon Hafren and Afon Gwy Annual Summary Progress Report April 2012 - March 2013. Report to the Welsh Government, Countryside Council for Wales and Environment Agency, Wales. 1-82. ENSIS Ltd, Environmental Change Research Centre, University College London, London.

Velle, G., Telford, R. J., Curtis, C. J., Eriksson, L., Fjellheim, A., Frolova, M., Fölster, J., Grudule, N., Halvorsen, G. A., Hildrew, A., Hoffmann, A., Indriksone, I., Kamasová, L., Kopáček, J., Orton, S., Krám, P., Monteith, D. T., Senoo, T., Shilland, E. M., Stuchlík, E., Wiklund, M. L., de Wit, H. & Skjelkvåle, B. L. (2013) Biodiversity in freshwaters: temporal trends and response to water chemistry. ICP Waters Report 114/2013, 1-66. NIVA, Norway.

Winterbottom, J. H. & Orton, S. E. (2013) United Kingdom Acid Waters Monitoring Network Invertebrate Survey. Twenty Sixth Year: 2013. Summary of species identification and abundance. 1-13. School of Biological Sciences, Queen Mary University of London, London.

5.10 Afon Hafren Summary Data to March 2013

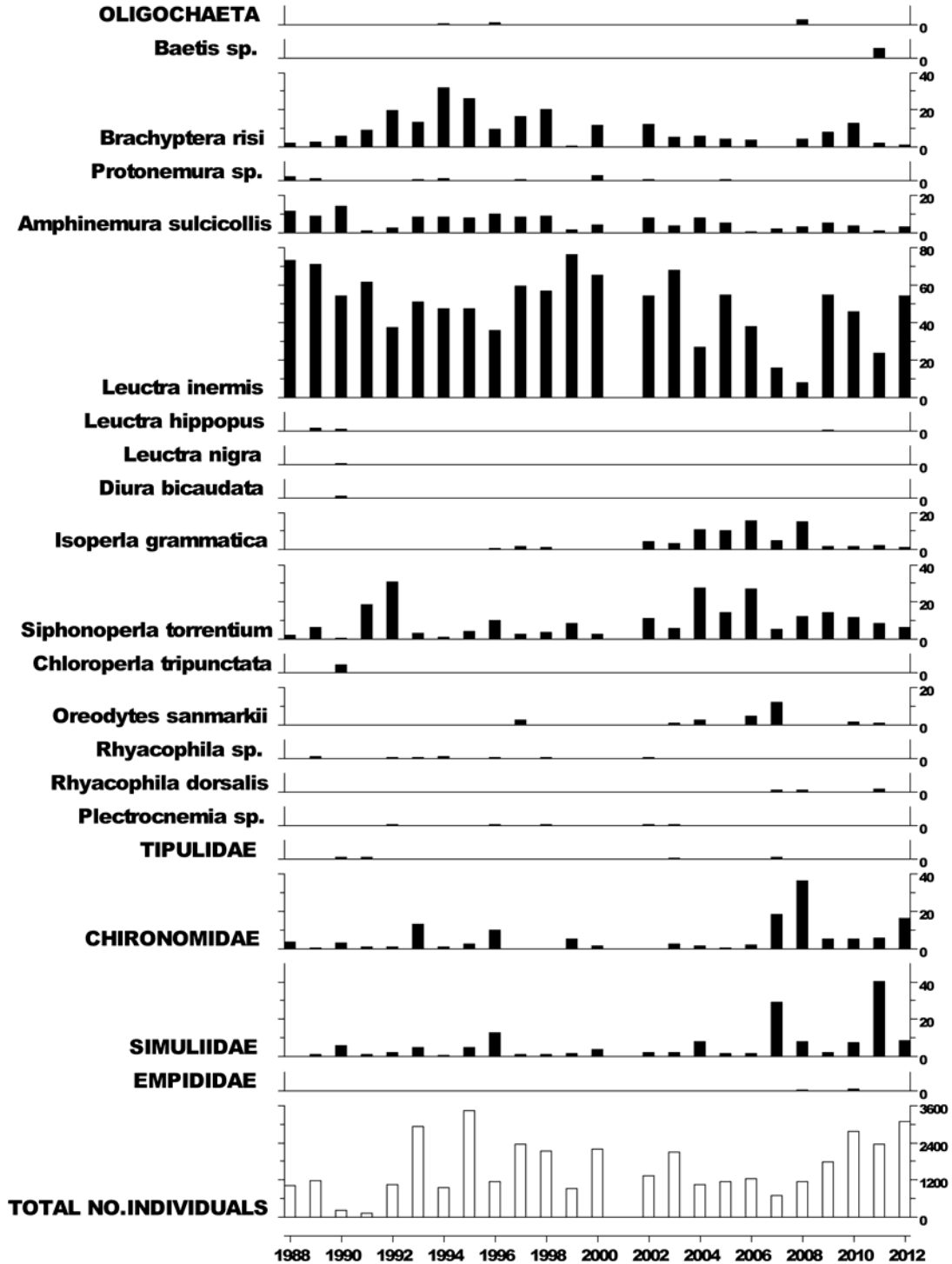
5.10.1 Spot sampled chemistry data



$\mu\text{eq l}^{-1}$, * $\mu\text{g l}^{-1}$, ** mg l^{-1}	pH	ANC	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	*Soluble Al	*Labile Al	Cl ⁻	*SO ₄ ²⁻	xSO ₄ ²⁻	NO ₃ ⁻	**DOC
Mean 1 st 5 yrs	5.29	-2.40	47.91	66.41	200.39	3.16	170.00	101.71	221.09	82.97	59.79	20.58	1.76
12-13 mean	5.74	25.78	45.34	52.18	144.89	3.59	95.92	28.50	142.28	55.08	40.16	10.52	3.62
12-13 std dev	0.41	13.90	25.41	6.72	14.18	1.00	51.74	19.39	17.49	5.38	4.75	4.51	2.11

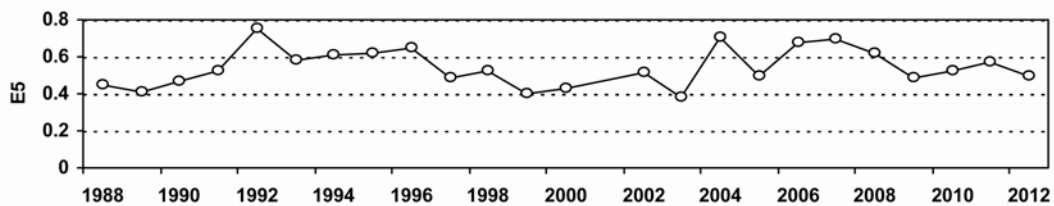
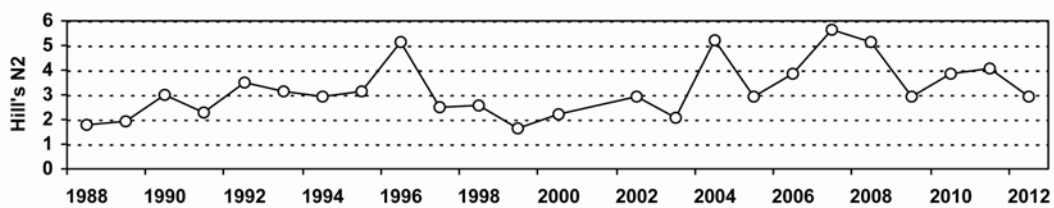
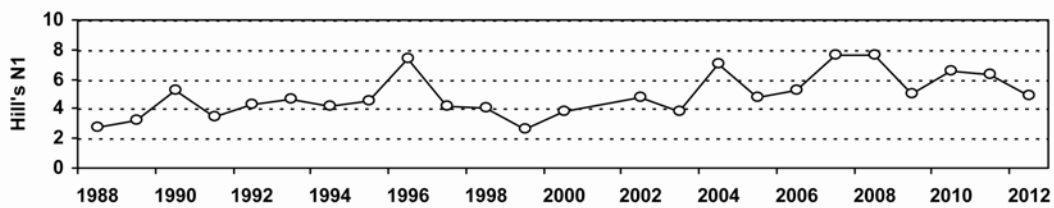
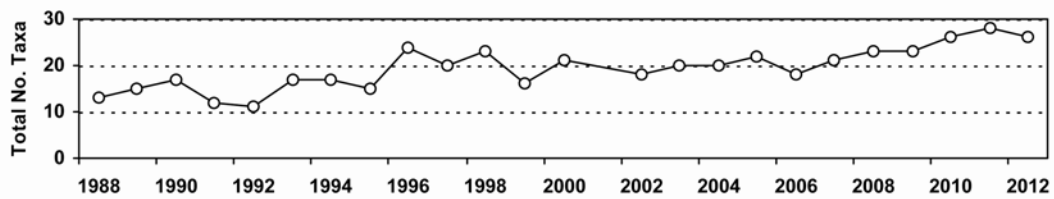
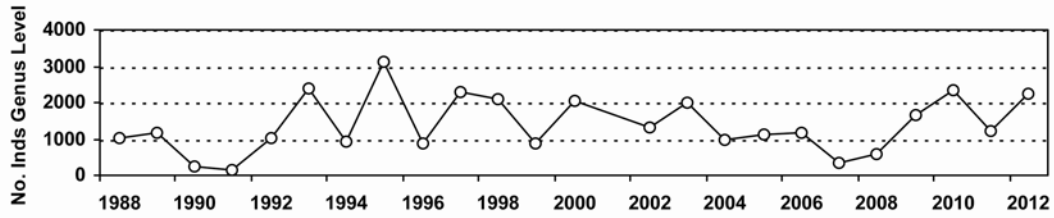
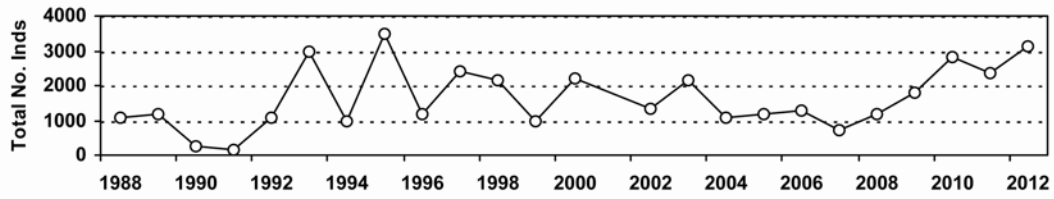
5.10.2 Macroinvertebrate data

5.10.2.1 Percentage abundance summary, Afon Hafren



No sampling in 2001 due to Foot and Mouth restrictions.

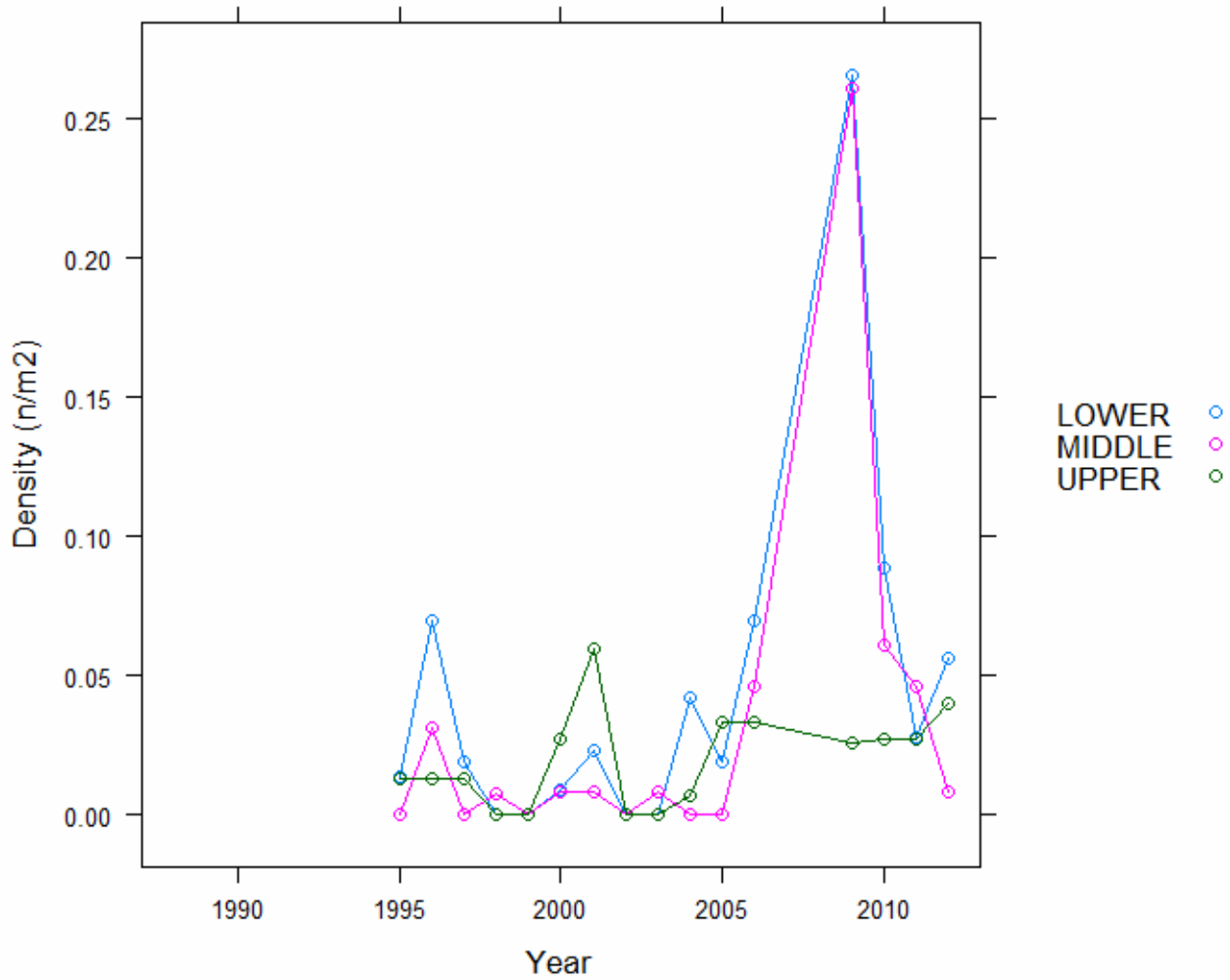
5.10.2.1 Macroinvertebrate summary statistics, Afon Hafren



No sampling in 2001 due to Foot and Mouth restrictions.

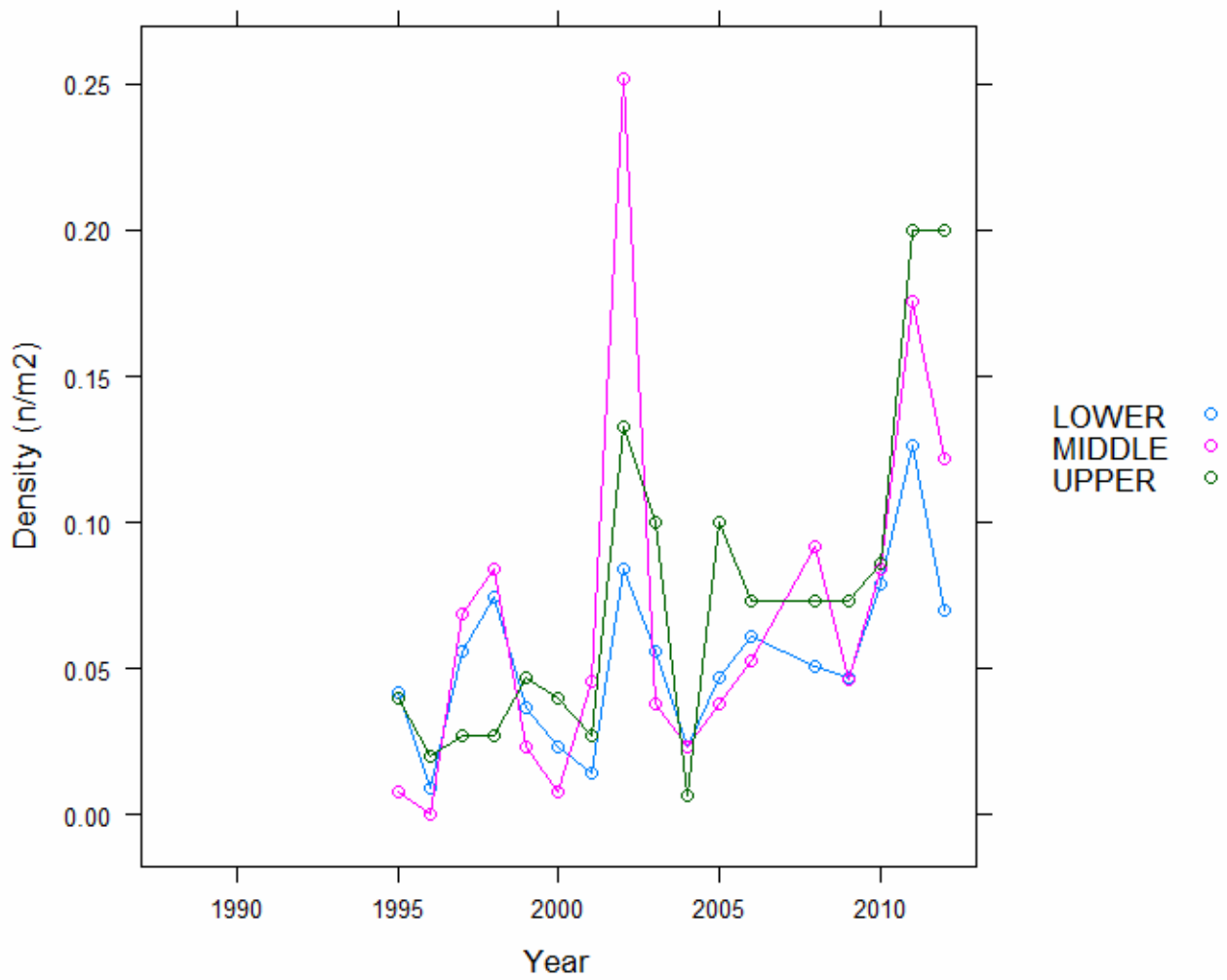
5.10.3 Fish data

5.10.3.1 Summary of Trout fry density (numbers m^{-2}), Afon Hafren



Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

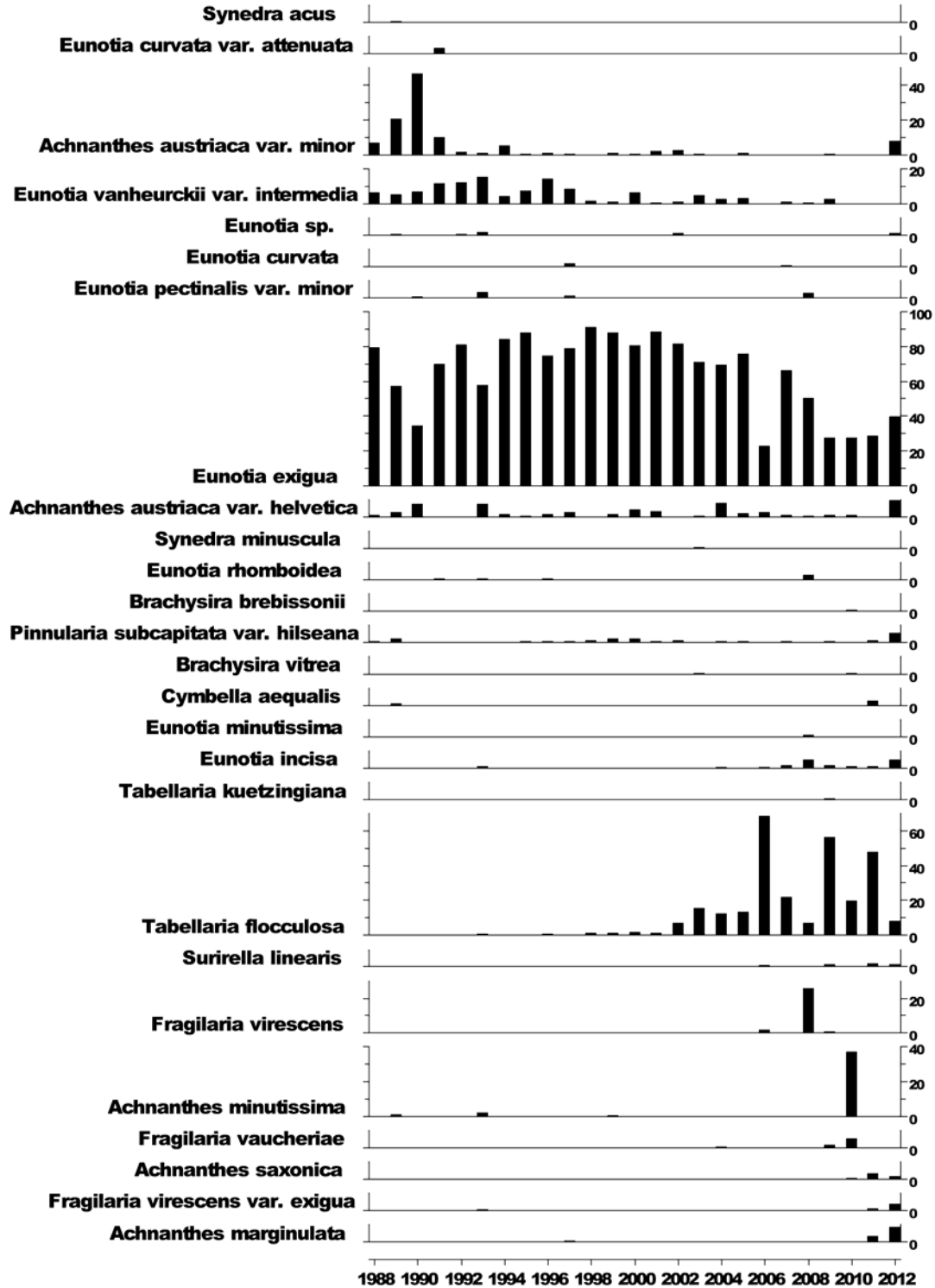
5.10.3.2 Summary of Trout parr density (numbers m⁻²), Afon Hafren



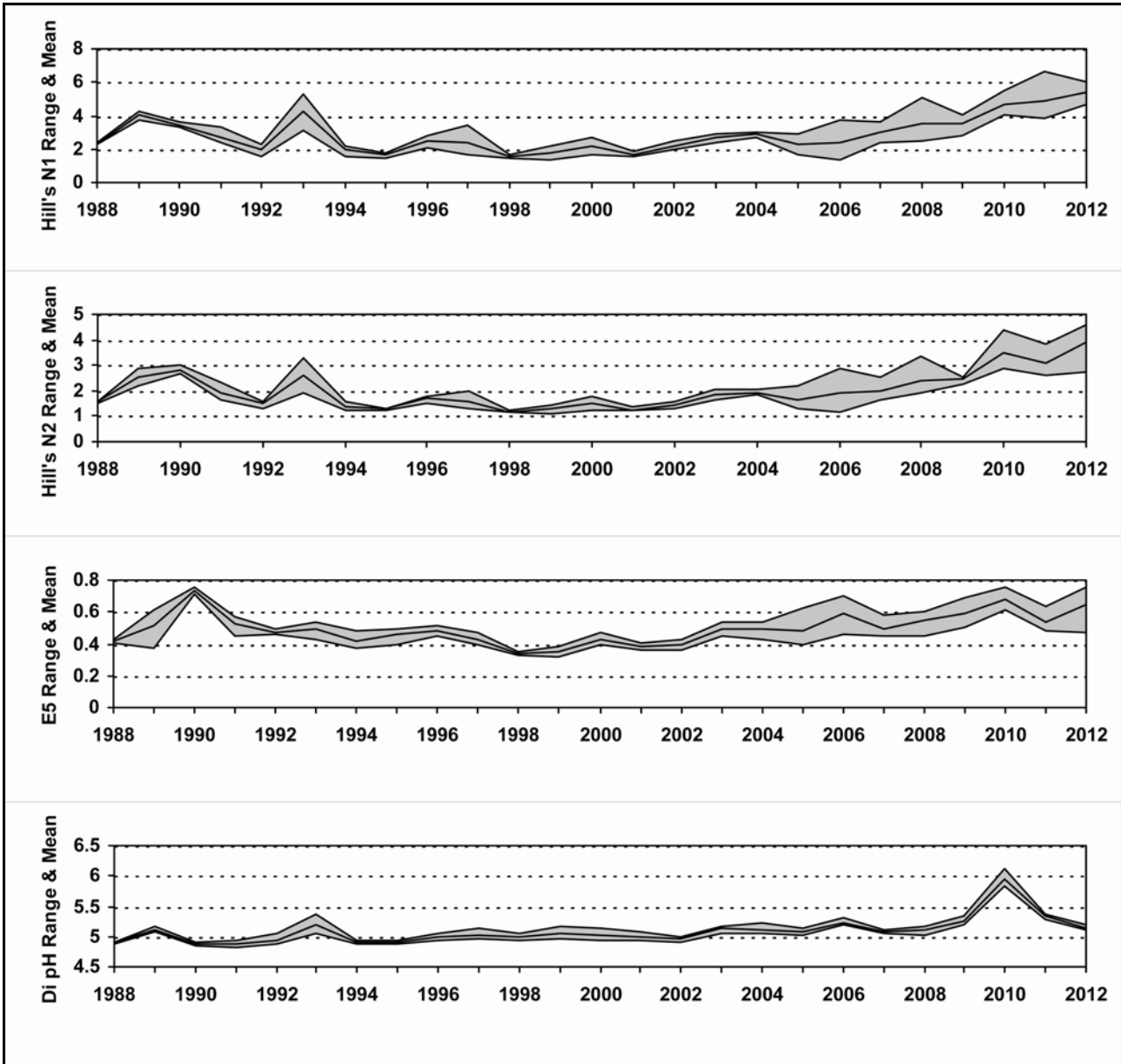
Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

5.10.4 Epilithic diatom data

5.10.4.1 Percentage abundance summary, Afon Hafren

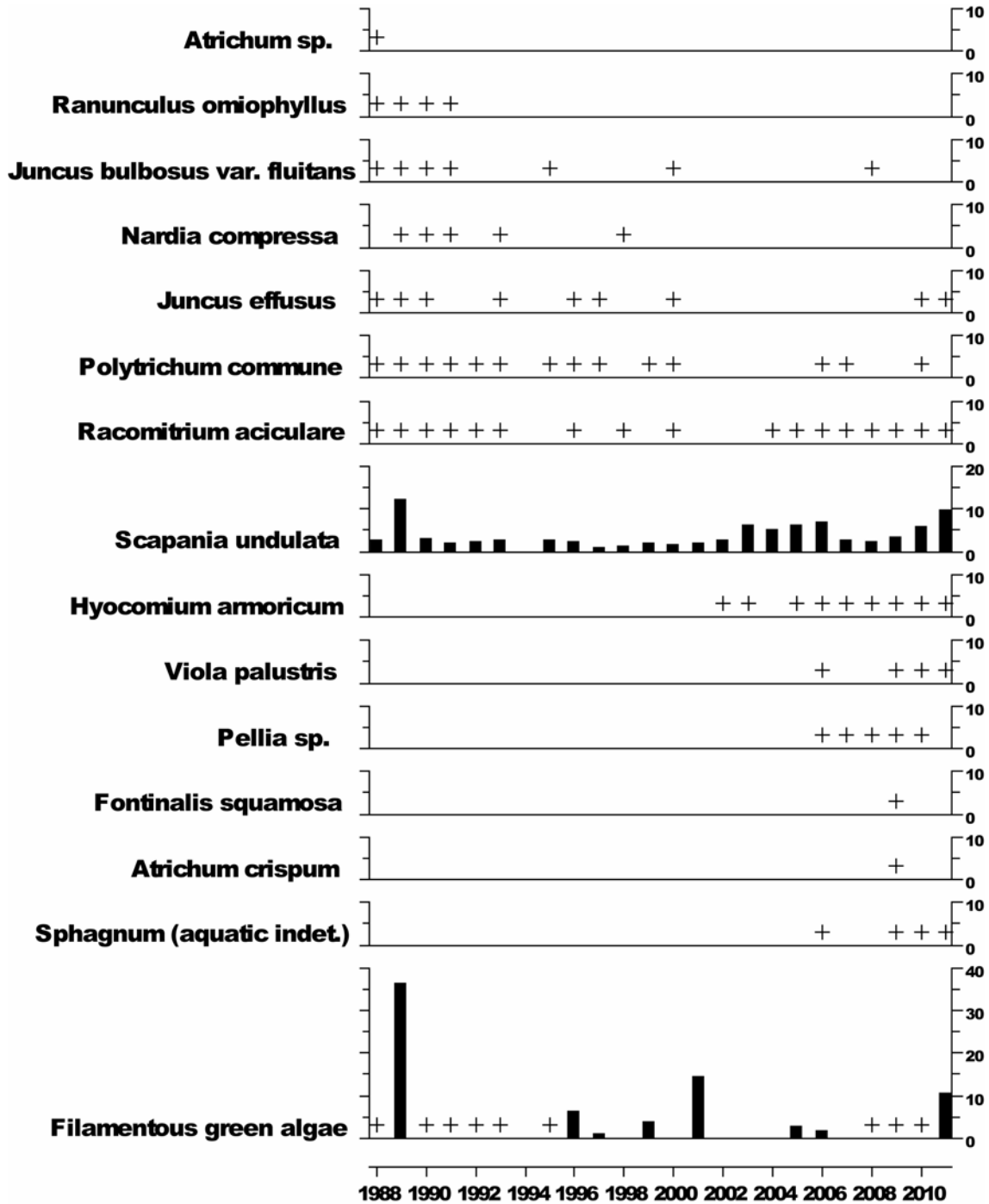


5.10.4.1 Diatom summary statistics, Afon Hafren



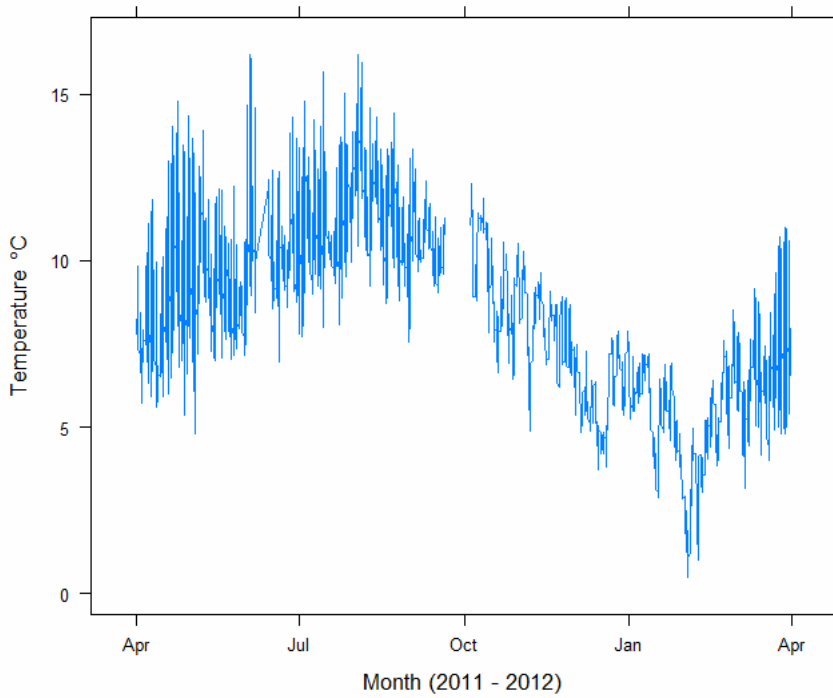
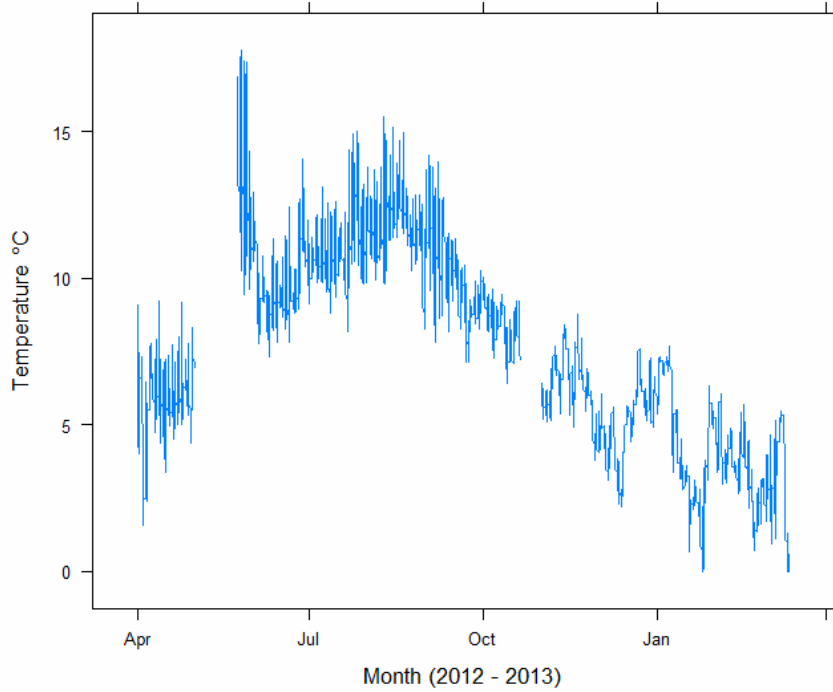
5.10.5 Aquatic macrophyte data, Afon Hafren

Percentage Species Cover



+ Represents <0.5% abundance
2012 data pending

5.10.6 Thermistor data, Afon Hafren



Gaps due to thermistor malfunction

6 Afon Gwy



Figure 4 Afon Gwy biological survey section 10th July 2013

6.1 Summary Overview

Chemical and biological sample collection, analysis and data collation, quality control and archiving proceeded without any problems at Afon Gwy during the period from April 2013 to March 2014. Of note was the positioning of experimental equipment by the DURESS project in the Gwy biological monitoring section. This experimental decomposition apparatus has now been removed.

6.2 Water Chemistry

Samples were collected by CEH early every month throughout the period April 2013 to March 2014, delivered to the analytical laboratories on schedule and are in the process

of being analysed, quality controlled and archived in the UKUWMN central chemistry database at CEH Lancaster.

6.3 Thermistors

A thermistor, supplied by Marine Scotland, was downloaded and replaced on 10th of July 2013 by a team from ENSIS Ltd. It had functioned well during the previous year and the data were added to the ENSIS and MS thermistor water temperature database.

6.4 Epilithic Diatoms

Epilithic diatoms were retrieved by a team from ENSIS from three sampling points in the stream on the 10th of July 2013. The samples have been made into slides and are currently in the process of being analysed.

6.5 Macroinvertebrates

Aquatic macroinvertebrates were sampled on the 17th April 2013 by a team from QMuL. Five 1 minute kick samples were performed. The samples were counted and the data sent to ENSIS Ltd. The data is in the process of being quality screened before being added to the UKUWMN biological database at ENSIS.

6.6 Fish

Fish surveying was performed on the 7th October 2013 by a team from the Game and Wildlife Conservation Trust. The data have been forwarded to ENSIS Ltd. After quality screening the data will be added to the UKUWMN biological database at ENSIS. No Salmon were recorded in 2011.

6.7 Aquatic Macrophytes

Aquatic macrophytes were surveyed by a team from ENSIS on 10th of July 2013. Percentage cover scores were recorded and data will be added to the ENSIS biological database after microscope confirmation of bryophyte identifications.

6.8 Data Management and Reporting

No problems or hiatus occurred with the collation and transfer of data within methodological programmes, or to the UKUWMN databases, during the reporting period.

Work on the 2012-2013 annual report is nearly finished and it should be uploaded to the UKUWMN web page in April 2014. The section on Afon Gwy appears in section 6.11 below.

The UKUWMN website page detailing Afon Gwy can be found here:
http://awmn.defra.gov.uk/sites/site_18.php

Further publications from the contract period utilizing UKUWMN data from Afon Gwy are detailed in section 6.9 below. Section 6.10 provides a bibliography for the site.

6.9 Afon Gwy Recent UKUWMN Output

Battarbee, R. W., Shilland, E. M., Kernan, M., Monteith, D. T. & Curtis, C. J. (2014) Recovery of acidified surface waters from acidification in the United Kingdom after twenty years of chemical and biological monitoring (1988–2008). *Ecological Indicators*, **37, Part B**, 267-273.

Curtis, C. J., Battarbee, R. W., Monteith, D. T. & Shilland, E. M. (2014) The future of upland water ecosystems of the UK in the 21st century: A synthesis. *Ecological Indicators*, **37, Part B**, 412-430.

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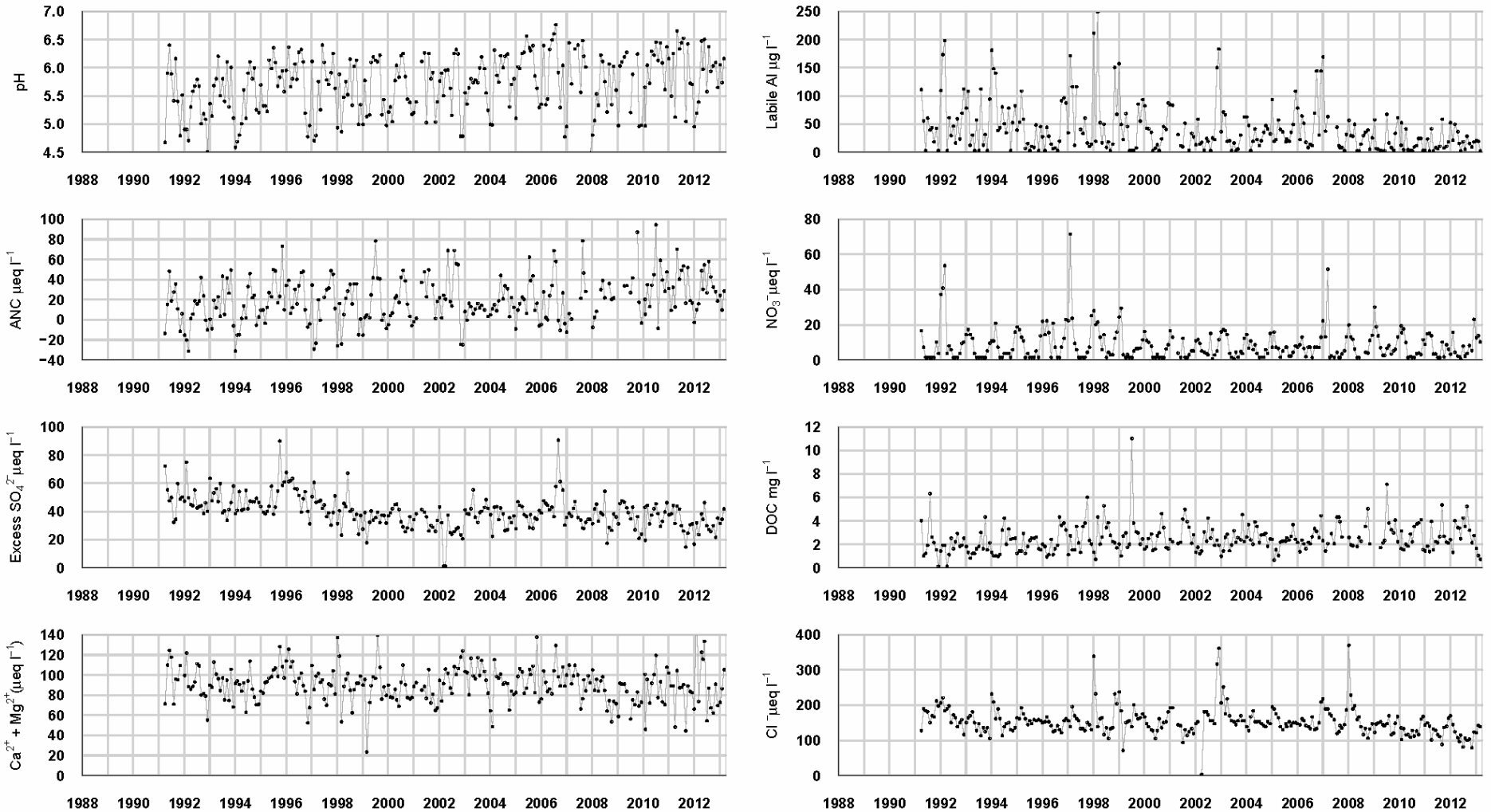
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6.10 Afon Gwy Summary Data to March 2013

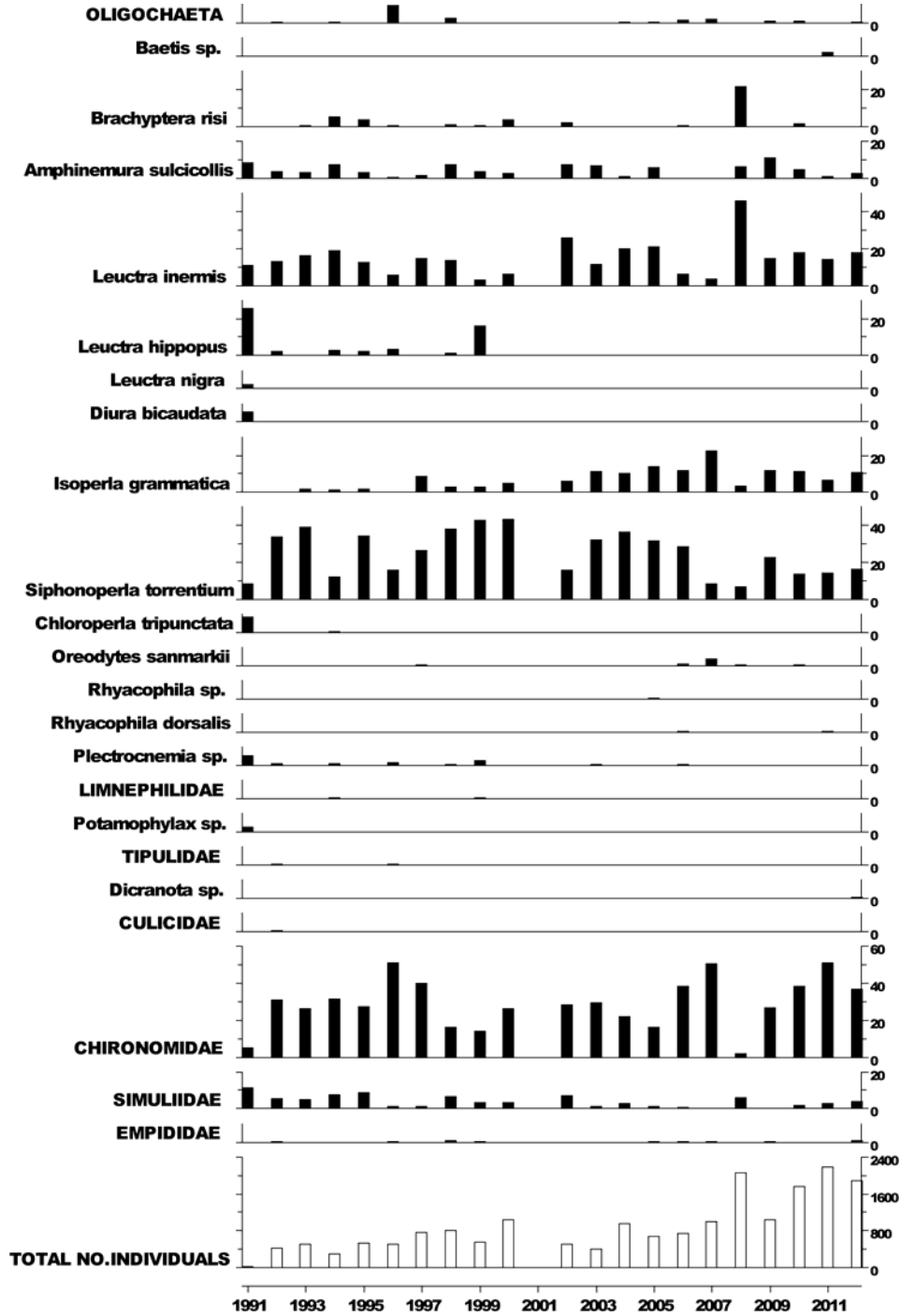
6.10.1 Spot sampled chemistry data



$\mu\text{eq l}^{-1}$, $^*\mu\text{g l}^{-1}$, $^{**}\text{mg l}^{-1}$	pH	ANC	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	*Soluble Al	*Labile Al	Cl ⁻	*SO ₄ ²⁻	xSO ₄ ²⁻	NO ₃ ⁻	**DOC
Mean 1 st 5 yrs	5.51	14.13	40.42	53.22	147.31	3.24	106.64	53.64	159.84	65.67	48.91	8.65	1.98
12-13 mean	6.04	33.34	44.05	44.71	114.26	2.53	50.75	15.33	108.87	44.32	32.89	7.52	2.79
12-13 std dev	0.30	14.60	24.11	7.57	14.34	1.32	25.46	10.55	19.86	8.36	6.96	6.56	1.30

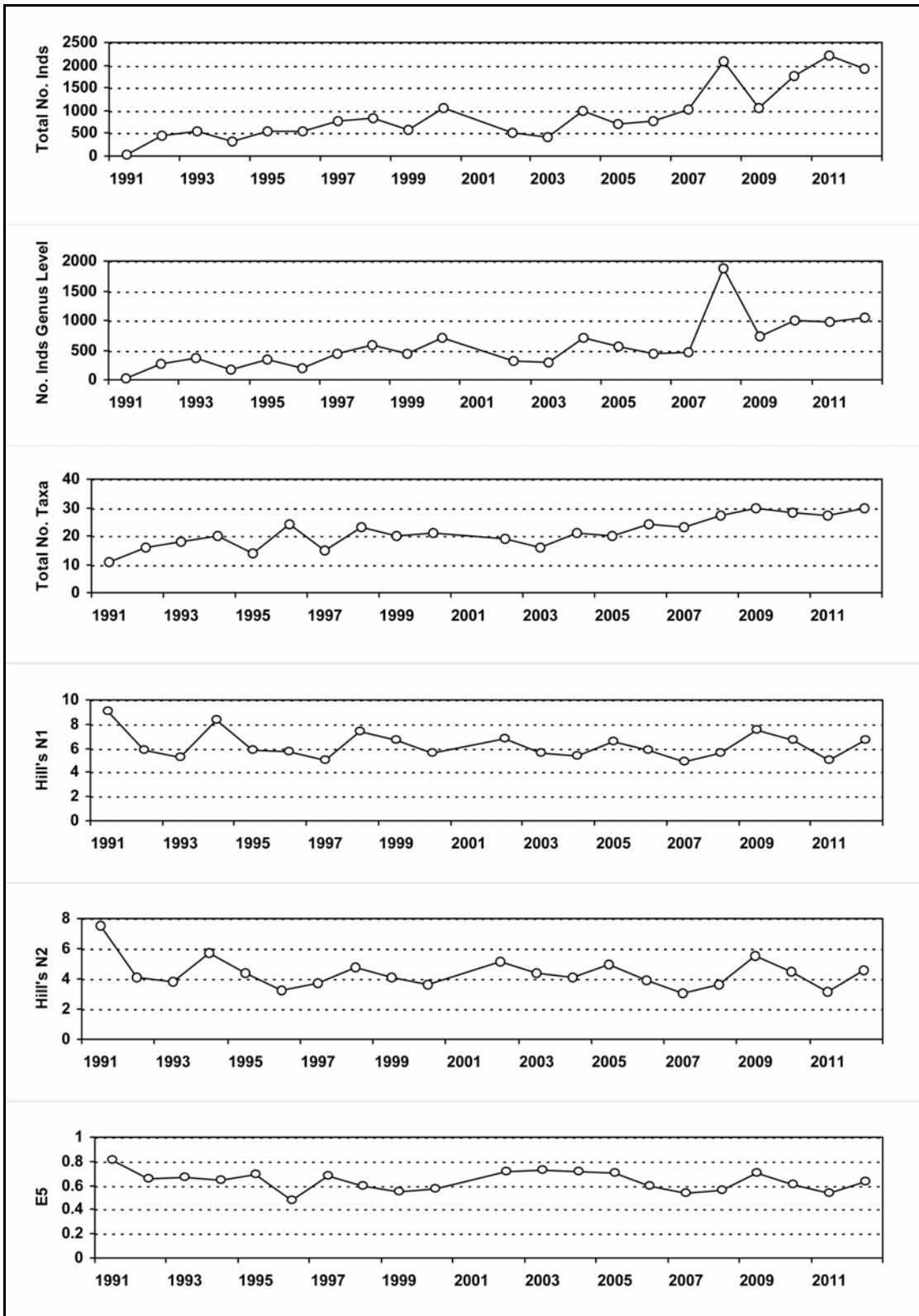
6.10.2 Macroinvertebrate data

6.10.2.1 Percentage abundance summary, Afon Gwy



No sampling in 2001 due to Foot and Mouth restrictions.

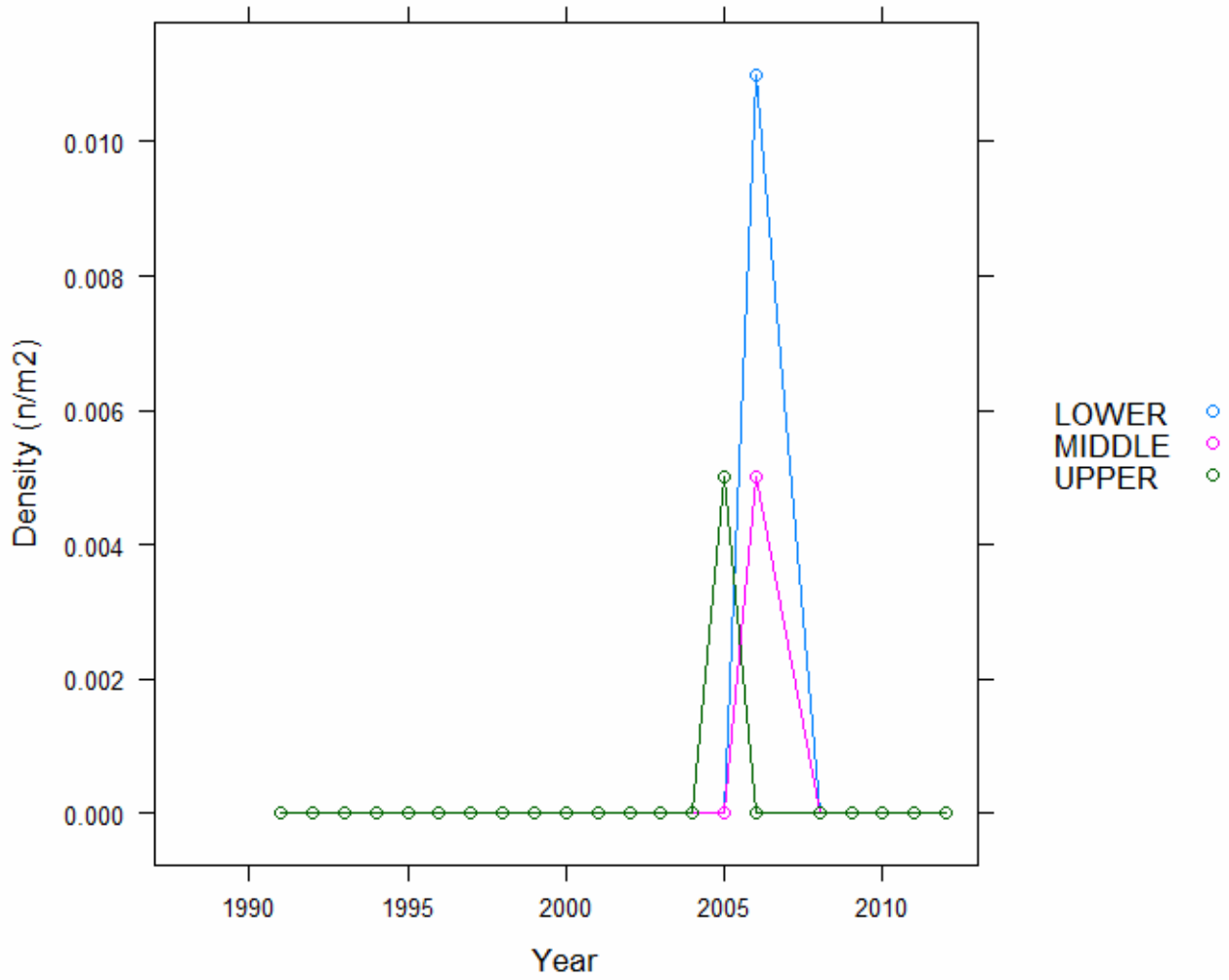
6.10.2.2 Macroinvertebrate summary statistics, Afon Gwy



No sampling in 2001 due to Foot and Mouth restrictions.

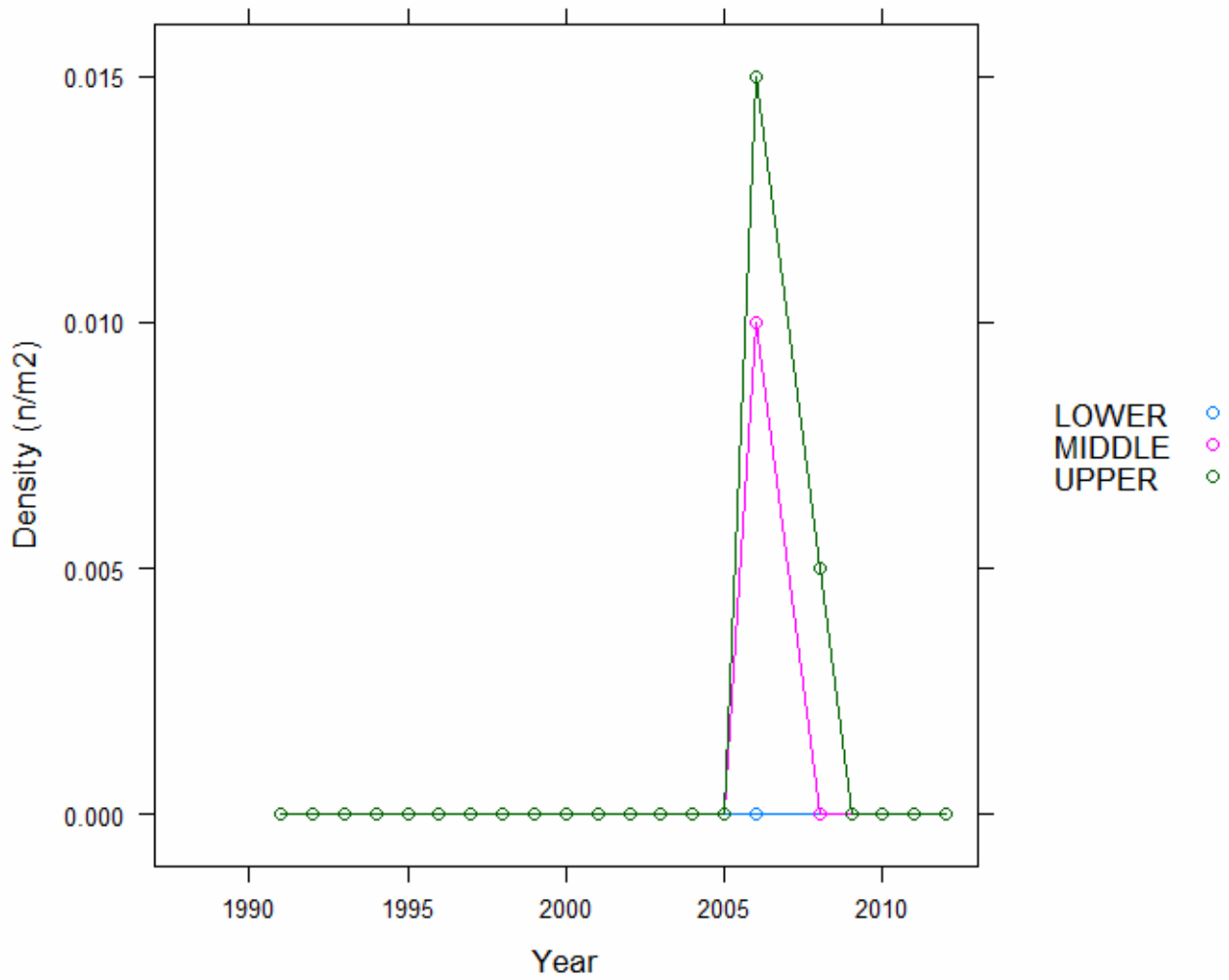
6.10.3 Fish data

6.10.3.1 Summary of Salmon fry densities (numbers m^{-2}), Afon Gwy



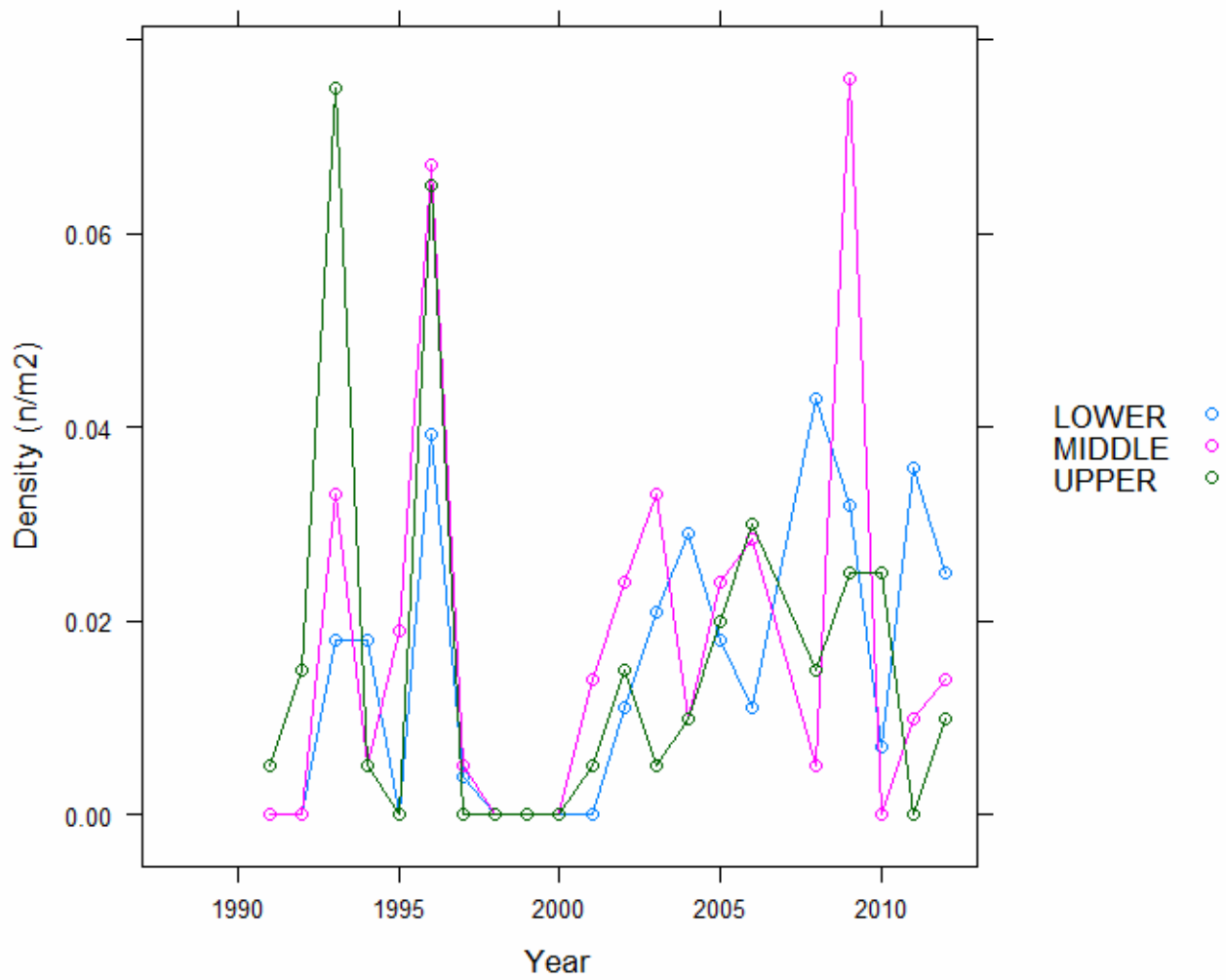
Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

6.10.3.2 Summary of Salmon parr densities (numbers m⁻²), Afon Gwy



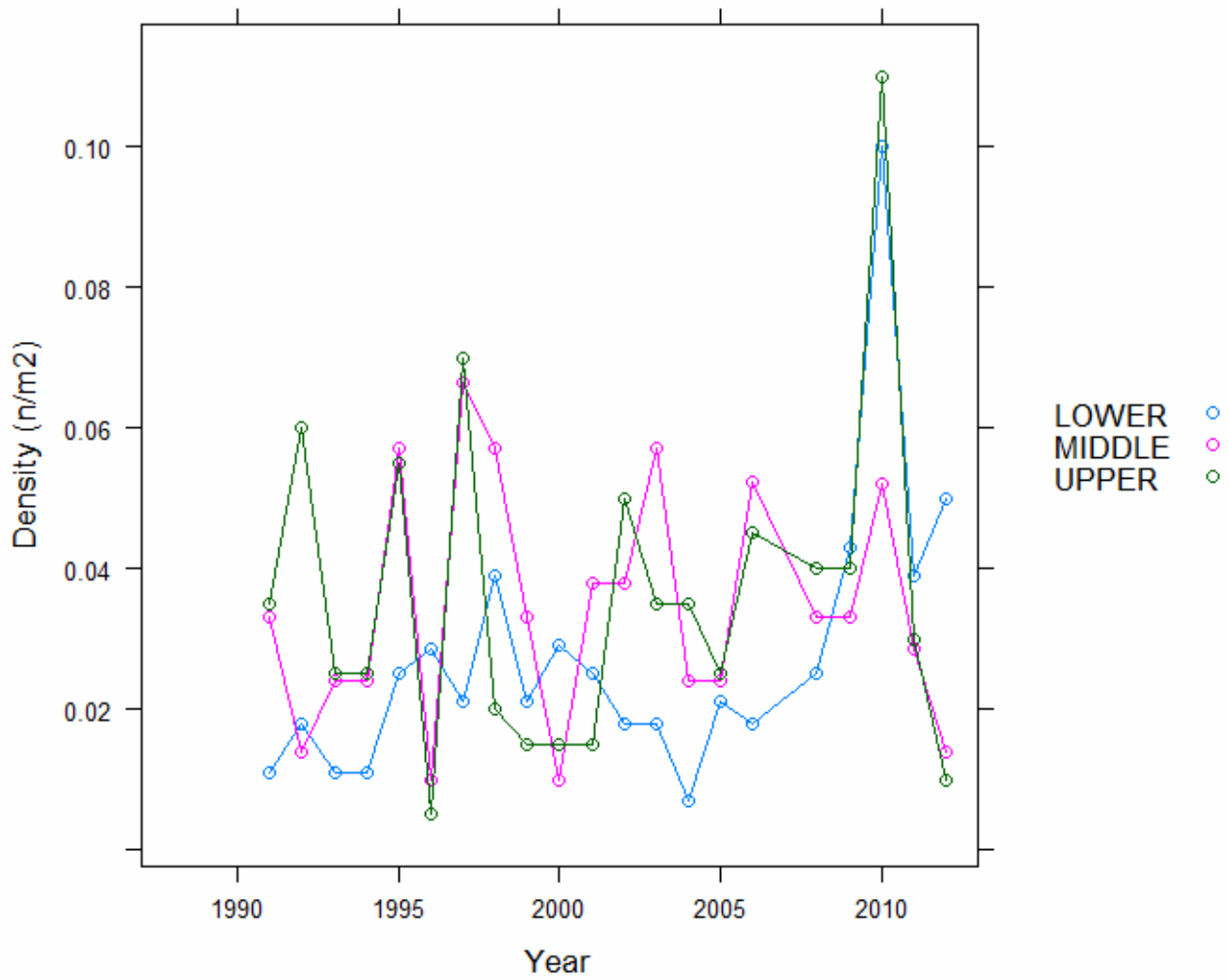
Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

6.10.3.3 Summary of Trout fry density (numbers m⁻²), Afon Gwy



Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

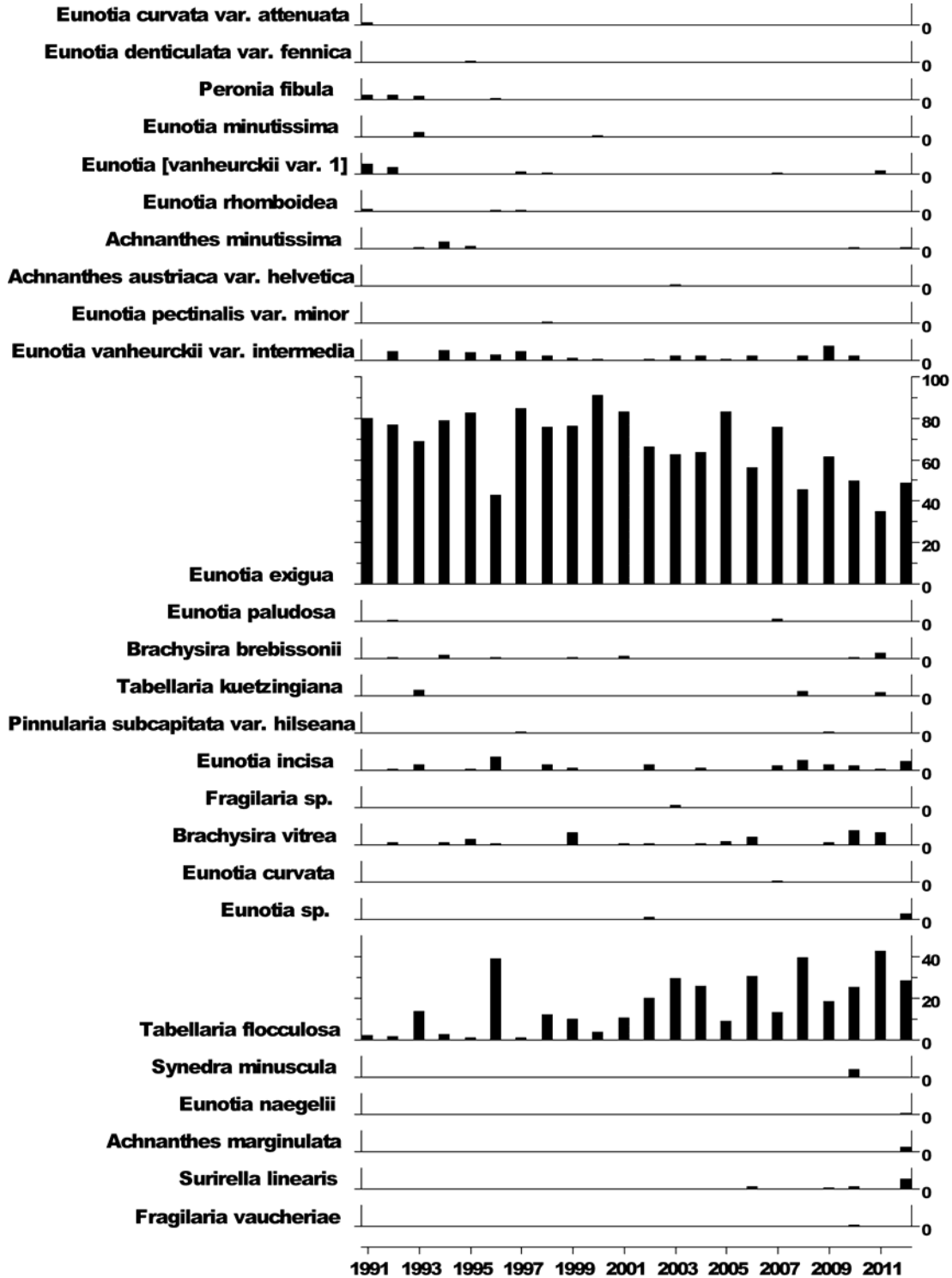
6.10.3.4 Summary of Trout parr density (numbers m⁻²), Afon Gwy



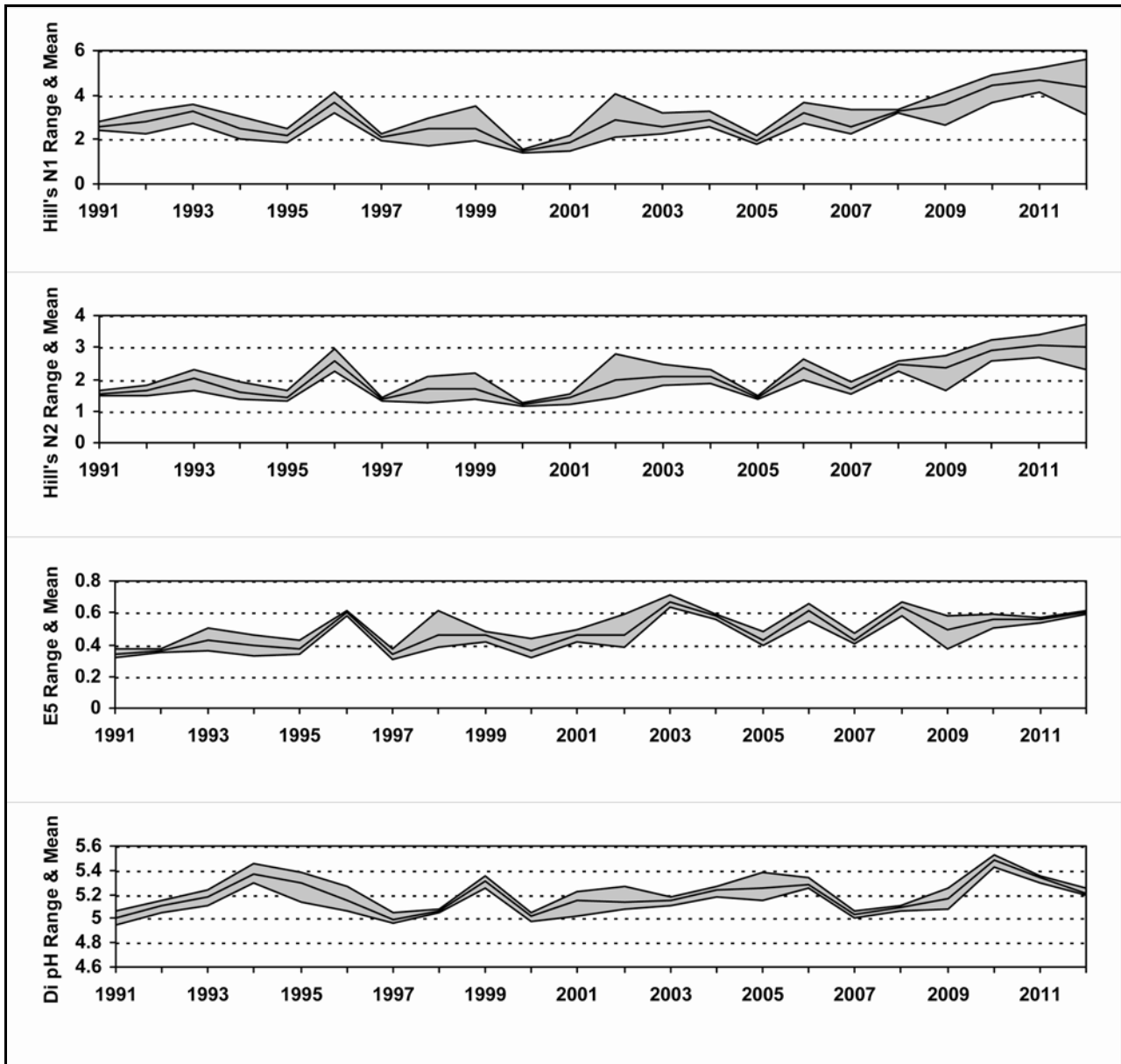
Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

6.10.4 Epilithic diatom data

6.10.4.1 Percentage abundance summary, Afon Gwy

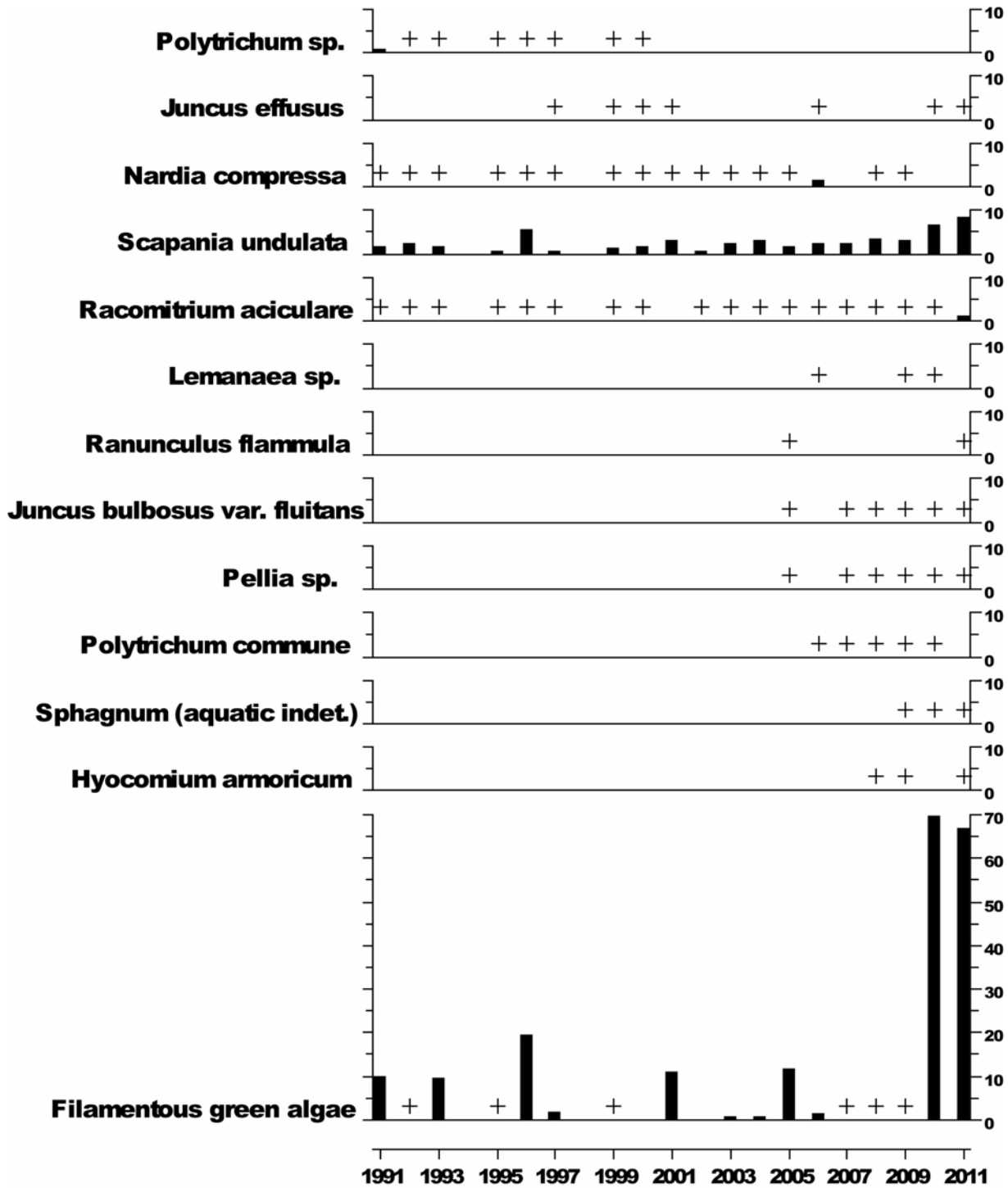


6.10.4.2 Diatom summary statistics, Afon Gwy



6.10.5 Aquatic macrophyte data, Afon Gwy

Percentage Species Cover



+ Represents <0.9% abundance
2012 data pending

6.10.6 Thermistor data, Afon Gwy

