



UCL

**UK Acid Waters Monitoring Network (UKAWMN)
Allt na Coire Nan Con, Loch Chon and Loch Grannoch
Annual Summary Progress Report to Forest Research. April 09 - March 10**

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

March 2010

UK ACID WATERS MONITORING NETWORK (UKAWMN)

**ALLT NA COIRE NAN CON, LOCH CHON AND LOCH
GRANNOCH**

**ANNUAL SUMMARY PROGRESS REPORT TO FOREST
RESEARCH. April 2009 - March 2010.**

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March 2010

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Cover Photo: Loch Grannoch, 17th of September 2009 © Ewan Shilland

1 TABLE OF CONTENTS

1	TABLE OF CONTENTS	3
2	INTRODUCTION	5
3	LOCATION OF UKAWMN SITES	6
4	SUMMARY OF WORK UNDERTAKEN 2009-2010	7
4.1	Summary Overview	7
4.2	Water Chemistry	7
4.3	Sediment Traps	7
4.4	Thermistors	7
4.5	Epilithic Diatoms	7
4.6	Macroinvertebrates	8
4.7	Fish	8
4.8	Aquatic Macrophytes	8
4.9	Data Management and Reporting	8
5	DATA FORMAT	9
6	REFERENCES	11
7	SITE DATA	12
7.1	Allt na Coire nan Con	12
7.1.1	Spot sampled chemistry data	12
7.1.2	Macroinvertebrate data	13
7.1.2.1	Percentage abundance summary, Allt na Coire nan Con	13
7.1.2.2	Summary statistics, Allt na Coire nan Con	14
7.1.3	Fish data	15
7.1.3.1	Summary of Salmon fry densities (numbers m ⁻²), Allt na Coire nan Con	15
7.1.3.2	Summary of Salmon parr densities (numbers m ⁻²), Allt na Coire nan Con	16
7.1.3.3	Summary of Trout fry densities (numbers m ⁻²), Allt na Coire nan Con	17
7.1.3.4	Summary of Trout parr densities (numbers m ⁻²), Allt na Coire nan Con	18
7.1.4	Epilithic diatom data	19
7.1.4.1	Percentage abundance summary, Allt na Coire nan Con	19
7.1.4.2	Summary statistics, Allt na Coire nan Con	20
7.1.5	Aquatic macrophyte data, Allt na Coire nan Con	21

7.2	Loch Chon	22
7.2.1	Spot sampled chemistry data	22
7.2.2	Macroinvertebrate data	23
7.2.2.1	Percentage abundance summary, Loch Chon	23
7.2.2.2	Summary statistics, Loch Chon	24
7.2.3	Fish data (for outflow stream)	25
7.2.3.1	Summary of Trout fry densities (numbers m ⁻²), Loch Chon	25
7.2.3.2	Summary of Trout parr densities (numbers m ⁻²), Loch Chon	26
7.2.4	Epilithic diatom data	27
7.2.4.1	Percentage abundance summary, Loch Chon	27
7.2.4.2	Summary statistics, Loch Chon	28
7.2.5	Aquatic macrophyte data, Loch Chon	29
7.2.6	Sediment trap data, Loch Chon	30
7.2.7	Thermistor data, Loch Chon	31
7.3	Loch Grannoch	32
7.3.1	Spot sampled chemistry data	32
7.3.2	Macroinvertebrate data	33
7.3.2.1	Percentage abundance summary, Loch Grannoch	33
7.3.2.2	Summary statistics, Loch Grannoch	34
7.3.3	Fish data (for outflow stream)	35
7.3.3.1	Summary of Trout fry densities (numbers m ⁻²), Loch Grannoch	35
7.3.3.2	Summary of Trout parr densities (numbers m ⁻²), Loch Grannoch	36
7.3.4	Epilithic diatom data	37
7.3.4.1	Percentage abundance summary, Loch Grannoch	37
7.3.4.2	Summary statistics, Loch Grannoch	38
7.3.5	Aquatic macrophyte data, Loch Grannoch	39
7.3.6	Sediment trap data, Loch Grannoch	40
7.3.7	Thermistor data, Loch Grannoch	41

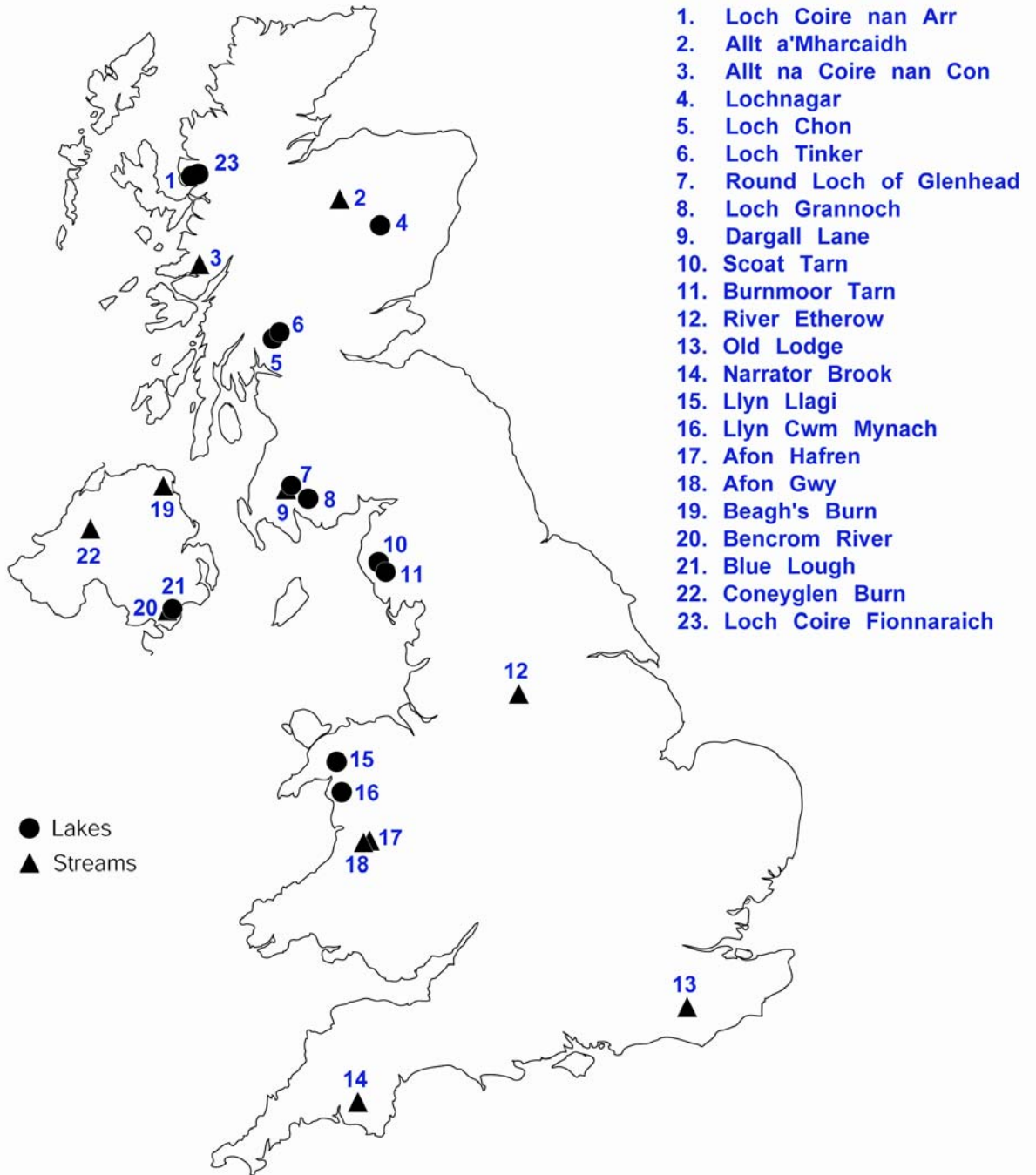
2 INTRODUCTION

The UK Acid Waters Monitoring Network (UKAWMN) has been operating continuously since 1988. This report presents a summary of work undertaken in the contract year 2009-2010 at three Scottish forested sites currently supported in part by Forest Research: Allt na Coire nan Con, Loch Chon and Loch Grannoch. The UKAWMN gratefully acknowledges Forest Research for providing resources that contribute towards the continuation of monitoring at these sites, and especially recognises Pete Madden for sample collection at Allt na Coire nan Con. We would also like to thank Marine Scotland, Queen Mary University of London, the Centre for Ecology and Hydrology and ENSIS Ltd who support the rest of the programme at the three sites.

In order to present the Forest Research funded aspects of the UKAWMN in context, all sampling performed in 2009-10 is described and time series summary data are presented for the full suite of chemical and biological measurements taken from the start of monitoring up to April 2009.

Detailed analysis of data has been presented in three interpretative reports, Monteith and Shilland (2007), Monteith (2005) and Monteith and Evans (2000) dealing with 18, 15 and 10 years of accumulated results respectively. All three can be found in the reports section of the [UKAWMN](#) web site. Currently a fourth interpretative report is in the final stages of production. A full description of sampling methods and analytical procedures, together with site descriptions, is also presented on the UKAWMN web page.

3 LOCATION OF UKAWMN SITES



4 SUMMARY OF WORK UNDERTAKEN 2009-2010

4.1 Summary Overview

During the period from April 2009 to March 2010 chemical and biological sample collection, analysis and data collation, quality control and archiving proceeded without any problems at Allt na Coire nan Con, Loch Chon and Loch Grannoch.

4.2 Water Chemistry

Samples were collected from the two lochs in early June, September and December 2009 by Marine Scotland Pitlochry. Monthly dip samples were collected from Allt na Coire nan Con by ENSIS Ltd from April – December 2009, after which the Forestry Commission kindly organized sampling by a local operative, Pete Madden. They have been delivered to the analytical laboratories at Marine Scotland and CEH on schedule and have been analysed and archived in the UKAWMN central chemistry database at CEH Lancaster. March 2010 samples have been collected and are in the process of being analysed. Quality control on the data will be performed before summary data is presented in the annual UKAWMN data report in late 2010.

4.3 Sediment Traps

Sediment traps were recovered and replaced on the 13th of August 2009 at Loch Chon and the 17th of September 2009 at Loch Grannoch. 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 13th of August 2009 at Loch Chon and the 17th of September 2009 at Loch Grannoch. All four had functioned well during the previous year and the data were added to the ENSIS thermistor water temperature database.

4.5 Epilithic Diatoms

Epilithic diatoms were retrieved from three sampling points around Loch Chon on the 13th of August 2009 and at four sampling points around Loch Grannoch on the 17th of September 2009. Three samples were retrieved from Allt na Coire nan Con on the 8th of July 2009. The samples have been made into slides and are currently in the process of being analysed by Dr R. J. Flower from UCL.

4.6 Macroinvertebrates

Aquatic macroinvertebrates were sampled at Allt na Coire nan Con by QMuL on the 7th May 2009, at Loch Chon by UCL on the 4th of May 2009 and at Loch Grannoch by UCL on the 5th of May 2009. Five 1 minute kick samples were performed at each site. The samples from all three sites were counted at QMuL and the data sent to ENSIS Ltd. The data awaits quality screening the before being added to the UKAWMN biological database at ENSIS.

4.7 Fish

Fish surveying was performed at Allt na Coire nan Con and Loch Chon in autumn 2009 by Marine Scotland, Pitlochry, who are checking the data before forwarding it to ENSIS Ltd.

4.8 Aquatic Macrophytes

Aquatic macrophytes were not surveyed at either of the two Loch sites in the 2009-2010 period. Allt na Coire nan Con was surveyed by ENSIS Ltd. on the 8th of July 2009.

4.9 Data Management and Reporting

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

The 2009-2010 annual report currently awaits uploading to the new AWMN web page, and the sections on Allt na Coire nan Con, Loch Chon and Loch Grannoch appear in section 7 below.

An interpretative report detailing 20 years of the UKAWMN was produced in early 2010 and is awaiting final edits by DEFRA prior to publication.

5 DATA FORMAT

The chemical and biological data are presented in a series of sections, summarised below, on a site-by-site basis.

Section 1:	<p>Time series graphs of key spot sampled chemical determinands for individual samples.</p> <p>Summary table for key chemical determinands including: the mean over the 1988-1993 baseline period; the mean for the current year (2007-2008) and the standard deviation for the current year. The normal number of observations per year is 4 for lakes and 12 for streams.</p>
Section 2:	<p>Macroinvertebrates. Time series of macroinvertebrate taxon % abundance in annual aggregated samples (5 kick samples from lake littoral habitats or from riffle areas in streams), and annual total number of individual animals. Some species occurring at less than 1% relative abundance are omitted.</p> <p>Macroinvertebrate summary statistic time series:</p> <ol style="list-style-type: none"> 1) total number of individuals; 2) number of individuals identified at Genus level only (excludes some ubiquitous groups such as the chironomids and oligochaetes); 3) total number of taxa; 4) Diversity Indices: <ol style="list-style-type: none"> a) Hill's N_1, the exponent of Shannon's Index and a measure of the number of abundant species in a sample (Hill, 1973). b) Hill's N_2, the reciprocal of Simpson's Index and a measure of the number of very abundant species in a sample (Hill, 1973). c) E_5, a measure of evenness based on the ratio $(N_2-1):(N_1-1)$. As a single species becomes more and more dominant, E_5 tends to zero.
Section 3:	<p>Salmonids. Summary histogram of mean density of trout and salmon, if present, in three 50m reaches (number of individuals caught per m^2 survey area) for each year of the monitoring period. (0+ = new recruits, "fry", >0+ = all fish over one year of age, "parr").</p>
Section 4:	<p>Epilithic diatoms. Time series of annual mean percentage frequency (from 3-4 replicate samples) of taxa occurring at greater than 2 % abundance in any one sample.</p> <p>Epilithic diatom summary statistic time series. Mean, maximum and minimum for:</p> <ol style="list-style-type: none"> a) Hill's N_1 (see above) b) Hill's N_2 (see above) c) E_5 (see above) d) Diatom inferred pH (Di pH), based on the weighted average of species pH optima in the surface sediments of the 167 lake Surface Water Acidification Project dataset (Stevenson <i>et al.</i> 1991). <p>pH reconstructions are intended only for application to sedimentary diatoms but directional trends in inferred pH of epilithic assemblages should provide an indication of the direction of a response to changing acidity.</p>

Section 5:	<p>Aquatic macrophytes. For lakes relative species abundance determined on a five point scale (comparable to the DAFOR scoring system, Palmer <i>et al.</i> 1992) following shoreline survey, shore transects and deep water grapnel trawls, as follows:</p> <ol style="list-style-type: none"> 1. rare/infrequent 2. occasional but not abundant 3. widespread but not abundant 4. locally abundant 5. widespread and abundant <p>For streams, total macrophyte cover estimated for 5m sections of a 50m survey stretch and each then partitioned into proportional species abundance to provide percentage cover for each species. Data analysed for this report are the mean species cover estimates for the 50m stretches.</p>
Section 6:	<p>For lake sites only. Histogram of diatom species composition from annually retrieved sediment traps. Species occurring at less than 1% abundance in all years are omitted.</p>
Section 7:	<p>For lake sites only. Time series graphs of annual data from thermistors attached to the sediment traps. Thermistor pairs are used, one 1.5m from the lake bottom and the other 1m from the water surface.</p>

6 REFERENCES

Hill, M. O. 1973 Diversity and evenness: a unifying notation and its consequences. *Ecology*, **54**, 427-31.

Monteith, D. T. (Ed.) 2005 *UK Acid Waters Monitoring Network: 15 Year Report. Analysis and Interpretation of Results, April 1988-March 2003*. ENSIS Ltd, London.

Monteith, D. T. & Evans, C. D. (Eds.) 2000 *UK Acid Waters Monitoring Network: 10 Year Report. Analysis and Interpretation of Results, April 1988-March 1998*. ENSIS Ltd, London.

Monteith, D. T. & Shilland, E. M. (Eds.) 2007 *The United Kingdom Acid Waters Monitoring Network Assessment of the First 18 Years of Data. Data Summary Annex Accompanying Research Project Final Report. Report to the Department for Environment, Food and Rural Affairs (Contract EPG 1/3/160)*. ENSIS Ltd, London.

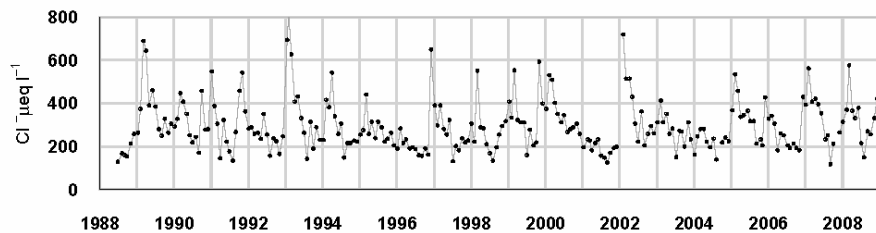
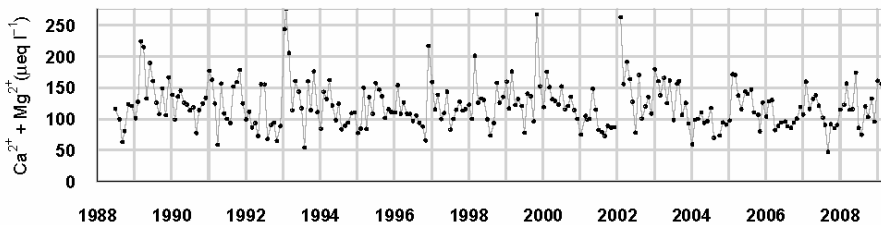
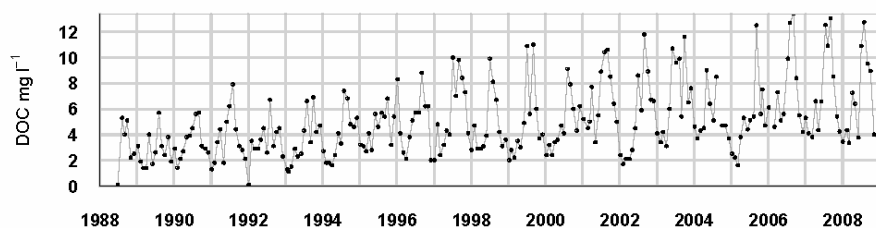
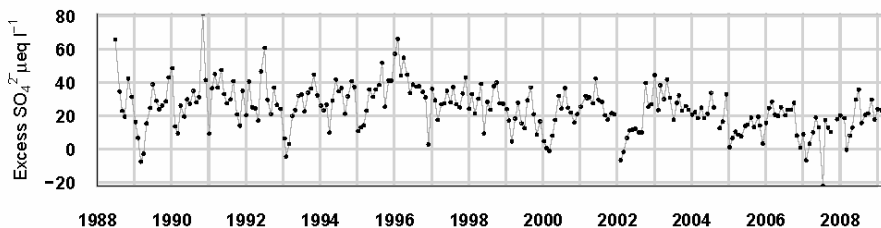
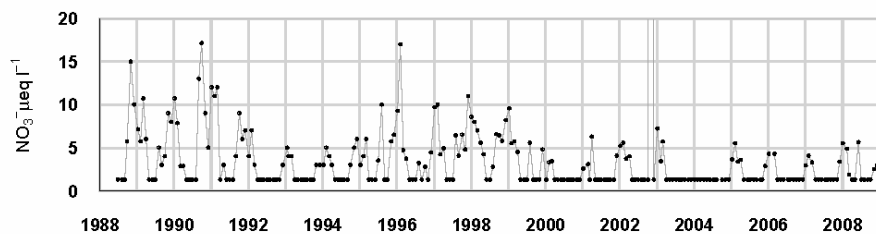
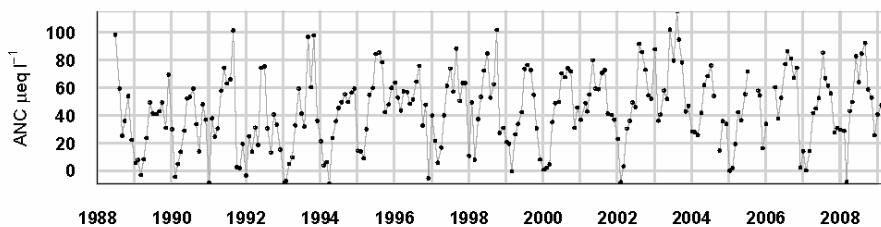
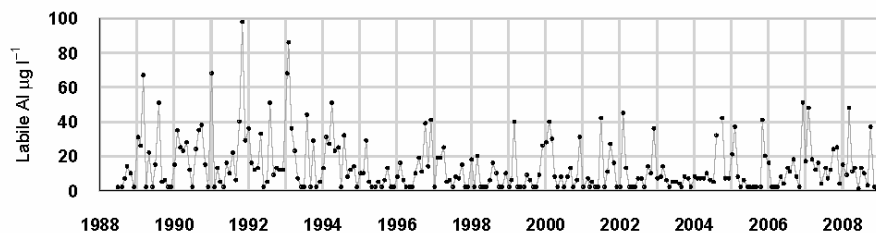
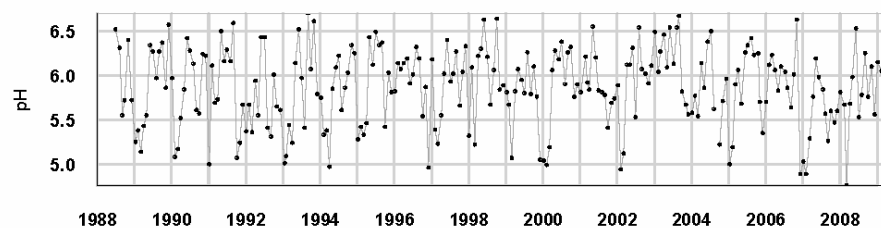
Palmer, M. A., Bell, S. L. & Butterfield, I. 1992 A botanical classification of standing waters in Britain: applications for conservation and monitoring. *Aquatic conservation: marine and freshwater ecosystems*, **2**, 125-143.

Stevenson, A. C., Juggins, S., Birks, H. J. B., Anderson, N. J., Battarbee, R. W., Berge, F., Davis, R. B., Flower, R. J., Haworth, E. Y., Jones, V. J., Kingston, J. C., Kreiser, A. M., Line, J. M., Munro, M. A. R. & Renberg, I. 1991 *The surface waters acidification project palaeolimnology programme: Modern diatom/lake-water chemistry data-set*. ENSIS Ltd, London.

7 SITE DATA

7.1 Allt na Coire nan Con

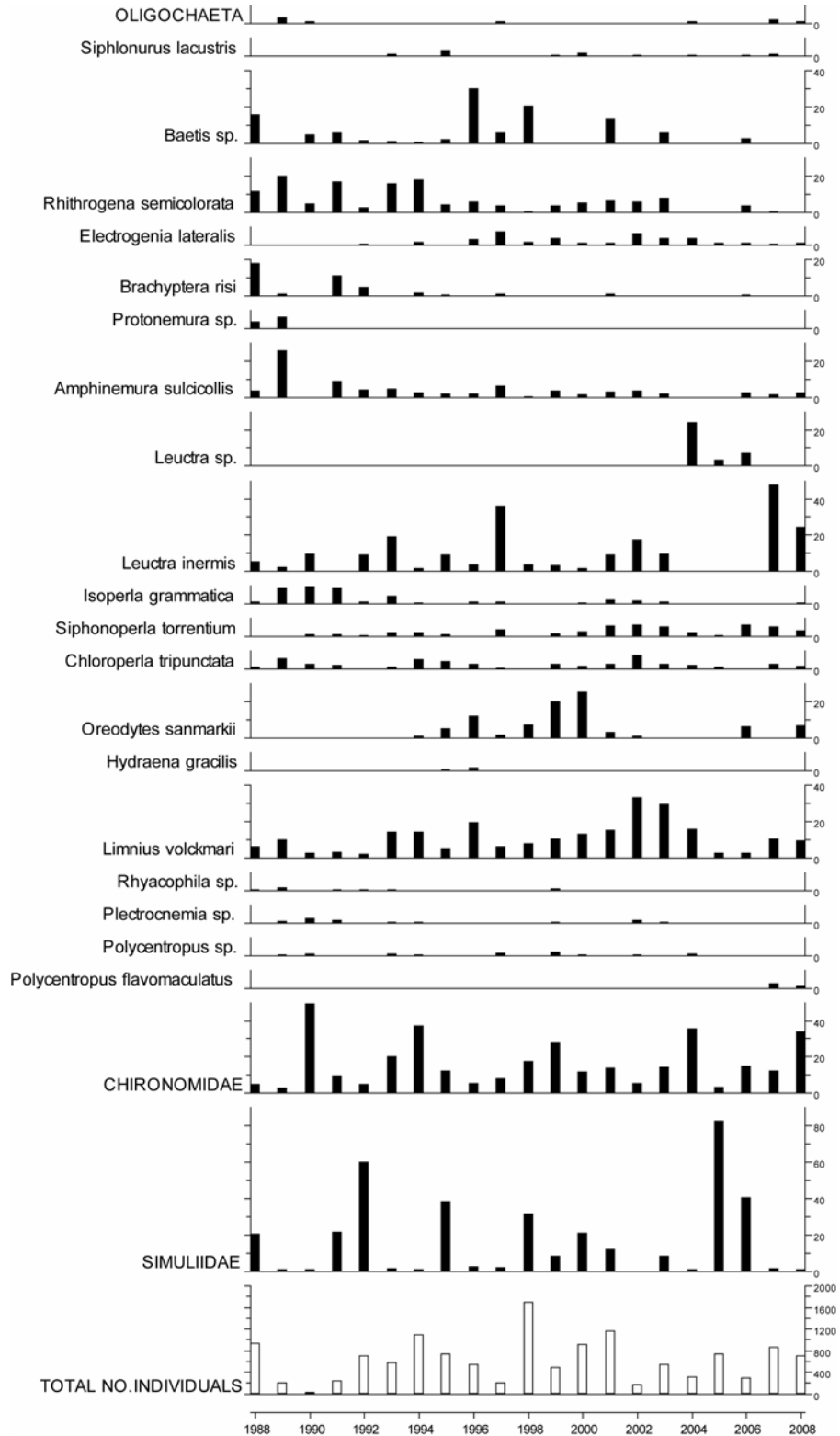
7.1.1 Spot sampled chemistry data



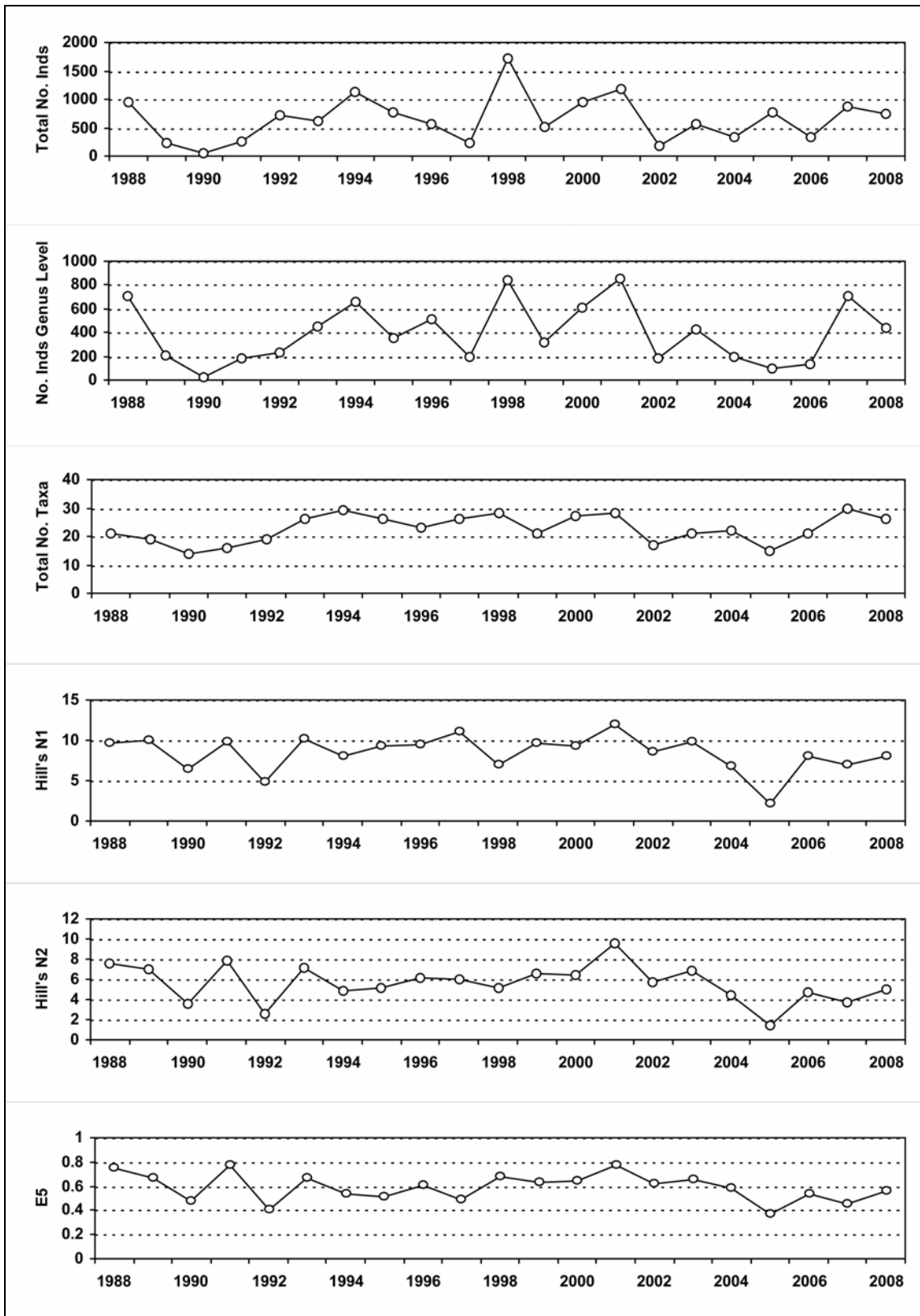
$\mu\text{eq l}^{-1}$, * $\mu\text{g l}^{-1}$, ** mg l^{-1}	pH	ANC	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	*Soluble Al	*Labile Al	Cl ⁻	*SO ₄ ²⁻	xSO ₄ ²⁻	NO ₃ ⁻	**DOC
Mean 1 st 5 yrs	5.81	32.14	58.91	70.20	274.34	9.14	64.76	21.47	325.23	62.07	27.96	4.79	3.18
08-09 mean	5.90	55.73	52.11	66.69	276.88	8.60	64.00	8.50	319.95	54.52	20.98	2.51	6.72
08-09 std dev	0.33	21.69	15.88	16.10	50.01	2.16	35.11	10.17	84.84	11.63	8.11	2.47	3.17

7.1.2 Macroinvertebrate data

7.1.2.1 Percentage abundance summary, Allt na Coire nan Con

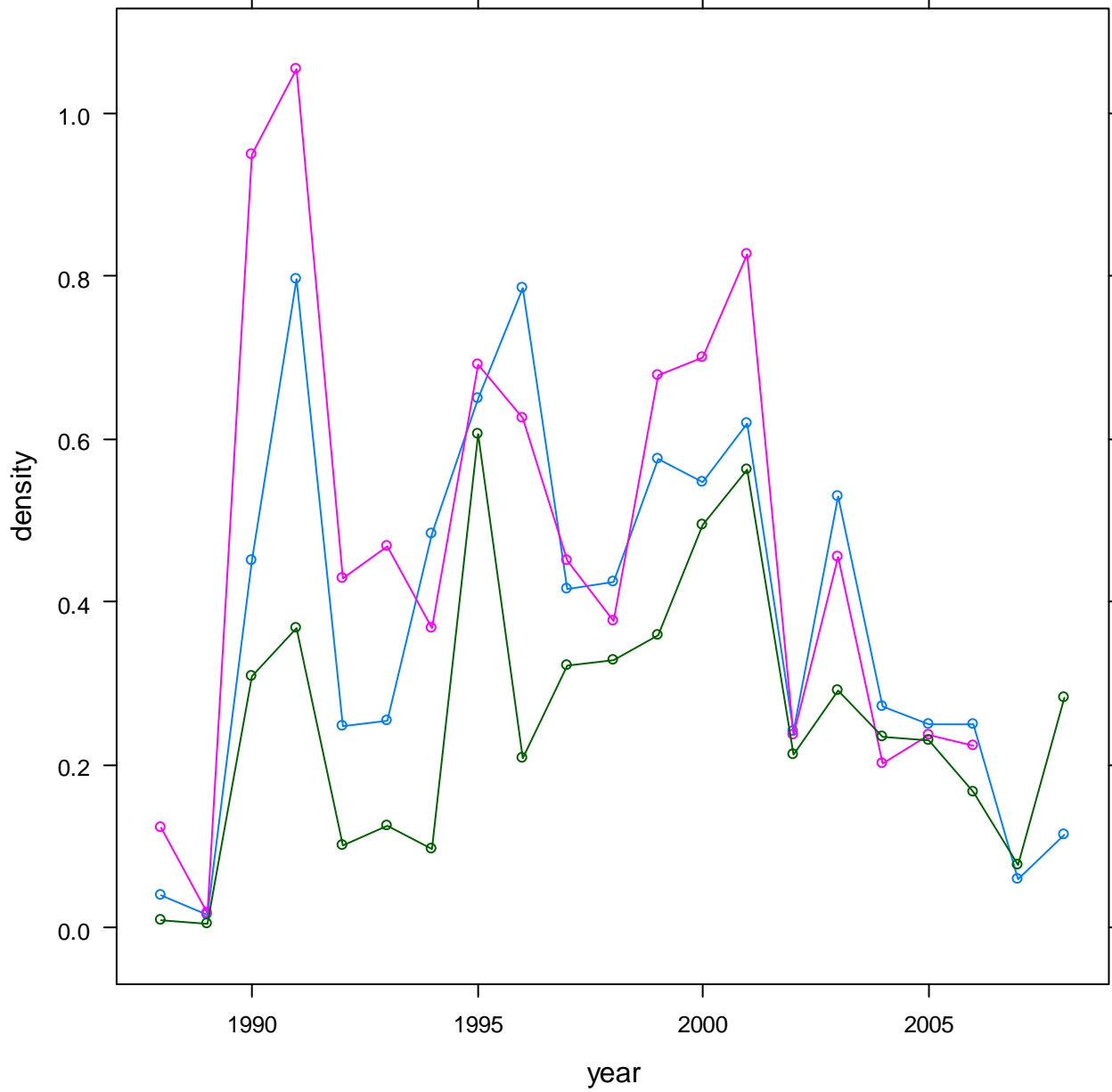


7.1.2.2 Summary statistics, Allt na Coire nan Con



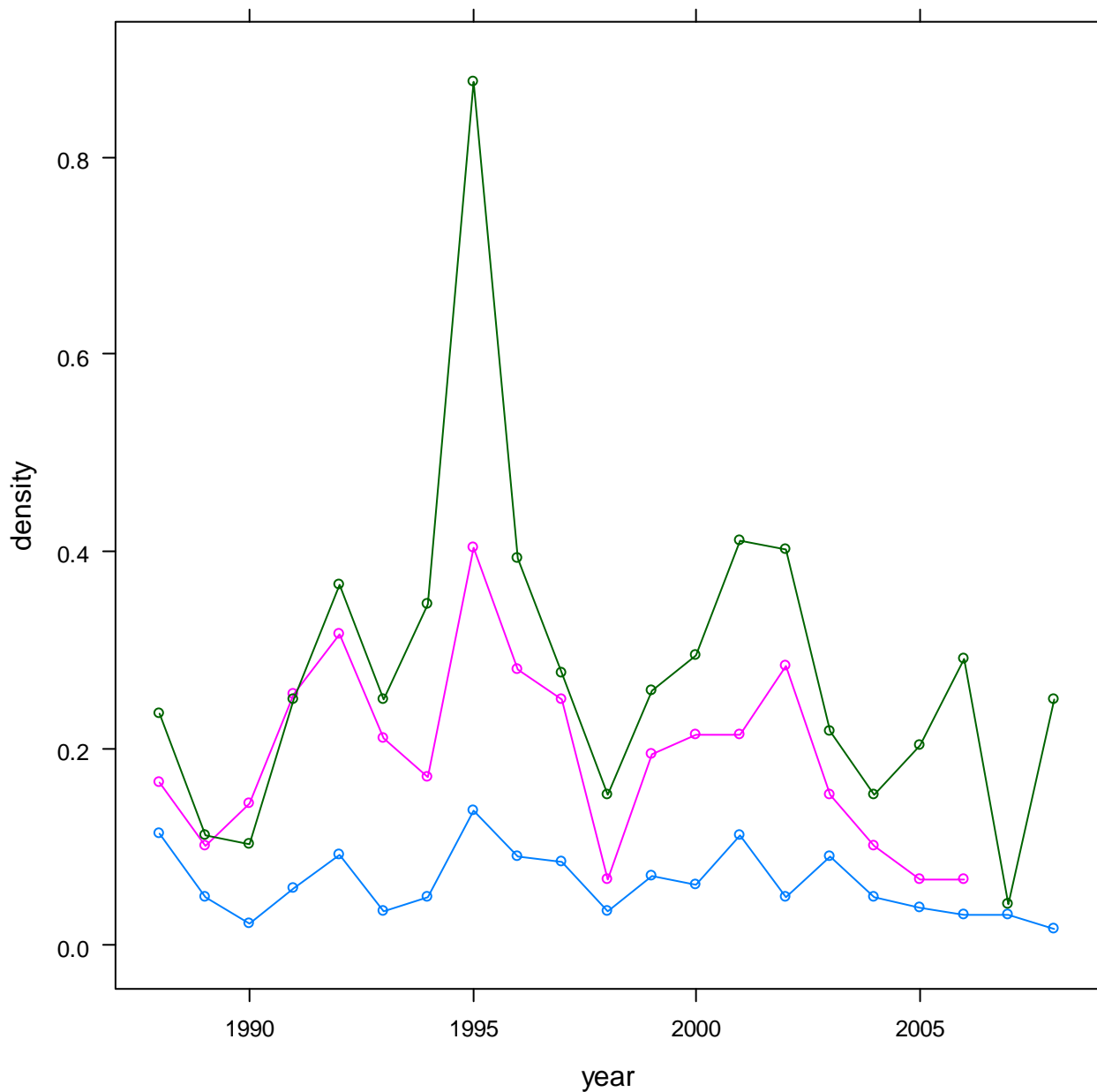
7.1.3 Fish data

7.1.3.1 Summary of Salmon fry densities (numbers m⁻²), Allt na Coire nan Con



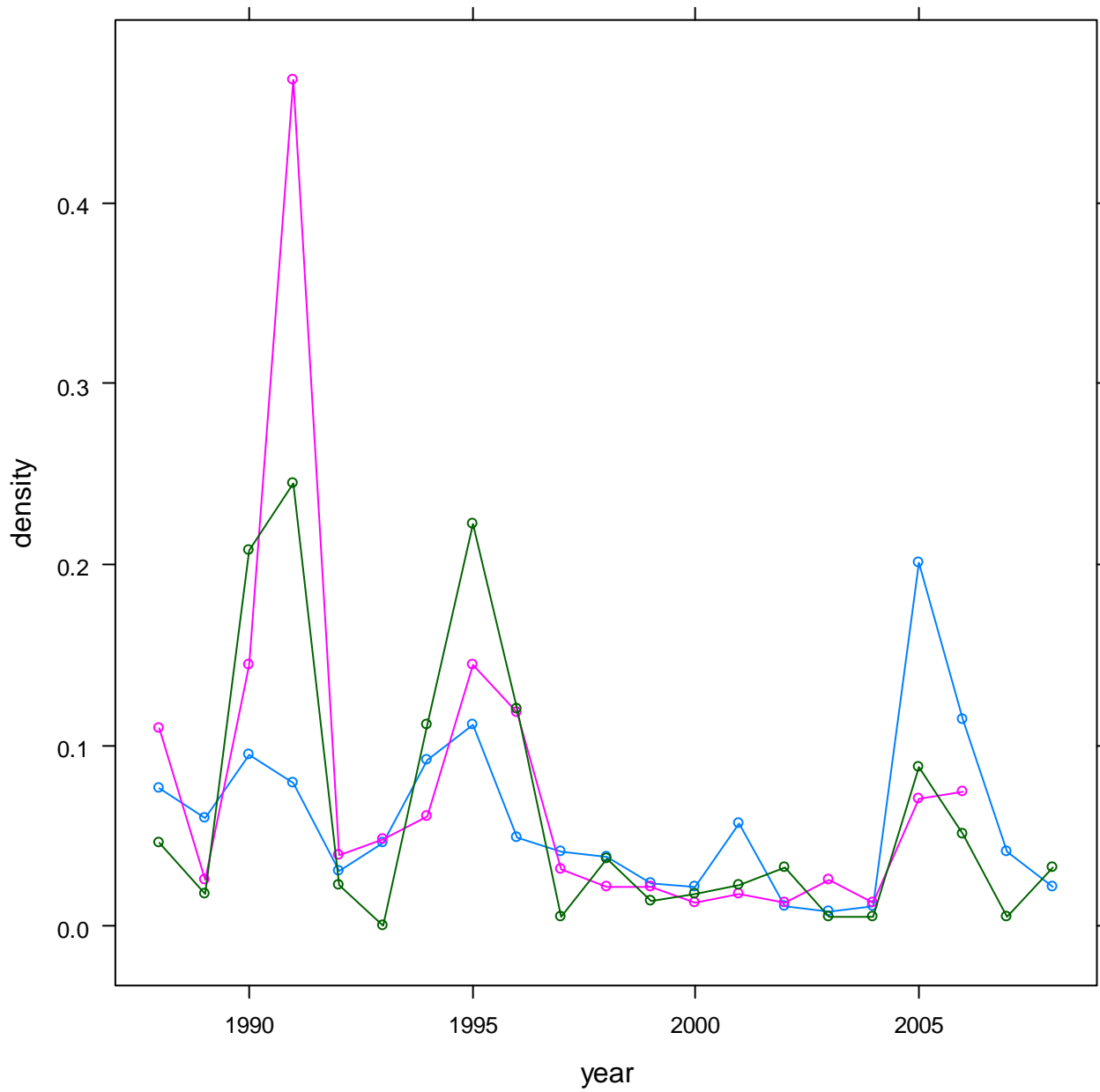
Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

7.1.3.2 Summary of Salmon parr densities (numbers m⁻²), Allt na Coire nan Con



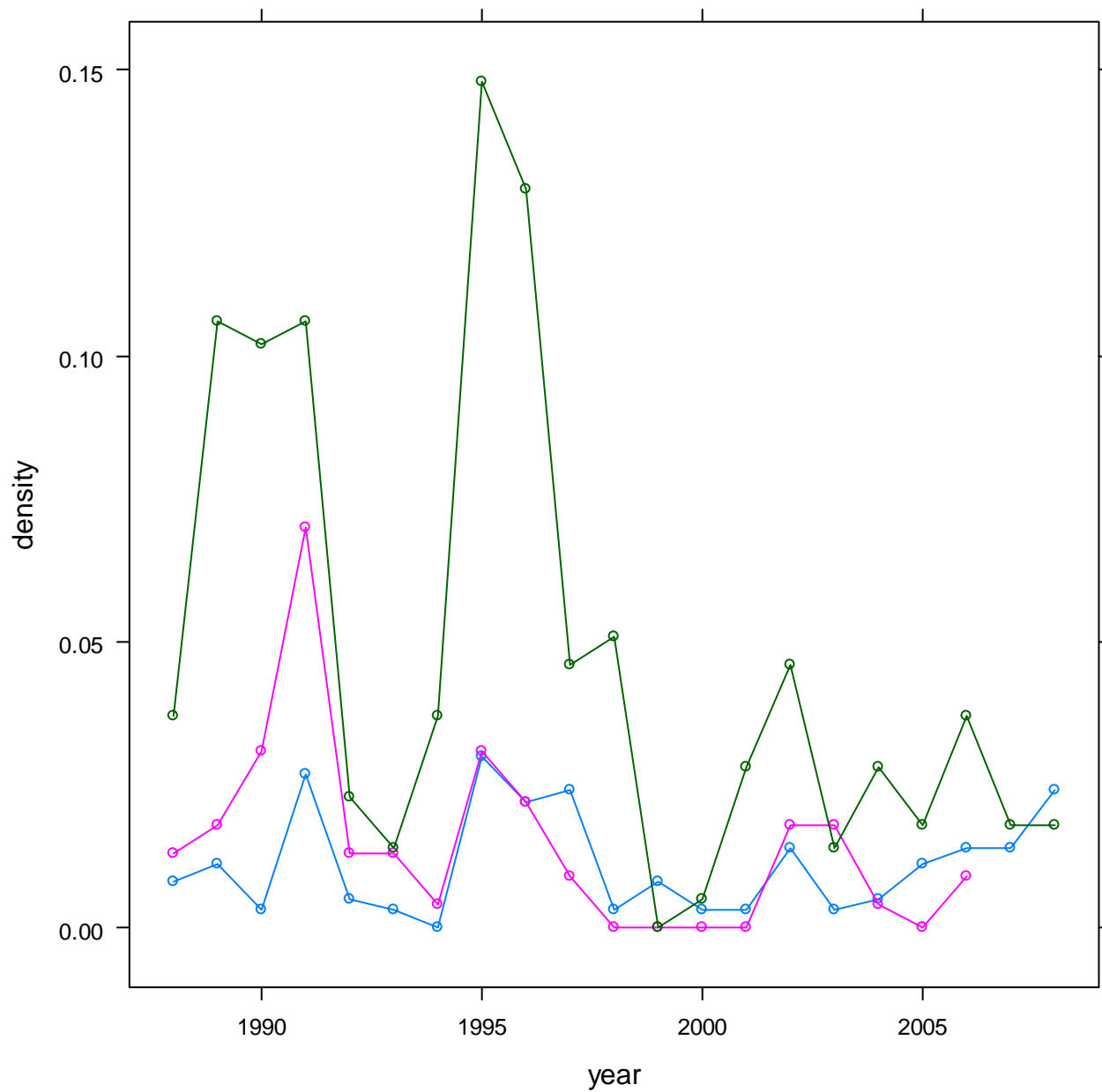
Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

7.1.3.3 Summary of Trout fry densities (numbers m⁻²), Allt na Coire nan Con



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

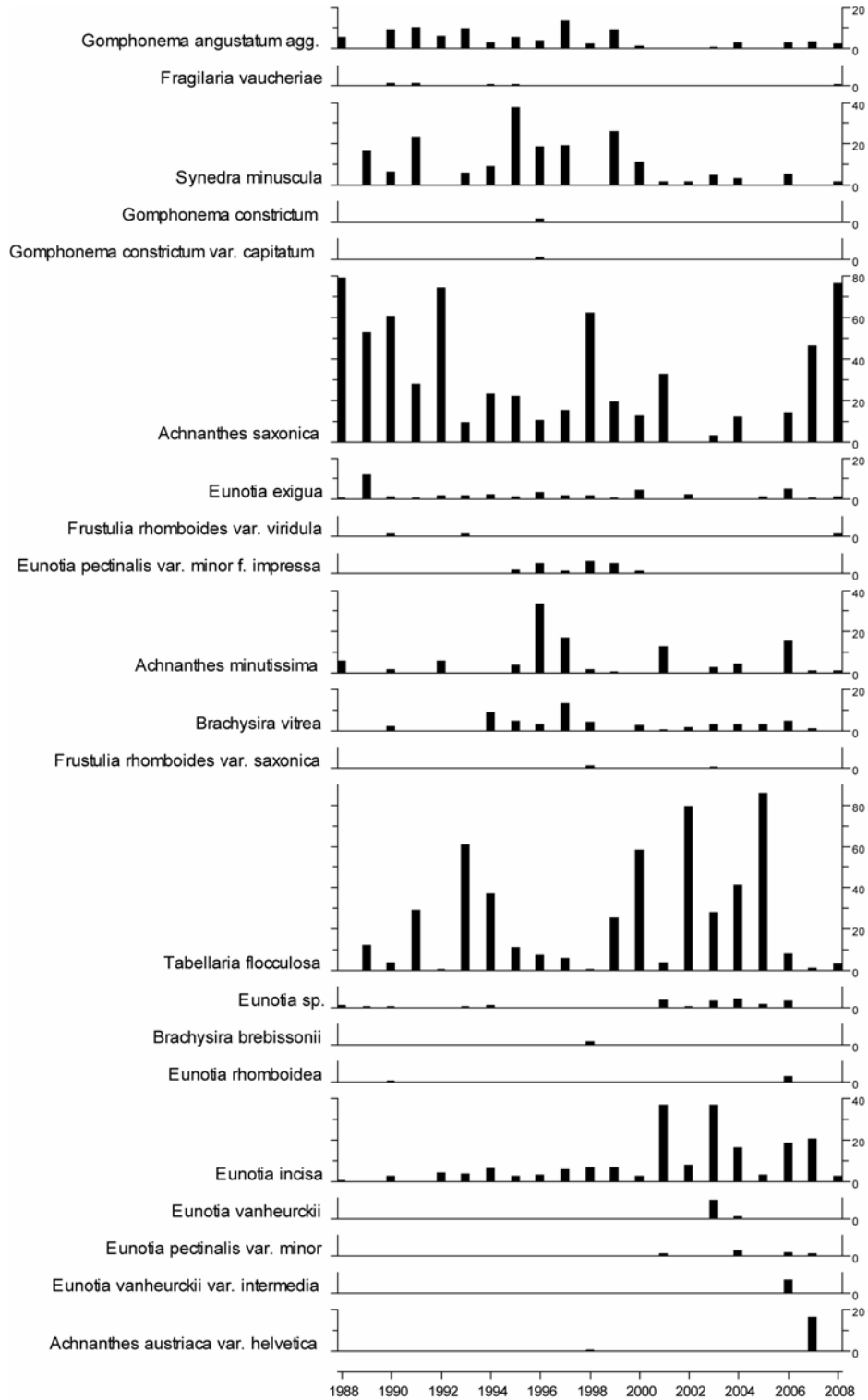
7.1.3.4 Summary of Trout parr densities (numbers m⁻²), Allt na Coire nan Con



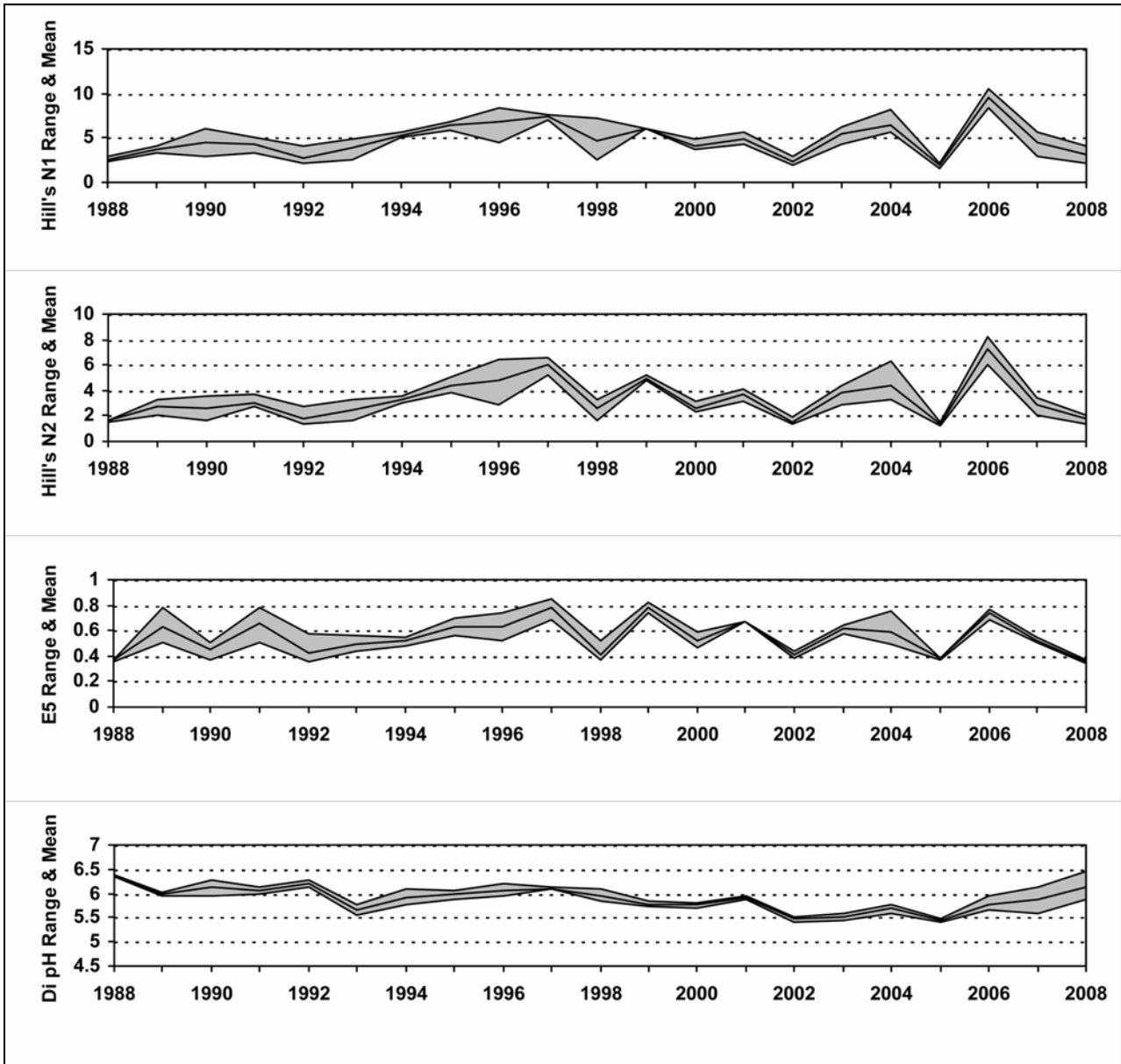
Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

7.1.4 Epilithic diatom data

7.1.4.1 Percentage abundance summary, Allt na Coire nan Con

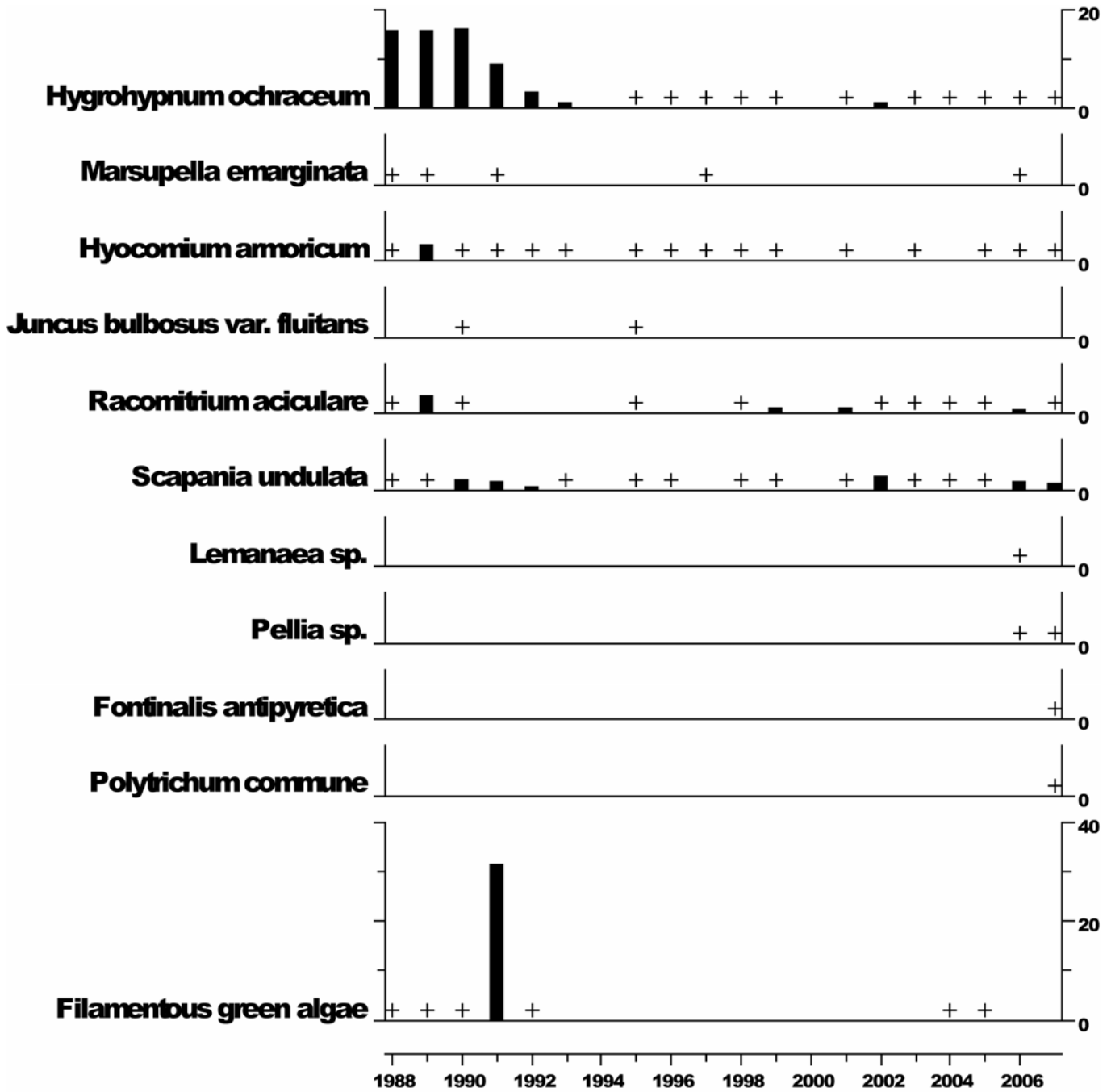


7.1.4.2 Summary statistics, Allt na Coire nan Con



7.1.5 Aquatic macrophyte data, Allt na Coire nan Con

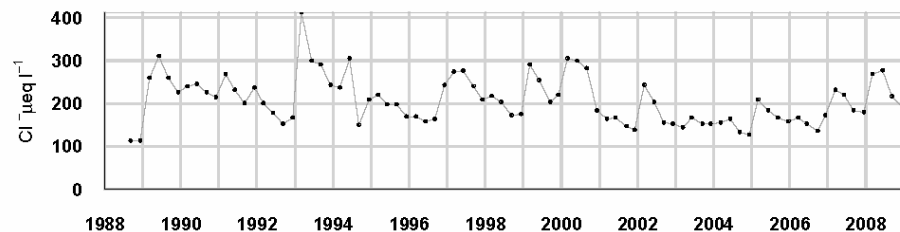
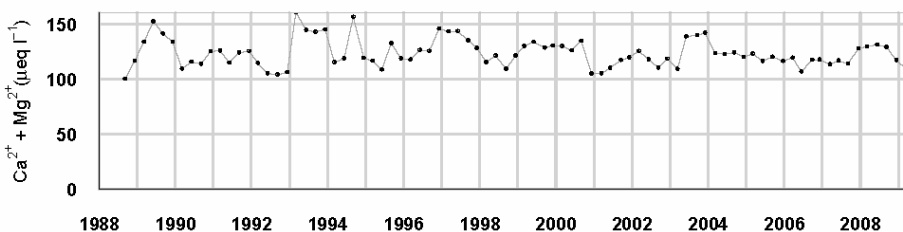
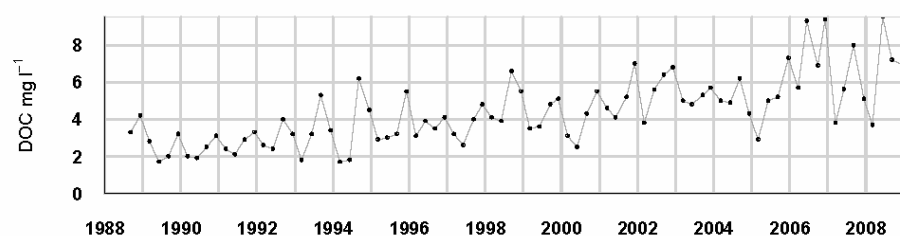
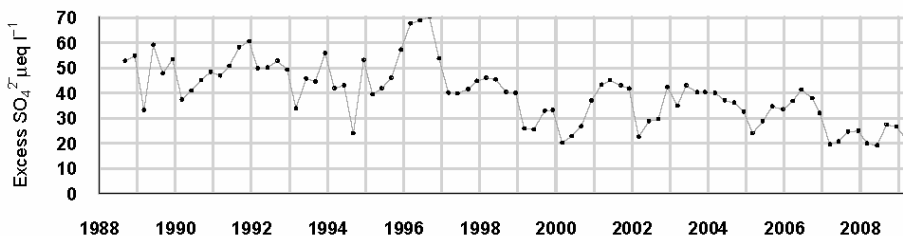
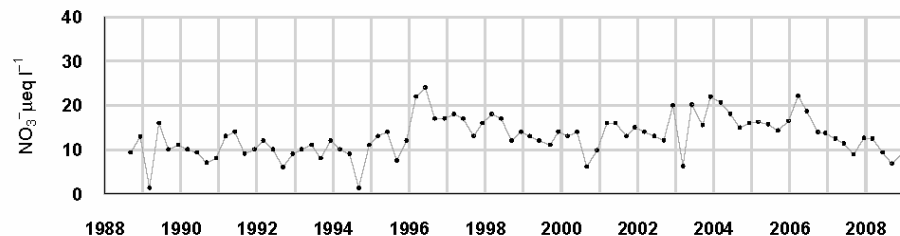
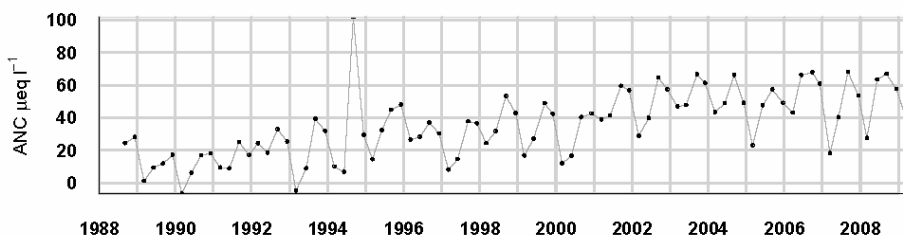
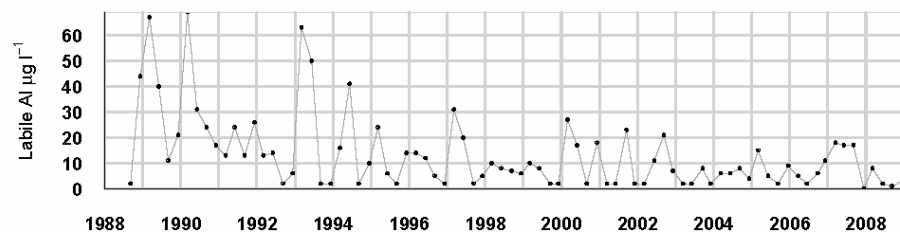
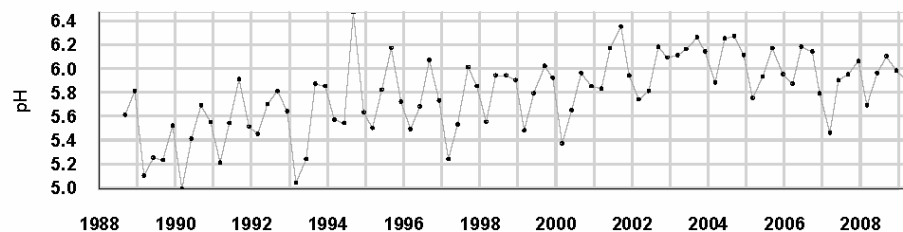
Percentage Species Cover



+ Represents <math><0.5\%</math> abundance
 No survey in 2008 due to spate conditions

7.2 Loch Chon

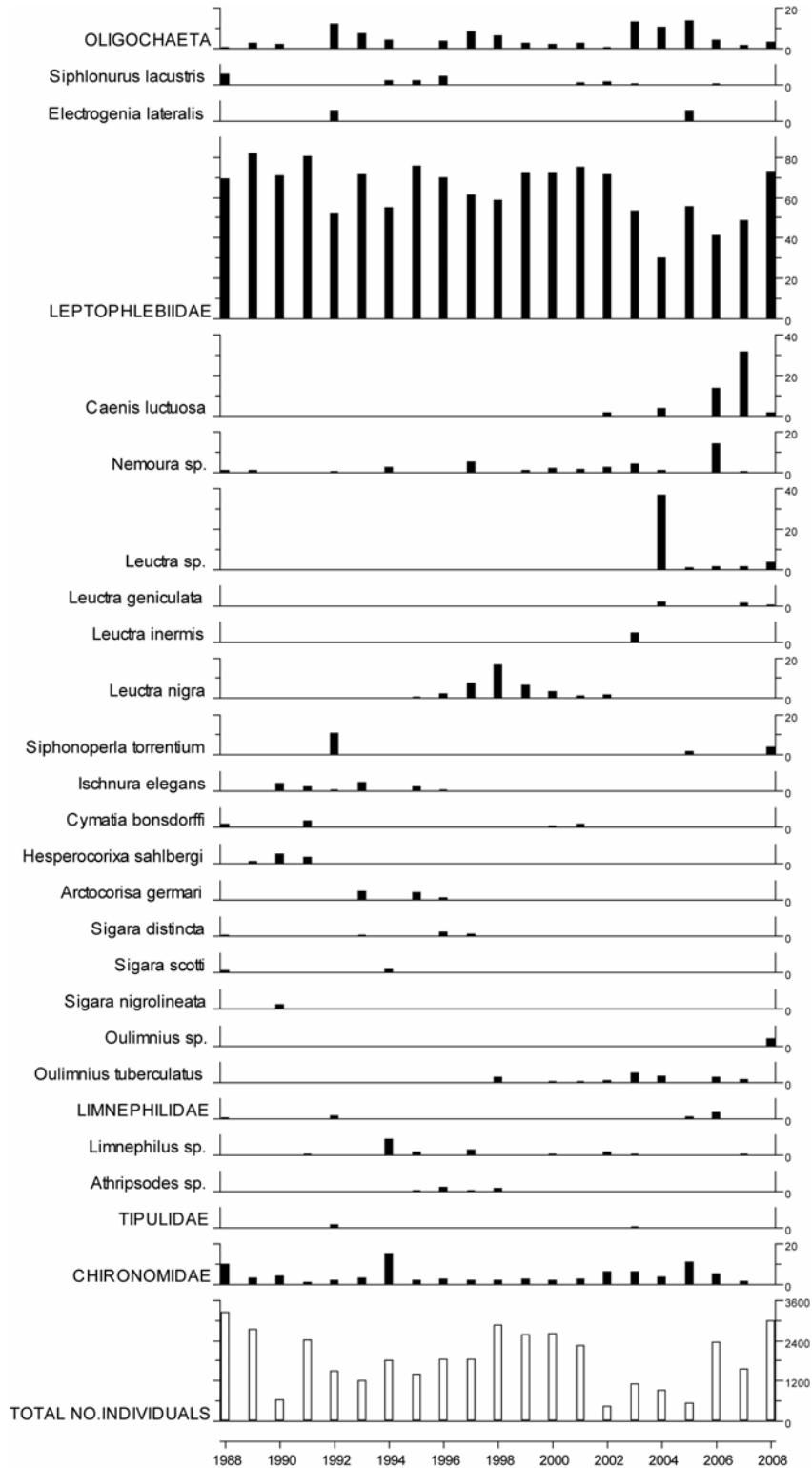
7.2.1 Spot sampled chemistry data



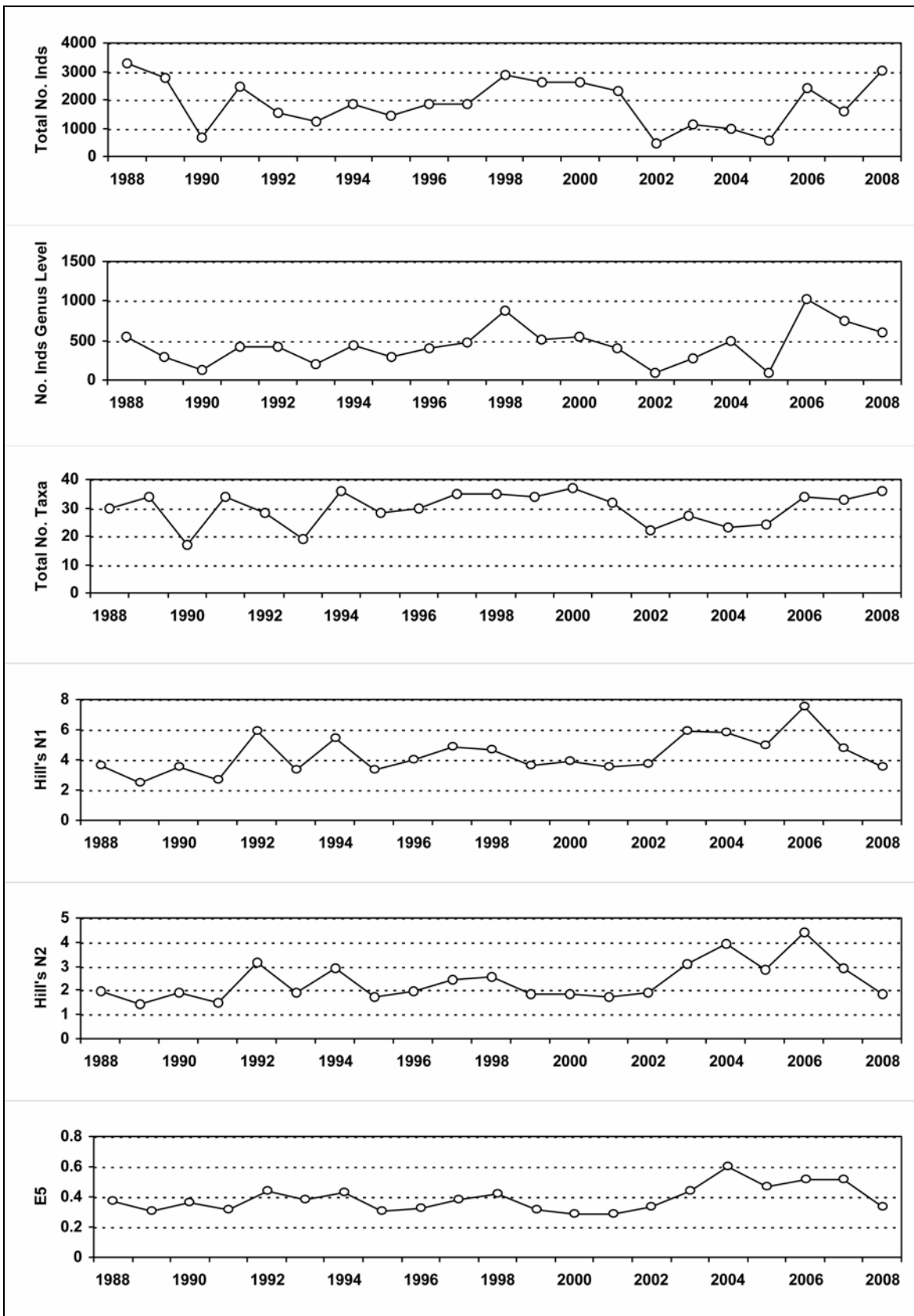
$\mu\text{eq l}^{-1}$, * $\mu\text{g l}^{-1}$, ** mg l^{-1}	pH	ANC	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	*Soluble Al	*Labile Al	Cl ⁻	*SO ₄ ²⁻	xSO ₄ ²⁻	NO ₃ ⁻	**DOC
Mean 1st 5 yrs	5.46	14.54	76.17	47.42	189.44	5.79	66.65	27.50	227.51	72.38	48.53	9.94	2.73
08-09 mean	5.99	56.75	73.23	48.66	186.94	5.96	38.25	3.50	223.07	47.02	23.63	9.05	7.03
08-09 std dev	0.08	12.35	5.64	5.14	23.12	0.44	10.87	3.11	36.95	2.90	3.97	1.76	2.09

7.2.2 Macroinvertebrate data

7.2.2.1 Percentage abundance summary, Loch Chon

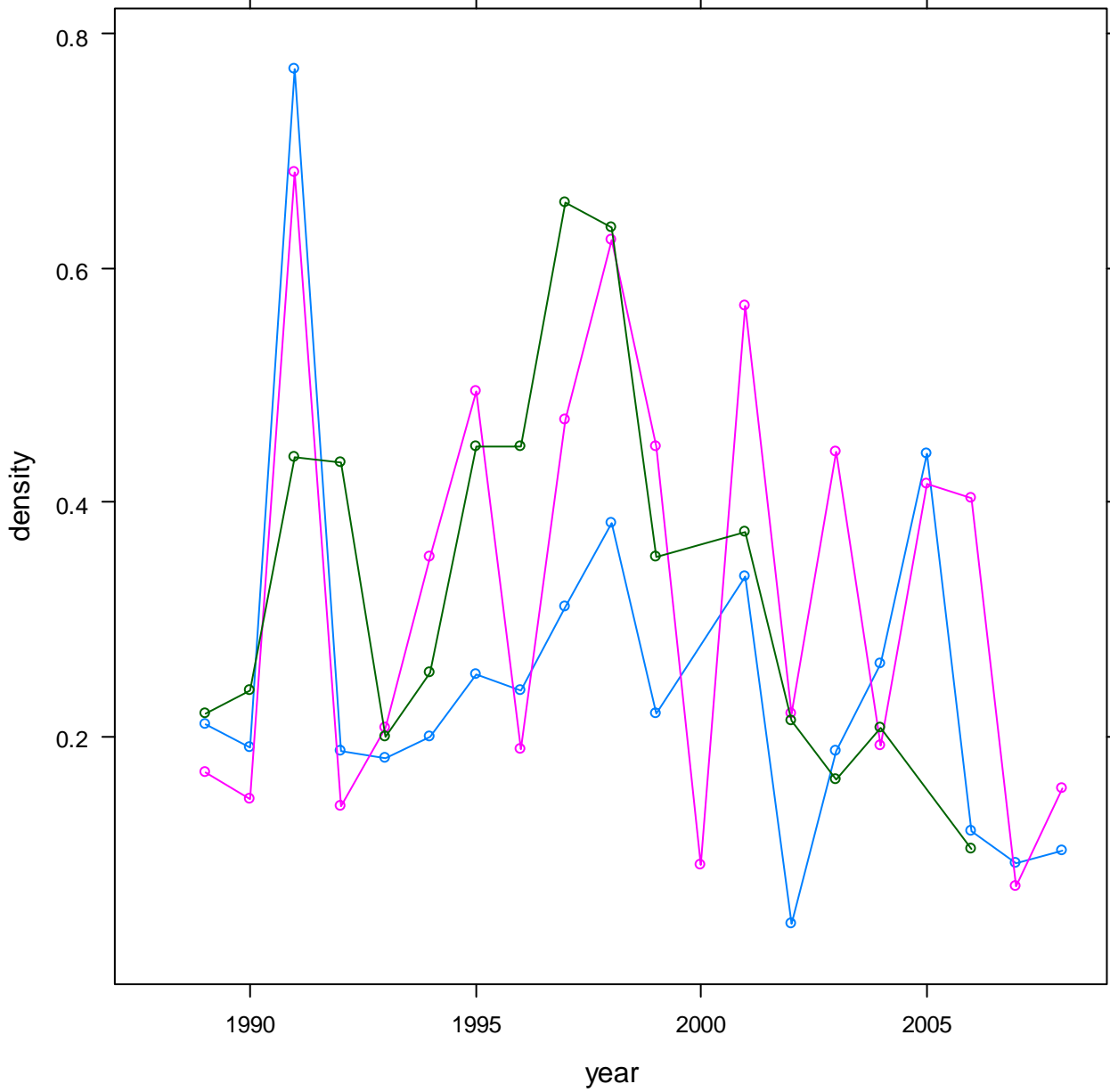


7.2.2.2 Summary statistics, Loch Chon



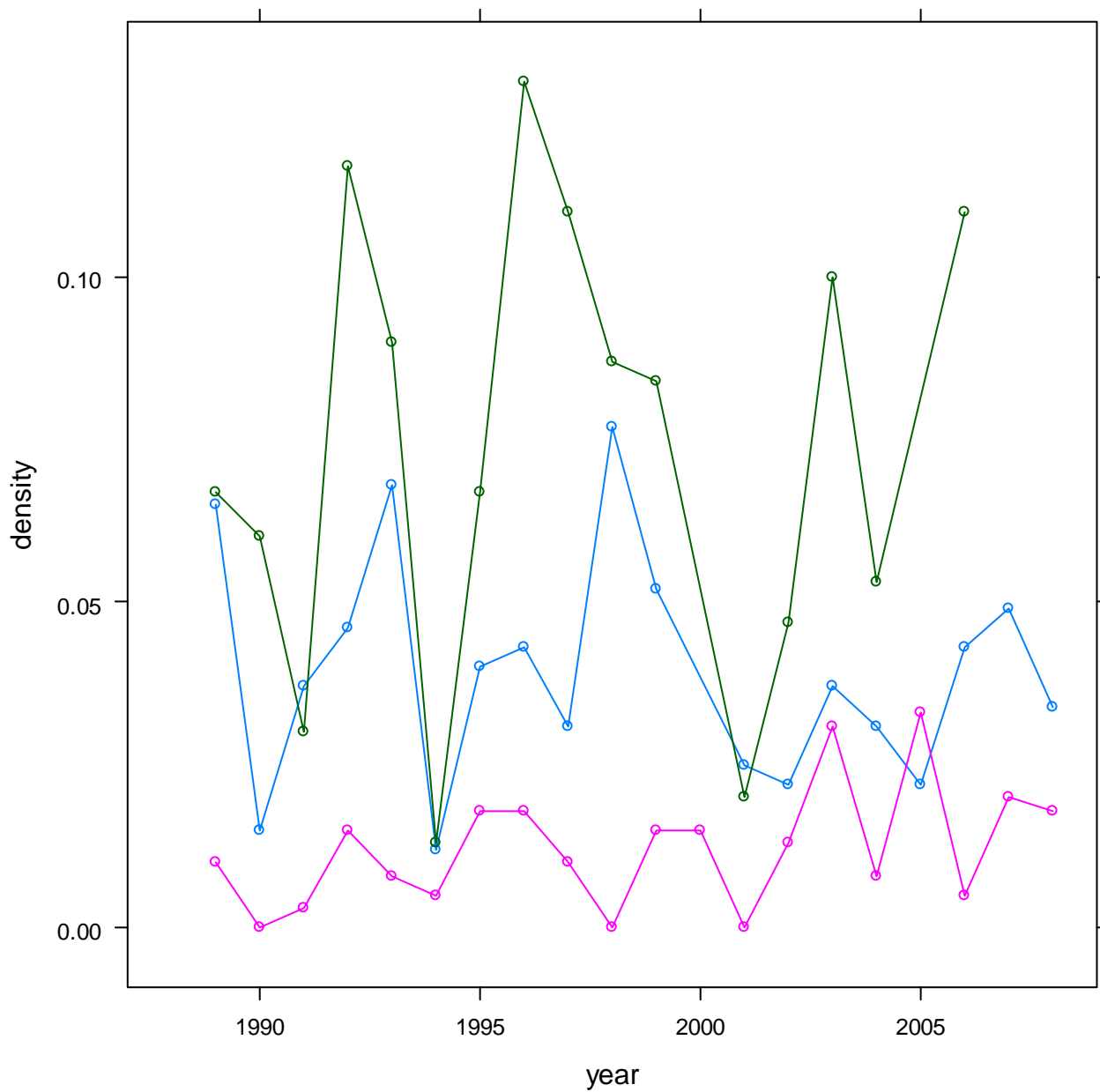
7.2.3 Fish data (for outflow stream)

7.2.3.1 Summary of Trout fry densities (numbers m^{-2}), Loch Chon



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

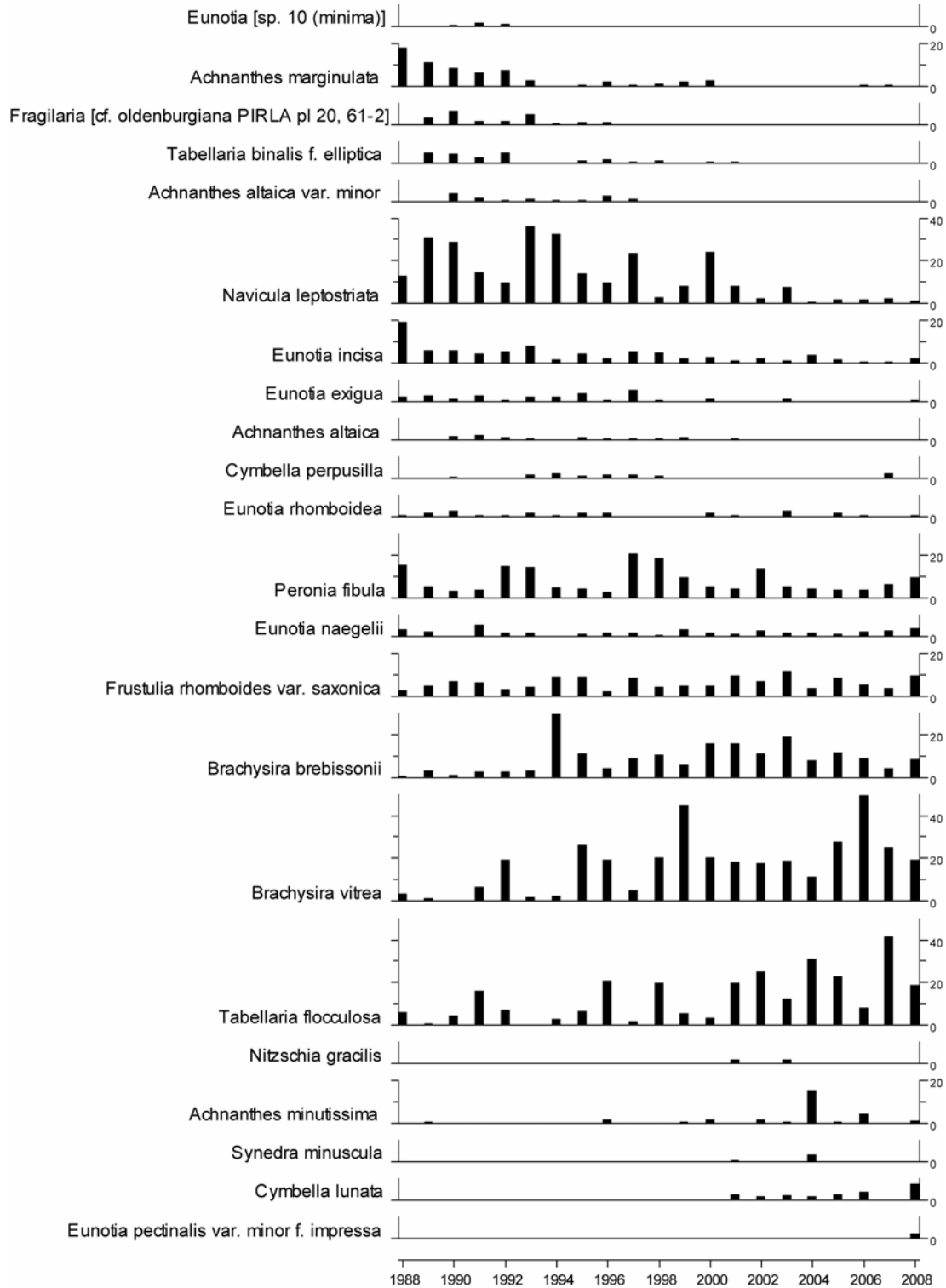
7.2.3.2 Summary of Trout parr densities (numbers m⁻²), Loch Chon



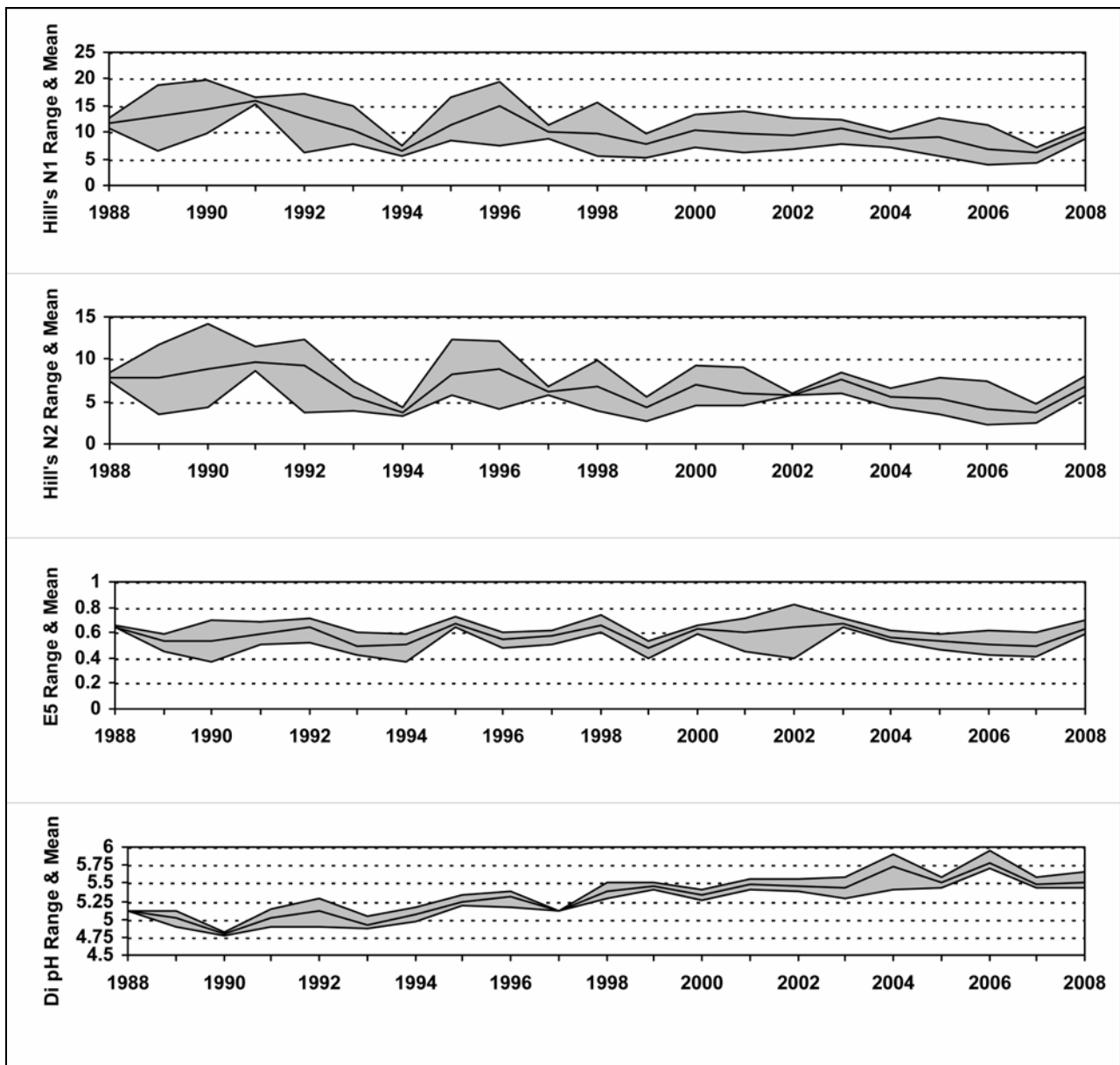
Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

7.2.4 Epilithic diatom data

7.2.4.1 Percentage abundance summary, Loch Chon

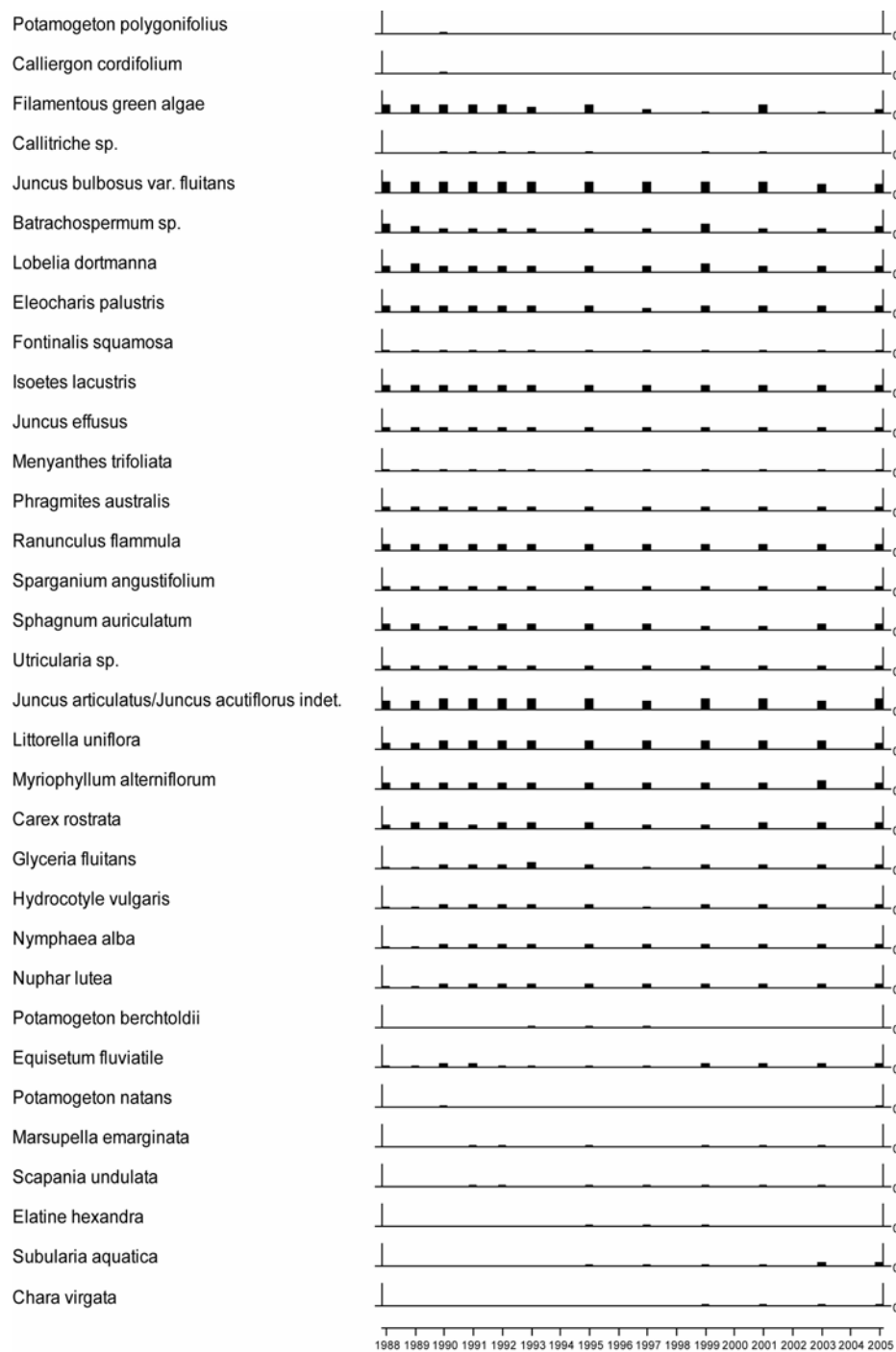


7.2.4.2 Summary statistics, Loch Chon



7.2.5 Aquatic macrophyte data, Loch Chon

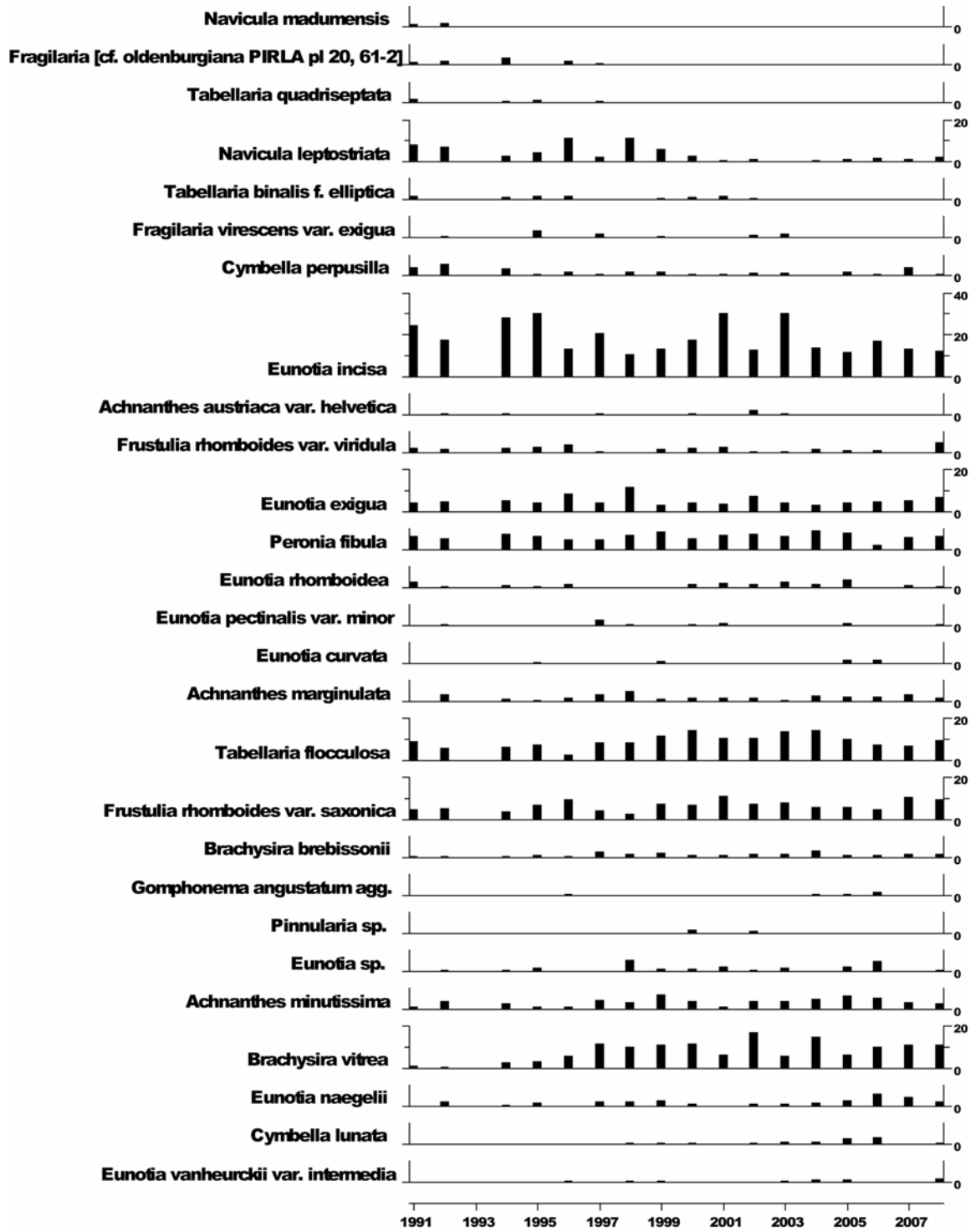
Species Scores (1-5)



No surveys since 2007 due to funding cuts

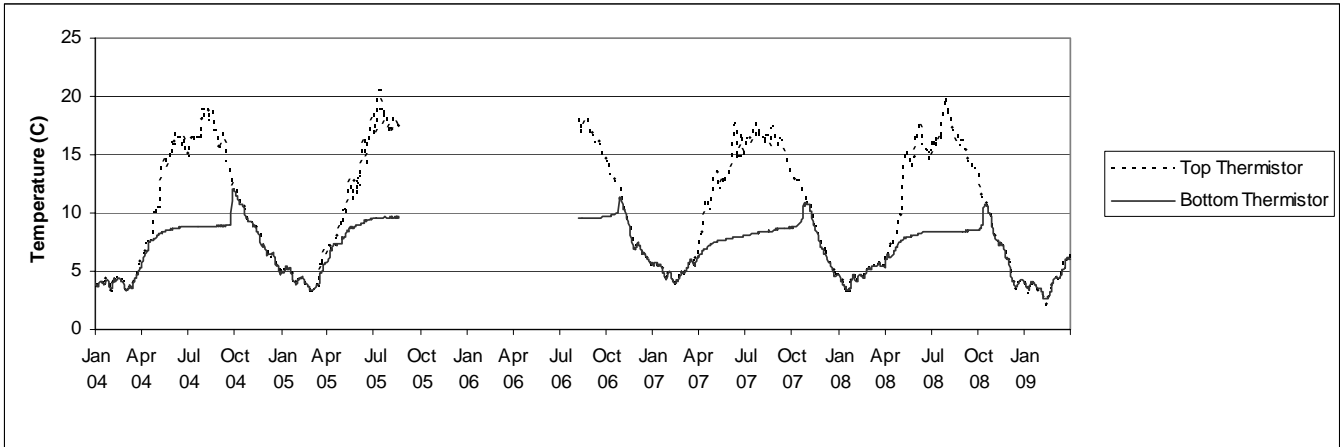
7.2.6 Sediment trap data, Loch Chon

Relative percentage frequency of diatom taxa



Traps not recovered in 1993

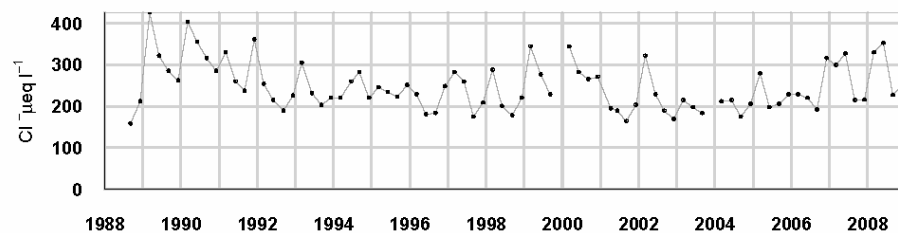
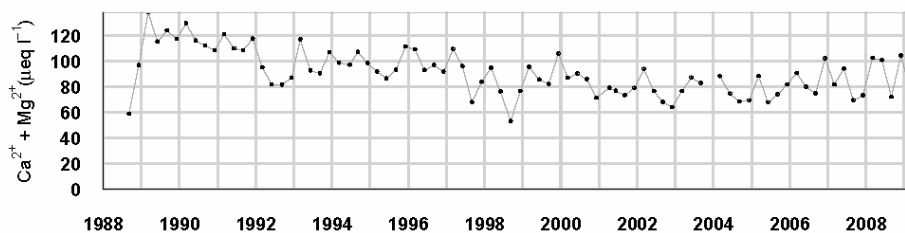
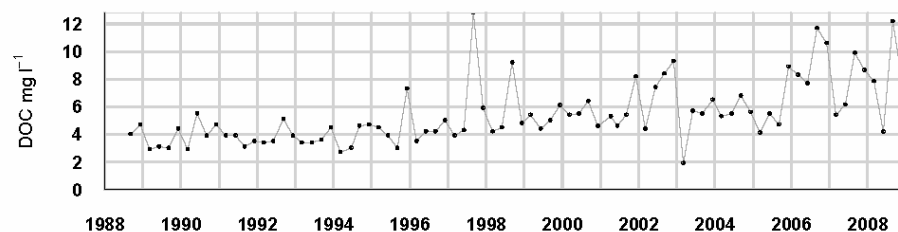
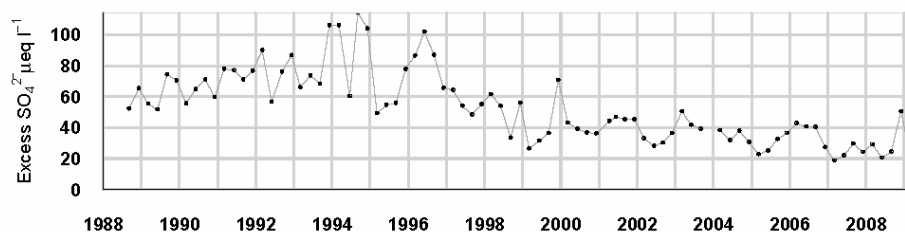
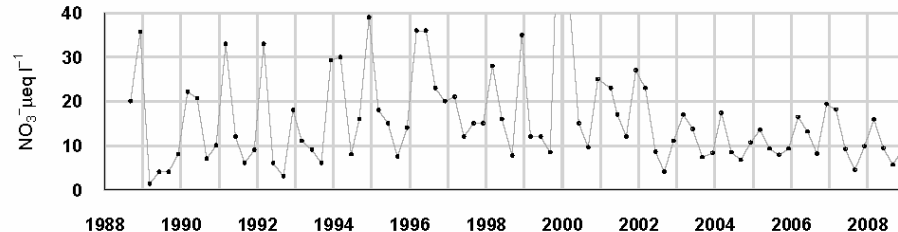
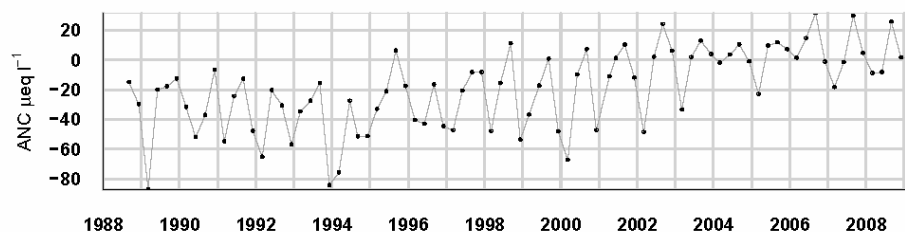
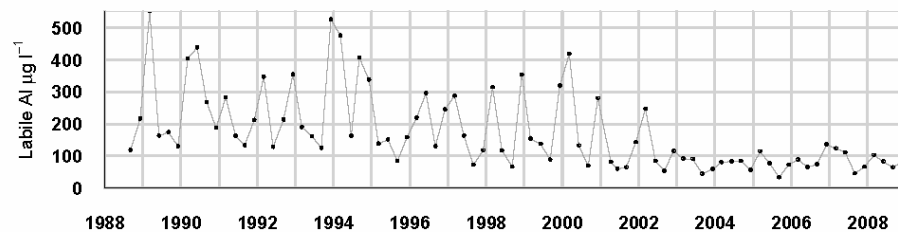
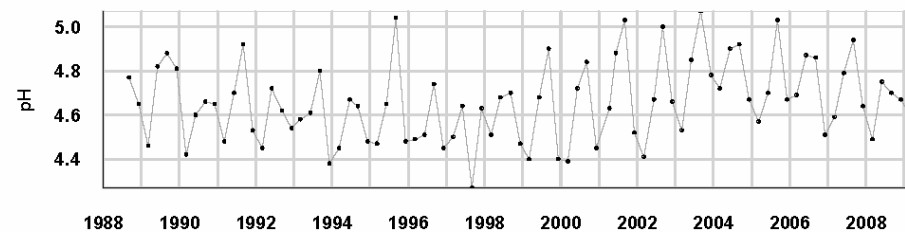
7.2.7 Thermistor data, Loch Chon



Thermistors not recovered in 2006

7.3 Loch Grannoch

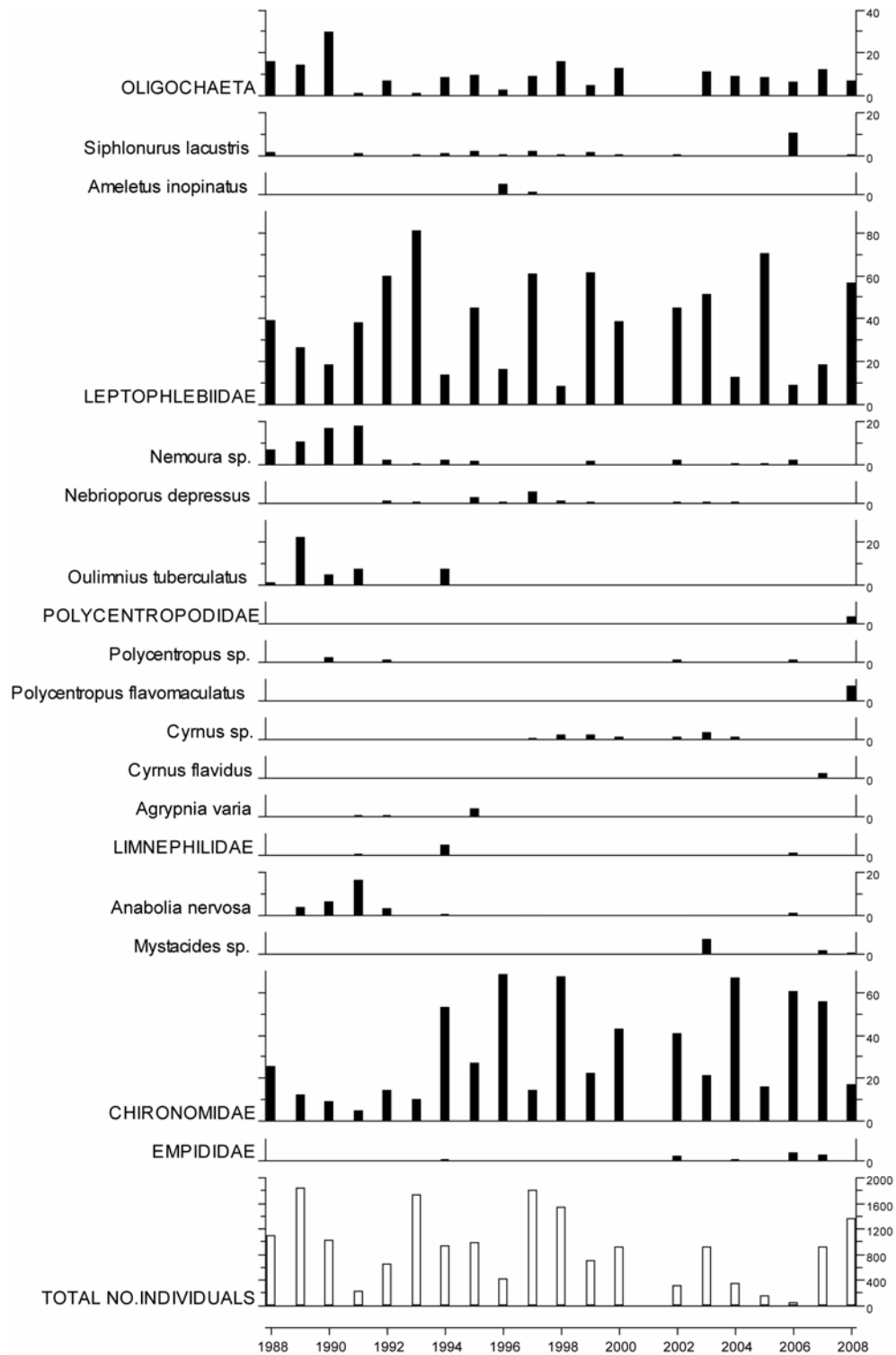
7.3.1 Spot sampled chemistry data



$\mu\text{eq l}^{-1}$, * $\mu\text{g l}^{-1}$, ** 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	4.64	-34.33	50.92	55.53	237.51	4.82	310.95	241.85	281.54	98.11	68.59	13.64	3.81
08-09 mean	4.68	5.07	38.80	49.75	232.40	6.58	175.50	74.00	269.90	57.49	29.19	9.59	8.18
08-09 std dev	0.06	14.53	12.74	8.69	33.94	2.04	28.59	8.91	56.21	13.70	14.28	3.56	3.29

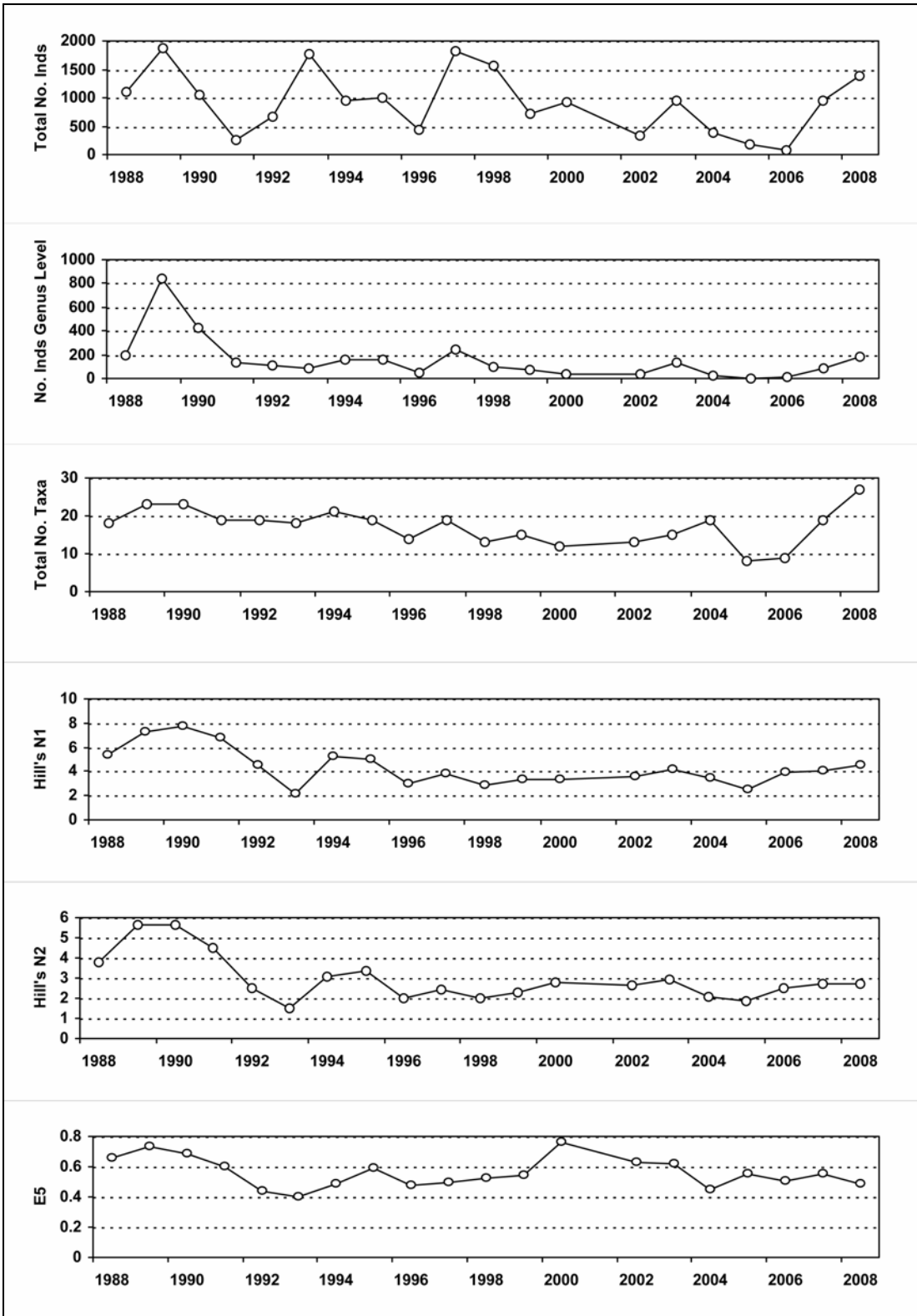
7.3.2 Macroinvertebrate data

7.3.2.1 Percentage abundance summary, Loch Grannoch



No sampling in 2001 due to Foot and Mouth restrictions.

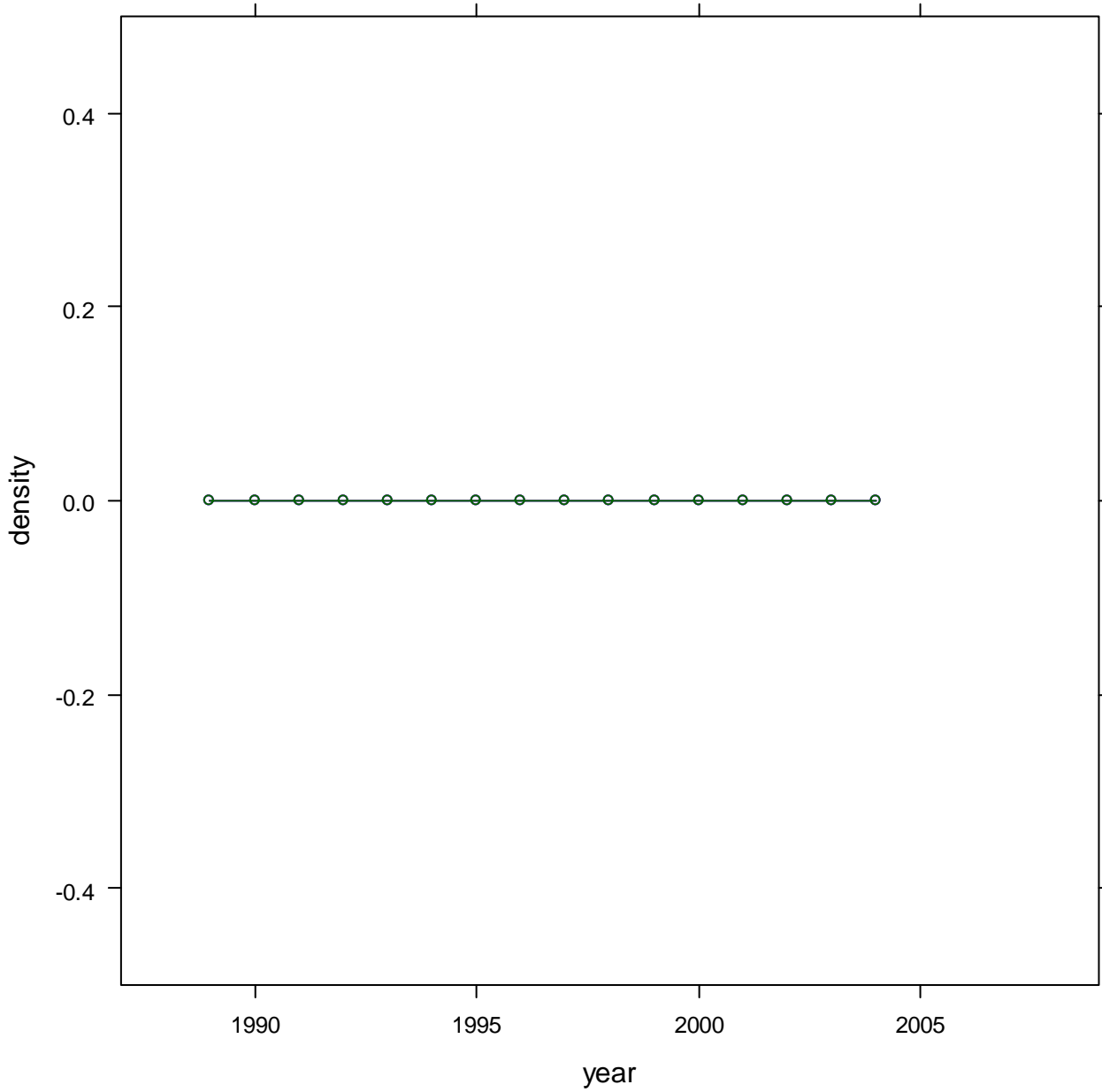
7.3.2.2 Summary statistics, Loch Grannoch



No sampling in 2001 due to Foot and Mouth restrictions.

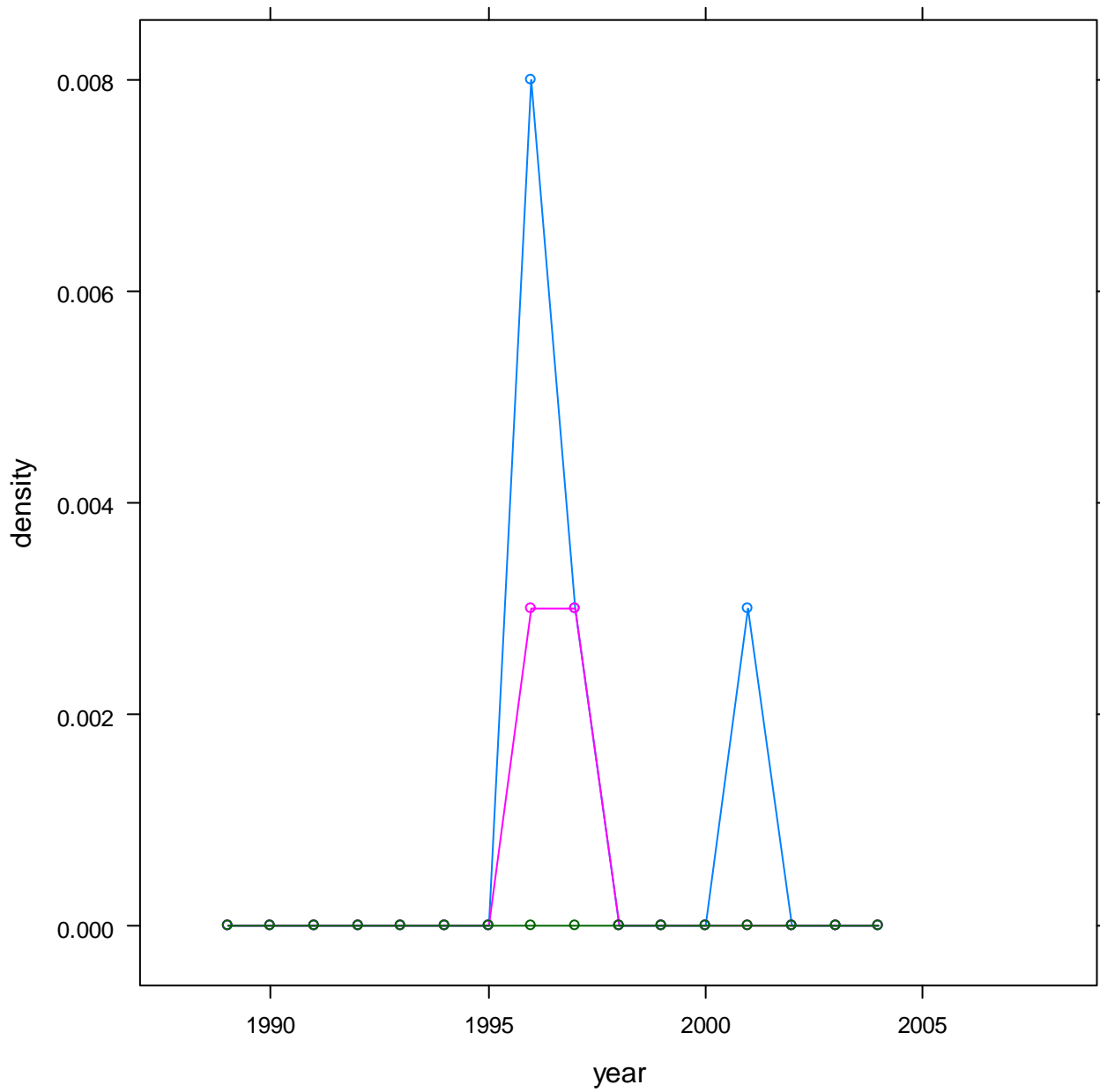
7.3.3 Fish data (for outflow stream)

7.3.3.1 Summary of Trout fry densities (numbers m^{-2}), Loch Grannoch



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

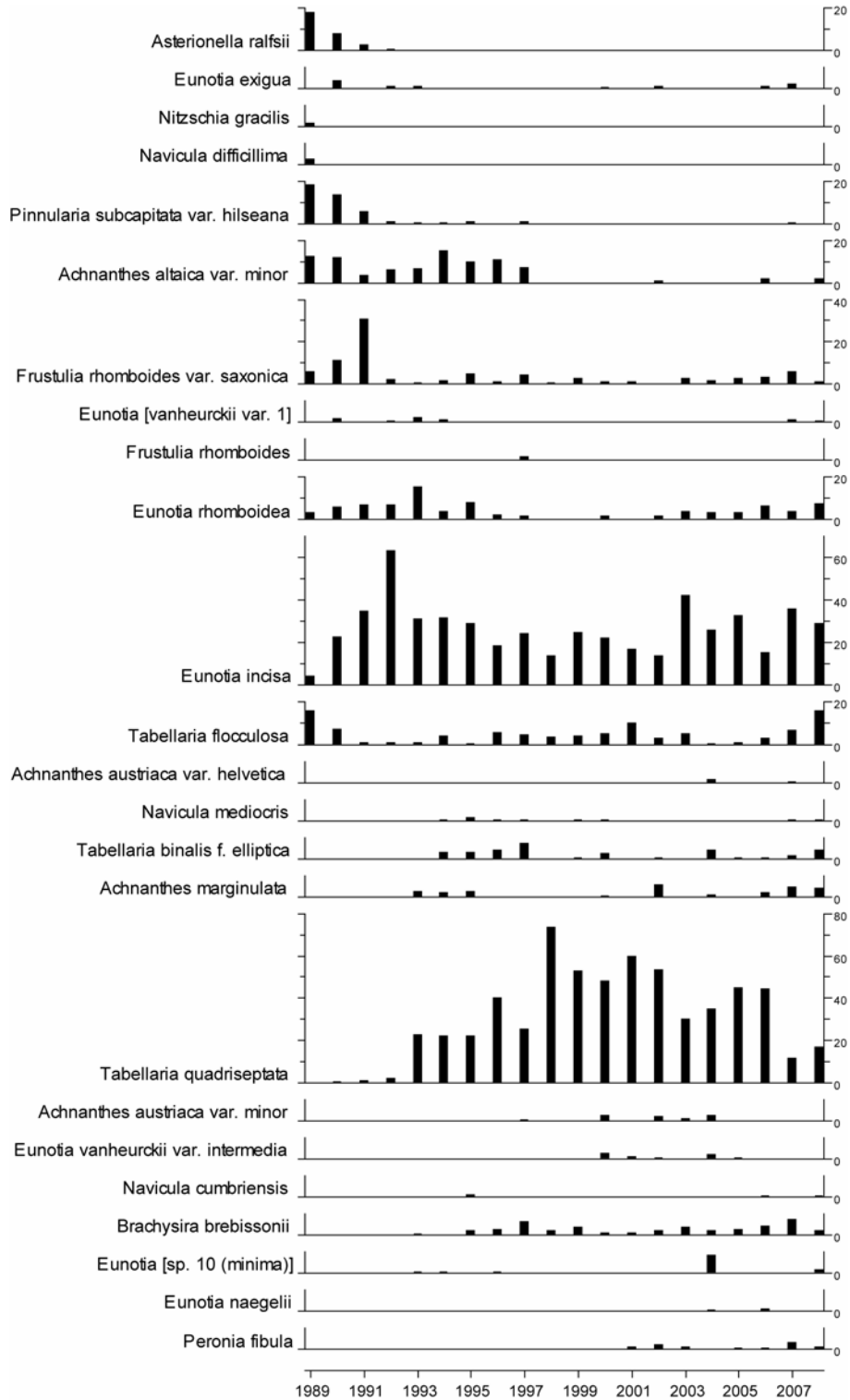
7.3.3.2 Summary of Trout parr densities (numbers m⁻²), Loch Grannoch



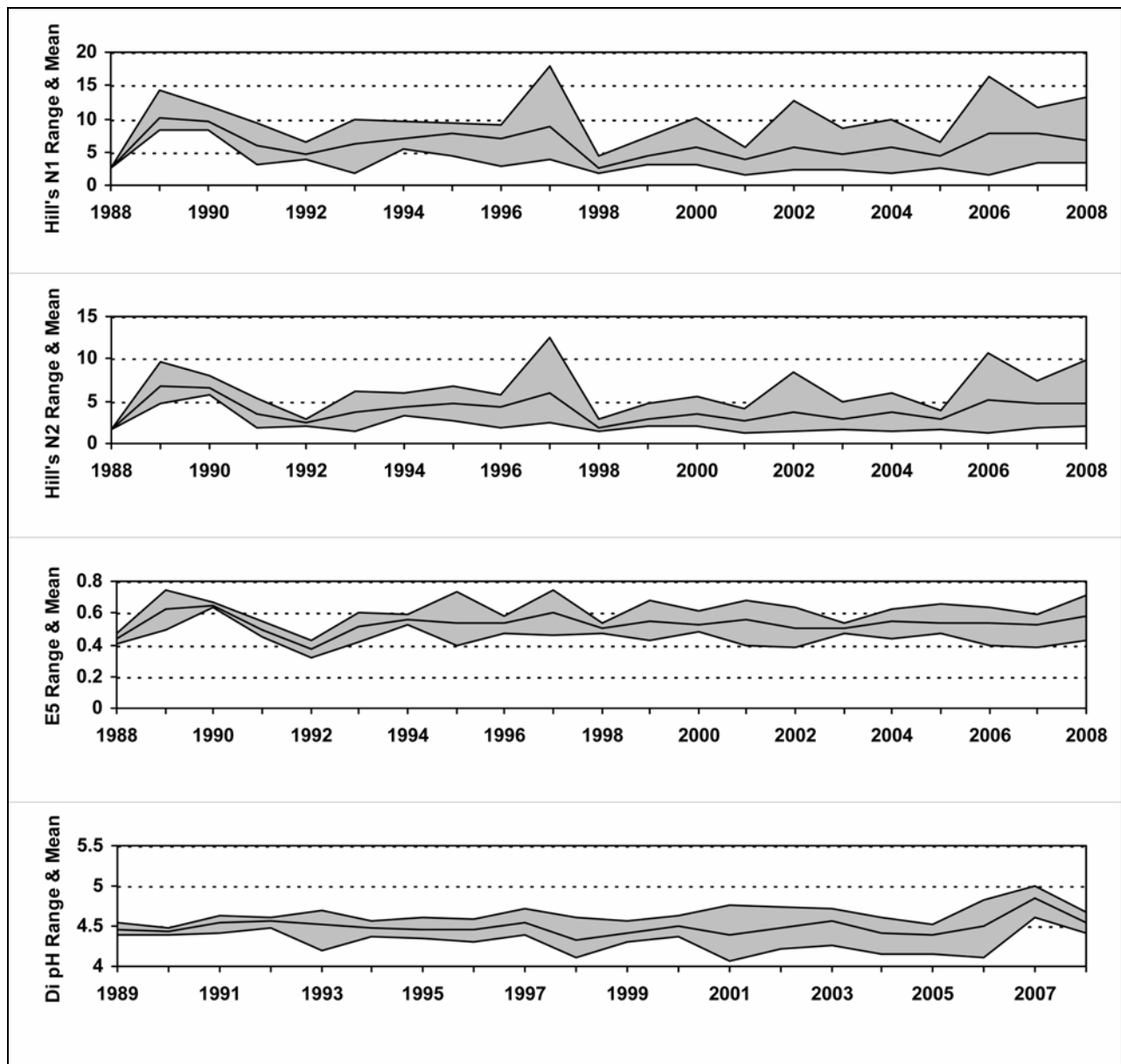
Blue series = Reach 1
Pink series = Reach 2
Green series = Reach 3

7.3.4 Epilithic diatom data

7.3.4.1 Percentage abundance summary, Loch Grannoch

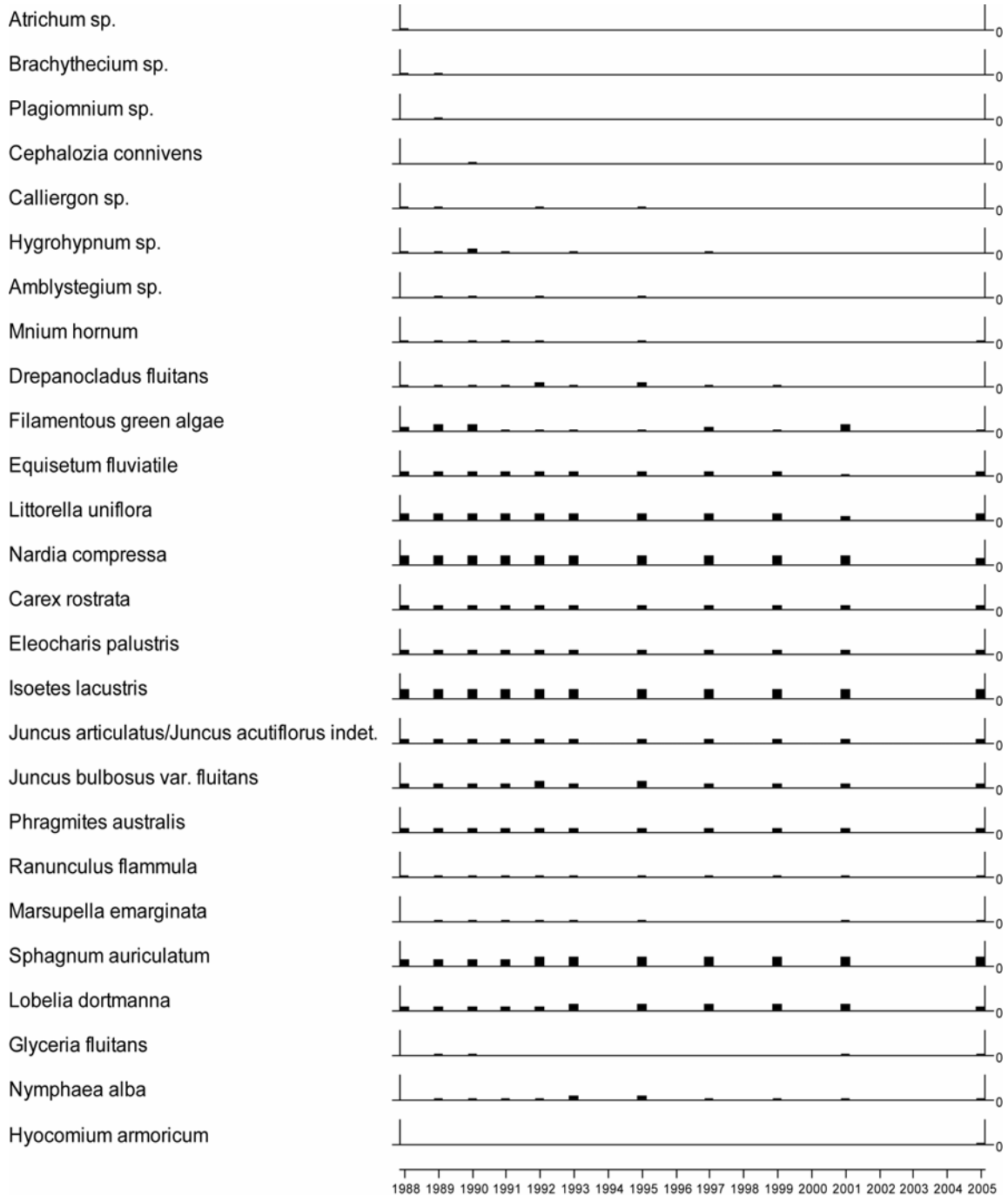


7.3.4.2 Summary statistics, Loch Grannoch



7.3.5 Aquatic macrophyte data, Loch Grannoch

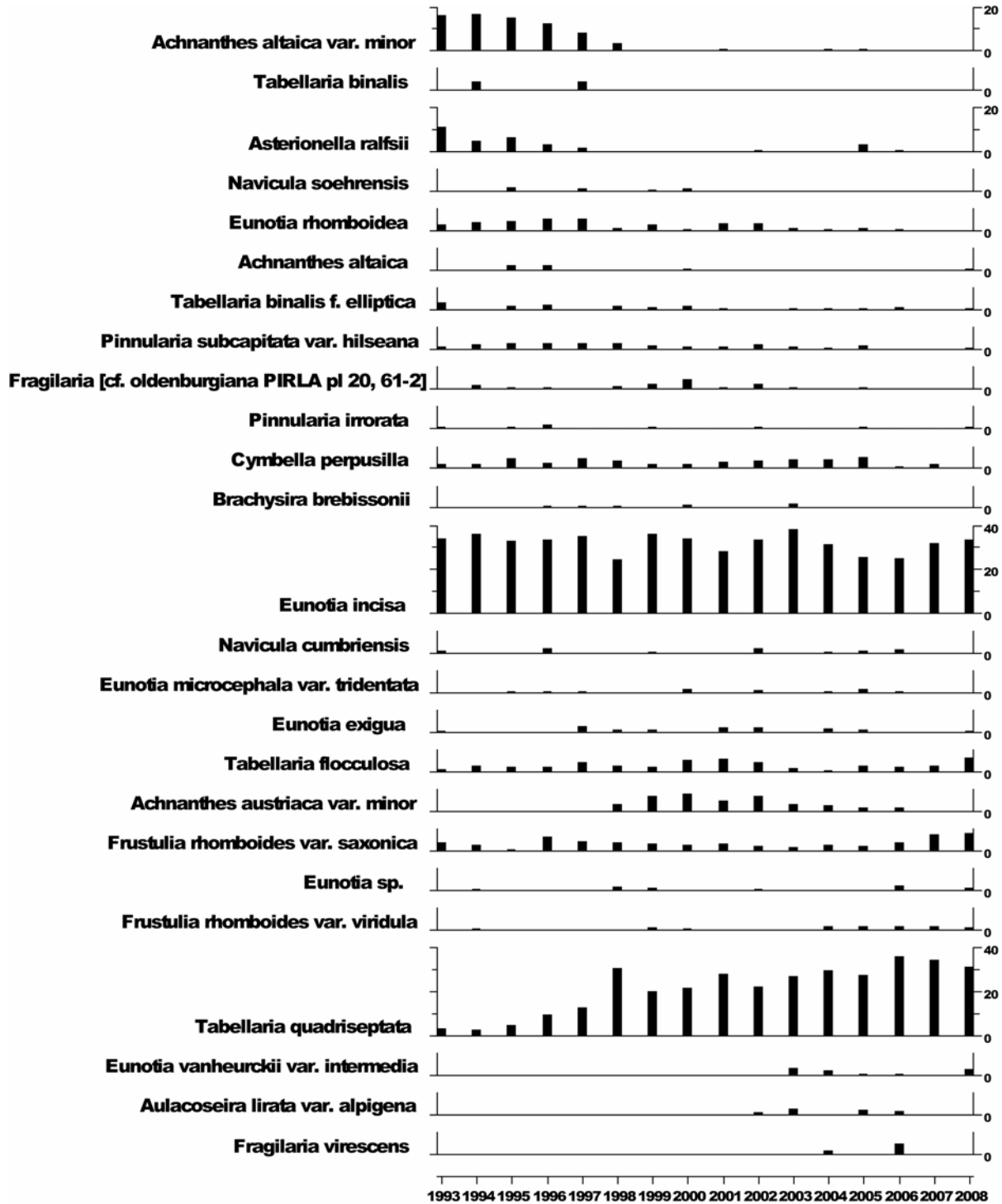
Species Scores (1-5)



No aquatic macrophyte survey in 2003.
No surveys since 2007 due to funding cuts

7.3.6 Sediment trap data, Loch Grannoch

Relative percentage frequency of diatom taxa



7.3.7 Thermistor data, Loch Grannoch

