LOCH A' CHOIRE GHLAIS: FRESHWATER INVERTEBRATE SURVEY

Report to Envirocentre

March 2011

Aquaterra Ecology




Aquaterra Ecology Crombie Cottage, Aberchirder, Huntly, Aberdeenshire AB54 7QU

Loch a' Choire Ghlais: Freshwater Invertebrate Survey 2010

1 Summary

1.1 Background

A proposed pumped storage scheme will enlarge Loch a' Choire Ghlais and produce fluctuating water levels, potentially impacting on freshwater invertebrate communities.

Macro-invertebrate communities were sampled using timed effort sampling methods from three sites on the 17th July and 28th September 2010. Major groups were identified to species level to characterise the communities, identify presence of rare species and to provide a baseline assessment for the EIA and Environmental Statement.

Environmental variables including depth, macrophyte cover and substrate profile were recorded at each site. Conductivity and pH were recorded on site and water samples were taken for analysis of alkalinity. GPS generated grid references and photographs (Annex 1) were taken to enable future site identification.

1.2 Main findings

- No rarities or notable species were identified.
- The relative proportions of invertebrate groups and species present indicate clean water conditions with a small level of organic enrichment.
- Loch a' Choire Ghlais appears to be atypical for a corrie lochan with a shallow depth and profile. This has resulted in high macrophyte coverage and autocthonous inputs of organic matter. Most of the loch has the character of a littoral zone.
- Impoundment and increased water levels will destroy the existing littoral zone and change the character of the loch significantly. The re-establishment of a new littoral zone after impoundment will be affected by the stability of the new littoral area of the larger loch; the efficiency of colonisation by macrophytes, phytobenthos and macroinvertebrates; and the magnitude, frequency and seasonality of water level fluctuations. If these are large and frequent enough then an established littoral habitat may remain absent from the impounded loch.
- The increase in water depth after impoundment will significantly impact the macrophytes and invertebrate communities throughout the loch resulting in the decrease in abundance and possible loss of some species of both macrophytes and invertebrates. After impoundment the benthic invertebrate community will likely change to one where profundal invertebrates are dominant.
- Mitigation would require a control of water level fluctuations to allow the establishment of a new stable littoral zone and areas of shallow water. This is unlikely to be practical.

2 Introduction

2.1 Lochs and the Littoral Zone

The terminology related to the physical structure of lakes is varied and there is no universally accepted definition of the littoral zone. However the benthic zone can usually be divided into littoral, sub-littoral and profundal zones. The littoral zone can be defined as the near-shore bottom area in which emerged macrophytic plants grow; the sub-littoral zone the bottom area where submerged and algal plants are found; and the profundal zone the area where plants are absent (Solimini *et al* 2006). Light availability is one of the most important factors that regulate abundance and distribution of aquatic macrophytes (Zimmerman *et al* 1994), and the maximum depth at which autotrophic aquatic plants grow is therefore related to the water transparency. The actual depths of the zones will vary from loch to loch depending upon this variable.

2.2 Invertebrates

In most lentic waters the littoral zone is generally the habitat with the highest structural diversity and the biodiversity of benthic animals is high (Bronmark & Hansson 2005). Structural diversity is provided by a diverse vegetation community of emergent and submerged plants and a rich fauna of aquatic invertebrates will be present particularly in open shade-free areas where sunshine provides warmth and light (http://www.buglife.org.uk/).

Macro-invertebrates are a diverse group with a wide range of environmental tolerances and preferences and consequently communities exhibit both qualitative and quantitative responses to a spectrum of environmental changes (Sykes *et al* 1999). The relative proportions of the invertebrate groups can therefore be used as indicators of the water chemistry status, for example absences of Gammaridae, Asellidae and Lymnaeidae are seen as an indication of acidification and presence of large numbers of Chironomidae, Corixidae and Cladocera an indication of eutrophication (http://www.ecn.ac.uk/).

Qualitative repeatable sampling strategies allow the broadest range of habitat possible to be surveyed for reasonable cost and effort. This approach provides a repeatable characterisation of the benthic macro-invertebrate fauna of lakes, which can document temporal change (Rosenberg *et al*).

3 Objectives and Methods

3.1 Objectives

The scheme of work had the following objectives:

- Describe the littoral macroinvertebrate community to species level in most major groups (including Ephemeroptera, Plecoptera, Trichoptera, adult Coleoptera, adult Heteroptera, Odonata and Crustacea).
- Provide semi-quantitative timed effort sampling and counts of each species present.
- Describe environmental variables at each littoral sampling site including depth and substrate profile (by ocular assessment) and estimates of vegetation cover.
- Provide a baseline assessment for the EIA and Environmental Statement.

3.2 Field Methods

Site Selection

The littoral zone provides an area where several sampling methods are possible without the use of a boat. This is particularly useful when waterbodies are in remote or upland areas.

Three sites were selected along the shore of the loch, representing the range of littoral habitats at the loch. One site was chosen in the vicinity of an inlet burn. Site selection was restricted to shallow areas sufficient in size for the range of sampling to be conducted.

Site Descriptions

Sites were accurately recorded using photographs and GPS grid references (Garmin etrex, accuracy of <15 metres RMS). Physical environmental factors including depth and substrate profiles (by ocular assessment using Wentworth scale) were recorded for the sites. Water temperature, pH and conductivity were recorded with a portable meter Hanna HI 98129, resolution 0.1ºC, 0.01 pH and 1 µS/cm and accuracy ± 0.5ºC, ± 0.01 pH and conductivity ± 2%. Water samples were taken and total alkalinity was measured using a Hanna Alkalinity Test Kit H3811, smallest increment 3mg/L $CaCO_3$. Data was recorded on standard fieldsheets.

Sampling

The littoral benthic macroinvertebrate community at each site was sampled by three timed effort techniques, a timed sweep through beds of submerged macrophytes and the submerged parts of emergent macrophytes if present, a timed stone pick and a timed kick sample. Both sweep netting and kick sampling have the advantage of being quick and simple field methods (Hill *et al* 2005). The results of all three were combined to give a description of the macro-invertebrate community present at each site. This method maximises the diversity of the invertebrates sampled and collects enough invertebrates to characterise the community even if invertebrate densities are low.

Sweep Sampling

A timed three minutes sample by sweep netting, of beds of submerged macrophytes and the submerged parts of emergent macrophytes if present, was taken to capture invertebrates colonising submerged vegetation.

Stone Pick

Substrate was sampled using a timed three minutes stone pick. Animals were carefully removed from stones into jars of 70% alcohol.

Kick Sampling

Three minutes timed kick samples using a standard 25cm diameter kick sample net with a 1mm mesh were taken at each of the three sample sites. The sampler disturbed the substrate vigorously with the heels, by kicking or rotating, to dislodge the substrate to a depth of about 10cm and the net was swept through the disturbed area immediately above the substrate. The effort spent in different substrate types present was broadly proportional to their cover. Animals were preserved in 70% alcohol.

Sampling Intensity

Three sampling periods are normally recommended: March - May, June - August, and September - November, as this procedure has been shown to give a reasonably comprehensive list (Sykes *et al* 1999). However two sampling periods were proposed, one summer (July) and one autumn (September) to produce enough information for most groups.

3.3 Laboratory Identification

Invertebrates were examined using a Wild binocular microscope at 6-50X magnification and a Brunel compound microscope at 40 – 400X magnification. Identification employed standard keys (Brooks & Lewington 1999, Edington & Hildrew 1995, Elliot 2009, Elliot & Humpesch 2010, Elliot, & Mann 1979, Friday 1988, Harding & Smith 1974, Hynes 1977, Killeen, Aldrich & Oliver 2004, Macan 1959, Macan 1977, Nilsson 1996, 1997, Reynoldson & Young 2000, Scourfield & Harding 1966, Timm & Veldhuijzen van Zanten 2002 and Wallace, Wallace & Philipson 1990).

The invertebrates in all samples were identified to species level in most major groups and the total numbers of invertebrates in each species or group were recorded.

4 Results

4.1 Site Descriptions

The environmental factors recorded at each site are shown in Table 1. Site photographs are found in Annex 1.

Loch a' Choire Ghlais is a small "corrie loch" with an atypical depth profile. Glacial plucking action usually results in a deep area at the base of the rock face side of a corrie loch but Loch a' Choire Ghlais is almost uniformly shallow. As a result of the atypical bathymetry emergent macrophytes grow extensively and the area with littoral character constitutes most of the loch, with only limited profundal areas present.

Loch a' Choire Ghlais is fed by a number of inlet burns and sample site LCG 1 was sited by one. Substrate composition at all sites consisted of a large proportion of pebbles and cobbles combined, 30-80% summer and autumn (mean 56%) but also with significant amounts of silt (10-50%). The site with the highest silt content was LCG 2 in the summer. It is possible that some of the small particles recorded as silt were in fact fine particulate organic matter from the breakdown of plant matter and not of soil or rock derivation.

Total macrophyte cover, both emergent and submerged plants, was high at all sites in both sample periods, 50-80% (mean 64%). The most widespread emergent macrophytes were *Juncus bulbosus* (bulbous rush) and *Eleocharis palustris* (common spike-rush). *Juncus bulbosus* grows to depths of two metres and is usually found in base poor water (Preston & Croft 1997). *Eleocharis palustris* grows to depths of 0.5 metres and tolerates moderate water level fluctuations but is absent if fluctuations are large (Grime *et al* 1988).

4.2 Invertebrate Communities

The proportional abundances of invertebrate groups are shown in Plate 1 (expressed as percentages of the total population). The numbers of each species found in the samples are recorded in Annex 2.

The common names of the invertebrate groups are given below:

Latin Name	Common Name	Latin Name	Common Name
Plecoptera	Stoneflies	Hemiptera	Bugs
Ephemeroptera	Mayflies	Crustacea	Shrimps, water fleas
Trichoptera	Caddis flies	Mollusca	Snails, mussels
Diptera	Two winged flies	Oligochaeta	Worms
Coleoptera	Beetles	Hirudinea	Leeches
Sialidae	Alderflies	Nematoda	Nematodes
Odonata	Dragonflies	Hydracarina	Mites

The categories in Plate 1 are Diptera (the most abundant insect group), other Insecta, Crustacea (the microcrustacea, cladocera and copepoda), Mollusca and Other.

Proportionally the largest groups in all samples were Diptera 22-63% (mean 46%) and Crustacea 14-69% (mean 37%). Diptera consisted almost entirely of chironomids, a group with a large number of species many of which feed on decaying organic matter. The high proportion of Diptera indicates a level of organic enrichment more common in mesotrophic to eutrophic water conditions than the more typical oligotrophic upland lochs. This is partly a result of the shallow depth of Loch a' Choire Ghlais and the level of coverage of macrophytes promoting autocthonous inputs of nutrients.

The Crustacea species present were all microcrustacea dominated by two species, the cladoceran *Eurycercus lamellatus* and the cyclopoid copepod *Cyclops viridis*. Calanoid copepods appear to dominate oligotrophic waters while cyclopoid copepods and cladocerans are relatively more abundant in eutrophic waters (Gannon & Stemberger 1978, Jones 1984) and the species composition here indicates a level of nutrient enrichment. *Eurycercus lamellatus* has been described as a benthic species that occasionally migrates into the plankton (Gunn & May 1999).

Other insects present included a considerable number of the mayflies *Baetis rhodani* and *Siphlonurus lacustris* at LCG 1 (summer) probably associated with the inlet burn. Small numbers of beetle larvae and adults were present from the families dytiscidae and haliplidae. The former are predatory mainly on cladocerans and small chironomids and haliplid larvae feed on algae. The alder fly larvae *Sialis lutaria* prefer soft sediments. Two species of water boatmen, *Sigara scotti* and *Sigara venusta,* were present almost entirely in autumn samples, supporting the need for sampling in different seasons to record invertebrates of varying phenologies. Two common species of damselflies were present, *Enallagma cyathigerum* common blue damselfly and *Pyhrrhosoma nymphula* large red damselfly.

Of the molluscs the small numbers of *Radix peregra* present indicated that acidification events are unlikely to have occurred. The numbers of *Pisidium* species found suggest a level of organic enrichment.

Overall no rare species were recorded and the relative proportions of invertebrate groups and species present indicated clean water conditions with a small level of organic enrichment.

4.3 pH, Conductivity and Alkalinity

pH recordings from all sites in both summer and autumn varied from 6.84-7.27 (mean 7.04) indicating Loch a' Choire Ghlais is circum-neutral.

Conductivity was low varying from 9.0- 20 µS/cm (mean 14.7 µS/cm). Conductivity is related linearly to total dissolved solids (TDS). The low conductivity therefore suggests a low loading of TDS indicating unpolluted conditions.

Similarly alkalinity levels were also low with recordings of 9.0-11.7 mg/L $CaCO_3$ (mean 10.3 mg/L $CaCO_3$) at Loch a Choire Ghlais sites. In the summary of river typography used in river macrophyte classification the United Kingdom Technical Advisory Group (UKTAG) classifies alkalinity as low (<10 mg/L $CaCO_3$), moderate (10-50), high (50-200) and very high (>200). The US Environmental Protection Agency classes watercourses with alkalinity levels of 10-20 mg/L $CaCO_3$ as sensitive to acid rain. The buffering capacity of Loch a' Choire Ghlais is low.

5 Potential Impacts

Impacts on the littoral habitat are likely during both the construction and operational phases of the development. The most important changes that may impact the littoral zone, and the invertebrate and macrophyte communities present, are the raising of the loch water level, and water level fluctuations during both construction and operational phases.

Raising the water level of the loch will change the profile of the shoreline, most likely to steeply sloping margins, reducing both the area and habitat diversity of the littoral zone, with likely impacts on invertebrate abundance and diversity. Re-profiling of banks to create steeply sloping margins is highly damaging to invertebrates (www.buglife.org.uk). Changes in shoreline topography may result from both direct re-profiling and from the natural topography of the new shoreline present in the enlarged and deepened loch.

The role of the littoral zone for the diversity and functioning of a lake ecosystem is probably strongly compromised by extensive and fast water level fluctuations (Solimini *et al* 2006). Variable drawdown regimes could have significant impacts on benthic food webs and the transfer of energy and nutrients to the pelagic area (Furey *et al* 2006), but this area is limited at Loch a' Choire Ghlais. Removal of macrophytes by drawdown creates large expanses of open areas likely resulting in a less diverse and much less abundant invertebrate fauna in littoral zone sediments (Beckett *et al* 1992).

The aquatic invertebrate communities of drawdown zones are often characterised by mobile groups such as microcrustaceans, beetles and water boatmen that are able to respond to changes in water level by migrating into new littoral regions. An alternative adaptation for species with low mobility and resistance to desiccation such as mussels and snails is to become dormant, sealing off the shell opening to resist drying out (http://www.drawdownzone.eu). However these groups are often associated with macrophytes and if macrophytes are absent drawdown zones will be depauperate. Some macroinvertebrate taxa have been shown to recolonise habitats within weeks of rewetting, while others may take over 3 months (Solimini *et al* 2006).

The level of drawdown is an important factor. In a study of 27 Scottish lochs, those with natural level fluctuations and those with fluctuations <5m in the preceding year, the littoral macrophytes and zoobenthos were usually varied and reasonably abundant, but in lochs with >5m fluctuation the flora and fauna were very impoverished and sometimes completely absent (Smith *et al* 1987).

6 Conclusion

Loch a Choire Ghlais is a shallow loch with extensive macrophyte growth with an associated macroinvertebrate community. The character of most of the loch is littoral and only small areas of profundal habitat occur. The current level of macrophyte growth promotes an autocthonous nutrient input resulting in the current relative proportions of invertebrate groups present. The proposed pumped storage scheme will enlarge and deepen the loch, destroying the existing littoral areas and changing the character of the invertebrate community. During the operational phase the fluctuating water levels of the new loch may prevent the establishment of a new littoral zone resulting in the reduced abundance and possible loss of some invertebrate and macrophyte species. After impoundment the benthic invertebrate community will likely change to one where profundal invertebrates are dominant.

7 References

Beckett, D.C., Aartilia, T.P. & Miller, A.C. 1992 Contrasts in Density of Benthic Invertebrates Between Macrophyte Beds and Open Littoral Patches in Eau Galle Lake, Wisconsin.

Bronmark, C. & Hansson, L. 2005 The Biology of Lakes and Ponds. Oxford University Press.

Brooks, S. & Lewington, R. 1999 Field Guide to the Dragonflies and Damselflies of Great Britain and Ireland. British Wildlife Publishing.

Edington, J.M. & Hildrew, A.G. 1995 Caseless Caddis Larvae of the British Isles. Pub. No. 53 Freshwater Biological Association.

Elliot, J.M. 2009 Freshwater Megaloptera and Neuroptera of Britain and Ireland. Pub. No. 65 Freshwater Biological Association.

Elliot, J.M. & Humpesch, U. H. 2010 Mayfly Larvae (Ephemeroptera) of Britain and Ireland: Keys and a Review of their Ecology. Pub.No. 66 Freshwater Biological Association.

Elliot, J.M. & Mann, K.H. 1979 A Key to the British Freshwater Leeches. Pub.No. 40 Freshwater Biological Association.

Friday, L.E. 1988 A Key to the Adults of British Water Beetles. Field Studies Council

Furey, P.C., Nordin, R.N. & Mazumder, A. 2006 Littoral benthic macroinvertebrates under contrasting drawdown in a reservoir and a natural lake. Journal of the North American Benthological Society. 25(1), 19-31

Gannon, J. E. and Sternberger, R. S. 1978 Zooplankton (especially crustaceans and rotifers) as indicators of water quality. Transactions of the American Microspical Society. 97, 1, 16-35.

Grime, J.P., Hodgson, J.G. & Hunt, R. 1988 Comparative Plant Ecology. London: Unwin Hyman

Gunn, I.D.M. & May, L. 1999 Analysis of 1998 zooplankton samples – Loch Leven. Report to Scottish Natural Heritage.

Harding, J.P. & Smith, W.A. 1974 A key to the British Freshwater Cyclopoid and Calanoid Copepods. Pub. No. 18 Freshwater Biological Association.

Hill, D., Fasham, M., Tucker, G., Shewry, M. & Shaw, P. 2005 Handbook of Biodiversity Methods. Survey, Evaluation and Monitoring. Cambridge University Press.

Hynes, H.B.N. 1977 Adults and Nymphs of the British Stoneflies (Plecoptera). Pub. No.17 Freshwater Biological Association.

Jones, D. H. 1984. Open-water zooplankton from five Tayside lochs. The Scottish Naturalist, 65-91.

Killeen, I., Aldridge, A. & Oliver, G. 2004 Freshwater Bivalves of Britain and Ireland. Aidgap

Macan, T.T. 1959 A Guide to Freshwater invertebrate Animals. Longmans.

Macan, T.T. 1977 British Fresh- and Brackish-Water Gastropods. A key. Pub. No. 13 Freshwater Biological Association.

Nilsson, A. (ed.) 1996 Aquatic Insects of North Europe Vol1. Apollo Books

Nilsson, A. (ed.) 1997 Aquatic Insects of North Europe Vol2. Apollo Books

Preston, C.D. & Croft, J.M. 1997 Aquatic Plants in Britain and Ireland. HarleyBooks

Reynoldson, T.B. & Young, J.O. 2000 A key to the Freshwater Triclads of Britain and Ireland. Freshwater Biological Association.

Rosenberg, D.M., Davies, I.J., Cobb, D.G. & Wiens, A.P. Protocols for Measuring Biodiversity: Benthic Macroinvertebrates in Freshwater. Department of Fisheries and Oceans. Freshwater Institute. Mannitoba

Scourfield, D.J. & Harding, J.P. 1994 British Freshwater Cladocera. A Key 1966 Pub. No. 5 Freshwater Biological Association.

Smith, B.D., Maitland, P.S. & Pennock, S.M. 1987 A comparative study of water level regimes and littoral benthic communities in Scottish lochs. Biological Conservation 39, 4, 291-316

Solimini, A.G., Free, G., Donohue, I., Irvine, K., Pusch, P., Rossaro, B., Sandin, L., & Cardoso, A.C. 2006 Using Benthic Macroinvertebrates to Assess Ecological Status of Lakes Current Knowledge and Way Forward to Support WFD Implementation. European Communities Technical report EUR 22347 EN

Sykes, J.M., Lane, A.M.J. & George, D.C. (eds) 1999 The United Kingdom Environmental Change Network. Protocols for Standard Measurements at Freshwater Sites. Natural Environment Research Council.

Timm, T. & Veldhuijzen van Zanten, H. H. 2002 Freshwater Oligochaeta of North-West Europe. Expert Center for Taxonomic Identification, University of Amsterdam.

Wallace, I.D., Wallace, B. & Philipson, G.N. 1990 A Key to the Case-Bearing Caddis Larvae of Britain and Ireland. Pub. No. 51 Freshwater Biological Association.

Zimmerman, R.C., Cabello-Pasini, A. and Alberte R.S. 1994. Modelling daily production of aquatic macrophytes from irradiance measurements: a comparative analysis. Marine Ecology Progress Series 114: 185-196.

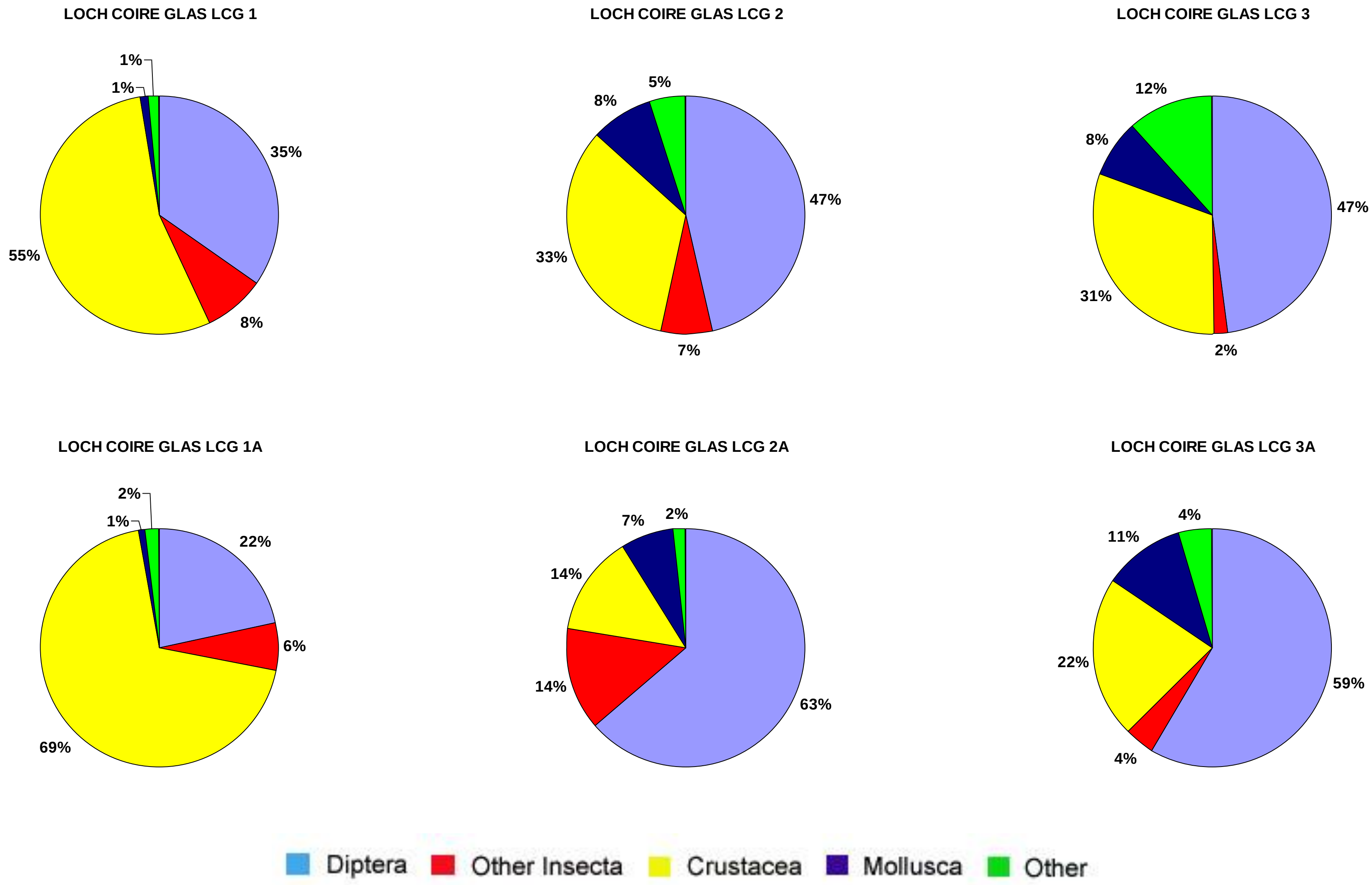
Table 1 *Sampling Sites: Environmental Factors*

Site Code	Date	10km Square	E	N	Depth (cm)	HO	SI	SA	GR	PE	CO	BO	BE	Clarity
July														
LCG 1	17/07/2010	NN	22816	95053	30	0	10	10	5	25	50	0	0	clear
LCG 2	17/07/2010	NN	22845	95167	30	0	50	9	10	10	20	1	0	clear
LCG 3	17/07/2010	NN	22938	95167	30	0	10	10	10	20	45	5	0	clear
September														
LCG 1A	28/09/2010	NN	22816	95053	30	0	10	5	5	15	65	0	0	clear
LCG 2A	28/09/2010	NN	22845	95167	25	0	25	20	10	10	30	5	0	clear
LCG 3A	28/09/2010	NN	22938	95167	30	0	20	15	15	20	25	5	0	clear

SI = silt SA = sand GR = Gravel PE = Pebble CO = Cobble BO = Boulder BE = Bedrock

Site	pH	Temp ºC	Conductivity µS/cm	Alkalinity mg/L $CaCO_3$	Macrophyte Cover %	Vegetation composition
July						
LCG 1	7.27	9.7	11.0	9.0	60	5% Bryophyte, 15% Algae, 40% Juncus bulbosus
LCG 2	6.84	11.1	9.0	9.0	70	5% Racomitrium aciculare, 10% Algae, 55% Potamogeton natans and Juncus bulbosus
LCG 3	6.91	10.5	13.0	9.3	50	5% Bryophyte, 5% Algae, 40% Juncus bulbosus and Eleocharis palustris
Sept						
LCG 1A	7.08	7.9	17.0	10.8	80	30% Algae, 50% Juncus bulbosus and Myriophyllum alternifolium
LCG 2A	7.12	8.7	18.0	11.7	72	2% Brachythecium plumosum and Racomitrium aciculare on boulders, 10% Algae, 60% Juncus bulbosus and Potamogeton natans
LCG 3A	7.03	8.7	20.0	11.7	50	5% Bryophyte, 20% Algae, 25% Eleocharis palustris, Juncus bulbosus and Littorella uniflora

Plate 1 *Invertebrate Groups: Percentages of Total Population*



Annex 1 *Photographs Loch a Choire Ghlais*


Loch a Choire Ghlais


Site LCG 1 with inlet burn.


Site LCG 2 with *Potamogeton natans* (background).


Site LCG 3 with *Eleocharis palustris* beds.

Annex 2 *Invertebrate numbers present in composite samples, spring and autumn (suffix A)*

Site Code	LCG 1	LCG 2	LCG 3	LCG 1A	LCG 2A	LCG 3A
Plecoptera						
Capniidae						
Capnia sp.				1		
Leuctridae	1					
Leuctra hippopus						
Nemouridae						
Nemoura avicularis				6		
Nemurella picteti	1					
Ephemeroptera						
Baetidae						
Alainites muticus	2			5		
Baetis rhodani	18			1		
Heptageniidae						
Electrogena lateralis	3					
Leptophlebiidae						
Paraleptophlebia sp.					4	1
Siphlonuridae						
Siphlonurus lacustris	39	7				
Trichoptera						
Hydroptilidae						
Hydroptila sp.				1	3	
Oxyethira sp.				20		
Limnephilidae						
Instar II				5		
Limnephilus lunatus	4					
Phryganidae						
Phrygania / Agrypnia					5	
Polycentropodidae						
Plectronemia conspersa	1				2	1
Polycentropus flavomaculatus	5		1	1		4

Rhyacophilidae						
Rhyacophila dorsalis				1		

Annex 2 *Invertebrate numbers present in composite samples, spring and autumn (suffix A)*

Site Code	**LCG 1**	**LCG 2**	**LCG 3**	**LCG 1A**	**LCG 2A**	**LCG 3A**
Diptera						
Chironomidae	357	216	347	199	396	234
Culicidae	5	2	2			
Empididae	1					
Limoniidae						
Eloeophila sp.				1		
Coleoptera						
Dytiscidae						
Agabus sp.					1	
Hydroporus sp	3					
Illybius					1	
Nebrioporus sp		3	4			1
Oreodytes sp			1			
Elmidae						
Elmis aenea	3			1		
Haliplidae						
Haliplus sp.		1	4	1	5	4
Haliplus ruficollis					1	
Haliplus wehnkeri	2	2				
Sialidae						
Sialis lutaria	3	17	3	15	16	2
Odonata						
Enallagma cyathigerum					1	
Pyhrrhosoma nymphula					1	
Hemiptera						
Corixidae						
Early nymphs I - III					9	
Sigara scotti ♂♂s					2	
Sigara venusta ♂♂s		2			13	4
Sigara sp. ♀♀s					22	

Annex 2 *Invertebrate numbers present in composite samples, spring and autumn (suffix A)*

Site Code	**LCG 1**	**LCG 2**	**LCG 3**	**LCG 1A**	**LCG 2A**	**LCG 3A**
Crustacea						
Cladocera						
Eurycercus lamellatus	527	148	221	578	70	75
Copepoda						
Cyclops viridis	40	9	6	60	14	13
Ostracoda	2			2		
Mollusca						
Lymnaeidae						
Radix peregra	4	2	2	6	2	2
Sphaeriidae						
Pisidium sp.	6	37	54		43	42
Oligochaeta						
Enchytraeidae				1	4	1
Lumbriculida	1	1	10			2
Naidida						
Stylaria lacustris		6	21	3	2	9
Tubificida	12	14	21	7	3	5
Hirudinea						
Helobdella stagnalis		1	31		1	1
Nematoda		1		1		
Hydracarina	2		2	7	1	