VIKING ENERGY WIND FARM

Invertebrate monitoring, autumn 2024

November 2024

Aquaterra Ecology

Waterside Ecology

   

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Invertebrate monitoring, autumn 2024

1 Background

Changes to the hydrochemistry of Burn of Lunklet and Burn of Weisdale occurred during the construction of the Viking Energy Wind Farm. In Burn of Lunklet, these included periods of very low pH (acidity), reduced concentration of dissolved organic carbon (DOC), increased concentrations of metals including aluminium, zinc, nickel and manganese, and elevated nitrate (TON). These impacts are still evident, although pH has increased significantly over the past 10 months (Headley 2024). In Burn of Weisdale, the main recorded changes were increases in the concentrations of zinc and aluminium. These have now dropped and over the past 6 months metals concentrations at monitoring sites in Burn of Weisdale have remained with the Good environmental standard given in The Scotland River Basin District (Standards) Directions 2014.

Routine monitoring and other investigations identified runoff from Scallafield Scord as the primary source of contamination. In the Burn of Lunklet, the likely source was identified as borrow pit KBP02 as early as February 2022 and possible mitigation was suggested (Headley 2022a). However the main contractor was disinclined to accept this and no mitigation was put in place until spring 2023.

By May 2022 substantial deposits of ochreous material were present on the streambed of Burn of Lunklet (Aquaterra Ecology 2022). Headley (2022b) found that the deposits had very high levels metals including iron, manganese, nickel and zinc. The composition of the deposits was consistent with the 'mine water' effects described by Headley (ibid.) in the previous months. The invertebrate community in the stream during spring 2022 was clearly impacted by the changes in water and habitat quality, with substantial declines in invertebrate abundance and a loss of acid intolerant species (Aquaterra Ecology 2022). By August 2022 trout were found to be absent from the most badly polluted reaches of Burn Lunklet i.e. upstream of the confluence with Burn of Marrofield Water and Burn of Lamba Water (Waterside Ecology 2022). Sampling in October 2022 showed that the invertebrate fauna of Burn of Lunklet was very severely impacted, with few animals in the samples and a loss of all but the most pollution tolerant taxa (Watt & Emes 2023). Invertebrate sampling in spring 2023, autumn 2023 and spring 2024 (Emes & Watt 2023a, 2023b, 2024) showed only minimal signs of recovery and acid intolerant species remained absent.

On the Weisdale (east) side of Scallafield Scord the main source of the metals seems likely to be turbine base K51, runoff from which enters Burn of Weisdale via an un-named tributary referred to as TWE. Invertebrate monitoring in the Burn of Weisdale between October 2022 and spring 2023 (Watt & Emes 2022, Emes & Watt 2023) suggested that changes in water quality may be starting to impact on stream fauna in this watercourse. Declines in a number of water quality indices were noted and these were consistent with the changes in hydrochemistry. Ochreous deposits were visible on the streambed downstream of the tributary (known as TWE) that drains to Burn of Weisdale from Scallafield Scord. The TWE tributary itself had very heavy ochre deposition in its lower reaches.

The developer has now put in place mitigation measures aimed at increasing pH in receiving watercourses. An enhanced monitoring regime has been put in place which includes increased hydrochemical sampling and two-season sampling of freshwater invertebrates. The main aims of the increased monitoring are to:

- Ensure there is up to date knowledge of the current status of water quality and fauna in affected streams;
- Assess the efficacy of mitigation measures in improving conditions for biota.

This report presents data from the autumn 2024 sampling period. In addition to providing an update in relation to the above watercourses and appropriate controls, it also includes assessments of invertebrate fauna at sites in Burn of Burrafirth up and downstream of the Burn of Lunklet confluence, Burn of Lamba Water, Burn of Marrofield Water and Burn of Droswall. Some chemical changes have been observed in these streams, so their inclusion was considered prudent and consistent with the Viking Energy Wind Farm WQMP.

2 Sites and methods

Sampling sites are listed in Table 1 and shown on Figure 1. Tables and Figures are located towards the end of this report.

All sites were sampled by kick sampling for a period of 3 minutes, the same technique used for routine invertebrate monitoring around the Viking Energy Wind Farm. Aquaterra Ecology (2020) provides details of sampling methods, analytical methods, biotic indices and classifications. The kick samples were taken on 4th and 5th November 2024. Water levels were low to moderate, providing suitable conditions for sampling.

Table (i) below summarises the indices that were calculated for each sample. Details are provided in Aquaterra Ecology 2020.

Table (i). Water quality indices calculated for each sample.

Index	Description
BMWP & ASPT	Designed for assessment of organic pollution but useful indicators of general degradation. Low score bad. High score good.
WHPT NTAXA	Number of scoring taxa for Water Framework Directive (WFD) compliant assessment. Low score bad. High score good.
WHPT ASPT	Average score per taxon present (WFD compliant). Low score bad. High score good.
Water Chemistry Status	An index of acidity/acidification. 1 = circumneutral; 2 = not significantly acidified; 3 = potentially acidified
PSI	Proportion of sediment intolerant species. Low score bad. High score good.
EPT%	Percent of Ephemeroptera, Plecoptera and Trichoptera. These groups are suggestive of good water quality. Low score bad. High score good.

A substantial flood event occurred on 17th October approximately two weeks prior to sampling. The SEPA gauge on Burn of Weisdale indicated that water level peaked at around 1.8 m, approximately 10 cm below the highest level recorded. A flood event of this magnitude has potential to impact on invertebrate communities. Possible effects on dataset are considered in the relevant sections below.

3 Results and discussion

3.1 Burn of Lunklet

Visible ochre deposits remained on the surface substrates at LU1 and LU2 at the time of sampling and sedimentation of streambed substrates still appeared substantial. Dense silty deposits were clearly present under and around stones and thick clouds of red-brown sediment were released when substrates were disturbed during kick sampling at both sites. Macrophytes remained absent.

Invertebrate numbers remained low at LU1 and LU2, with totals of 27 and 16 individual animals per sample respectively (Table 2). The paucity of invertebrates means that the calculated values for most indices, in particular ASPT, WHPT-ASPT and PSI should be treated with caution. Values for the number of scoring taxa are realistic however, and the low numbers of taxa present resulted in scores of B (bad) for the WHPT-NTAXA classifications at both LU1 and LU2 (Table 4). The BMWP scores of

24 at both LU1 and LU2 classify both sites as C (poor) on the Scottish River Classification scale used by SEPA.

ASPT at both sites in Burn of Lunklet was 4.8, classified as B (fair). The WHPT ASPT classifications were H (high) at LU1 and G (good) at LU2. As noted above, these be unreliable due to the very small numbers of animals. However, they do also reflect the fact that some pollution intolerant species were present. Both metrics were developed primarily to assess organic pollution, but they are also used as more general indicators of degradation.

As noted above PSI values must be treated with caution due to low numbers of invertebrates. PSI at LU1 and LU2 were 80.0 and 71.4 respectively, suggestive of slightly sedimented conditions. The scores and classifications are at odds with the observed state of the streambed.

Both sites were classified at 2 for Water Chemistry Status, suggesting the stream may no longer be classified as significantly acidified. The score was due to the presence of the mayfly species *Baetis rhodani* at both sites. No other acid intolerant species were present (Appendix 8.2).

3.2 Burn of Lambawater

At the time of sampling the stream was running clear. There were no visible silt or ochre deposits and only a slight silt plume (normal) when sampling. Algal cover was zero.

Total number of invertebrates in the sample at LM1 was 429 (Table 2) and a total of 13 taxa were present in the sample, of which 12 were scored for the standard BMWP classification. The BMWP score of 62 is classified as Fair (B) in the SEPA system. ASPT was 5.17, classified as A2. EPT made up over 90% of the sample suggesting clean well oxygenated conditions. Water chemistry status was 2, indicating the stream was not significantly acidified. Group 2 indicator species present were *Baetis rhodani* and *Hydropsyche siltalai* (Appendix 8.2).

The WHPT-NTAXA and WHPT-ASPT classifications (Table 4) were both H (high). The PSI of 67.9 indicates slightly sedimented conditions, typical of Shetland streams.

Taken together, the indices suggest that water quality and habitat conditions for benthic macroinvertebrates in Burn of Lambawater remain good.

3.3 Burn of Marrofield Water

At the time of sampling the stream was running clear. There were no visible silt or ochre deposits and the silt plume when sampling was minimal. Algal cover was low (<5%).

Total number of invertebrates at MA1 was 533, the highest of any sample (Table 2). The stonefly *Leuctra inermis* was particularly abundant with 255 individuals in the sample (Appendix 8.1). There were also 186 specimens of *Baetis rhodani*. Together these species contributed to the unusually high EPT of 97.6%.

A total of 14 taxa were present of which 11 scored for BMWP and the BMWP score of 59 is classified as Fair. ASPT was 5.36 (A2 or Good). Where sufficient animals are present, ASPT is generally considered the more reliable index. The Water Framework Directive compliant WHPT-NTAXA and WHP-ASPT classifications (Table 4) were both H (high). The PSI of 65.5 indicates slightly sedimented conditions.

Together, the indices suggest good water quality and substrate conditions.

3.4 Burn of Burrafirth

Site BF1 is downstream of Burn of Lunklet and therefore receives run-off from KPB02, albeit in a more diluted form than Burn of Lunklet itself. Changes in water chemistry, including elevated levels of metals attributable to KPB02 have been recorded at BF1. BF2 is upstream of the Burn of Lunklet confluence.

No changes to physical habitats were recorded at BF1. However BF2 showed substantial change and appeared unstable, with extensive recent deposition of gravel, pebble and some coarse sand across the site. It is likely that these materials were mobilised during the October spate event before being deposited at BF2. Little silt was evident at either site during sampling.

The total number of animals in the sample from BF1 was 70 while at BF2 it was 32. Numbers of taxa were low: 8 and 7 and BF1 and BF2 respectively. BMWP classifications at both sites were C (Poor). The ASPT score at BF1 was 4.17, classified as B (Fair). ASPT at BF2 was A2 (Good).

The WHPT-NTAXA classifications were B (Bad) at both sites (Table 4). This reflects the low diversity but it should be noted that confidence in the classification at BF1 is low at 28.3% (see Appendix 8.2). There was a near-equal probability for a classification of M at this site (27.7%). WHPT-ASPT classifications were H (High) at BF1 and BF2.

Both sites were classified as not significantly acidified (2) based on the presence of *Baetis rhodani* and, at BF1 only, *Hydropsyche siltalai*. BF1 was classified as unsedimented with a PSI of 83.3. The score of 63.6 at BF2 indicated slightly sedimented conditions. The percent EPT was over 90% at both sites.

3.5 Burn of Weisdale

Three sites were sampled, WE2, WE3 and WE4. WE5, which had been sampled in the spring was not sampled in the autumn as no suitable habitat could be found. WE5 had always consisted of three small patches of gravel and pebble in a long reach that is predominantly slow flowing with soft substrates. It seems probable that the October flood removed these patches.

A light coating of ochre was visible covering the stones at WE4 and WE3. Substantial plumes of red-brown sediment were released when the streambed was kicked during sampling. No ochre was present at WE2 and substrates were clean, with minimal release of silt or fines when disturbed. Physical habitats seemed largely unchanged at all three sites compared with spring 2024.

Total numbers of invertebrates at sites on Weisdale Burn decreased with distance upstream, ranging from 219 at WE2 to 81 at WE4. A similar trend was observed in the number of taxa in the samples, which ranged from 15 to 10. BMWP was classified as A2 (Good) at WE2, B (Fair) at WE3 and C (Poor) at WE4. ASPT classifications were A2 at WE2 and WE3 and A1 (Excellent) at WE4. The Water Framework Directive WHPT-NTAXA classifications were H at all sites. WHPT-ASPT was H at WE2 and WE3 and G at WE4.

EPT was similar at all three sites, ranging from 66.7 at WE4 to 70.9 at WE3. PSI scores were also very similar across the three sites, ranging from 64.7 to 73.3 and all were classified as slightly sedimented.

3.6 Burn of Droswall

A light coating of red-brown silt/ochre was present on the stones in the faster flowing riffles at DR1. A moderate amount of silt was released when substrates were kicked during sampling.

The total number of invertebrates in the sample at DR1 was 209 and 13 taxa were identified (Table 2). Eleven BMWP scoring taxa were present and the BMWP was 56, classified as B. ASPT was 5.09, classified as A2.

Twelve WHPT scoring taxa were present in the sample and NTXA was classified as H (Table 4). The WHPT-ASPT was 5.79 and classified as H.

EPT made up 73% of the sample. The most common invertebrates were *Baetis rhodani* and *Rhyacophila dorsalis* (a caseless caddis), which together made up 61% of the sample (Appendix 8.1). Lumbricidae worms were also quite abundant (N = 36). The PSI score of 76.2 gave a streambed classification of slightly sedimented.

3.7 Control sites

3.7.1 Seggie Burn

The two sites in Seggie Burn, SB1 and SB2, appeared unchanged since the May invertebrate sampling and September electric fishing survey. Substrates were clean at both sites, without ochre. Silt release during kick sampling was minimal.

Total invertebrate numbers at SB1 and SB2 were 225 and 95 respectively. Thirteen taxa were present in the sample at SB1 and 14 at SB2. The number of BMWP scoring taxa was 10 at both sites. BMWP at SB1 was 54 and SB2 it was 61; both sites therefore classified as B. ASPT scores at SB1 and SB2 were 5.4 and 6.1 respectively giving classifications of A2 and A1. Both sites were classified as H for the WHPT-NTAXA and WHPT-ASPT indices.

EPT was a little over 70% at both Seggie Burn sites. PSI scores were 69.6 and 63.0 giving classifications of slightly sedimented at both sites.

3.7.2 Burn of Laxobigging

The two sites in Burn of Laxobigging showed little morphological change compared with previous visits. The channel at both sites is somewhat entrenched and flood debris high up the banks indicated that the October spate had been substantial. Few invertebrates were present at either site with totals of 19 and 28 at LB1 and LB2 respectively. Eight taxa were present at LB1 of which only 5 scored on the BMWP system. The resulting BMWP score was 22, classified as C (Poor). LB2 had 7 scoring taxa and a BMWP of 42, also classified as C. ASPT classifications at LB1 and LB2 were B and A respectively.

Six WHPT scoring taxa were present at LB1 and the most probable WHPT-NTAXA classification was B (Bad). Confidence in the classification was low (28.8) and there were similar probabilities of a Moderate (26.6%) or Poor (23.6%) classification (Appendix 8.3). The most probable WHPT-ASPT was M (Moderate). LB2 was classified as H for WHPT-NTAXA but probabilities were near-equal for H (27.02%), G (26.67%) and M (26.98%). WHPT-ASPT at LB2 was H, with a 96.5% probability.

It seems probable that the low numbers of invertebrates and corresponding low numbers of scoring taxa at Burn of Laxobigging were a result of the preceding spate. Burn of Laxobigging was sampled shortly after a spate in autumn 2019 and it was also noted at that time that invertebrate abundance was low.

3.8 Comparison with baseline and previous data

3.8.1 Burrafirth catchment

The main focus of concern in the Burrafirth catchment has been Burn of Lunklet, as it is known to have suffered serious contamination. Total abundance of invertebrates in a 3-minute kick sample at LU1 went from 139 in the autumn baseline to 27 in the current survey, a decline of 80%. Figure 3 shows trends in invertebrate numbers during spring and autumn at those sites in the Burrafirth catchment where reasonably complete time series are available. Burn of Laxobigging is included as the most appropriate control stream. The decline in invertebrate numbers in Burn of Lunklet at spring 2022 is clear and this was followed by a further drop in autumn that year. Numbers have increased slightly since then, but remain far below baseline or pre-contamination levels.

More positively, the rise in pH over the past months has been reflected in an improved water chemistry status, which has shifted from 3 (acidified) to 2 (not significantly acidified). The latter classification is consistent with baseline and is due to the presence of small numbers of *Baetis rhodani* in the sample.

Biomonitoring scores and classifications from sites in Burn of Lambawater and Burn of Marrofield Water showed no concerning deviations from baseline (Tables 3 and 4) and the invertebrate communities in both suggest good water quality and environmental conditions.

Data from the Burn of Burrafirth itself suggest declines in invertebrate numbers and in the number of scoring taxa (Table 3). The WHPT-NTAXA classification at both fell from H during the 2019 baseline to B in autumn 2024 (Table 4). These changes were largely mirrored at sites in Burn of Laxobigging and this may suggest that the results are due to the floods that preceded the survey rather than to any construction effects. All sites are due to be re-sampled in spring 2025, when this may become clearer. Interestingly, the time series (Figure 3) show quite similar trends in invertebrate numbers in Burn of Burrafirth and Burn of Laxobigging, with hints of longer term declines in numbers.

3.8.2 Weisdale catchment

Time series data (Figure 4) show a decline in invertebrate numbers at WE3 and WE4 in autumn 2022, after ochre deposition and increases in metals were first noted. The impacts were not detected further downstream at WE2, where autumn invertebrate numbers remained more stable. Whether the observed change in invertebrate abundance at WE3 and WE4 was due to the identified impacts on water quality is uncertain, as a similar trend was seen at control sites SE1. Nevertheless, it was of sufficient concern to improve monitoring and mitigation of runoff from the east side of Scallafield Scord.

Invertebrate numbers at WE4 and WE3 during autumn 2024 were close to the baseline, despite the October flood event (Table 3). The middle reaches of Burn of Weisdale have a low gradient and it is likely that animals displaced from faster flowing reaches are quite quickly replaced from nearby pools and glides. Despite the continuing presence of some visible ochre, the scores and classifications for water quality indices at WE3 and WE4 are all now close to baseline (Tables 3 and 4). This is also true of Burn of Droswall, where the invertebrate fauna suggests good environmental conditions.

4 Conclusions and recommendations

4.1 Conclusions

The survey suggests that streambed conditions in the Burn of Lunklet are poor and that the invertebrate fauna remains impacted by changes in water and substrate quality. However there are some signs of improvement, in particular the presence of *Baetis rhodani*, one of the acidity indicator species. Its recurrence has coincided with the improved pH in the stream.

Interpretation of data in autumn 2024 is made difficult by the likelihood that a major flood event impacted on invertebrate communities at some sites. The effect of the flood on physical habitats at BF2 was very clear. Declines in the WHPT-NTAXA classification at BF1 and BF2 are a concern. However a similar decline was apparent at control site LB1, raising the possibility that the observed changes in Burn of Burrafirth may be unrelated to construction effects on water quality.

No deterioration was noted in invertebrate assemblages in Burn of Lamba Water or Burn of Marrofield Water.

Water quality index scores and classifications from WE3 and WE4 are now close to baseline, consistent with the improved quality of runoff from the east side of Scallafield Scord.

No significant changes were observed in indices or classification in Burn of Droswall and the invertebrate fauna suggests good environmental conditions.

4.2 Recommendations

Efforts to mitigate metals runoff from Scallafield Scord to Red Burn/Burn of Lunklet and TWE/Burn of Weisdale should continue, since elevated concentrations remain a concern in most months (Headley 2024). The efficacy of the mitigation measures should be monitored and periodically reviewed, and changes made where necessary. It should be noted that mitigation should focus not only on increasing the pH of runoff, but ensuring that metal-rich complexes are deposited and removed before they reach sensitive stream habitats. Concern has been raised on a number of occasions that capture of metals complexes before they reach Red Burn and Burn of Lunklet may be inadequate.

Visible ochre deposition is still present in Burn of Lunklet and at WE3 and WE4, and metals concentrations remain high in some of the runoff from Scallafield Scord. Two season sampling of freshwater invertebrates should continue at LU1, LU2, WE2, WE3 and WE4 along with control sites in Seggie Burn and Burn of Laxobigging. The need for autumn sampling at other sites should be assessed based on the routine spring sampling, due to take place in May 2025.

Physical changes, apparently unrelated to the development, have now rendered site WE5 unsuitable for invertebrate sampling. It should be retained as a monitoring site for hydrochemistry but consideration should be given to identifying a more suitable upstream control for biology, or dropping WE5 and relying on time-series data from WE3 and WE4 without an upstream control. Due to the nature of this reach of stream (low gradient, fine sediments), any alternative site would have to be a considerable distance upstream of WE4.

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6 Tables

Table 1 Sampling sites and rationale for sampling at each, autumn 2024

Site	Watercourse	NGR	Autumn baseline data	Other autumn sampling	Rational for inclusion in current round of sampling
BF1	Burn of Burrafirth	HU 36686 57507	2019	2022, 2023	Receives runoff from Burn of Lunklet resulting in increase in metals concentrations.
BF2	Burn of Burrafirth	HU 36702 56890	2019	2021, 2022, 2023	Upstream of Burn of Lunklet confluence, so acts a 'control' in relation to contamination from that source.
LM1	Burn of Lamba Water	HU 41416 72398	2019	2023	Reduced annual mean pH and DOC during course of development.
LU1	Burn of Lunklet	HU 37380 57302	2019	2021, 2022, 2023	Reduced pH and increased metals. Metal contamination of sediments.
LU2	Burn of Lunklet	HU 37724 57519	None	2021, 2022, 2023	Low pH and high levels of metals. Metal contamination of sediments.
MA 1	Burn of Marrofield Water	HU 37337 57310	2019	2023	Elevated levels of aluminium and zinc in 2022-23
WE2	Burn of Weisdale	HU 40222 55270	2019	2020, 2022, 2023	Few impacts on water quality – well downstream of contaminated runoff.
WE3	Burn of Weisdale	HU 40511 56722	2019	2020, 2022, 2023	Elevated metals in some samples. Light ochre deposition.
WE4	Burn of Weisdale	HU 40525 57790	2019 & 2020	2022, 2023	Elevated metals. Moderate ochre deposition. Approx. 100 m downstream of contaminated TWE tributary.
DR1	Burn of Droswall	HU 39956 54988	2019	None	Elevated levels of metals in some samples. Siltation episodes.
SE1	Seggie Burn	HU 43950 63766	N/A	2019, 2020, 2021, 2022, 2023	Control site with similar baseline chemistry to Burn of Weisdale
SE2	Seggie Burn	HU 43609 64718	2019	2023	Control site with similar baseline chemistry to Burn of Weisdale
LB1	Burn of Laxobigging	HU 41416 72398	N/A	2019, 2020 & 2021, 2023	Control site
LB2	. Burn of Laxobigging	HU 41416 72398	2019	2020, 2023	Control site

Green fill indicates control sites

Table 2 Biological Monitoring Scores and Classifications autumn 2024

Site	Total Invertebrates (n)	Number of Taxa (n)	BMWP score	Scoring taxa (n)	ASPT score	ASPT class SEPA	WHPT BMWP	WHPT scoring taxa (n)	WHPT ASPT	PSI	Water Chemistry status	EPT (%)
BF1	70	6	25	6	4.17	B	35.2	6	5.87	83.3	2	94.3
BF2	32	7	27	5	5.40	A2	30.4	5	6.08	63.6	2	90.6
LM1	429	13	62	12	5.17	A2	79.9	12	6.66	67.9	2	92.5
LU1	27	5	24	5	4.80	B	29.4	5	5.88	80.0	2	92.6
LU2	6	5	24	5	4.80	B	26.7	5	5.34	71.4	2	66.7
MA1	533	14	59	11	5.36	A2	73.9	11	6.72	65.5	2	97.6
WE2	219	15	70	13	5.38	A2	91.7	14	6.55	65.4	1	68.5
WE3	103	14	50	10	5.00	A2	69.1	12	5.76	64.7	1	70.9
WE4	81	10	42	7	6.00	A1	54.5	8	6.81	73.3	2	66.7
DR1	209	13	56	11	5.09	A2	69.5	12	5.79	76.2	2	73.2
SE1	225	13	54	10	5.40	A2	66.6	11	6.05	69.6	1	74.2
SE2	95	14	61	10	6.10	A1	80.6	11	7.33	63.0	2	70.5
LB1	19	8	22	5	4.40	B	27.1	6	4.52	71.4	2	57.9
LB2	28	10	42	7	6.00	A1	55.5	8	6.94	64.7	2	64.3

Table 3 Biomonitoring scores, comparison of autumn baseline and autumn 2024

Site	BMWP Score		ASPT score		WHPT scoring taxa (n)		WHPT ASPT		PSI Score		Water Chemistry Status		EPT %	
	Baseline	Autumn 2024	Baseline	Autumn 2024	Baseline	Autumn 2024	Baseline	Autumn 2024	Baseline	Autumn 2024	Baseline	Autumn 2024	Baseline	Autumn 2024
BF1	49	25	5.44	4.17	12	6	6.71	5.87	73.9	83.3	2	2	93.2	94.3
BF2	61	27	5.55	5.40	12	5	6.70	6.08	73.1	63.6	2	2	84.9	90.6
LM1	61	62	5.55	5.17	12	12	6.64	6.66	70.0	67.9	2	2	91.6	92.5
LU1	46	24	5.75	4.80	9	5	6.42	5.88	65.0	80.0	2	2	75.5	92.6
LU2	N/A	24	N/A	4.80	10	5	N/A	5.34	N/A	71.4	N/A	2	N/A	66.7
MA1	62	59	5.17	5.36	13	11	6.42	6.72	66.7	65.5	2	2	95.1	97.6
WE2	67	70	5.58	5.38	13	14	6.30	6.55	68.0	65.4	1	1	67.3	68.5
WE3	45	50	5.00	5.00	11	12	5.77	5.76	62.5	64.7	2	1	78.5	70.9
WE4	49	42	5.44	6.00	10	8	6.14	6.81	56.5	73.3	1	2	80.4	66.7
DR1	58	56	4.46	5.09	15	12	5.95	5.79	72.0	76.2	2	2	77.0	73.2
SE1	51	54	5.67	5.40	8	11	6.88	6.05	71.4	69.6	2	1	87.5	74.2
SE2	57	61	5.18	6.10	11	11	6.40	7.33	68.2	63.0	1	2	76.8	70.5
LB1	74	22	5.69	4.40	15	6	6.31	4.52	69.2	71.4	1	2	69.0	57.9
LB2	67	42	6.09	6.00	12	8	6.65	6.94	83.3	64.7	2	2	75.5	64.3

*Values for LB1 and LB2 are from autumn 2020 as 2019 data were impacted by spates

Table 4 Total invertebrates and biomonitoring classifications, comparison of autumn baseline and autumn 2024

Site	Total invertebrates in sample		ASPT class		WHPT-NTAXA class		WHPT ASPT class		PSI class	
	Baseline	Autumn 2024	Baseline	Autumn 2024	Baseline	Autumn 2024	Baseline	Autumn 2024	Baseline	Autumn 2024
BF1	322	70	A2	B	H	**B**	H	H	Slightly sedimented	Unsedimented
BF2	225	32	A2	A2	H	**B**	H	H	Slightly sedimented	Slightly sedimented
LM1	431	429	A2	A2	H	H	H	H	Slightly sedimented	Slightly sedimented
LU1	139	27	A2	B	H	B	H	H	Slightly sedimented	Slightly sedimented
LU2	N/A	6	N/A	B	N/A	B	N/A	G	N/A	Slightly sedimented
MA1	445	533	A2	A2	H	H	H	H	Slightly sedimented	Slightly sedimented
WE2	205	219	A2	A2	H	H	H	H	Slightly sedimented	Slightly sedimented
WE3	121	103	A2	A2	H	H	H	G	Slightly sedimented	Slightly sedimented
WE4	107	81	A2	A1	H	G	H	H	Moderately sedimented	Slightly sedimented
DR1	92	209	B	A2	H	H	G	G	Slightly sedimented	Slightly sedimented
SE1	160	225	A2	A2	H	H	H	H	Slightly sedimented	Slightly sedimented
SE2	177	95	A2	A1	H	H	H	H	Slightly sedimented	Slightly sedimented
LB1	129	19	A2	B	H	**B**	H	**M**	Slightly sedimented	Slightly sedimented
LB2	106	28	A1	A1	H	H	H	H	Unsedimented	Slightly sedimented

Red font indicates declines of more than two classifications, the proposed threshold for detection of potential impact

7 Figures

Figure 1. Sampling sites October 2023. Red diamonds show locations of sampling sites (control sites not shown).

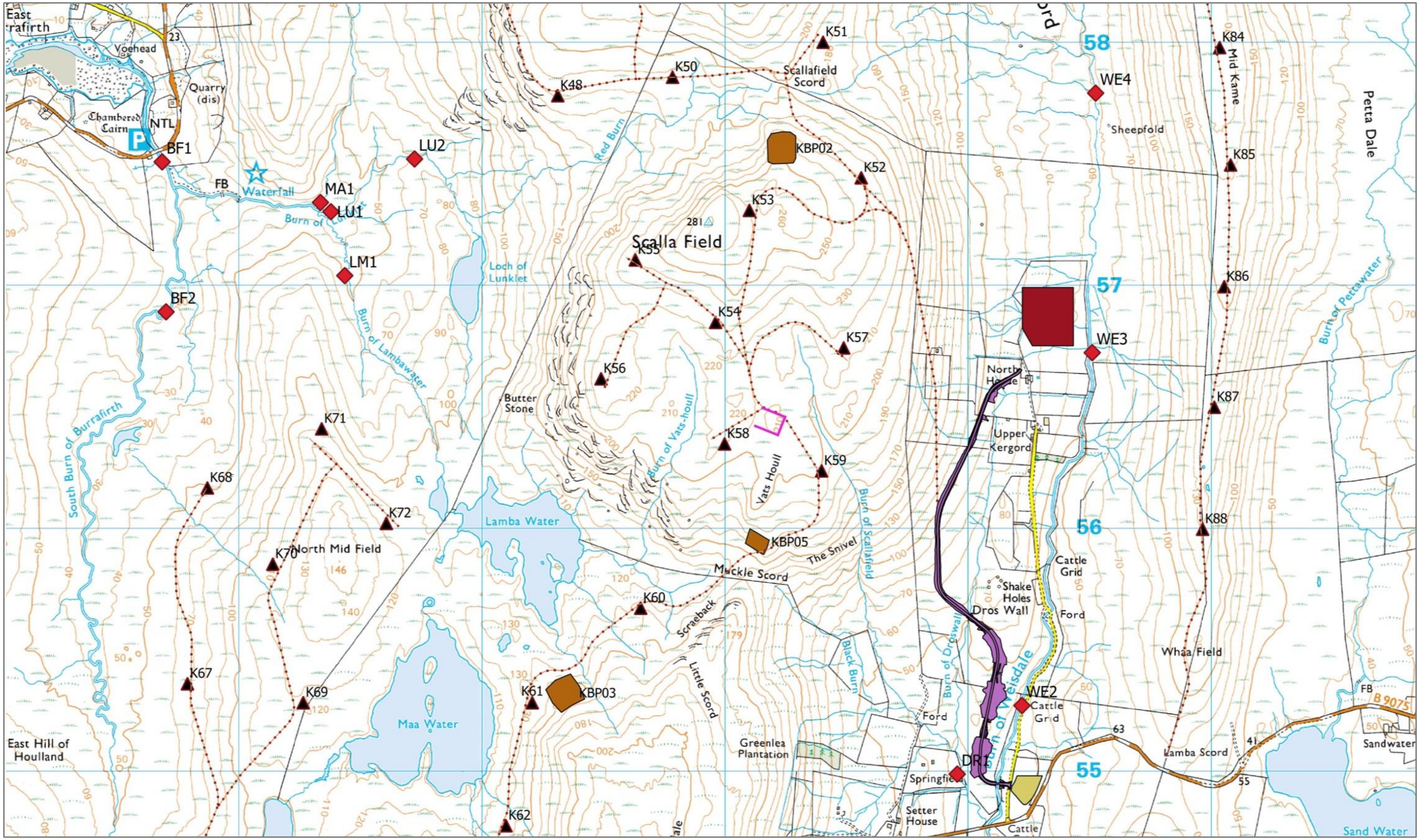


Figure 2 Invertebrate groups: percentages of sample by number autumn 2024.

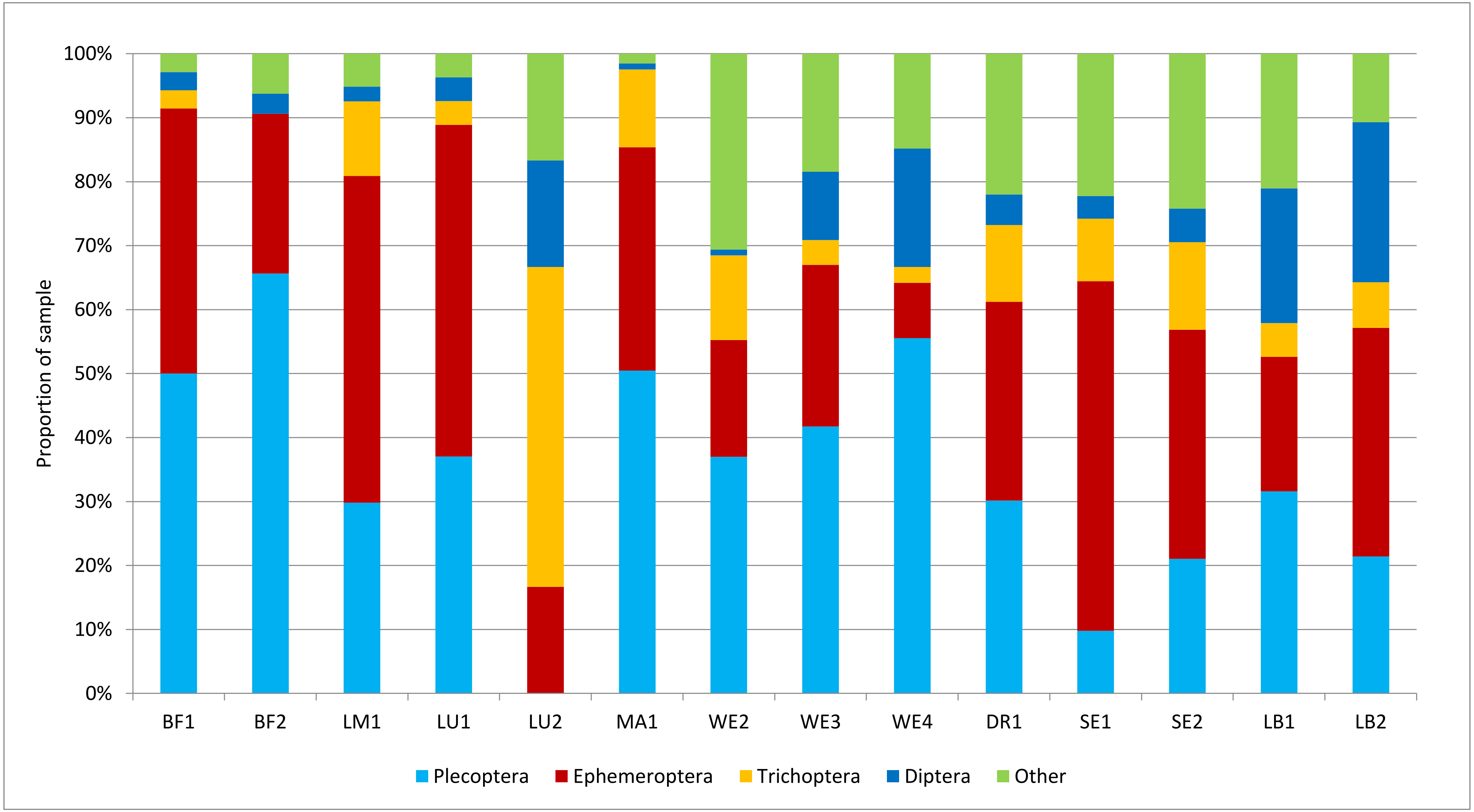
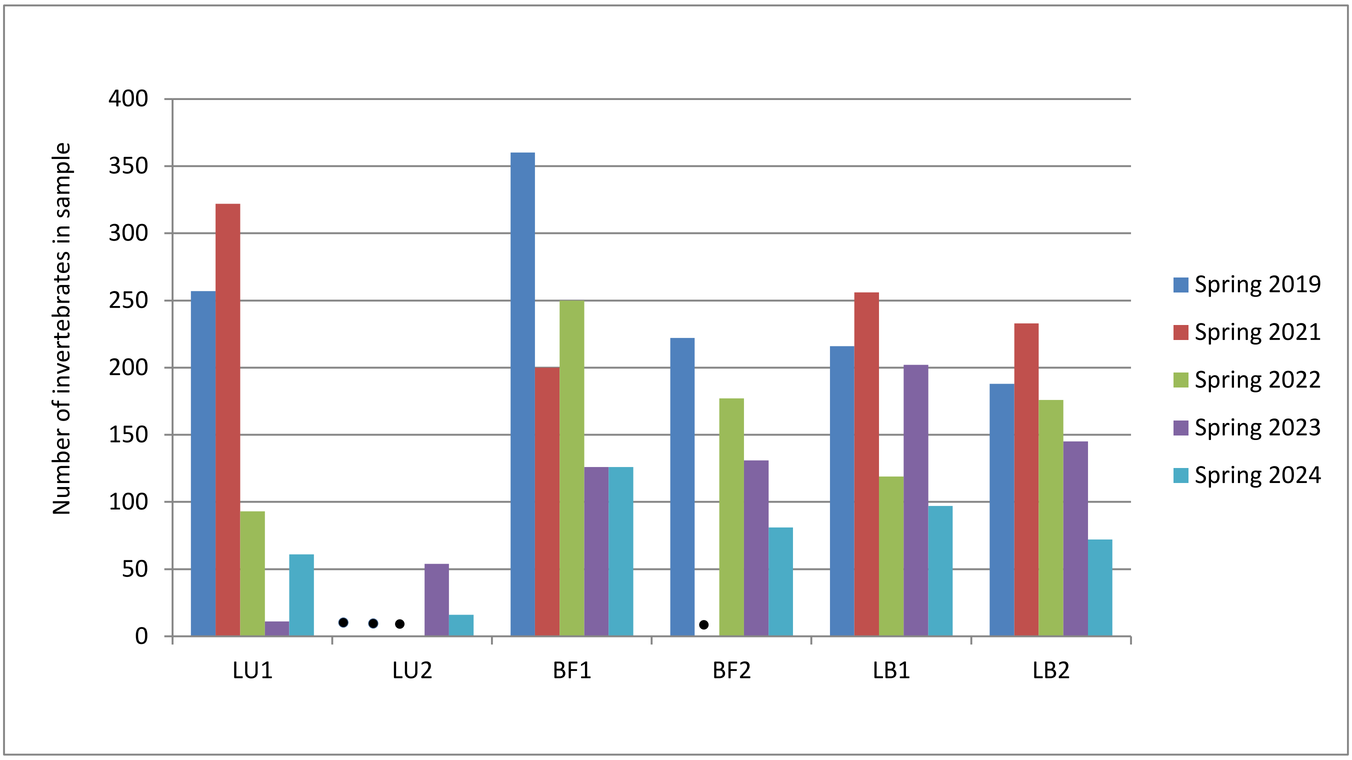
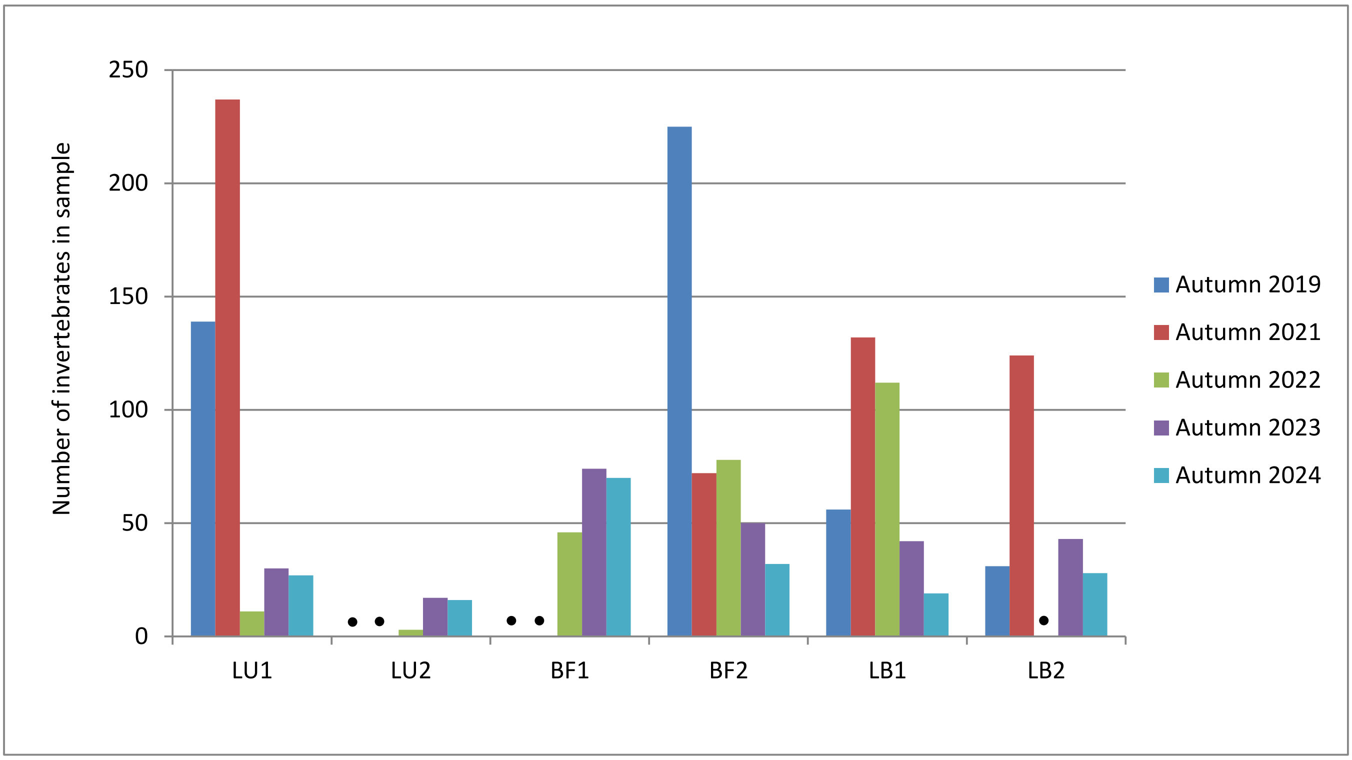


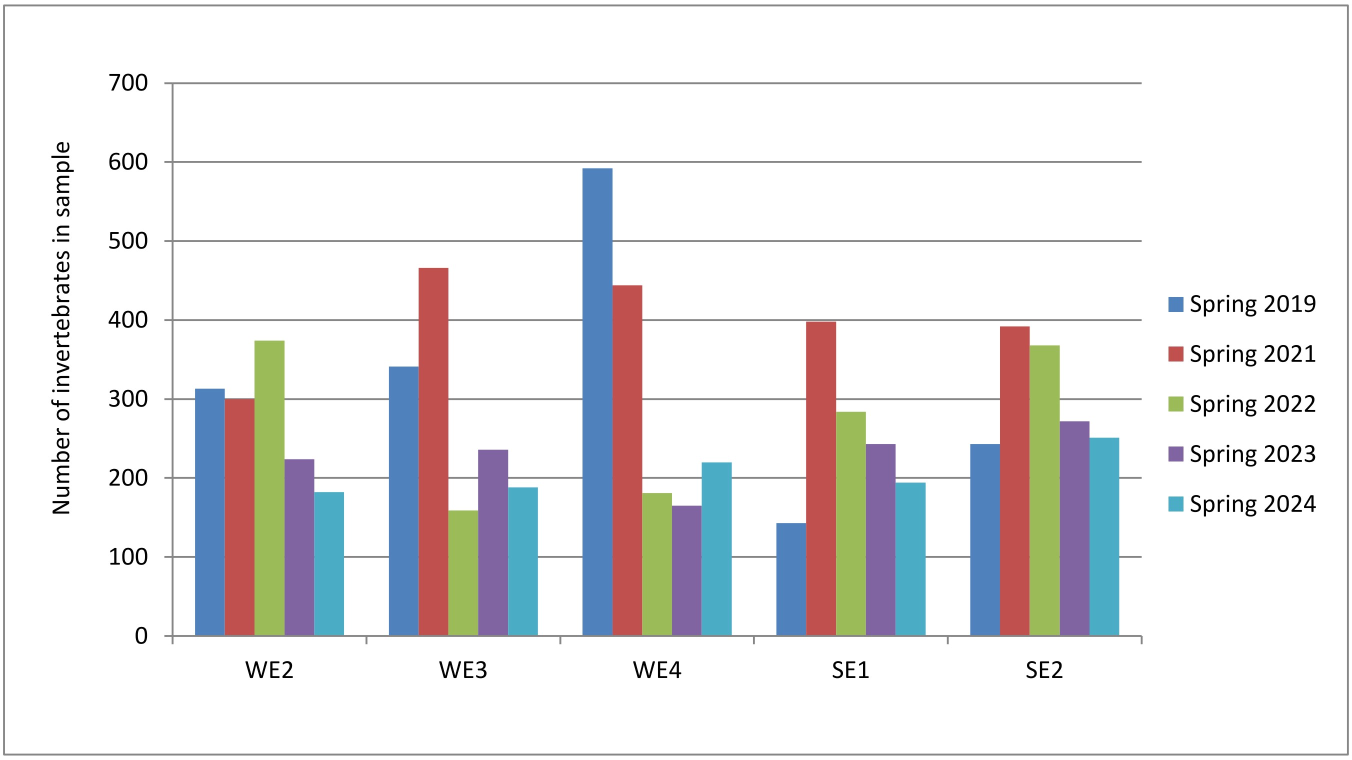
Figure 3. Time series data, total number of invertebrates in autumn and spring samples, Burrafirth catchment and Burn of Laxobigging control sites.

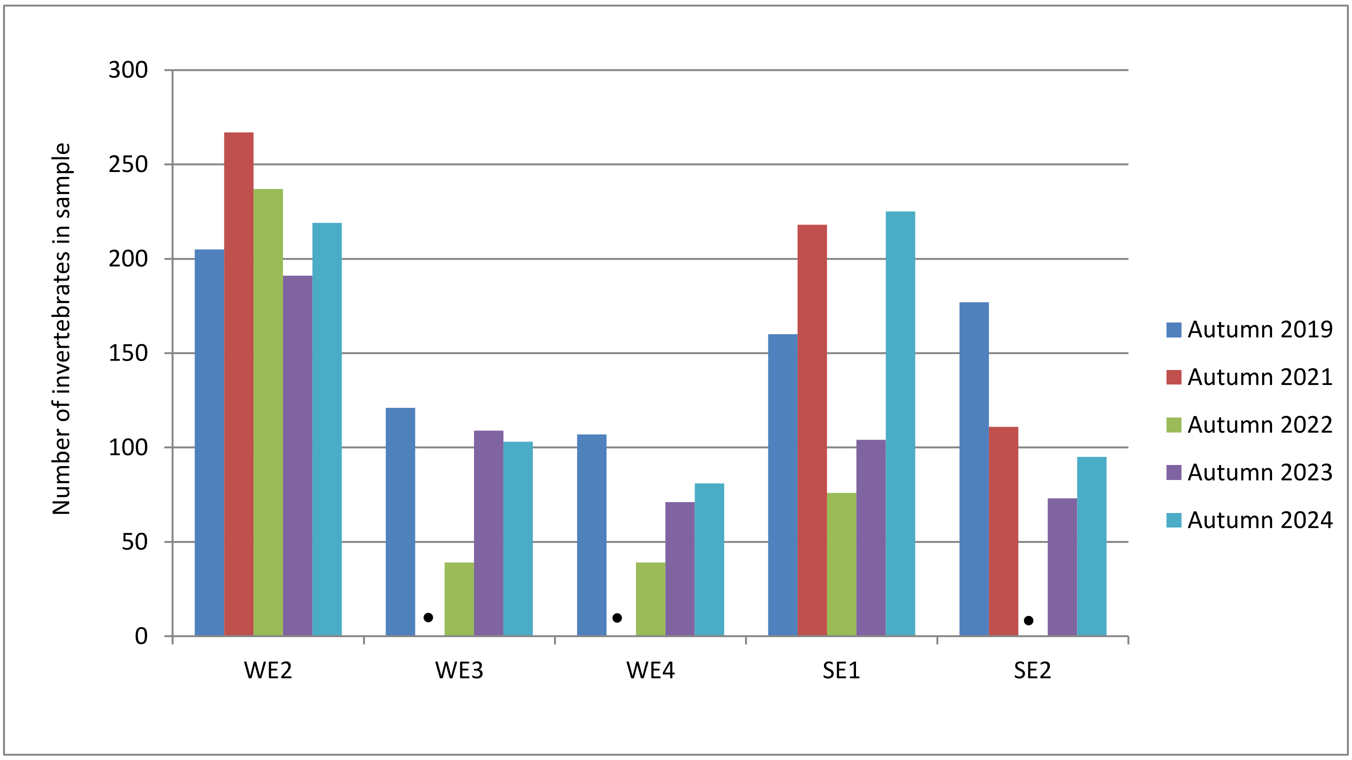




Dots indicate not sampled

Figure 4. Time series data, total number of invertebrates in autumn and spring samples, Weisdale catchment and Seggie Burn control sites.





8 Appendices

8.1 Invertebrates present in samples November 2024

Taxon	**Site**													
	BF1	**BF2**	**LM1**	**LU1**	**LU2**	**MA1**	**WE2**	**WE3**	**WE4**	**DR1**	**SE1**	**SE2**	**LB1**	**LB2**
Plecoptera														
Chloroperlidae														
Chloroperla torrentium		1	5			4	2	1	1		2	2		3
Leuctridae														
Leuctra sp.		1				10		2	3					
Leuctra inermis	35	19	123	10		255	79	40	41	63	20	18	6	3
Ephemeroptera														
Baetidae														
Baetis rhodani	29	8	219	14	1	186	40	26	7	65	123	34	4	10
Trichoptera														
Hydropsychidae														
Hydropsyche siltalai	1		37			43	22			2	9	4		
Limnephilidae														
Potamophlax sp.					1		1	1					1	
Potamophylax cingulatus			1							1		2		
Philopotamidae														
Philopotamus montanus														2
Polycentropidae														
Plectronemia conspersa					2									
Polycentropus flavomaculatus			2			6	1			1	10	1		
Rhyacophilidae														
Rhyacophila dorsalis	1		10	1		16	5	3	2	21	3	6		
Diptera														
Ceratopogonidae							2	3		3				
Chironomidae	2	1	7	1		2		5		3	5		1	4
Empididae								3	13			3		2
Limoniidae					1									1
Muscidae														
Limnophora sp.											1		1	
Pediciidae														
Dicranota sp.										1	2			
Pedicia sp.												2	1	

Taxon	Site													
	BF1	**BF2**	**LM1**	**LU1**	**LU2**	**MA1**	**WE2**	**WE3**	**WE4**	**DR1**	**SE1**	**SE2**	**LB1**	**LB2**
Simulidae						2			1	3				
Tipulidae			3			1			1				1	
Coleoptera														
Hydraenidae														
Hydraena gracilis							2					1		
Scirtidae														
Elodes sp.			1				1					1		
Mollusca														
Hydrobiidae														
Potamopyrgus antipodarum							2	1		9				
Lymnaeidae														
Radix balthica							1	2			25			
Sphaeriidae														
Pisidium sp.			2			4								
Hirudinea														
Erpobdellidae														
Helobdella stagnalis							3	1						
Oligochaeta														
Enchytraeidae	2	1				1	1	4	7	1	3	7	4	1
Lumbricidae		1	17			2	57	11	5	36	20	13		1
Lumbriculidae			2	1	1	1					2	1		1

8.2 Water chemistry status indicator taxa present in samples

Taxon	Site													
	BF1	**BF2**	**LM1**	**LU1**	**LU2**	**MA1**	**WE2**	**WE3**	**WE4**	**DR1**	**SE1**	**SE2**	**LB1**	**LB2**
Group 1														
Radix balthica							✓	✓			✓			
Group 2														
Baetis rhodani	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hydropsychidae	✓		✓			✓	✓			✓	✓	✓		
Score	2	2	2	2	2	2	1	1	2	2	1	2	2	2

8.3 Ecological Quality Index and Water Framework Directive Ecological Status Class for WHPT NTAXA autumn 2024

Site	Observed WHPT NTAXA	Predicted WHPT NTAXA	WHPT ASPT EQR	Most Probable Class	Probability of class %					Suitability Code
					H	G	M	P	B	
BF1	6	13.89	0.562	B	6.62	14.12	27.72	23.26	28.28	1
BF2	5	13.89	0.488	B	2.04	7.04	19.61	23.27	48.04	1
LM1	12	13.89	0.994	H	84.78	11.45	3.25	0.47	0.05	1
LU1	5	13.89	0.486	B	1.99	7.11	19.35	23.74	47.81	1
LU2	5	13.90	0.487	B	2.26	7.45	19.23	23.29	47.77	1
MA1	11	13.89	0.924	H	73.74	17.99	6.65	1.41	0.21	1
WE2	14	13.91	1.138	H	96.04	3.34	0.56	0.06	0	1
WE3	12	13.90	0.993	H	84.33	11.50	3.60	0.48	0.09	1
WE4	8	13.90	0.707	G	26.83	27.54	26.8	11.99	6.84	1
DR1	12	13.92	0.994	H	84.64	11.30	3.52	0.50	0.04	1
SE1	11	14.01	0.917	H	72.42	18.2	7.51	1.55	0.32	1
SE2	11	14.06	0.912	H	72.06	18.41	7.68	1.47	0.38	1
LB1	6	13.89	0.562	B	6.83	14.12	26.64	23.6	28.81	1
LB2	8	13.89	0.705	H	27.02	26.67	26.98	12.75	6.58	1

8.4 Ecological Quality Index and Water Framework Directive Ecological Status Class for WHPT ASPT autumn 2024

Site	Observed WHPT ASPT	Predicted WHPT ASPT	WHPT ASPT EQR	Most Probable Class	Probability of class %				
					H	G	M	P	B
BF1	5.87	6.08	0.959	H	44.42	44.03	11.22	0.32	0.01
BF2	6.08	6.08	0.989	H	58.49	33.97	7.17	0.37	0.00
LM1	6.66	6.08	1.077	H	93.73	6.17	0.10	0.00	0.00
LU1	5.88	6.08	0.961	H	45.37	41.33	12.74	0.55	0.01
LU2	5.34	6.08	0.888	G	17.89	43.92	35.41	2.67	0.11
MA1	6.72	6.08	1.085	H	94.86	5.07	0.07	0.00	0.00
WE2	6.55	6.08	1.061	H	91.05	8.86	0.09	0.00	0.00
WE3	5.76	6.08	0.942	G	33.54	54.93	11.48	0.05	0.00
WE4	6.81	6.08	1.095	H	94.76	5.06	0.18	0.00	0.00
DR1	5.79	6.08	0.948	G	36.92	53.09	9.94	0.05	0.00
SE1	6.05	6.09	0.987	H	58.82	37.52	3.66	0.00	0.00
SE2	7.33	6.09	1.173	H	99.62	0.38	0.00	0.00	0.00
LB1	4.52	6.08	0.770	M	1.60	13.16	56.91	27.01	1.32
LB2	6.94	6.08	1.113	H	96.45	3.46	0.09	0.00	0.00