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**Balgray Wind Farm Fisheries and
Invertebrate Baseline Monitoring Survey
Report**

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Summary

Balgray Wind Farm Fisheries and Invertebrate Baseline Monitoring Survey Report

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Background

The Galloway Fisheries Trust (GFT) was commissioned by Locogen Limited to carry out electrofishing and invertebrate surveys at six locations. This was to provide baseline monitoring data for the Balgray Wind Farm development.

Surveys were carried out during September 2023.

Main findings of the 2023 electrofishing and macroinvertebrate survey

- A total of six sites were surveyed within the River Annan catchment for the proposed Balgray Wind Farm on the Dryfe Water. One site (BG2) was classed as unsuitable for fish and invertebrate surveys and should not be used in any future monitoring surveys.
- Of the five fishable sites, three had Brown trout and two had no fish. One site (BG6) was deemed unlikely to support fish at that location but could be used for invertebrate monitoring.
- The invertebrate samples showed “moderate” to “good” water quality and some level of sedimentation across all sites.
- Site BG6 should be replaced with a new site further downstream on the Hope Burn to include a site which is deemed suitable for fish and invertebrate surveys.
- Future surveys as part of a Fisheries Management Plan should include at least two external control sites for comparing with sites within the boundary of the wind farm development to accurately determine if any impacts on fish and invertebrate health are due to the development works or due to external causes.

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1 INTRODUCTION

The Galloway Fisheries Trust (GFT) was commissioned by Locogen Limited to carry out electrofishing and invertebrate surveys at six locations on the Annan catchment. This was to provide baseline monitoring data for the proposed Balgray Wind Farm development. The data from this survey will be able to inform the design of a Fisheries Management Plan (FMP) to monitor possible construction impacts if the development was to proceed. A FMP would need to include suitable control sites too.

The possible impacts that any land-based wind farm development and its associated infrastructure could have on surrounding fish populations are well known. The potential for fish species and their habitats to be affected by the development mainly occurs during the construction and decommissioning phases of the development. During the construction phase potential impacts include siltation from ground disturbance, accelerated or exacerbated erosion of watercourse banksides, hydrological changes to watercourses and surface water run-off, pollution of watercourses, and the blocking or hindering of the upstream/downstream migration of fish. During the operational phase, concerns include the effects of poor road drainage, accelerate levels of erosion, fish access issues through watercourse crossings such as culverts, and the maintenance of silt traps and watercourse crossings. Potential risks to fish populations and their habitats during the decommissioning phase are broadly similar to those in the construction phase. These potential effects could all impact fish populations by causing direct mortality of juveniles and adults, causing changes in food availability, creating avoidance behaviour resulting in unused habitat, blocking fish migration routes to spawning grounds or causing damage to instream and riparian habitats.

There is a variety of legislation, regulations and guidance in place relating to fish species that may be present in watercourses within the surveyed catchments.

There is a variety of legislation in place relating to various fish species that could be present in the watercourses draining the development site:

- Atlantic salmon are protected by a suite of legislation. They are an internationally important fish species and are listed under Annex II and V of the European Habitats Directive (1992) (only in freshwater)*, Appendix III of the Bern Convention (1979) (only in freshwater) and they are a priority species in most Local Biodiversity Action Plans.
- Brown trout/sea trout are a UK Biodiversity Action Plan Priority species.
- There have been concerns around Europe over falling eel stocks. It is currently unknown as to why they have undergone such a rapid decline, but suggestions include over-exploitation, inland habitat loss, climate and ocean current changes, disease and pollution. European Eel Regulations (EC) No 1100/2007 aim to establish measures to recover eel stocks. One such measure was the writing of Eel Management Plans. Fishing or taking eels is illegal (unless licensed) under The Freshwater Fish Conservation (Prohibition on Fishing for Eels) (Scotland) Regulations 2008. Eels are also a UK Biodiversity Plan Priority Species.

In 2021 Marine Directorate (formerly Marine Science Scotland) published guidance titled 'Monitoring watercourses in relation to onshore wind farm developments: generic monitoring programme' (<https://www.gov.scot/publications/monitoring-watercourses-in-relation-to-onshore-wind-farm-developments-generic-monitoring-programme/>). The baseline survey which GFT designed and completed for this development adheres to this guidance.

2 AIMS

The aims of this work were as follows:

- 2.1** Undertake quantitative electrofishing surveys to gather information on fish species at six sites.
- 2.2** Carry out a detailed bankside and habitat survey at all sites during electrofishing surveys.
- 2.3** Complete macroinvertebrate surveys at all sites.
- 2.4** Analyse and present results from electrofishing, habitat and invertebrate surveys to provide baseline (pre-construction) data for this development.

3 METHODOLOGY

3.1 Data recording

The GFT is a partner in the Scottish Fisheries Co-ordination Centre (SFCC)⁽¹⁾, an initiative involving twenty six Scottish Fishery Trusts and others, including Marine Directorate (Scottish Government), the Tweed Foundation, the Spey Research Trust, the Tay Foundation and the Cromarty Firth Fisheries Trust.

This group has, in partnership, developed a set of agreed survey and data collection methodologies for electrofishing surveys and an associated database in which to record information gathered from such surveys. The electrofishing surveys undertaken by GFT for this study have been completed to the high standards that are required by the SFCC and recorded using the agreed methodologies.

3.2 Electrofishing surveys

To assess those fish populations present within a section of river, various techniques have been developed in recent decades. The main method of determining the status of a juvenile salmonid population is through employing the use of electrofishing equipment.

Electrofishing involves the 'stunning' of fish using an electric current which overpowers the nervous system of the fish and enables the operator to remove them from the water. Once captured, the fish recover in a holding container. They are then anaesthetised using a specific fish anaesthetic, identified to species level, measured and recorded. Once recovered, they are then returned unharmed to the area from which they were captured. This method of fishing involves the anode operator drawing stunned fish downstream to a net held against the current by an assistant. A hand net operator completes the three-man team. Captured fish are then transferred to a water-filled recovery container. The fishing team works its way across the survey section and upstream, thereby thoroughly fishing all the water in the chosen survey area.

To obtain fully quantitative information on the fish populations (primarily juvenile salmonids – see Section 3.2.1) within an area of interest, each survey site is fished through up to four times consecutively to allow the calculation of a more accurate estimate of the fish population present. A Zippin estimation of a fish population is a common calculation carried out using data derived from the depletion method of fishing (i.e. multiple-run fishing)⁽²⁾. The result provides an estimate of the fish population density per 100 m² of water, including the 95% confidence limits. When the calculation of a Zippin estimate of the population is not possible, a minimum estimate of the fish population is calculated for that section of river.

For this study, electrofishing was undertaken by three trained GFT staff at all survey sites. After the electrofishing exercise has been completed, a targeted and detailed SFCC habitat survey is completed of the actual fishing site. Results are provided in Section 4.1.1.

¹ <http://www.sfcc.co.uk/>

² Zippin, C. (1958). The Removal Method of Population Estimation. *Journal of Wildlife Management*, 22. Pp 82-90.

3.2.1 Limitations of electrofishing surveys

The SFCC method of electrofishing was primarily developed to survey juvenile salmonids in relatively shallow running water. Non-salmonid fish species may be present and caught during these surveys, but their populations may not be properly determined using this method of electrofishing. Any non-salmonid fish species are therefore counted and measured (eels only) but no population estimate is made.

Electrofishing will never capture all the fish in a survey site, therefore densities presented in this report are an estimate - either a minimum estimate, or, where possible, the calculation of a Zippin estimate of the juvenile salmonid population residing within the site has been presented (see Section 4.1.1). The absence of fish cannot be ascertained with certainty using electrofishing techniques so a density of zero does not always guarantee fish are altogether absent from the surveyed section of watercourse. Finally, although a low density of fish can be assessed with electrofishing techniques, low and patchy distributions of fish may make drawing conclusions from the data more difficult.

The juvenile salmonid density classification scheme (see Section 3.2.3) is based solely on the data from surveyed sites containing fish in 1997 to 2002 and refers to regional conditions at that time⁽³⁾; it must only be used as a very relative guide and not be used to draw conclusions. Moreover, the figures for juvenile trout are less reliable for various reasons (e.g. some surveyed populations of trout are isolated; sea trout contributing to stock in some areas etc.) and so can only be used as a relative indication of numbers.

3.2.2 Electrofishing equipment

The location of all the electrofishing survey sites selected for this study required the use of a mobile backpack electrofishing kit. The battery powered E-fish backpack electrofishing kit consists of an electronic controller unit with a linked cathode of braided copper (placed instream) and a linked, mobile, single anode, consisting of a pole-mounted stainless-steel ring and trigger switch, which is used instream to capture the fish. Smooth direct current was used in all survey sites.

3.2.3 Age determination and density

For this study the electrofishing survey concentrated on assessing the status of juvenile salmonid species, namely salmon and trout. In the majority of cases age determination can be made by assessment of the length of fish present. However, with older fish it is often more difficult to clarify age classes. In these cases, a small number of scale samples are taken from fish, in addition to taking length assessments, to verify the ages of fish whose age cannot be determined with certainty from the length.

In this study, juvenile salmon and trout are differentiated into fry (age 0+) and parr (age 1++) age groups (Table 1).

Table 1: Salmonid age classifications referred to in this report

Salmon and Trout Fry (0+):	Young fish less than one year old resulting from spawning at the end of 2022
Salmon and Trout Parr (1+ and older (1++)):	Young fish of greater than one year and greater than two years old (where present) from spawning in 2021 or previously. Trout of up to three or four years old are also included in this category

³ Godfrey, J. D. (2006), Site Condition Monitoring of Atlantic Salmon SACs: Report by the SFCC to Scottish Natural Heritage, Contract F02AC608 <https://www2.gov.scot/resource/doc/295194/0096508.pdf>

Juvenile salmon and trout numbers recorded have also been classified into several 'density' categories. A classification scheme for densities of salmonids was previously generated by the SFCC using data collected from 1,638 Scottish electrofishing survey sites covering the period 1997 to 2002⁽³⁾. From this, regional figures were created to allow more accurate local 'density ranges' (Table 2). The categories referred to in this report are based on quintile ranges for one-run electrofishing events in the Solway region (Solway Salmon Fishery Statistical Region), within which the River Annan catchment lies.

Table 2: Quintile ranges for juvenile salmon and trout (per 100 m² of water; see Table 1 for age classifications) based on one-run electrofishing events, calculated on densities >0 over 291 sites in the Solway Statistical Region

	Salmon 0+	Salmon 1++	Trout 0+	Trout 1++
Minimum (Very Low)	0.22	0.38	0.38	0.35
20 th Percentile (Low)	5.21	2.86	4.14	2.27
40 th Percentile (Moderate)	12.68	5.87	12.09	4.71
60 th Percentile (High)	25.28	9.12	26.63	8.25
80 th Percentile (Very High)	46.53	15.03	56.49	16.28

3.2.4 Non-salmonid fish species

At each survey site the presence of non-salmonid fish species is noted. Population densities for these species are not calculated (see Section 3.2.1) but numbers of individuals are counted.

3.2.5 Site measurement

At each survey site a total site length was recorded, and average wet and channel widths calculated. The average wet width is calculated from five or more individual widths recorded at equidistant intervals from the bottom of the site (0 m) to the top. At each site the final width is noted at the upper limit of the surveyed water. From these site measurements the total area fished can be calculated.

3.2.6 Bankside/instream electrofishing site habitat assessment

At each electrofishing site a detailed habitat assessment using SFCC protocol is made of the instream habitat available for older (parr (1++) aged) fish. This assessment grades the instream 'cover' available to salmonids as none, poor, moderate, good or excellent. This grading provides an index of instream cover where diverse substrate compositions will score more favorably than areas of uniform substrate which provides lower levels of cover for individuals.

In accordance with SFCC protocols, percentage estimates of depths, substrate type and flow type are made at each electrofishing site. Additionally, percentage estimates of the quantity of the bankside cover features such as undercut banks, draped vegetation, bare banks and marginal vegetation are made. When any reference to left or right bank is made, it is always classed as left and right bank when facing downstream.

3.2.7 Survey areas and site selection

Sites were selected by GFT after consultation with Locogen Limited.

3.2.8 Site sensitivity

Data from across the survey sites was analysed and a traffic light sensitivity rating was added to Table 7.

Table 3: Showing traffic light rating of sensitivity based on densities of juvenile salmonids found at each location

Traffic Light Rating	Description
Green	Not sensitive for fish at the survey location and unlikely to cause a localised effect. Works could still potentially cause downstream impact, so mitigations still need to be in place. No fish rescue required for any instream works.
Amber	Moderately sensitive for fish at the survey location as non-salmonid fish species are present. Fish rescue will be required prior to any instream work such as culvert placement. May cause a localised and downstream impact so strict pollution requirements still stand.
Red	Very sensitive for fish at the survey location and work could potentially cause a localised and downstream impact on fish populations. Fish rescue required prior to any instream works.

For a water to be classified as having a Green sensitivity rating (Low Sensitivity) it was found to contain any of the following: no fish present, site is a field ditch/drain, has unsuitable habitat to support fish, no watercourse visible during the surveys.

For a water to be classified as having an Amber sensitivity rating (Moderately Sensitive) it was found to contain any of the following: only non-salmonid species of fish. In general, the habitat was not suitable to support salmon or trout populations.

For a water to be classified as having a Red sensitivity rating (Very Sensitive) it was found to contain any of the following: presence of salmonids in any density or display habitats of particular significance.

All watercourses which have an Amber or Red sensitivity rating should be included in any Fisheries Monitoring Plan which would monitor for possible impacts during construction works.

3.3 Macroinvertebrate surveys

Macroinvertebrate surveys were conducted to gain an understanding of the health of the invertebrate communities at each sample site, with samples being collected alongside electrofishing sites (at the first suitable habitat upstream of the electrofishing site unless stated otherwise) on the days when the electrofishing was carried out. As with the electrofishing the samples represent a pre-construction baseline for future comparison and two control sites. This report will summarise and provide key information from the macroinvertebrate surveys conducted.

Invertebrate samples were collected using a standard 25 cm frame kick sampling net with 1 mm mesh. The sampling methodology used was the standard macroinvertebrate sampling method of three minutes of kick sampling followed by one minute of manual searching. As with the standard procedure protocols the kick sampling was split proportionally based on the invertebrate habitats present within the sample sites. The manual search focused on the surface layer, bankside vegetation/undercuts and stone washing. The resultant material collected during the kick sample and manual search was placed into a labelled container and preserved in 70% isopropanol. Samples were sorted at the GFT office with all individuals being counted and identified to family level in accordance with WHTP sampling for biotic assessment. Identification was completed using a low powered microscope with x10 to x40 variable magnification and using the Freshwater Biological Association Guide to British Freshwater Macroinvertebrates for Biotic Assessment identification guide. Samples were scored using the WHTP scoring system, which scores different invertebrate families based on their general water quality requirements, and analysed using the River Invertebrate Classification Tool (RICT) Model 44 software. Model 44 is still in development but is expected to replace the current Model 1 software. Based on environmental variables recorded at sample sites the RICT software predicts the invertebrate communities that should be found within a given site and compares the predictions with the invertebrates recorded during the invertebrate sample. This gives a score (essentially a proportion of the predicted results) which can be used to assess general water quality based on the scoring system shown in Table 4.

Table 4: RICT WHTP Average Score per Taxon (ASPT) and NTAXA Ratings

ASPT	NTAXA	Water Quality
0.97+	0.80+	High
0.86 to 0.96	0.68 to 0.79	Good
0.72 to 0.85	0.56 to 0.67	Moderate
0.59 to 0.71	0.47 to 0.55	Poor
<0.59	<0.47	Bad

ASPT (Average Score per Taxon) represents the average WHPT water quality score for the invertebrate families recorded within a sample. NTAXA is the number of different invertebrate families recorded within a sample. Two additional Biotic Indices have been used to analyse the results and give an indication of the condition of the invertebrate communities at each sample site at the time of sampling (both of which can also be calculated by the RICT Software). The two Indices used are The Proportion of Sediment-sensitive Invertebrate Index (PSI) and the Acid Water Indicator Community (AWIC) Index. Whilst the WHTP Scoring gives an overall indication of water quality/invertebrate community health the PSI Index assesses the levels of sedimentation within watercourses by looking at the proportion of sediment sensitive invertebrate families within an invertebrate sample. Drainage and land erosion can result in high levels of sediment input from the surrounding land, which can “smother” riverbeds resulting in the death of buried fish eggs and some sediment intolerant invertebrate species. In a similar manner to the WHTP and PSI Indices the AWIC Index uses the pH tolerance of different families

of invertebrates to estimate the mean pH within a watercourse based on the invertebrates recorded. The scoring systems for both indices are shown in Tables 5 and 6.

Table 5: PSI Score Ratings

PSI Score	River Bed Condition
81 to 100	Minimally Sedimented/Unsedimented
61 to 80	Slightly Sedimented
41 to 60	Moderately Sedimented
21 to 40	Sedimented
0 to 20	Heavily Sedimented

Table 6: AWIC Score Ratings

AWIC Score	Mean pH	Low 95 Percentile	Upp 95 Percentile
2	5.46	4.55	6.37
2.5	5.84	4.93	6.75
3	6.22	5.31	7.12
3.5	6.6	5.69	7.5
4	6.98	6.07	7.88
4.5	7.36	6.45	8.27
5	7.74	6.83	8.65
5.5	8.12	7.21	9.03
6	8.5	7.59	9.41

The land use surrounding the Dryfe Water, within which the Balgray Wind Farm is to be constructed, is predominately moorland used for sheep grazing. The area is drained to facilitate grazing. Extensive grazing can result in erosion within the drains resulting in unnaturally high levels of silt entering watercourses. It can also potentially amplify the impacts of acidification on base-poor geology due to the shorter retention time of the rainwater and associated leaching of buffering particles. In addition to the impacts of land drainage on water quality, wind farm construction also has the potential to impact both sediment input and lower pH. Poorly designed access roads cut into the landscape can often act like drains and carry sediment laden water from the greater catchment down to watercourses at locations where roads cross them. Where the land is disturbed during construction of turbines and buildings this can also result in direct silt run-off over the land if poorly planned. Although the potential for wind farms to amplify the impacts of acidification in poorly buffered areas are still poorly understood some studies have found that some wind farm constructions can make watercourses more acidic. One example being Millidne et al. (2015) who recorded a drop in both pH and acid neutralising capacity within an upland catchment after a wind farm construction. As such the PSI and AWIC Indices used in this report are ones that were thought appropriate for the report at this phase, in addition to the WHPT Indices which is recommended by Marine Science Scotland. The macroinvertebrate results allow for a number of other additional Indices to be used in future reports if required.

4 RESULTS

4.1 Electrofishing surveys

The results of the electrofishing surveys are outlined in this section and presented in detail in Table 7. Site code, watercourse, site location, grid reference, survey date and non-salmonid species are also shown in Table 7. Electrofishing and habitat information for all electrofishing survey sites surveyed are discussed in Section 4.1.2.

4.1.1 Electrofishing summary

All electrofishing sites are summarised below in Table 7.

Table 7: Results from the 2023 electrofishing surveys. The number in each fish column represents a minimum estimate of fish density per 100 m² of water. Traffic light colour coding represents sensitivity of sites with regards to fish, with red indicating very sensitive, amber moderately sensitive and green not sensitive.

Site Code	Watercourse /River Order	Grid Ref	Survey Month	Density per 100 m ² water				Sensitivity Rating
				Atlantic Salmon Fry	Atlantic Salmon Parr	Brown Trout Fry	Brown Trout Parr	
BG1	Hewke Burn (below loch)	315838 588667	September 2023	0	0	0	3.003	FISH
BG2	Tributary of Halhills Loch	316065 588705	September 2023	NA	NA	NA	NA	unfishable
BG3	Hewke Burn (above loch)	316564 588550	September 2023	0	0	52.891	1.824	FISH
BG4	Tributary of Hewke Burn	316626 588534	September 2023	0	0	72.581	0	FISH
BG5	Kirkcroft Burn	315629 587864	September 2023	0	0	0	0	NONE
BG6	Upper Hope Burn	316522 586714	September 2023	0	0	0	0	NONE

4.1.2 *Electrofishing and habitat survey results*

- BG1, Hewke Burn (Below Halhills Loch)

This site was situated just downstream of where the burn widens (Figure 1). Instream cover was moderate and the water was deep with all depths ranging from 40 – 50+ cm deep. Substrates consisted of pebbles (30%), cobbles (30%), boulders (20%), gravel (15%) and some high organic (5%). Flows consisted of run (40%) and riffle (40%) with deep glide (20%). Both bankings had 80% of cover provided by areas of undercut and draped vegetation. The surrounding landscape was grazed improved grassland.

Brown trout parr were found in low density (Figure 2).



Figure 1: BG1, Hewke Burn



Figure 2: Brown trout parr caught at BG1

- BG2, Tributary of Halhills Loch

This site was located upstream of the inflow to Halhills Loch (Figure 3).

This site was deemed as unsuitable for fish and invertebrate surveys due to the very small size of the burn and being densely covered in vegetation. The burn is likely dry during most of the year due to its size.



Figure 3: BG2, Tributary of Halhills Loch

- BG3, Hewke Burn (above Halhills Loch)

This site was situated along the fence line (Figure 4).

Instream cover was moderate and depths ranged from 0 – 40 cm. Substrates consisted of cobbles (40%), gravel (30%) and pebbles (30%). Flows consisted primarily of deep glide (60%) with run (30%) and riffle (10%). Both banks had 90% of cover provided by areas of undercuts. The surrounding landscape was moorland heath.

Brown trout fry were found in high density and trout parr were found in very low density (Figure 5).



Figure 4: BG3, Hewke Burn



Figure 5: Brown trout fry and parr caught at BG3

- BG4, Tributary of Hewke Burn

This site was upstream of the confluence with Hewke Burn (Figure 6).

Instream cover was poor and depths did not exceed 10 cm. Substrates consisted primarily of gravel (60%) with sand (20%), pebbles (15%) and some cobbles (5%). Flows consisted primarily of run (70%) with riffle (20%) and run (10%). Neither banking had any cover. The surrounding landscape was lightly grazed moorland heath.

Brown trout fry were found in very high density (Figure 7).



Figure 6: BG4, Tributary of Hewke Burn



Figure 7: Brown trout fry caught at BG4

- BG5, Kirkcroft Burn

This site was located downstream of the wooden fence (Figure 8).

Instream cover was poor and depths ranged from 0 – 30 cm. Substrates consisted primarily of gravel (40%) and pebbles (40%) with some cobbles (15%) and boulders (5%). Flows consisted primarily of run (40%) and riffle (40%) with shallow glide (20%). Both banks had 20% of cover provided by areas of undercut and draped vegetation. The surrounding landscape was grazed improved grassland.

Fish were absent from this site. Fish would be expected to be present in this watercourse.



Figure 8: BG5, Kirkcroft Burn

- BG6, Hope Burn (upper)

This site was located in the field along the dyke and fence (Figure 9).

Instream cover was poor and depths were all between 40 – 50+ cm. Substrates consisted almost entirely of high organic (95%) with a small amount of gravel (5%). Flows consisted of run (60%), deep glide (30%) and deep pool (10%). Both banks had 100% of cover provided by

draped vegetation. The surrounding landscape was improved grassland and rough pasture. It was noted that this area of the burn was essentially a flooded field and may dry up during long periods of dry weather.

Fish were absent from this site.



Figure 9: BG6, Hope Burn

4.2 Macroinvertebrate surveys

Macroinvertebrate samples were taken immediately upstream of electrofishing sites during September 2023. As such the rough grid references and site pictures are the same as those listed in Table 6 within the electrofishing section. The results for the WHPT/RICT, PSI and AWIC Indices are shown in Table 7 and the ranking/ratings are shown in Table 8.

Table 7: Biotic Indice Scores for the Balgray WF Invertebrate Monitoring Sites

Site	WHTP ASPT	WHTP NTAXA	PSI Score	AWIC Score
BG1	0.86	1.1	48.8	4.9
BG3	0.83	0.95	57.9	5.1
BG4	0.91	0.9	54.1	4.9
BG5	0.9	1.12	70.7	4.7
BG6	0.72	0.67	30	5.3

Table 8: Biotic Indice Ratings for the Balgray WF Invertebrate Monitoring Sites

Site	WHTP ASPT	WHPT NTAXA	PSI Score	AWIC Mean pH
BG1	Good	High	Moderately Sedimented	7.36
BG3	Moderate	High	Moderately Sedimented	7.74
BG4	Good	High	Moderately Sedimented	7.36
BG5	Good	High	Slightly Sedimented	7.36
BG6	Moderate	Moderate	Sedimented	7.74

The full result table for the invertebrate sampling sites is listed in Table 9 - Appendix 1.

5 DISCUSSION

Six sites were surveyed for the proposed Balgray Wind Farm to provide baseline data which can be compared against future survey data. Three sites supported Brown trout and two sites had no fish. One site was classed as being unsuitable for surveying or supporting fish (BG2) and should not be included in any future monitoring programmes.

The main potential impacts, from this development, to surrounding fish populations are most likely to occur during the construction phase. Trout populations fall within the wind farm development site. If pollution entered any of the watercourses at these sites it could, in the worst case, kill fish, their prey items and potentially degrade habitats. Works such as constructing watercourse crossings, large scale excavation work (for example for turbine bases) and road drainage must be carefully considered and designed to ensure minimal disturbance to fish species residing in the watercourses in the vicinity and downstream of the development site. In the opinion of GFT it should be possible to mitigate against these impacts through the design and utilising best practice protocols to address potential fish access issues, silt management and pollution risks. Where construction will take place directly next to sites where fish populations are found, it is suggested that fish rescues are undertaken prior to any instream work to reduce the risk of impacting sensitive fish populations.

The 2023 surveys looked at specific sites. Some sites contained Brown trout which are protected under the UK Biodiversity Action Plan. Appropriate protocols must be followed when working in or near watercourses to ensure no harm is done to the sensitive fish populations residing near the work site.

The invertebrate samples showed “moderate” to “good” water quality across the five sites as shown by the WHTP ASPT scores. All sites had some level of sedimentation indicated by the PSI scores. Being surrounded by agricultural land, the watercourses may be more susceptible to increases in levels of silt and other sediments following long periods of heavy rainfall and high water flows. This can also decrease the water quality by introducing various forms of sedimentation into the water. Appropriate protocols must always be met during wind farm developments to ensure this issue is not exacerbated by ongoing works.

Site BG6 was deemed unsuitable for supporting fish due to how high up on the Hope Burn the site was selected. This area of the burn is likely to dry up and be completely inaccessible to fish. It is suggested that during any future survey programme, a site further downstream is selected where it is deemed potentially more suitable for supporting fish and invertebrates year round. Future surveys should also include at least two external control sites to compare to and determine if any impacts on fish and invertebrate health are due to the wind farm development or to external causes.

6 APPENDIX

Appendix 1

Table 9: Results Table for Macroinvertebrate Samples

Macroinvertebrate Type/Family	BG1	BG3	BG4	BG5	BG6
Mayflies					
Baetidae		38	13	15	
Heptageniidae	38	193		195	
Ephemerillidae		2			
Leptophlebiidae		9			
Ephemeridae	10		1	1	
Stoneflies					
Leuctridae		8	6	22	
Perlodidae		1		14	
Perlidae	6				
Nemouridae					
Chloroperlidae					
Dragonflies					
Damselflies					
Cordulegastridae			1		
Coenagrionidae					
Bugs					
Veliidae				1	
Corixidae	1				
Nepidae			2		
Alderflies					
Sialidae	6	1		1	
Caddisflies					
Hydropsychidae	280			51	
Rhyacophilidae		7		2	
Polycentropodiidae	27			3	
Ecnomidae		7			2
Limnephilidae	10	15	29	50	
Lepidostomatidae					
Sericostomatidae	196				
Odontoceridae	1				
Philopotamidae			108	360	2
Beraeidae					
Phryganeidae					36
Glossomatidae			30		
True Flies					
Chironomidae	13	15	31	4	
Simuliidae	197	1	63	57	3
Tipulidae					
Pediciidae	4		16	9	
Limoniidae					1
Muscidae	46				
Ptychopteridae			108		
Ceratopogonidae					3
Thaumelidae					14

Beetles

Elmidae	462	32	65	134	17
Dytiscidae					
Scirtidae	7		84	7	
Noteridae					
Gyrinidae	3				
Chrysomeliidae					
Hydrophilidae					

Crustaceans

Gammaridae	768	406	411	206	51
Asselidae					

Worms/Leeches

Oligochaeta	40	6	9	22	90
Glossiphoniidae					
Dugesidae					
Planariidae					

Snails/Limpets

Planorbidae	533	2		2	
Hydrobiidae		45	166	3	62
Sphaeridae		1	1		183
Acroloxidae	46				
Physidae	17	4	2	11	2

7 REFERENCES

Millidine, K.J., Malcolm, I.A., McCartney, A., Laughton, R., Gibbins, C.N. & Fryer, R.J. (2015) The Influence of Windfarm Development on the Hydrochemistry and Ecology of an Upland Stream. *Environmental Monitoring & Assessment*, 187

Dobson, M. & Fletcher, M. (2014). *Guide to British Macroinvertebrates for Biotic Assessment*. Freshwater Biological Association, Scientific Publication No. 67