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Fisheries electrofishing survey for Benbrack Wind Farm (pre-construction)

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Summary

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Keywords

Electrofishing; Benbrack; Wind Farm; salmonids; juvenile surveys; pre-construction

Background

The Galloway Fisheries Trust (GFT) was commissioned by Wood plc to carry out pre-construction electrofishing surveys for the Benbrack Wind Farm near Carsphairn in Dumfries and Galloway.

Surveys were undertaken in September 2021 on the upper Dee catchment on tributaries of the Water of Deugh.

This report is provided to address the matters raised in condition 16 of the Section 36C consent for operation of the Benbrack Wind Farm (decision issued 19 November 2019).

Main findings of the 2021 electrofishing survey

- A total of twelve sites were surveyed using electrofishing techniques for this study. All sites were located within the upper Dee catchment.
- Ten sites fell within the wind farm boundaries with two external control sites.
- Of the ten sites within the wind farm boundaries, Brown trout were present in seven sites with three sites having no fish present.
- Brown trout were found within both control sites, with Atlantic salmon present within one of the control sites.

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1 INTRODUCTION

Condition 16 'Migratory Fish' of the Section 36C Electricity Act consent for operation of the Benbrack wind farm (issued 5th November 2019) states the following:

(1) No construction works shall be undertaken within 50 metres of any part of watercourse within the Site unless a baseline electrofishing and water quality survey has been carried out at such locations as have been agreed in writing with the Planning Authority in consultation with the Galloway Fisheries Trust and Marine Scotland, to confirm the presence of any migratory fish and the water quality of watercourses.
(2) Electrofishing check surveys shall be undertaken at those same locations throughout the construction stages at agreed intervals (but no more than once per annum). The results of the surveys shall be submitted to the Planning Authority. Should migratory fish or water quality be likely to be materially adversely affected by such works, measures to mitigate these material adverse impacts shall be submitted for the written approval of the Planning Authority and implemented thereafter.

Galloway Fisheries Trust (GFT) was commissioned by Wood plc to undertake pre-construction electrofishing surveys for the proposed Benbrack Wind Farm in order to ensure that the matters raised in condition 16 can be addressed. This report details the results of the surveys and prior to these surveys, GFT were commissioned to carry out a targeted walk-over fish habitat survey in 2013 for the development to assess the potential of these watercourses to support fish populations and to make recommendations regarding whether electrofishing surveys were required.

The habitat survey identified that there were several watercourse sites in the immediate vicinity of the development, which contain habitats suitable to potentially support a fish population. It was recommended that electrofishing surveys should be undertaken.

An electrofishing survey carried out in 2020 checked for the presence of fish at various planned new crossing points and found no fish present within any of the sites.

Electrofishing surveys were carried out in 2021 to provide pre-construction data and an overview of the fish populations present in the area of the development and prior to its construction. These included sites within the wind farm boundaries as well as controls outside its boundary.

The development is within the River Dee catchment in the South West of Scotland. The River Dee is within the area managed by the Dee District Salmon Fishery Board and is covered by GFT.

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, accelerated 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 River Dee catchment. Atlantic salmon are an internationally important fish population which is 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 are a local priority species in the Dumfries and Galloway Local Biodiversity Action Plan. Atlantic salmon are also a species of conservation concern on a UK level. Brown trout/sea trout are also a UK Biodiversity Action Plan species. Salmon and sea trout are unable to access the upper river above Kendoon Dam due to the lack of a fish pass.

2 AIMS

The aims of this work were as follows:

2.1 To undertake electrofishing surveys within and downstream of the boundary of the Benbrack Wind Farm Development, on the Dee catchment, including control sites.

2.2 Undertake a detailed bankside and habitat survey at each electrofishing survey site.

2.3 To analyse and present results from the surveys in report form which includes discussing the juvenile salmonids present, to assess any impacts on these fish from the construction works and if necessary to ensure that suitable mitigation measures are prescribed by GFT and Marine Scotland.

3 METHODOLOGY

3.1 Data recording

The GFT is a partner in the Scottish Fisheries Co-ordination Centre[1] (SFCC), an initiative involving twenty-six Scottish Fishery Trusts and others, including Marine Scotland Science (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 the fish population, present within a section of river various techniques have been developed in the recent decades. The main method of determining the status of a juvenile salmonid population is through employing the use of electrofishing equipment.

This technique of 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, measured and recorded, and once recovered, returned unharmed to the area from which they were captured.

The 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 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[2] of a fish population is a common calculation carried out using data derived from the depletion method of fishing (multiple run fishing). The result provides an estimate of the fish population density per 100 m^2 of water, including the 95% confidence limits (information pertaining to the 2020 electrofishing survey is presented in Table 1). 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.

After the electrofishing exercise has been completed, a targeted and detailed SFCC habitat survey is completed of the actual fishing site.

For this study, electrofishing was undertaken by three experienced GFT staff at all survey sites.

[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 but no population estimate is made (see Table 4 for the results of the 2021 electrofishing survey).

Electrofishing will never capture all the fish in a survey site so 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. 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.

A low density of fish can be assessed with electrofishing techniques, however it is harder to fully assess the actual population density of the watercourse or the representative site. If there is a low and patchy distribution of fish it may be harder to draw conclusions from the data.

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

For this study the electrofishing survey concentrated on assessing the status of juvenile salmonid species. 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 can be 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 salmonids are differentiated into fry (age 0+) and parr (age 1++) age groups (see Table 1).

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 was 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 was 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 Wood plc, GFT and Marine Scotland. Sites were directed by a targeted walk-over habitat survey completed in 2013. Discussion was held between all parties to ensure the sites were suitable to allow an understanding of the juvenile salmonids present, to be able to assess any impacts on these fish from the construction works and if necessary to ensure that suitable mitigation measures can be prescribed by GFT and Marine Scotland.

Survey work was carried out in September 2021.

4 RESULTS

4.1 Electrofishing survey

The results of the electrofishing survey are outlined in this section and presented in detail in Table 4, which provides information on the population densities of juvenile salmonids at each survey site. Ages of fish were determined from length frequency distributions. Site code, watercourse, site location, O.S. Grid reference, survey date, non-salmonid species and area fished (m^2) are also shown in Table 4.

With regard to the juvenile salmonid age classes, these are separated into four categories, which are defined in Table 1 below.

Table 1: Salmonid age classifications referred to in this report

Salmon Fry (0+):	Young fish less than one year old resulting from spawning at the end of 2020
Trout Fry (0+):	Young fish less than one year old resulting from spawning at the end of 2020
Salmon Parr (1+ and older (1++)):	Young fish of greater than one year and greater than two years old (where present) from spawning in 2019 or previously
Trout Parr (1+ and older (1++)):	Young fish of greater than one year and greater than two years old (where present) from spawning in 2019 or previously. Trout of up to three or four years old are also included in this category

Along with classifying salmonids into age brackets within the electrofishing results, juvenile salmonid 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 (SFCC, 2006[3]). From this, regional figures were created to allow more accurate local 'density ranges'. 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).

4.1.1 Survey limitations

The juvenile salmonid density classification scheme (SFCC, 2006) is based solely on data from surveyed sites containing fish in 1997 to 2002 and refers to regional conditions at that time; 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. Table 2 shows these quintile ranges for the Solway region, within which the River Dee catchment lies.

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

Table 2: Quintile ranges for juvenile salmonids (per 100 m^2 of water) 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
20th Percentile (Low)	5.21	2.86	4.14	2.27
40th Percentile (Moderate)	12.68	5.87	12.09	4.71
60th Percentile (High)	25.28	9.12	26.63	8.25
80th Percentile (Very High)	46.53	15.03	56.49	16.28

Electrofishing and habitat information for all electrofishing survey sites surveyed is discussed in Section 4.1.4.

4.1.2 Site sensitivity

Data from across the survey was analysed and a traffic light sensitivity rating was added to Table 4.

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.

Several areas across the electrofishing survey can be classed as sensitive.

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 ration (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 monitored during construction and post construction phases.

4.1.3 Electrofishing results summary

Below is the information for each site surveyed in 2021. The locations are stated with use of national grid references and include the presence/absence of fish species encountered within each site. A brief description of the physical properties of each site is included with site photos and some photos of fish caught during this survey. Table 4 includes the recorded data relevant to fish capture and highlights sites which may be impacted by wind farm construction.

- Site 1, Un-named Tributary of Brownhill Burn: Grid ref: 254585 601286

No fish were found within this site.

- Site 2, Polgavin Burn: Grid ref: 254557 601182

No fish were found within this site.

- Site 3, Brownhill Burn: Grid ref: 254635 601153

Brown trout fry were found in moderate density and Brown trout parr were found in very low density.

- Site 4, Brownhill Burn: Grid ref: 254984 600532

Brown trout fry and parr were both found in very low densities. Common minnows and stone loach were also present within this site.

- Site 5, Goat Burn: Grid ref: 254482 599838

Brown trout fry were found in very low density and Brown trout parr were found in high density.

- Site 6, Meadowhead Burn: Grid ref: 252379 599356

Brown trout fry were found in very low density. No Brown trout parr were found within this site.

- Site 7, Meadowhead Burn: Grid ref: 252228 599245

Brown trout fry and parr were both found in low densities.

- Site 8, Water of Deugh: Grid ref: 254581 599762

Brown trout fry were found in very low density and Brown trout parr were found in low density. Common minnows and stone loach were also present within this site.

- Site 9, Lamford Burn: Grid ref: 252367 598922

No fish were found within this site.

- Site 10, Pulnuskie Burn: Grid ref: 251604 600641

Brown trout fry were present in moderate density. No trout parr were found within this site.

- Site 11, Polmaddy Burn: Grid ref: 258891 587679

Control site. Salmon fry were found in very low density. Brown trout fry were found in moderate density. No salmon or trout parr were found within this site. Common minnows were also present within this site.

- Site 12, Water of Deugh: Grid ref: 260783 604514

Control site. Brown trout fry were found in low density and Brown trout parr were found in moderate density. Stone loach were also present within this site.

4.1.4 Detailed electrofishing results

Below are the results from the electrofishing survey which can also be found in Table 4.

- Site 1, Un-named tributary of Brownhill Burn

Site 1 is situated below Dodd Hill by the forestry (Figure 1).

This burn was very small and goes underground at some points. Instream cover was considered to be poor. Substrates are primarily gravel (40%) and pebbles (20%) with very few cobbles (10%) and a layer of high organic material (20%). The depth did not go under 30 cm. This burn has a severe lack of flow and consisted primarily of deep pool (90%) with a small riffle (10%) section at the upstream limit of the site. There was 100% bankside cover on both banks with the entire surveyed stretch of burn being undercut and covered with draped vegetation. The surrounding landscape was un-grazed moorland heath.

Fish were absent from this site.

Figure 1: Site 1 at the bottom of Dodd Hill

- Site 2, Polgavin Burn

Site 2 is located upstream of Polgavin Burn's confluence with Brownhill Burn (Figure 2).

This site was also very small with poor instream cover. The depths were varied between 0-50 cm. The flow was primarily very slow with the main flow type being deep pools (50%) and the remaining flow types being shallow pool (10%), riffle (30%), and run (10%). The substrates were primarily small and consisted of pebbles (40%), gravels (20%), cobbles (20%), and a layer of high organic material (20%). There was 90% cover on both banks with 60% being undercut and 30% being draped vegetation. The surrounding landscape was un-grazed moorland heath.

Fish were absent from this site.

Figure 2: Site 2, Polgavin Burn

- Site 3, Brownhill Burn

This site was situated downstream of the Polgavin Burn inflow (Figure 3).

This site had good instream cover for parr-aged fish. Depths were evenly spread between 0-50 cm. Substrates were well mixed with gravel (10%), pebbles (30%), cobbles (40%), and boulders (30%). Flows were varied throughout the site with areas of still marginal pools (10%), deep glide (20%), shallow glide (10%), with larger areas of run (30%) and riffle (30%). The left banking had 30% of cover provided by rocks embedded in the banking and areas of undercut. The right banking had 60% of cover from areas of undercut and large rocks embedded in the banking. Both banks had areas of erosion where the banking has fallen away and the surrounding landscape was un-grazed moorland heath.

Brown trout fry were found in moderate density and Brown trout parr were found in very low density.

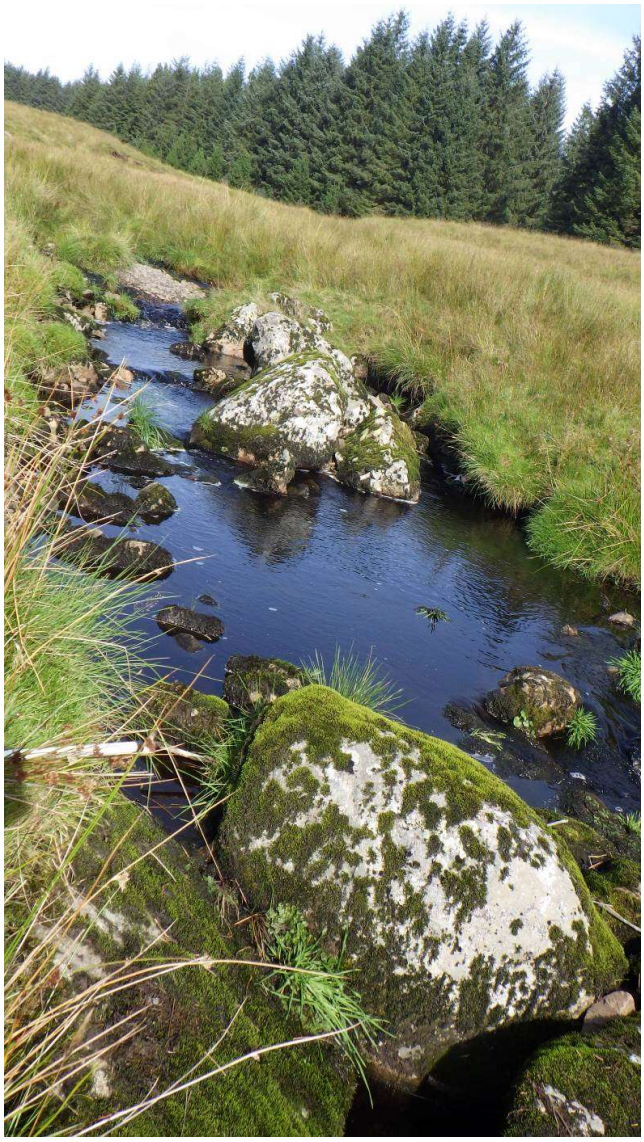

Figure 3: Site 3, Upper Brownhill Burn

- Site 4, Brownhill Burn

This site was located upstream of the road bridge (Figure 4).

This site had poor instream cover. Depths were spread between 0-50 cm. The substrates were primarily small with gravel (30%), pebbles (30%), cobbles (35%), and sporadic boulders (5%). The flow was mostly riffle (30%) with areas of run (20%), shallow glide (20%), deep glide (20%), and still marginal pools (10%). The left banking had 60% cover from undercut areas and the right banking had 80% cover from undercut areas. The surrounding landscape was grazed with some erosion on both banks.

Brown trout fry and parr were both found in very low densities (Figure 5). Common minnows and stone loach were also present within this site.

Figure 4: Site 4, Lower Brownhill Burn

Figure 5: Brown trout parr and fry caught at Site 4

- Site 5, Goat Burn

The site was adjacent to the sheep fold (Figure 6).

Instream cover was moderate. Depths did not exceed 20 cm with 70% of the site being under 10 cm deep. Substrates were well mixed with gravel (20%), pebbles (30%), cobbles (40%), and boulders (10%). There was a lack of flows with the site being primarily shallow pools (70%) with some areas of riffle (30%) in-between. Both banks were 50% covered provided by undercuts and draped vegetation. The sheep grazed moorland heath.

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

Figure 6: Site 5 on Goat Burn

Figure 7: Brown trout fry and parr caught at Site 5

- Site 6: Meadowhead Burn (upper)

The site was situated downstream of the watergate in the field (Figure 8).

Instream cover was poor within this site. Depths were varied between 0-50 cm. The substrates were varied throughout with small amounts of gravel (10%), pebbles (10%), cobbles (20%) and boulders (20%) with large stretches of bedrock (40%). The flows were very varied within this site due to a series of small falls throughout the site. The flows ranged from still marginal pools (20%), deep pools (10%), shallow pools (30%), run (10%) and riffle (30%). Both banks were mostly bear with only 20% of cover coming from rocks embedded in the banking on each. There was quite a bit of erosion on both banks which caused them to be very steep. This site was moved downstream from the original given location due to waterfalls causing access issues for fish. The small number of fish here may be due to further falls downstream of this site.

Brown trout fry were found in very low density. No Brown trout parr were found within this site.

Figure 8: Site 6, Meadowhead Burn

- Site 7: Meadowhead Burn (lower)

The site was situated downstream of the watergate in the field (Figure 9). This data has been included to help pick up potential impacts that may affect fish downstream of the original site. GFT are aware of trout populations within lower areas of this burn therefore after Site 6 was surveyed on Meadowhead Burn, Marine Scotland provided further comment that a downstream site should be included to compensate for the lack of fish found in the original site.

Instream cover was good within this site. Depths were varied between 20–50+ cm. The substrates were evenly mixed between gravel, pebbles, cobbles and boulders (20% each). The flows were primarily fast with run (30%), riffle (30%) and torrent (20%), with areas of deep glide (20%). The left bank had 30% of cover provided by undercut areas and rocks embedded in the banking while the right bank had 20% of cover coming from undercut areas. The surrounding landscape was a grazed field.

Brown trout fry and parr were both found in low densities.

Figure 9: Site 7, Meadowhead Burn

- Site 8: Water of Deugh

This site is situated downstream of the burn inflow (Figure 10).

This site had moderate instream cover. Depths did not exceed 40 cm. The substrates were primarily small with gravel (10%), pebbles (30%), and cobbles (55%) with few boulders present (5%). There flow consists primarily of shallow glide (60%) with areas of shallow pool (10%) and some run (15%) and riffle (15%) towards the right bankside. The left bank had 70% of cover provided by undercut areas and draped vegetation while the right bank had no cover and was completely bare. The site was surrounded by rushes and tall grass.

Brown trout fry were found in very low density and Brown trout parr were found in low density (Figure 11). Common minnows and stone loach were also present within this site.

Figure 10: Site 8, Water of Deugh

Figure 11: Brown trout parr caught at Site 8

- Site 9, Lamford Burn

Site 9 is located by the layby on the road (Figure 12).

This site had moderate instream cover and the burn disappeared underground at the upstream limit of the site. Depths did not go under 20 cm deep and exceeded 50 cm in some areas.

Substrates were a mix of gravel (20%), pebbles (30%), cobbles (40%), and some boulders (10%). The site was mostly deep pools (40%) and shallow pools (30%) with some riffle (20%) and run (10%). The left bank was 100% covered by undercuts and the right bank was 80% covered by undercuts. The landscape was slightly grazed and eroded on the left bank. There may be falls downstream which contribute to the lack of fish.

Fish were absent from this site.

Figure 12: Site 9, Lamford Burn

- Site 10, Pulnuskie Burn

This site is located upstream of Loch Muck and the A713 (Figure 13). This site was requested by Marine Scotland and agreed by GFT after the original sites were confirmed.

This site had poor instream cover for parr. Depths did not exceed 40 cm. The substrates were mostly small and consisted of gravel (40%), pebbles (40%), cobbles (15%) and boulders (5%). The flow was mostly run (70%) with areas of riffle (10%) and shallow glide (20%). Both banks had 40% of cover provided by undercut areas and draped vegetation. The surrounding landscape was un-grazed moorland heath.

Brown trout fry were present in moderate density. No trout parr were found within this site.

Figure 13: Site 10, Pulnuskie Burn

- Site 11, Polmaddy Burn (CONTROL SITE)

This site is located downstream of the tributary inflow (Figure 14). This is a suitable control site as it is within the upper Dee catchment and is similar to the wind farm sites.

This site had good instream cover and varied depths between 0-50 cm. Substrates were varied but mostly large with a mix of gravel (10%), pebbles (20%), cobbles (30%), boulders (20%), and bedrock (20%). The flows were mostly fast with the majority being run (40%) and riffle (30%) with some shallow glide (20%) and shallow pools (10%). Both banks were completely bare with 0% cover. The site falls within forestry and was surrounded by rough pasture.

Salmon fry were found in very low density (Figure 15). Brown trout fry were found in moderate density. No salmon or trout parr were found within this site. Common minnows were also present within this site.

Figure 14: Site 11, Polmaddy Burn (CONTROL)

Figure 15: Atlantic salmon fry caught at site 11

- Site 12, Water of Deugh (CONTROL SITE)

This site is located downstream of where the pylon crosses the water (Figure 16). This site has been included in replacement of the original Black Burn control site. This site is suitable as a control as it is away from any potential wind farm influence but is similar to sites within the wind farm boundaries and lies within the upper Dee catchment.

This site had moderate instream cover. Depths did not exceed 40 cm. Substrates were primarily small and consisted of gravel (20%), pebbles (25%), cobbles (40%) and boulders (15%). The flows consisted primarily of run (50%) with areas of riffle (30%) and shallow glide (20%). The left banking had 10% of cover provided by draped vegetation and the right banking had 30% of cover provided by areas of undercut and draped vegetation. The surrounding landscape was very open and exposed.

Brown trout fry were found in low density and Brown trout parr were found in moderate density. Stone loach were also present within this site.

Figure 16: Site 12, Water of Deugh (CONTROL)

*Table 4: Results from the 2021 electrofishing survey for Benbrack Windfarm (*Where a Zippin (1958) calculation could be carried out, 95% confidence limits are shown. Where only the number appears, a Zippin estimation could not be carried out. In these cases, the number represents a minimum estimate of fish density per 100 m^2). 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	Site Location	Grid Ref	Survey Date	Presence Of Other Species	Area Fished (m²)	Density per 100 m² *				Sensitivity
							Salmon Fry (0+)	Salmon Parr (1+ and older)	Trout Fry (0+)	Trout Parr (1+ and older)	
1 (DDBB5)	Dee, Un-named tributary of Brownhill Burn	At bottom of Dodd Hill by forestry	254585 601286	21/09	NONE	22.8	0	0	0	0	NONE
2 (DDPO1)	Dee, Polgavin Burn	Upstream confluence with Brownhill Burn	254557 601182	21/09	NONE	42.5	0	0	0	0	NONE
3 (DDBB4)	Dee, Brownhill Burn	Downstream Polgavin Burn inflow	254635 601153	21/09	NONE	96	0	0	25.057 ± 0.789	2.083	FISH
4 (DDBB3)	Dee, Brownhill Burn	Upstream bridge	254984 600532	21/09	Common Minnow (89), Stone loach (20)	122	0	0	2.459	1.639	FISH
5 (DDPG1)	Dee, Goat Burn	Adjacent to sheepfold	254482 599838	13/09	NONE	63.2	0	0	3.164	14.243 ± 6.738	FISH
6 (DDCM4)	Dee, Meadowhead Burn	Upstream watergate	252379 599356	21/09	NONE	71	0	0	1.408	0	FISH
7 (DDCM2)	Dee, Meadowhead Burn	Upstream of sheep/wall area	252228 599245	04/10	NONE	72.5	0	0	4.138	2.759	FISH
8 (DD16)	Dee, Water of Deugh	Downstream burn entry	254581 599762	13/09	Common Minnow (70), Stone loach (100+)	115	0	0	0.869	2.608	FISH
9 (DDCF1)	Dee, Lamford Burn	By layby on road	252367 598922	21/09	NONE	65.1	0	0	0	0	NONE
10	Dee, Pulnuskie Burn (ADDITIONAL SITE)	Upstream Loch Muck and A713	251604 600641	29/09	NONE	69.7	0	0	14.399	0	FISH
11 (DDP3)	Dee, Polmaddy Burn (CONTROL)	Downstream Burn inflow	258891 587679	23/09	Common Minnow (10)	56.6	1.776	0	21.198	0	FISH
12 (DD24)	Dee, Water of Deugh (CONTROL)	D/S pylon crossing	260783 604514	20/10	Stone loach (19)	95.8	0	0	7.52 ± 1.33	6.266	FISH

5 DISCUSSION

Twelve sites were surveyed within the Dee catchment to gather pre-construction data for the proposed Benbrack Wind Farm. Ten sites were within the wind farm boundaries and surveyed to highlight the watercourses which contain sensitive fish populations which may be impacted during construction. Two control sites were included which were also within the upper Dee catchment and away from any wind farm influence.

The main potential impacts, from this development, to surrounding fish populations are most likely to occur during the construction phase. Salmonid 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. Issues such as 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. If construction will take place directly next to sites where fish populations are found, it is suggested that fish rescues are carried out by GFT to reduce the risk of impacting sensitive populations this would include any new or upgrading of watercourse crossings.

The 2021 surveys looked at specific sites. Although some sites had very few or no fish, these results cannot be used to conclude that there are no fish populations upstream or downstream of the surveyed sites. Appropriate protocols should always be followed when working in or near water to ensure no harm is done to potential populations near the work site.

This pre-construction fisheries survey provides an important dataset and should be repeated annually to monitor fish populations during the construction phase and highlight any impacts. When repeated, comparisons can be made during construction and post-construction. This will provide a robust fish monitoring plan to enable any impacts to be highlighted and mitigation measures carried out. If impacts are identified, then the report should outline necessary mitigation works.

6 Appendix 1: Map of Electrofishing Sites