Appendix 6.1

Botanical Survey of Proposed Windfarm Site

Keerglen Wind Farm

Keerglen Windfarm

Botanical Survey of Proposed Windfarm Site

Prepared By:

Delichon Ecology

Prepared For:

O'Donnell Environmental Ltd. / ABO Energy

Keerglen Windfarm
Botanical Survey

Revision	Document Number	Description	Prepared by	Checked by	Date
0	40_2024	Botanical Survey	ED	ED	29/06/2024
1	40_2024	Botanical Survey	ED	ED	10/07/2024

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1. INTRODUCTION

Delichon Ecology were commissioned by O'Donnell Environmental Ltd. on behalf of ABO Energy to undertake detailed botanical surveys for a proposed windfarm development at Keerglen, Ballycastle, Co. Mayo. The detailed botanical and habitat walkover surveys were undertaken on September 29th 2022, April 24th 2023, June 23rd 2023 and September 29th 2023.

1.1 STUDY AREA

The proposed development, located in the townlands of Keerglen, Ballinglen and Ballkinlettragh, comprises the construction of an eight-turbine wind farm, an electrical substation, temporary construction compounds, associated Underground Electricity Export Connection Route (UEECR) and Turbine Delivery Route (TDR) and all associated ancillary works. The on-site substation will be connected to the existing Tawnaghmore 110kV substation via underground cabling.

The land-use within the proposed windfarm site predominantly consists of turbary while the access track and ancillary works are fringed by extensive farms, one-off private residential dwellings and farm outbuildings. The dominant habitat within the proposed windfarm site includes cutover bog in varying stages of recolonisation.

A site location map is presented in **Figure 1.1** below.

1.2 STATEMENT OF AUTHORITY

Eamonn Delaney BSc, MSc, MCIEEM, CECOL prepared this Screening for Appropriate Assessment report. Eamonn has seventeen years consultancy experience and has prepared Screening for Appropriate Assessment and Natura Impact Statements for various projects, including residential, amenity, renewable energy and transport developments in addition to strategic policy and planning proposals. Eamonn conducted field visits to the proposed windfarm site in August and September 2022, April 2023, June 2023 and September 2023. Eamonn's initial years in ecological consultancy involved botanical and habitat surveys for the purposes of EIA, EcIA and large scale habitat surveys for local authorities. This included plant species identification and habitat classification in a wide range of rural, urban and peri-urban environments. Eamonn is a member of the Botanical Society of Britain and Ireland (BSBI) and regularly attends local and regional BSBI field meetings in addition to carrying out recording for the proposed BSBI 2020 Atlas, in north Co. Galway and south Co. Mayo.

Eamonn has extensive experience in the Ecological Clerk of Works (ECoW) role for Flood Relief Schemes, roads and pipeline developments which requires weekly site visits, monitoring of mitigation measures, reviewing contactors method statements in addition to ongoing liaison with site operational staff and the design team. Eamonn has also been involved in the preparation and review of numerous Screening for Appropriate Assessment reports, Natura Impact Statements, Ecological Impact Assessments and Invasive Species Management Plans for a range of project types including roads, water infrastructure, solar farms, wind farms and peatland rehabilitation works. Through his involvement in all of these projects, Eamonn has honed his skills in field based

assessments and the subsequent reporting and interpretation of information yielded from desk and field based resources.

Eamonn routinely drafts, reviews and completes AA's for numerous projects. As the project design is developed, Eamonn seeks to influence the project design and refine the AA process to avoid and reduce potential impacts to the habitats and species for which the potentially impacted European site is designated. The outcome ensures that the finalised AA has been developed through an iterative process where the findings of the AA inform and are being informed by the project design throughout.

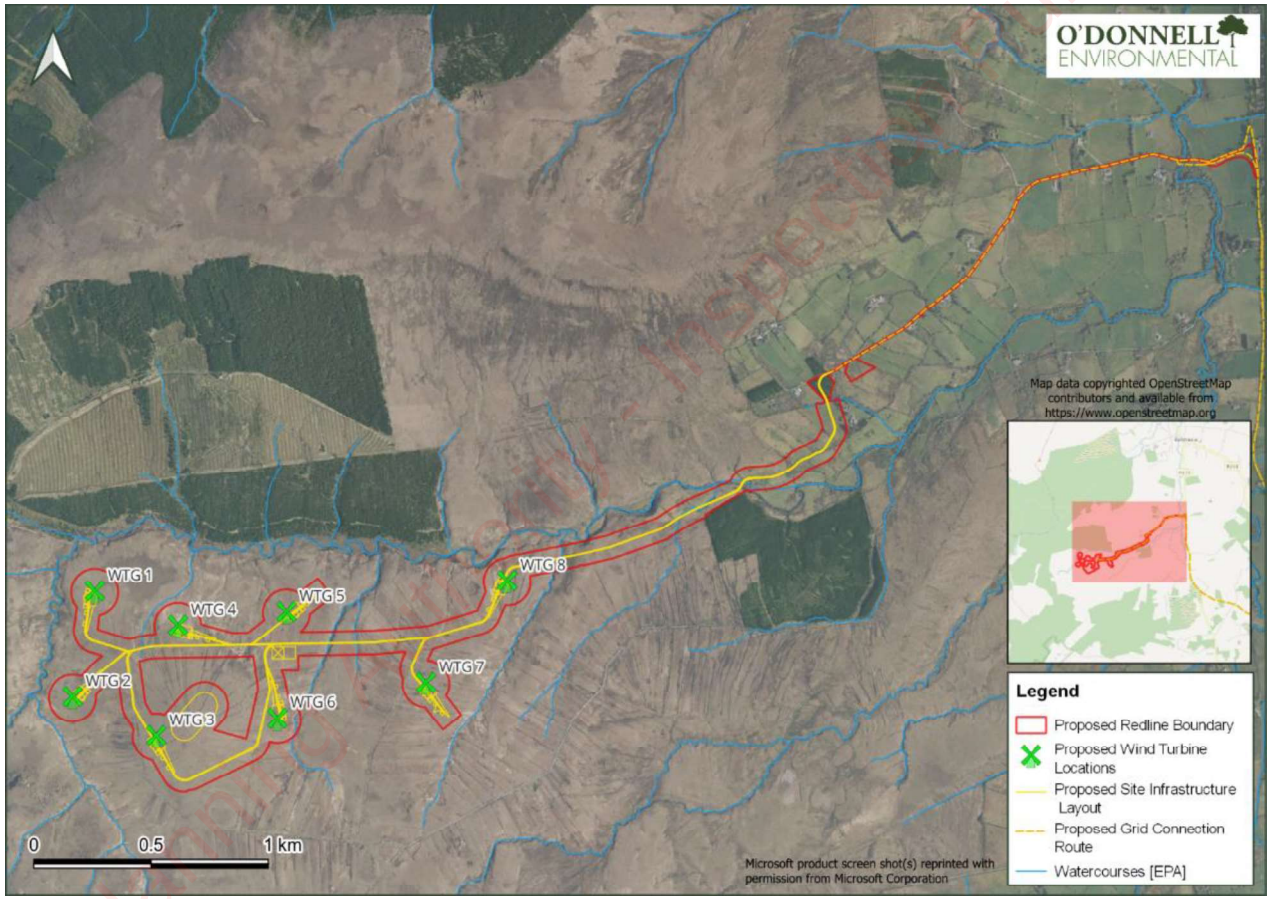

Figure 1-1: Site Location

2 METHODOLOGY

2.1 Phase 1 Habitat Mapping

A Phase 1 Habitat Survey was undertaken as part of the site walkover survey. The methodology used during this survey was based on the Heritage Council's *Best Practice Guidance for Habitat Survey and Mapping* (2011)[1]. The classification of habitats recorded during the field survey is based on the *A Guide to Habitats in Ireland* (Fossitt, 2000)[2]. The *Guide to Habitats in Ireland* classifies habitats according to a hierarchical framework with Level 1 habitats representing broad habitat groups, Level 2 representing habitat subgroups and Level 3 representing individual habitat types. The Phase 1 Field Survey focused on identifying habitats to Level 3 of the *Guide to Habitats in Ireland*.

The annotation of vegetation occurring within sites was undertaken using the DAFOR scale. This scale refers to plant species in terms of dominance, abundance, frequency, occasional and rare (DAFOR). All species were readily identifiable during the survey. Plant nomenclature for vascular plants follows 'New Flora of the British Isles' (Stace, 2019)[3], while mosses and liverworts nomenclature follows 'Mosses and Liverworts of Britain and Ireland - a field guide' (British Bryological Society, 2010)[4].

2.2 Relevé Sampling

In addition to Phase 1 habitat mapping, relevés were undertaken at the footprint at each of the proposed eight turbine locations and other locations (See **Figure 3.1**). Relevé size of 2m x 2m were sites within the wetland area and the surrounding and adjoining lands to identified changes in vegetation communities and associated / representative species cover, diversity and abundance. Within each relevé, the vascular plant species and bryophytes present and their cover abundance were recorded using the Domin Scale (see below). Information on mean vegetation height, bare rock, aspect, scrub encroachment, litter and threats were also noted. Each relevé was geolocated using a handheld Garmin GPS receiver (5m accuracy).

Table 2-1: Domin Scale for determining plant Cover / Abundance at each relevé

Domin Scale	Cover / Abundance %
10	91-100%
9	76_90%
8	51-75%
7	34-50%
6	26-33%

[1] Smith, G. F., O'Donoghue, P., O'Hora, K. & Delaney, E. (2011) *Best Practice Guidance for Habitat Survey and Mapping.* Heritage Council, Kilkenny.
[2] Fossitt, J. (2000) *A Guide to Habitats in Ireland*. Kilkenny: Heritage Council.
[3] Stace, C. (2019) New Flora of the British Isles. Fourth Edition. C&M Floristics
[4]Atherton, I. Bosanquet S. & Lawley, M (2010) Mosses and Liverworts of Britain and Ireland a field guide. British Bryological Society

Domin Scale	Cover / Abundance %
5	11-25%
4	4-10%
3	<4% (many individuals)
2	<4% (several individuals)
1	<4% (few individuals)

3 RESULTS

3.1 Relevé Survey

The findings of the 10 no. relevés completed are presented in full below. A synopsis and descriptive analysis for each relevé is presented in **Table 3.1** below while relevé locations are presented in **Figure 3.1**.

Releve 1 Turbine 7

Turbine 1 is located on an area of cutover bog habitat near the eastern margins of the proposed windfarm site footprint. The relevé is located on an area of bare, low growing recolonising cutover bog habitat (PB4), characterised by grass and sedge vegetation recolonising from historic and nearby cutover bog / turbary activities. The relevé and surrounding areas support low or locally absent *Sphagnum* cover abundance, with localised areas of bare peat and standing water in areas of past / previous cutover.

Table 3-1: Relevé 1Turbine 7 Botanical Relevé Results

	Common Name / Species Name	Cover Domin Scale
Releve 1 **Date: 29.09.2022** **Grid Reference: 0506978 0831972**	Bog asphodel (*Narthecium ossifragum*)	5
	Deergrass (*Trichophorum germanicum*)	7
	Purple moor grass (*Molinia caerulea*)	3
	Carnation sedge (*Carex panicea*)	5
	Ling heather (*Calluna vulgaris*)	2
	Cross leaved heath (*Erica tetralix*)	3
	Bog myrtle (*Myrica gale*)	1
	Common cottongrass (*Eriophorum angustifolium*)	5
	White-beaked sedge (*Rhynchospora alba*)	2
Bare Ground %	20%	
Standing Water %	10%	
Litter %	3%	
Vegetation Height (cm)	7cm	
Aspect	North-west	
Slope	Moderate	

Relevé 2 Turbine 8

Relevé 2 is located near the north-eastern boundary of the proposed windfarm site on a former turf spread area. Releve 2 is comparatively wetter and lower lying than Relevé 1 and is again characterised by a grassy / sedge plant species assemblage with low growing and localised ericoid cover on a habitat that corresponds to transitionary upland blanket bog - cutover bog mosaic. Unlike Releve 1, Releve 2 supports small percentage cover of *Sphagnum* moss, with *Sphagnum cuspidatum* and *Sphagnum papillosum* occurring in and adjoining localised areas of ponding water.

Table 3-2: Relevé 2 Turbine 8 Botanical Relevé Results

	Common Name / Species Name	Cover Domin Scale
Releve 2 **Date: 29.09.2022** **Grid Reference:** **0507325 0832373**	Bog asphodel (*Narthecium ossifragum*)	6
	Deergrass (*Trichophorum germanicum*)	5
	Purple moor grass (*Molinia caerulea*)	5
	Carnation sedge (*Carex panicea*)	5
	Ling heather (*Calluna vulgaris*)	5
	Cross leaved heath (*Erica tetralix*)	3
	Bog myrtle (Myrica gale)	1
	Common cottongrass (*Eriophorum angustifolium*)	4
	Racomitrium lanuginosum	3
	Aulacomnium palustre	1
	Sphagnum capillifolium	4
	Sphagnum papillosum	2
	Sphagnum cuspidatum	2
Bare Ground %	2%	
Standing Water %	None	
Litter %	3%	
Vegetation Height (cm)	9cm	
Aspect	North-west	
Slope	Moderate	

Relevé 3 Turbine 9

Releve 3 is located to the north of the Keerglen River on an area of localised poor fen and flush, that is surrounding by more expansive areas of wet heath. The habitat comprises a localised area of flushed and slightly waterlogged ground, fringing a tributary / steep ravine which joins the Keerglen River to the south. The habitat is characterised by a reduction of ling heather, which in turn is replaced by sedges and grasses including jointed rush, purple moor grass and black bog rush. It is no longer proposed to advance construction for Turbine 9 or its ancillary works, given their location north of the Keerglen River, within and adjoining areas of wet heath which supports correspondence with the Annex I habitat 'northern Atlantic wet heaths with *Erica tetralix* (4010)'.

Table 3-3: Relevé 3 Turbine 9 Botanical Relevé Results

	Common Name / Species Name	Cover Domin Scale
Releve 3 **Date: 29.09.2022** **Grid Reference:** **0505796 0831819**	Joinyed rush (*Juncus articulatus*)	6
	Bog myrtle (*Myrica gale*)	4
	Star sedge (*Carex echinata*)	5
	Black bog rush (*Schoenus nigricans*)	5
	Cross leaved heath (*Erica tetralix*)	2
	Bog pimpernel (*Anagallis tenella*)	2
	Devil's bit scabious (*Succisa pratensis*)	3
	Tormentil (*Potentilla erecta*)	2
	Meadow thistle (*Cirsium dissectum*)	2
	Pseudoscleropodium purum	1
	Carnation sedge (*Carex panicea*)	4
	Lesser spearwort (*Ranunculus flammula*)	1
	Purple moor grass (*Molinia caerulea*)	6
Bare Ground %	3%	
Standing Water %	1%	
Litter %	1-2%	
Vegetation Height (cm)	20cm	
Aspect	South / south-west	
Slope	Moderate	

Releve 4 Turbine 6

The Relevé footprint and general environs comprise more recently cutover bog habitat with large areas of bare ground, with localised sparse coverings of deergrass, purple moor grass and bog asphodel.

Table 3-4: Relevé 4 Turbine 6 Botanical Relevé Results

Releve 5 **Date: 29.09.2022** **Grid Reference:** **0506345 0831821**	**Common Name / Species Name**	**Cover Domin Scale**
	Deergrass (*Tricophorum cespitosum*)	5
	Common cottongrass (*Eriophorum angustifolium*)	4
	Purple moorgrass (*Molinia caerulea*)	2
	Bog asphodel (*Narthecium ossifragum*)	2
	Carnation sedge (*Carex panicea*)	1
	Campylopus introflexus	2
Bare Ground %	65%	
Standing Water %	No water	
Litter %	1-2%	
Vegetation Height (cm)	6cm	
Aspect	North / north-east	
Slope	Moderate	

Turbine 5 Releve 5

This releve is located on an area if revegetated cutover bog comprising abundant deergrass, frequent common cottongrass and occasional purple moor grass. The habitat is characteries by sedge and grass cover with wet patches and with localised bog myrtle signifying some localised flushing.

Table 3-5: Relevé 5 Turbine 5 Botanical Relevé Results

	Common Name / Species Name	Cover Domin Scale
Releve 5 **Date: 29.09.2022** **Grid Reference:** **0506383 0832273**	Common cottongrass (*Eriophorum angustifolium*)	7
	Cladonia portentosa	4
	Ling heather (*Calluna vulgaris*)	3
	Bog asphodel (*Narthecium ossifragum*)	3
	Sphagnum capillifolium	4
	Deergrass (*Tricophorum germanicum*)	4
	Cross leaved heath (*Erica tetralix*)	4
	Campylopus introflexus	2
	Carnation sedge (*Carex panicea*)	3
	Purple moor grass (*Molinia caerulea*)	4
	Hypnum jutlandicum	1
	Racomitrium lanuginosum	1
	Sphagnum tenellum	1
Bare Ground %	5%	
Standing Water %	No water	
Litter %	1-2%	
Vegetation Height (cm)	16cm	
Aspect	North-West	
Slope	Gentle	

Releve 6 Turbine 3

The Relevé footprint and general environs comprise previously cutover bog habitat that has recolonised to support a grassy / sedgy sward, with low growing common cottongrass, deegrass and bog asphodel.

Table 3-6: Relevé 6 Turbine 3 Botanical Relevé Results

	Common Name / Species Name	Cover Domin Scale
Releve 6 **Date: 29.09.2022** **Grid Reference:** **0505830 0831745**	Deergrass (*Tricophorum cespitosum*)	6
	Common cottongrass (*Eriophorum angustifolium*)	8
	Cladonia uncialis	3
	Cladonia portentosa	3
	Ling heather (*Calluna vulgaris*)	3
	Bog asphodel (*Narthecium ossifragum*)	6
	Carnation sedge (*Carex panicea*)	2
	Sphagnum capillifolium	2
	Racomitrium lanuginosum	2
	Tormentil *(Potentilla erecta*)	1
	Cross leaved heath (*Erica tetralix*)	2
Bare Ground %	8%	
Standing Water %	No water	
Litter %	1-2%	
Vegetation Height (cm)	8cm	
Aspect	South / south-west	
Slope	Moderate	

Releve 7 Turbine 1

This releve and its surrounding area is located on relatively undisturbed upland blanket bog habitat with no signs of recent or ongoing turbary. *Sphagnum* content does not exceed 10% cover abundance, but the bog habitat is characterised by a grassy / sedgy appearance with common cottongrass, bog asphodel, deergrass and occasional purple moor grass.

Table 3-7: Relevé 7 Turbine 1 Botanical Relevé Results

	Common Name / Species Name	Cover Domin Scale
Releve 7 **Date: 29.09.2022** **Grid Reference:** **0505570 0832366**	Bog asphodel (*Narthecium ossifragum*)	6
	Purple moor grass (*Molinia caerulea*)	6
	Common cottongrass *(Eriophorum angustifolium)*	7
	Racomitrium lanuginosum	3
	Ling heather (*Calluna vulgaris*)	4
	Tormentil (*Potentilla erecta*)	1
	Bell heather (*Erica cinerea*)	2
	Heath lousewort (Pedicularis sylvatica)	1
	Pleurozia purpurea	+
	Sphagnum tenellum	3
	Carnation sedge *(Carex panicea)*	2
	Sphagnum subnitens	2
	Deergrass *(Tricophorum germanicum)*	4
	Heath milkwort *(Polygala serpyllifolia)*	+
	Campylopus introflexus	1
Bare Ground %	3%	
Standing Water %	No water	
Litter %	1-2%	
Vegetation Height (cm)	12cm	
Aspect	North-west	
Slope	Gentle	

Releve 8 Turbine 4

The Relevé footprint and general environs comprise previously cutover bog habitat that has recolonised to support a grassy / sedgy sward, with low growing common cottongrass, deergrass and bog asphodel. Some bare soil from recent cutover activities in localised areas around the localised area.

Table 3-8: Relevé 8 Turbine 4 Botanical Relevé Results

	Common Name / Species Name	Cover Domin Scale
Releve 8 **Date: 29.09.2022** **Grid Reference:** **0505921 0832218**	Deergrass (*Tricophorum germanicum*)	5
	Bog asphodel (*Narthecium ossifragum*)	6
	Common cottongrass (*Eriophorum angustifolium*)	5
	Purple moorgrass (*Molinia caerulea*)	3
	Cross leaved heath (*Erica tetralix*)	3
	Sphagnum papillosum	2
	Sphagnum tenellum	1
	Sphagnum cuspidatum	2
	Ling heather (*Calluna vulgaris*)	2
	Campylopus atrovirens	1
	Hare's tail cottongrass (*Eriophorum vaginatum*)	6
Bare Ground %	1%	
Standing Water %	No water	
Litter %	0%	
Vegetation Height (cm)	12cm	
Aspect	North	
Slope	Moderate	

Releve 9 Turbine 2

The turbine footprint and releve location and area to the west supports upland blanket bog. The bog within the turbine area and surrounds exhibits some direct and indirect disturbance and degradation from historic cutover activities but the bog exhibits signs of recolonisation with improving *Sphagnum* cover and locally frequent ling heather.

Table 3-9: Relevé 9 Turbine 2 Botanical Relevé Results

	Common Name / Species Name	Cover Domin Scale
Releve 9 **Date: 29.09.2022** **Grid Reference:** **0505469 0831916**	Purple moor grass (*Molinia caerulea*)	6
	Common cottongrass (*Eriophorum angustifolium*)	5
	Bog asphodel (Narthecium ossifragum)	6
	Ling heather (Calluna vulgaris)	5
	Sphagnum papillosum	3
	Sphagnum capillifolium	4
	Cladonia uncialis	2
	Sphagnum tenellum	2
	Pleurozia purpurea	4
	Dicranum scoparium	1
	Racomitrium lanuginosum	3
Bare Ground %	1%	
Standing Water %	No water	
Litter %	0%	
Vegetation Height (cm)	16cm	
Aspect	West / north-west	
Slope	Gentle	

Releve 10 Proposed Access Track

This releve is located on flushed wet heath habitat on the riparian river channel of the Keerglen_010 river. The terrain slopes slightly to the north toward the river valley, and the surrounding vegetation is characterised by low growing ling heather and locally frequent bog myrtle. The wet heath habitat within the footprint and environs of this releve correspond with the Annex I habitat 'Northern Atlantic wet heaths with *Erica tetralix* (4010)'.

Table 3-10: Relevé 10 Proposed Access Track Botanical Relevé Results

	Common Name / Species Name	Cover Domin Scale
Releve 10 **Date: 23.06.2023** **Grid Reference:** **0507763 0832646**	Ling heather (*Calluna vulgaris*)	7
	Purple moor grass (*Molinia caerulea*)	2
	Hare's tail cottongrass (*Eriophorum vaginatum*)	5
	Cross leaved heath (*Erica tetralix*)	3
	Cladonia portentosa	2
	Bog myrtle (*Myrica gale*)	4
	Tormentil (*Potentilla erecta*)	2
	Sphagnum papillosum	4
	Hypnum cupressiforme	2
	Round leaved sundew (*Drosera rotundifolia*)	1
	Carnation sedge (*Carex panicea*)	2
	Bilberry (*Vaccinium myrtillus*)	1
	Heath milkwort (*Polygala serpyllifolia*)	1
Bare Ground %	1%	
Standing Water %	No water	
Litter %	0%	
Vegetation Height (cm)	14cm	
Aspect	West / north-west	
Slope	Gentle to Moderate	

Releve 11 Proposed Access Track

This releve is located on degraded upland blanket bog habitat located on gently sloping ground. The blanket bog habitat supports locally degraded dried out areas, in addition to remnant ponding / wet hollows with *Sphagnum cuspidatum* and areas of locally frequent reindeer lichen.

Table 3-11: Relevé 11 Proposed Access track Botanical Relevé Results

	Common Name / Species Name	Cover Domin Scale
Releve 11 **Date: 23.06.2023** **Grid Reference:** **0508108 0832649**	Ling heather (*Calluna vulgaris*)	7
	Common cottongrass (*Eriophorum angustifolium*)	4
	Hare's tail cottongrass *(Eriophorum vaginatum)*	5
	Deergrass *(Tricophorum cespitosum)*	3
	Heath rush *(Juncus squarrosus)*	4
	Tormentil *(Potentilla erecta)*	3
	Purple moor grass *(Molinia caerulea)*	3
	Sphagnum papillosum	4
	Sphagnum capilifolium	5
	Brookweed *(Samolus valerandi)*	1
	Sphagnum cuspidatum	3
	Cross leaved heath (*Erica tetralix*)	2
	Cladonia portentosa	5
	Cladonia uncialis	2
Bare Ground %	1%	
Standing Water %	No water	
Litter %	0%	
Vegetation Height (cm)	18cm	
Aspect	North / north-east	
Slope	Gentle	

Releve Photos

	
Image 3-1: Upland blanket bog within the environs of Turbine 1	**Image 3-2: Proposed location for Turbine 2 comprising recolonising upland blanket bog**
	
Image 3-3: Proposed location for Turbine 3 comprising recolonising cutover bog	**Image 3-4: Proposed location for Turbine 4 comprising recolonising cutover bog**

	
Image 3-5: Proposed location for Turbine 5 comprising recolonising cutover bog	**Image 3-6: Proposed location for Turbine 6 comprising bare cutover bog**
	
Image 3-7: Proposed location for Turbine 7 comprising cutover bog	**Image 3-8: Proposed location for Turbine 8 comprising recolonising cutover bog**

Image 3.9: Poor fen and flush habitat under the footprint of proposed Turbine 9[5]

[5] Now no longer considered for development.

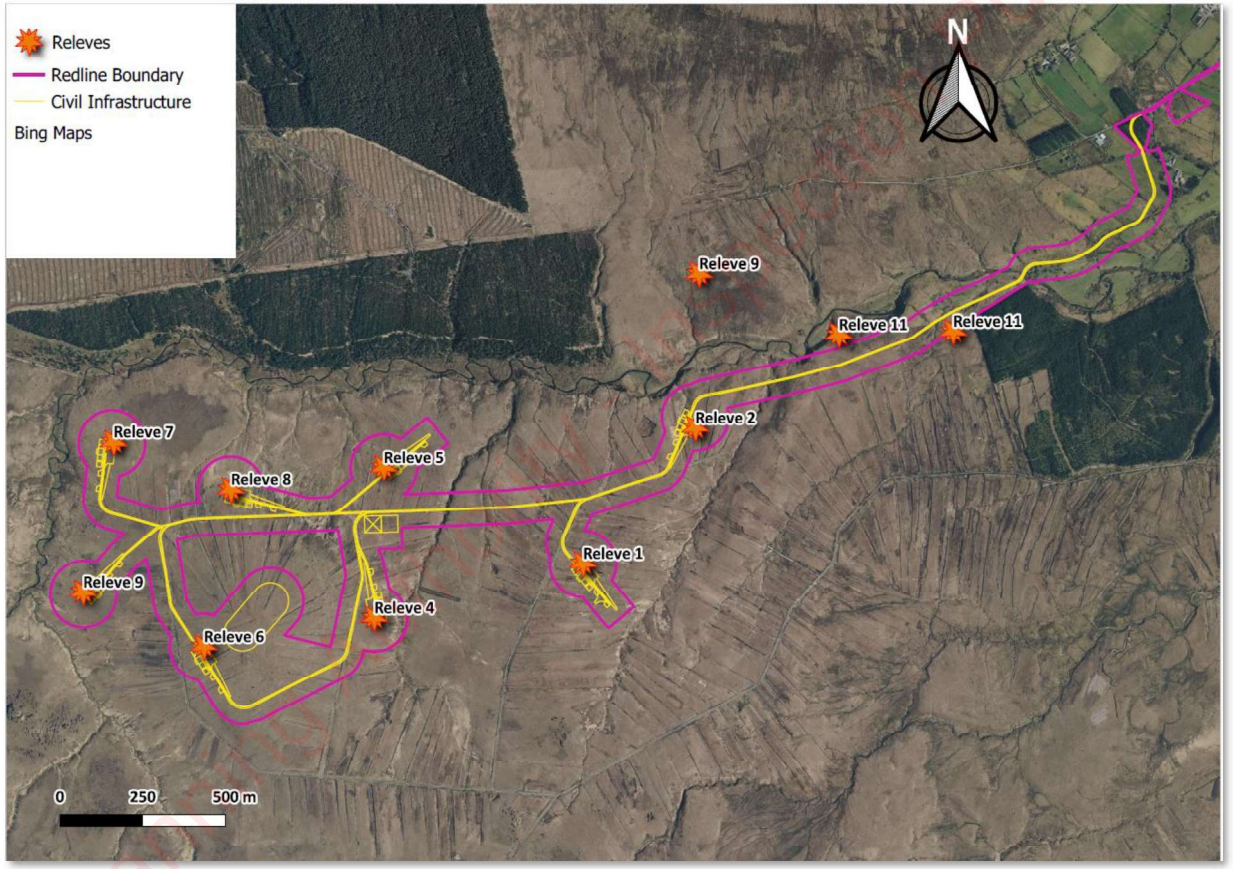

Figure 3-1: Relevé Locations at Keerglen Windfarm

Appendix 6.2

Fisheries Assessment for Keerglen Wind Farm

Keerglen Wind Farm

Fisheries assessment for Keerglen wind farm, Co. Mayo

Prepared by Triturus Environmental Ltd. for O'Donnel Environmental Ltd.

March 2024

Please cite as:

Triturus (2024). Fisheries assessment report for Keerglen Wind Farm, Co. Mayo. Report prepared by Triturus Environmental Ltd. for O'Donnel Environmental Ltd. March 2024.

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by O'Donnell Environmental on behalf of ABO Energy to undertake a baseline fisheries assessment of numerous watercourses in the vicinity of the proposed Keerglen wind farm, located approximately 6km south-west of Ballycastle, Co. Mayo (**Figure 2.1**).

The survey was undertaken to establish baseline fisheries data used in the preparation of the EIAR for the proposed project. In order to gain an accurate overview of the existing and potential fisheries value of the riverine watercourses within the vicinity of the proposed project, inclusive of the underground electricity export connection route (UEECR) and turbine delivery route (TDR), a catchment-wide electro-fishing survey across 27 no. sites was undertaken (**Table 2.1; Figure 2.1**). Electro-fishing helped to identify the importance of the watercourses as nurseries and habitats for salmonids, lamprey species and European eel (*Anguilla anguilla*). Other species of lower conservation value were also recorded. The presence and or absence of fish populations and or associated supporting habitat would help inform impact assessment and any subsequent mitigation for the project.

Triturus Environmental Ltd. made an application under Section 14 of the Fisheries (Consolidation) Act, 1959 as substituted by Section 4 of the Fisheries (Amendment) Act, 1962, to undertake a catchment-wide electro-fishing survey in the vicinity of the proposed Keerglen wind farm. The survey was undertaken on the 14th September 2023 (sites A7b, A7c & A7d[1]) and 16th to 18th August 2022 (all other sites).

1.2 Fisheries data (existing)

The proposed Keerglen Wind Farm development footprint encompassed numerous small streams and rivers within the wider Blacksod-Broadhaven (HA33) and Moy & Killala Bay (HA34) hydrometric areas. The majority of survey sites were located to the south of the wind farm boundary in the Glencullin[NorthMayo]_SC_010 sub-catchment, with a low number of watercourses associated with the proposed cable route located in the Cloonaghmore_SC_010 sub-catchment.

Fisheries survey sites were located on the Keerglen River (EPA code: 33K01) and 3 no. unnamed tributaries, Keerglen Stream (33K15), Ballinglen River (33B01), Annagh More Stream (33A10), Annagh Beg River (33A09), Farmhill Stream (33F21), Cloonaghmore River (34C03), Farragh River (34F20), Magherabrack River (34M16), Duvowen River (34D03), Garrynagran River (34G21) and several unnamed watercourses. (**Table 6.3**).

The Keerglen River is known to support Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*) (Triturus 2021 data; Holmes et al., 2022; IFI 2021 data[2];).

The Ballinglen River (33B01), to which the Keerglen River joins approx. 3km downstream of the proposed site boundary, is also known to support Atlantic salmon and brown trout in addition to sea

[1] Additional sites added to reflect changes in proposed site infrastructure (i.e. access tracks)

[2] Inland Fisheries Ireland 2021 data, available at https://opendataifigis.hub.arcgis.com/datasets/IFIgis::water-framework-directive-fish-ecological-status-2008-2021/explore?location=53.374419%2C-8.013350%2C8.54

trout (*Salmo trutta*), European eel (*Anguilla anguilla*) and three-spined stickleback (*Gasterosteus aculeatus*) (IFI 2021 data; Kelly et al., 2015, 2010). Brown trout growth within the river is noted as being very slow (Kelly et al., 2015). This catchment is under environmental pressure with fish stocks below their conservation limit. As a result, the fishery is closed to recreational salmonid angling. This closure was introduced as a conservation measure to allow stocks recover (A. Donegan, IFI pers. comm., April 2021). The Ballinglen River sub-catchment (which included the Keerglen River) had a mean salmon parr abundance of 10.73 fry/5min CPUE electro-fishing across 14 no. sites in 2021 (Holmes et al., 2022).

The Cloonaghmore River (crossed by the proposed GCR) is known to support Atlantic salmon, brown trout and sea trout (IFI, 2015).

Fisheries data for the other watercourses surveyed was not available at the time of survey.

2. Methodology

2.1 Fisheries assessment (electro-fishing)

A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish sites on watercourses in the vicinity of the proposed Keerglen wind farm (**Table 2.1, Figure 2.1**) on Thursday 14th September 2023 (sites A7b, A7c & A7d) and Tuesday 16th to Thursday 18th August 2022 (all other sites) following notification to Inland Fisheries Ireland and under the conditions of a Department of the Environment, Climate and Communications (DECC) licence. Both river and holding tank water temperature was monitored continually throughout the survey to ensure temperatures of 20°C were not exceeded, thus minimising stress to the captured fish due to low dissolved oxygen levels. A portable battery-powered aerator was also used to further reduce stress to any captured fish contained in the holding tank.

Salmonids, European eel and other captured fish species were transferred to a holding container with oxygenated fresh river water following capture. To reduce fish stress levels, anaesthesia was not applied to captured fish. All fish were measured to the nearest millimetre and released in-situ following a suitable recovery period.

As three primary species groups were targeted during the survey, i.e., salmonids, lamprey, and eel, the electro-fishing settings were tailored for each species. By undertaking electro-fishing using the rapid electro-fishing technique (see methodology below), the broad characterisation of the fish community at each sampling reach could be determined as a longer representative length of channel can be surveyed. Electro-fishing methodology followed accepted European standards (CEN, 2003) and adhered to best practice (e.g., CFB, 2008).

2.1.0 Lamprey

Electro-fishing for lamprey ammocoetes was conducted using targeted box quadrat-based electro-fishing (as per Harvey & Cowx, 2003) in objectively suitable areas of sand/silt, where encountered. As lamprey take longer to emerge from silts and require a more persistent approach, they were targeted at a lower frequency (30Hz) burst DC pulse setting which also allowed detection of European eel in sediment, if present. Settings for lamprey followed those recommended and used by Harvey & Cowx (2003), APEM (2004) and Niven & McAuley (2013). Using this approach, the anode was placed under the water's surface, approximately 10-15cm above the sediment, to prevent immobilising lamprey ammocoetes within the sediment. The anode was energised with 100V of pulsed DC for 15-20 seconds and then turned off for approximately five seconds to allow ammocoetes to emerge from their burrows. The anode was switched on and off in this way for approximately two minutes. Immobilised ammocoetes were collected by a second operator using a fine-mesh hand net as they emerged.

Lamprey species were identified to species level, where possible, with the assistance of a hand lens, through external pigmentation patterns and trunk myomere counts as described by Potter & Osborne (1975) and Gardiner (2003).

2.2 Fisheries habitat

A fisheries habitat appraisal of all 27 no. sites was undertaken to establish the importance of the supporting habitats as nursery, spawning, and or holding habitats. The appraisal surveys focused on evaluating the spawning, nursery, and or holding habitat for salmonids and lamprey species but also considered European eel and other fish species. The appraisals of salmonids and lamprey were cognisant of species-specific habitat requirements and preferences as outlined in O'Grady (2006), Hendry et al. (2003), Armstrong et al. (2003), Harvey & Cowx (2003), Maitland (2003) and Hendry & Cragg-Hine (1997). River habitat surveys and fisheries assessments were also carried out utilising elements of the approaches in the River Habitat Survey Methodology (EA, 2003) and Fishery Assessment Methodology (O'Grady, 2006) to broadly characterise the riverine sites (i.e., channel profiles, substrata, etc.).

2.3 Biosecurity

A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites. Specific consideration was given to highly virulent crayfish plague (*Aphanomyces astaci*). Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation of pathogens and invasive species. Where feasible, equipment was also thoroughly dried (through UV exposure) between survey areas. Any aquatic invasive species or pathogens recorded within or adjoining the survey areas were geo-referenced. All Triturus staff are certified in 'Good fieldwork practice: slowing the spread of invasive non-native species' by the University of Leeds.

Table 2.1 Location of *n*=27 fisheries survey sites in the vicinity of Keerglen wind farm, Co. Mayo

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Unnamed river	n/a	Keerglen	505511	831556
A2	Keerglen River	33K01	Keerglen	505405	832234
A3	Keerglen Stream	33K15	Keerglen	505770	832128
A4	Keerglen River	33K01	Keerglen	506305	832510
A5	Unnamed stream	n/a	Keerglen	506565	832140
A6	Keerglen River	33K01	Keerglen	507387	832613
A7	Unnamed stream	n/a	Keerglen	507445	832291
A7b	Unnamed stream	n/a	Keerglen	507558	832505
A7c	Unnamed river	n/a	Keerglen	507967	832392
A7d	Keerglen River	33K01	Keerglen	508293	832821
A8	Unnamed stream	n/a	Keerglen	507665	832815
A9	Ballinglen River	33B01	Ballinglen Bridge	510209	834207
B1	Unnamed stream	n/a	Local road crossing, Clydagh	506950	831308
B2	Unnamed stream	n/a	Local road crossing, Clydagh	508365	832190
B3	Unnamed stream	n/a	Local road crossing, Keerglen	508938	832658
B4	Ballinglen River	33B01	Local road crossing, Keerglen	510283	833535
B5	Annagh More Stream	33A10	R315 road crossing, Annagh More	510510	832934
B6	Unnamed stream	n/a	R315 road crossing, Annagh More	510561	832803
B7	Annagh Beg River	33A09	R315 road crossing, Annagh Beg	510683	832450
B8	Unnamed river	n/a	R315 road crossing, Creevagh More	510752	831287
B9	Farmhill Stream	34F21	Local road crossing, Kincon	513690	829574
B10	Cloonaghmore River	34C03	Tonrehown Bridge	515682	828680
B11	Farragh River	34F20	Local road crossing, Clooncran	517906	827351
B12	Magherabrack River	34M16	Local road crosing, Cloonawillin	518518	827074
C1	Duvowen River	34D03	R315 road crossing, Garranard	511641	826156
C2	Garrynagran River	34G21	R315 road crossing, Garrynagran	512001	825329
C3	Cloonaghmore River	34C03	Ballyglass, Moygownagh	512048	824331

Figure 2.1 Overview of the *n*=27 fisheries survey site locations in vicinity of the proposed Keerglen wind farm, Co. Mayo

3. Results

A catchment-wide electro-fishing survey of 27 no. riverine sites in the vicinity of the proposed Keerglen wind farm was conducted on 14th September 2023 (sites A7b, A7c & A7d) and 16th to 18th August 2022 (all other sites) following notification to Inland Fisheries Ireland. The results of the survey are discussed below in terms of fish population structure, population size and the suitability and value of the surveyed areas as nursery and spawning habitat for salmonids, European eel and lamprey species. Scientific names are provided at first mention only.

3.1.1 Salmonids and European eel

For salmonid species and European eel, as well as all other incidental species, electro-fishing was carried out in an upstream direction for a 10-minute CPUE, an increasingly common standard approach for wadable streams (Matson et al., 2018). A total of approx. 50-75m channel length was surveyed at each site, where feasible, in order to gain a better representation of fish stock assemblages. At certain, more minor watercourse sites or sites with limited access, it was more feasible to undertake electro-fishing for a 5-minute CPUE. Discrepancies in fishing effort (CPUE) between sites are accounted for in the subsequent results section (**Table 3.1**).

Relative conductivity of the water at each site was checked in-situ with a conductivity meter and the electro-fishing backpack was energised with the appropriate voltage and frequency to provide enough draw to attract salmonids and European eel to the anode without harm. For the varied conductivity waters of the sites (draining mixed geologies) a voltage of 200-300v, frequency of 35-40Hz and pulse duration of 3.5-4ms was utilised to draw fish to the anode without causing physical damage.

3.2 Fisheries assessment & appraisal

3.2.1 Site A1 – unnamed river, Keerglen

Brown trout (*Salmo trutta*) (*n*=19) was the only fish species recorded via electro-fishing at site A1 on an unnamed Keerglen River tributary (**Figure 3.1**).

The site was of moderate value for salmonids, supporting a relatively low density of mixed-cohort brown trout. The site provided some good quality albeit localised spawning habitat given relatively loose mixed gravel substrata. However, siltation reduced the value. Deeper glide and pool habitat, along with undercut (scoured) banks provided some good quality holding habitat for adult trout. The site was of moderate value as a nursery. Despite some physical habitat suitability, no European eel were recorded.

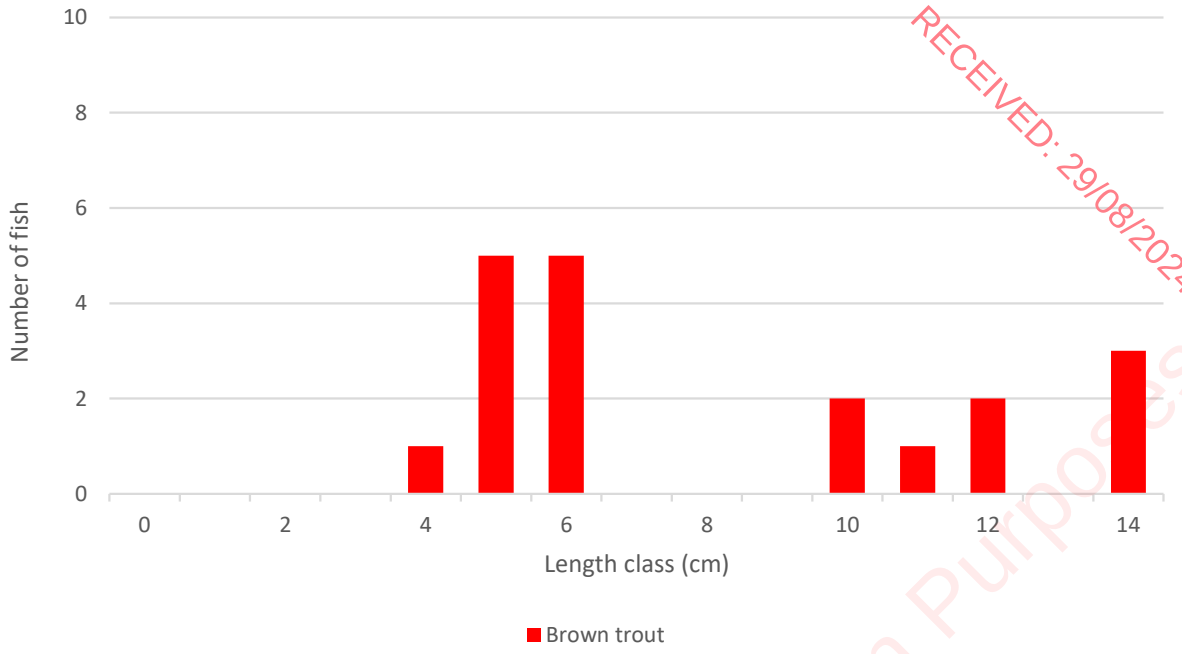

Figure 3.1 Length frequency distribution recorded via electro-fishing at site A1 on an unnamed Keerglen River tributary, August 2022

Plate 3.1 Mixed cohort brown trout recorded site A1 on an unnamed Keerglen River tributary, August 2022

3.2.2 Site A2 – Keerglen River, Keerglen

Brown trout (*n*=61) and European eel (*Anguilla anguilla*) (*n*=2) were the only fish species recorded via electro-fishing at site A2 on the upper reaches of the Keerglen River (**Figure 3.2**).

The site was of excellent value for salmonids, supporting a relatively high density of mixed-cohort brown trout. The site provided some good quality albeit localised spawning habitat given relatively loose mixed gravel substrata. However, siltation reduced the value overall. Good quality nursery habitat was also present given uncompacted boulder and cobble with high bryophyte coverage. However, the site was of highest value as a holding habitat, with bank scours and deep pool associated with meanders providing excellent quality habitat for adult salmonids (inclusive of Atlantic salmon, which were not recorded). The site provided some good quality European eel habitat, with ample instream refugia. However, the species was present only at low densities. The upland eroding site was unsuitable for lamprey.

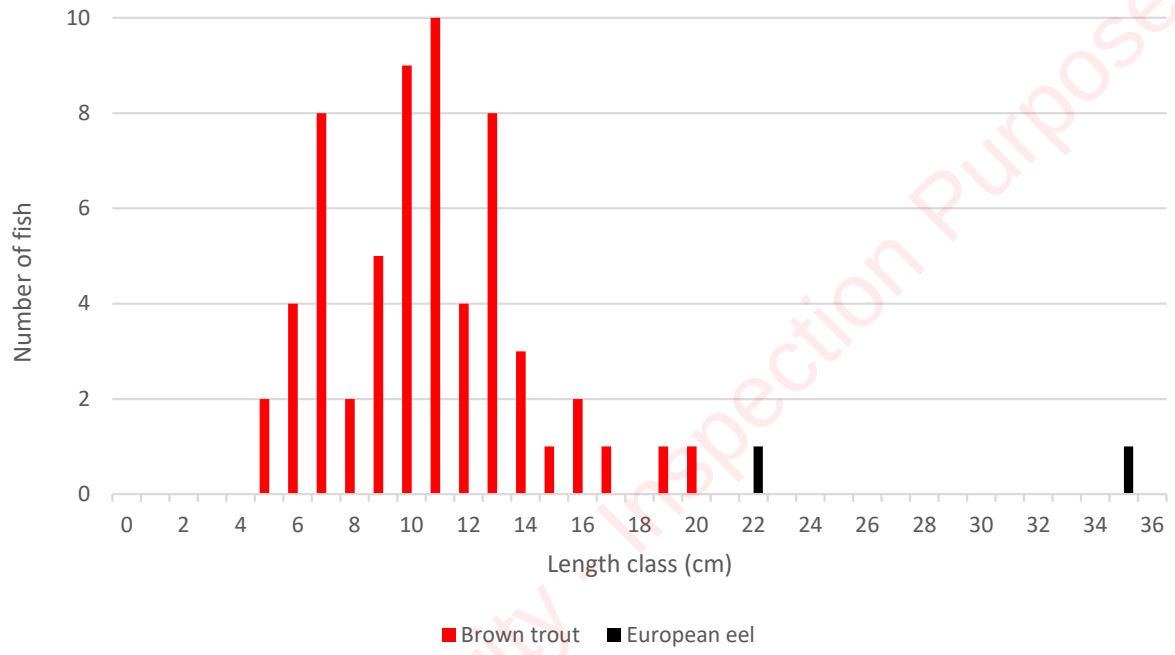

Figure 3.2 Length frequency distribution recorded via electro-fishing at site A2 on the Keerglen River, August 2022

Plate 3.2 Mixed cohort brown trout recorded at site A2 on the upper reaches of the Keerglen River, August 2022

3.2.3 Site A3 – Keerglen Stream, Keerglen

No fish were recorded via electro-fishing at site A3. The site was not of fisheries value given an absence of flowing water, heavy siltation, its likely ephemeral nature (i.e. seepage channel) and poor connectivity with downstream habitats. However, fisheries value increased downstream near the Keerglen River confluence.

Plate 3.3 Representative image of site A3 on the Keerglen Stream, August 2022

3.2.4 Site A4 – Keerglen River, Keerglen

Brown trout (*n*=44) was the only fish species recorded via electro-fishing at site A4 on the upper reaches of the Keerglen River (**Figure 3.3**).

The site was of high value to salmonids, supporting a relatively high density of brown trout. The site was of highest value as a salmonid nursery, with abundant bryophyte-rich cobble and boulder refugia. Spawning habitat was of moderate value given a paucity of suitable substrata in addition to siltation pressures. Some good quality holding habitat was present for adult salmonids, albeit localised. Despite some good physical habitat suitability, no Atlantic salmon were recorded (however, the species is present downstream). The site provided some good quality European eel habitat, with ample instream refugia. However, the species was not recorded. The upland eroding site was unsuitable for lamprey.

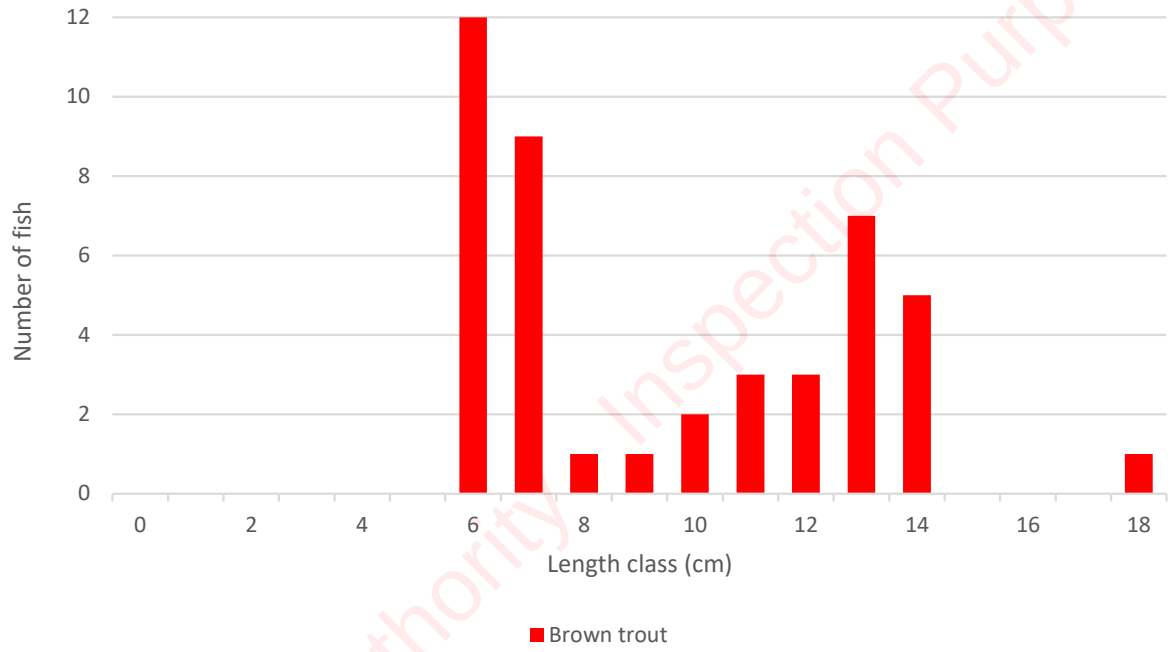

Figure 3.3 Length frequency distribution recorded via electro-fishing at site A4 on the Keerglen River, August 2022

Plate 3.4 Representative image of site A4 on the upper reaches of the Keerglen River, August 2022

3.2.5 Site A5 – unnamed stream, Keerglen

Despite some physical habitat suitability for salmonids and European eel, no fish were recorded via electro-fishing at site A5. This was considered reflective of low summer flows and evident water quality pressures (siltation, floc) but also natural gradients and frequent barriers (cascades), resulting in poor connectivity with the downstream-connecting Keerglen River.

Plate 3.5 Representative image of site A5 on an unnamed Keerglen River tributary, August 2022

3.2.6 Site A6 – Keerglen River, Keerglen

Brown trout (*n*=69) was the only fish species recorded via electro-fishing at site A6 on the Keerglen River (**Figure 3.4**).

The was of high value to salmonids, supporting high densities of mixed-cohort brown trout. The site was of highest value as a salmonid nursery, with abundant bryophyte-rich cobble and boulder refugia. Spawning habitat was of moderate value only given a paucity of suitable substrata (high compaction also) in addition to siltation pressures. Some good quality holding habitat was present for adult salmonids, albeit localised. Despite some good physical habitat suitability, no Atlantic salmon were recorded (however, the species is present downstream). The site provided some good quality European eel habitat, with ample instream refugia. However, the species was not recorded. The upland eroding site was unsuitable for lamprey.

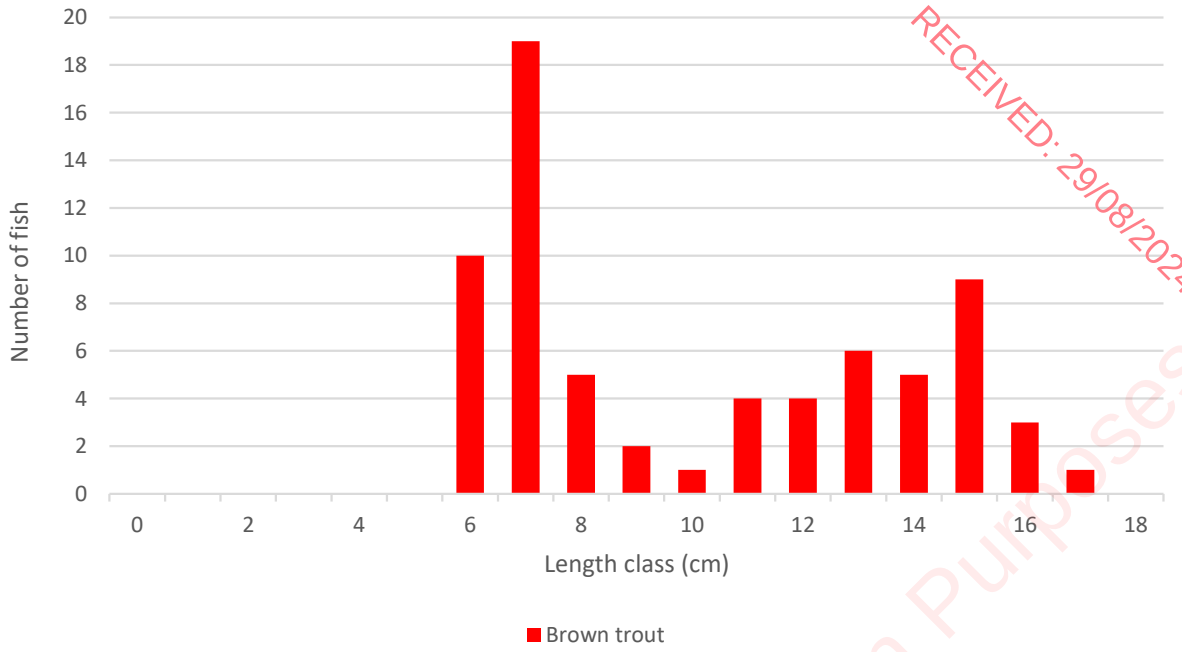

Figure 3.4 Length frequency distribution recorded via electro-fishing at site A6 on the Keerglen River, August 2022

Plate 3.6 Mixed cohort brown trout recorded at site A6 on the Keerglen River, August 2022

3.2.7 Site A7 – unnamed stream, Keerglen

No fish were recorded via electro-fishing at site A7 on the lower reaches of an unnamed Keerglen River tributary. The stream was not of fisheries value at this location given its diminutive size, natural gradients and low summer flows. However, brown trout were recorded in the lower reaches (see site A7b below). The upland eroding site was unsuitable for lamprey.

Plate 3.7 Representative image of site A7 on an unnamed Keerglen River tributary, August 2022

3.2.8 Site A7b – unnamed stream, Keerglen

Brown trout (*n*=13) was the only fish species recorded via electro-fishing at site A7b on the lower reaches of an unnamed Keerglen River tributary (**Figure 3.5**).

The site was of moderate value for salmonids only given the diminutive size of the stream and low summer flows, supporting a low density of mixed-cohort brown trout. Whilst the upper and middle reaches were not of fisheries value (poor flows and high natural gradients), the lowermost reaches were evidently of some value as a brown trout nursery. The stream likely contributed to the trout population of the downstream-connecting Keerglen River and supported higher fish densities during higher flow periods given good connectivity with downstream habitats. Spawning habitat was largely absent given the predominance of larger and compacted substrata. Holding habitat for adult salmonids was present but suitable for smaller trout only (not Atlantic salmon). As per the adjoining Keerglen River, despite some low suitability for Atlantic salmon, none were recorded. Similarly, no European eel were recorded despite some physical habitat suitability. The upland eroding site was unsuitable for lamprey.

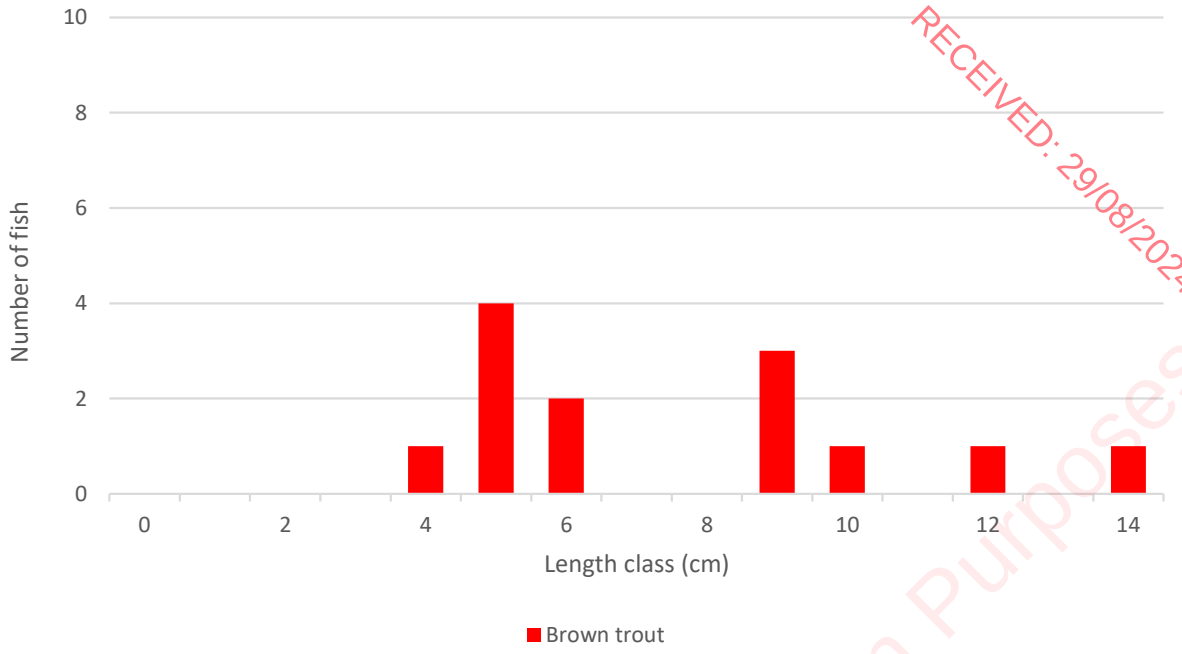

Figure 3.5 Length frequency distribution recorded via electro-fishing at site A7b on an unnamed Keerglen River tributary, September 2023

Plate 3.8 Adult and juvenile brown trout recorded at site A7b on an unnamed Keerglen River tributary, September 2023

3.2.9 Site A7c – unnamed stream, Keerglen

Brown trout (*n*=8) was the only fish species recorded via electro-fishing at site A7c on an unnamed Keerglen River tributary (**Figure 3.6**).

Deeper glide and pool provided moderate quality nursery conditions for salmonids with improved nursery habitat in lower gradient areas downstream. The site was of moderate value for salmonid spawning given localised pockets of mixed gravels between coarser substrata in deep pool areas. Plunge pools also provided high quality holding areas for adult salmonids. Despite some good suitability for European eel (abundant refugia), none were recorded and this likely reflected high natural gradients (barriers to migration). The upland eroding site was unsuitable for lamprey.

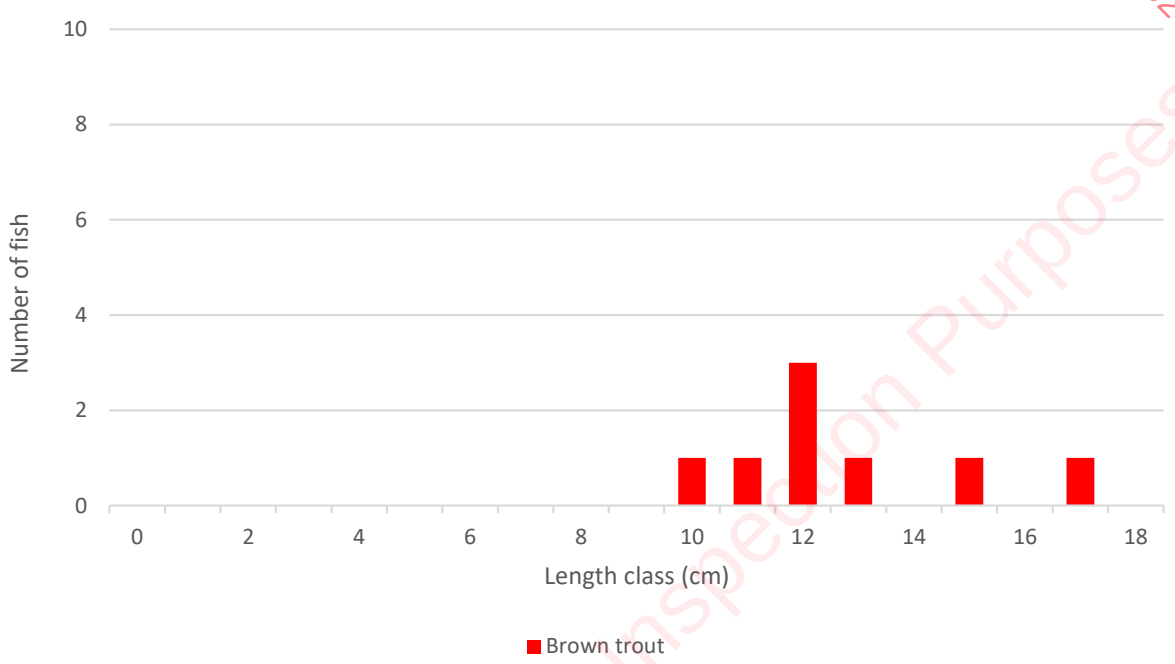

Figure 3.6 Length frequency distribution recorded via electro-fishing at site A7c on an unnamed Keerglen River tributary, September 2023

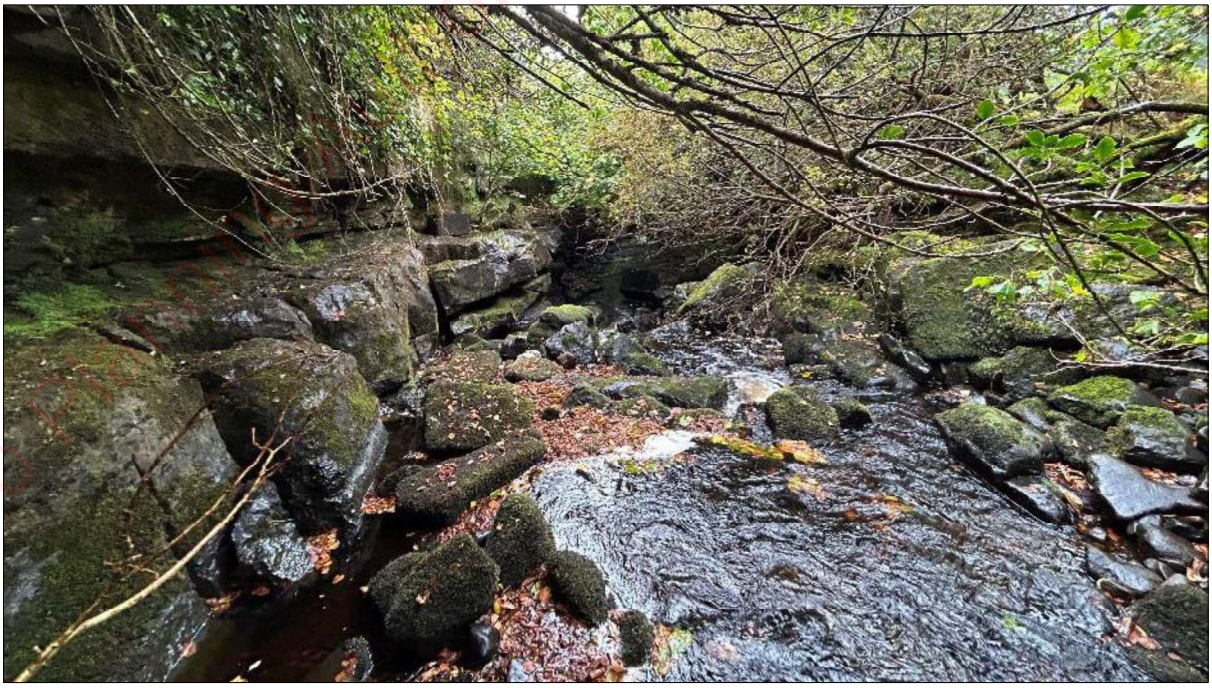

Plate 3.9 Representative image of site A7c on an unnamed Keerglen River tributary, September 2023

3.2.10 Site A7d – Keerglen River, Keerglen

Brown trout (*n*=30) was the only fish species recorded via electro-fishing at site A7d on the Keerglen River (**Figure 3.7**).

The site was a very good quality nursery for salmonids, with abundant flow refugia and a mixed cohort population recorded. However, the site was of moderate value only as a spawning habitat due to the dominance of boulder and larger cobble. The shallow nature of the site resulted in only a low frequency of suitable holding areas for adult salmonids (holding habitat improved upstream). Despite some good suitability for European eel (abundant refugia), none were recorded. The upland eroding site was unsuitable for lamprey.

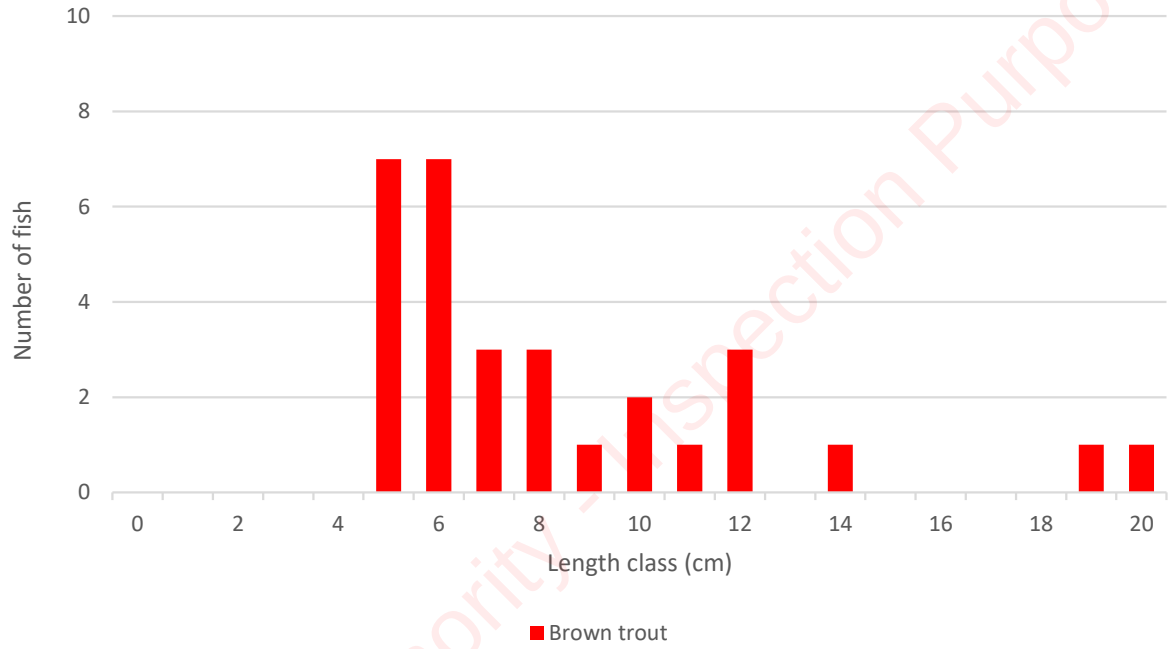

Figure 3.7 Length frequency distribution recorded via electro-fishing at site A7d on the Keerglen River, September 2023

Plate 3.10 Representative image of site A7d on the Keerglen River, September 2023

3.2.11 Site A8 – unnamed stream, Keerglen

Brown trout (*n*=2) was the only fish species recorded via electro-fishing at site A8 on an unnamed Keerglen River tributary (**Figure 3.8**).

The site was of low value to salmonids and supported a very low density of adult brown trout. The low summer flows and high natural gradients reduced the fisheries value significantly, with a near absence of spawning habitat and poor nursery conditions. The fisheries value of the small stream increased considerably at lower gradients near the Keerglen River confluence. Small plunge pools provided some holding habitat for adult trout. Despite some low suitability for European eel (abundant instream boulder refugia), none were recorded. The upland spate channel was unsuitable for lamprey.

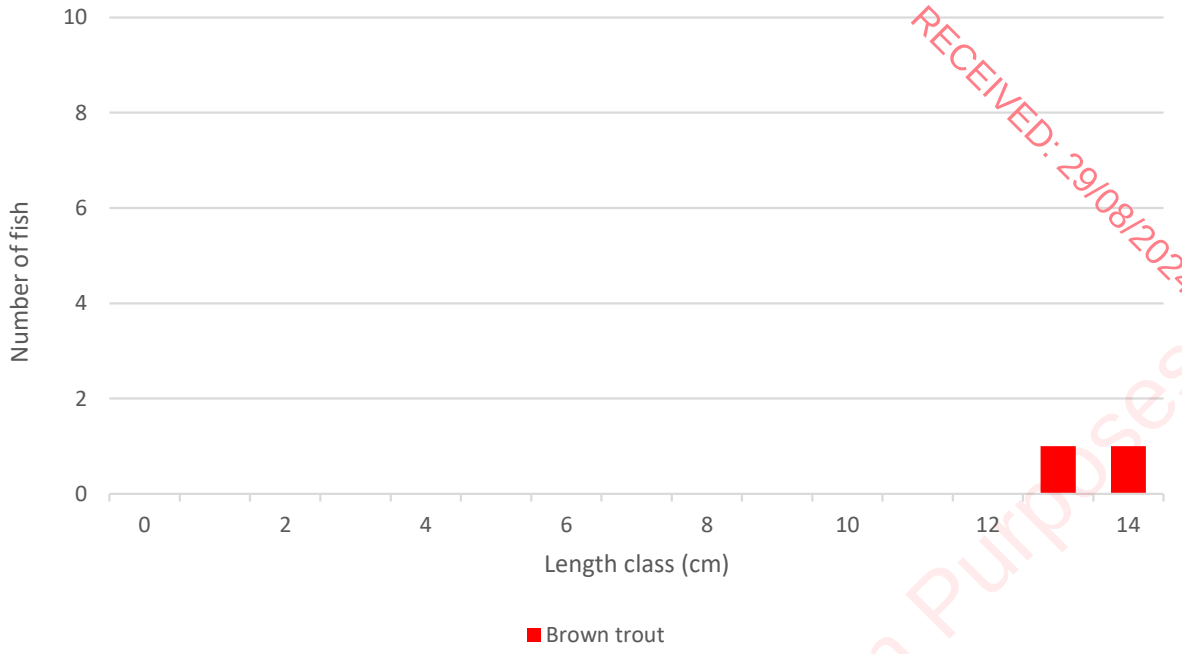

Figure 3.8 Length frequency distribution recorded via electro-fishing at site A8 on an unnamed Keerglen River tributary, August 2022

Plate 3.11 Representative image of site A8 on an unnamed Keerglen River tributary, August 2022

3.2.12 Site A9 – Ballinglen River, Ballinglen Bridge

Atlantic salmon (*Salmo salar*) (*n*=38), brown trout (*n*=66), European eel (*n*=3) and flounder (*Platichthys flesus*) (*n*=2) were recorded via electro-fishing at site A9 on the Ballinglen River (**Figure 3.9**).

The site was of high value for salmonids, supporting very high densities of both mixed-cohort brown trout and Atlantic salmon (the highest densities and highest value salmonid habitat recorded during the survey). The site was of excellent value as a spawning habitat with clean loose mixed cobbles and mixed gravels throughout riffle and shallow glide areas (especially upstream of the bridge). The site was also of excellent value as a nursery habitat for salmonids and European eel given an abundance of boulder and cobble refugia, in addition to instream large woody debris (LWD) and bank covours. Salmonid holding habitat (including for sea trout, none recorded) was also of excellent quality in the vicinity of the bridge and downstream. Whilst some soft sediment accumulations were present these were sand-dominated and no lamprey ammocoetes were recorded during targeted electro-fishing (as would be expected for a high energy site). A low number of flounder were also recorded, confirming free fish passage from the site to the sea (5.9km downstream).

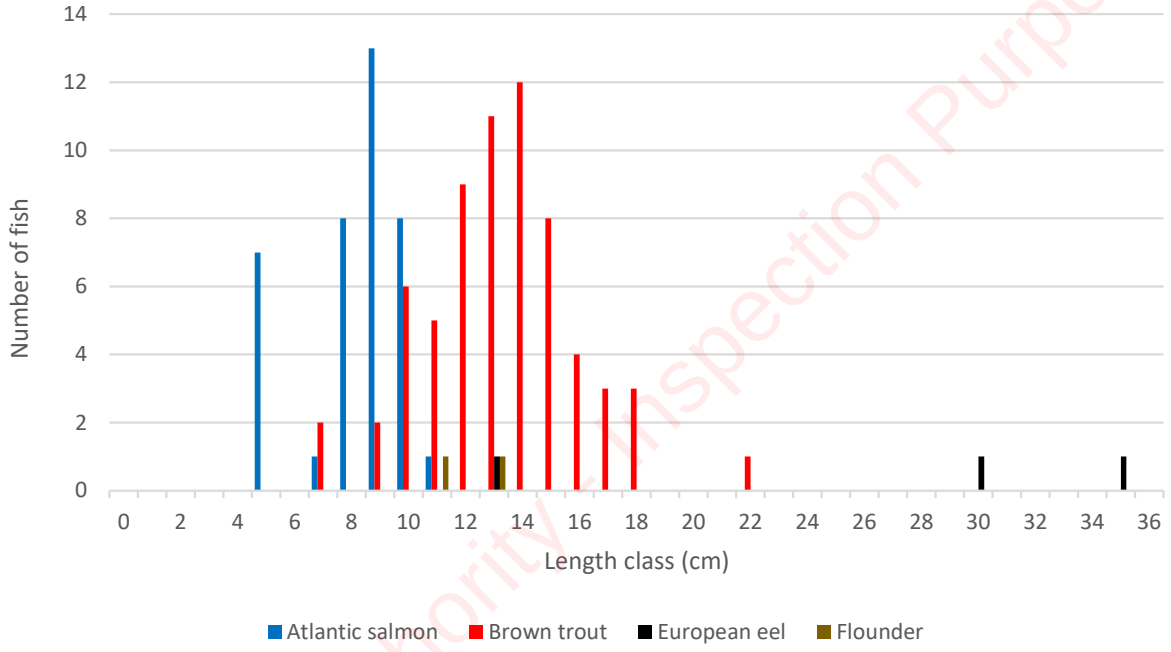

Figure 3.9 Length frequency distribution recorded via electro-fishing at site A9 on the Ballinglen River at Ballinglen Bridge, August 2022

Plate 3.12 Atlantic salmon parr (top) and adult brown trout recorded at site A9 on the Ballinglen River at Ballinglen Bridge, August 2022

3.2.13 Site B1 – unnamed stream, Clydagh

No fish were recorded via electro-fishing at site B1 on the uppermost reaches of an unnamed Keerglen River tributary. The site was not of fisheries value given an absence of flowing water, heavy siltation, its likely ephemeral nature (i.e. seepage channel) and poor connectivity with downstream habitats. However, fisheries value increased downstream near the Keerglen River confluence.

Plate 3.13 Representative image of site B1 on an unnamed Keerglen River tributary, August 2022

3.2.14 Site B2 – unnamed stream, Clydagh

No fish were recorded via electro-fishing at site B2 on the uppermost reaches of an unnamed Keerglen River tributary. The site was not of fisheries value given poor hydromorphology, intermittent flows, very shallow water and its likely ephemeral nature. Given its location in the headwaters of the stream, the site was not suitable or accessible to fish given poor connectivity with downstream habitats. However, fisheries value increased >1.4km downstream near the Keerglen River confluence.

Plate 3.14 Representative image of site B2 on an unnamed Keerglen River tributary, August 2022

3.2.15 Site B3 – unnamed stream, Clydagh

No fish were recorded via electro-fishing at site B3 on the uppermost reaches of an unnamed Keerglen River tributary. Despite some physical suitability, the site was not of fisheries value given poor hydromorphology, intermittent flows and its semi-dry, ephemeral nature. Given its location in the uppermost reaches of the stream, the site was not accessible to fish given poor connectivity with downstream habitats. Whilst the upland stream conveys more water seasonally (given site characteristics) it was still considered unlikely to be of value to fish at this location (I.e. uppermost reaches).

Plate 3.15 Representative image of site B3 on an unnamed Keerglen River tributary, August 2022

3.2.16 Site B4 – Ballinglen River, Keerglen

Atlantic salmon (*n*=6), brown trout (*n*=69), European eel (*n*=1) and three-spined stickleback (*Gasterosteus aculeatus*) (*n*=2) were recorded via electro-fishing at site B4 on the upper reaches of the Ballinglen River (**Figure 3.10**).

The site was of high value to salmonids, supporting a relatively high density of mixed-cohort brown trout and lower numbers of Atlantic salmon. The site was of most value as a holding habitat owing to the presence of deep pool, glide and undercut (shaded) banks upstream of the bridge (especially important during low flow periods). Good quality spawning habitat was present throughout although the value was reduced by filamentous algal cover and siltation pressures. The site was also of good value as a salmonid nursery habitat given ample instream refugia. However, low summer flows and water levels reduced this value, seasonally. The cobbled bridge apron was not a significant impediment to fish passage, even at low flows. European eel habitat was of good quality although the site only supported a low density. Whilst some lamprey spawning habitat was present, the sand-dominated soft sediment was largely unsuitable for lamprey ammocoetes and none were recorded.

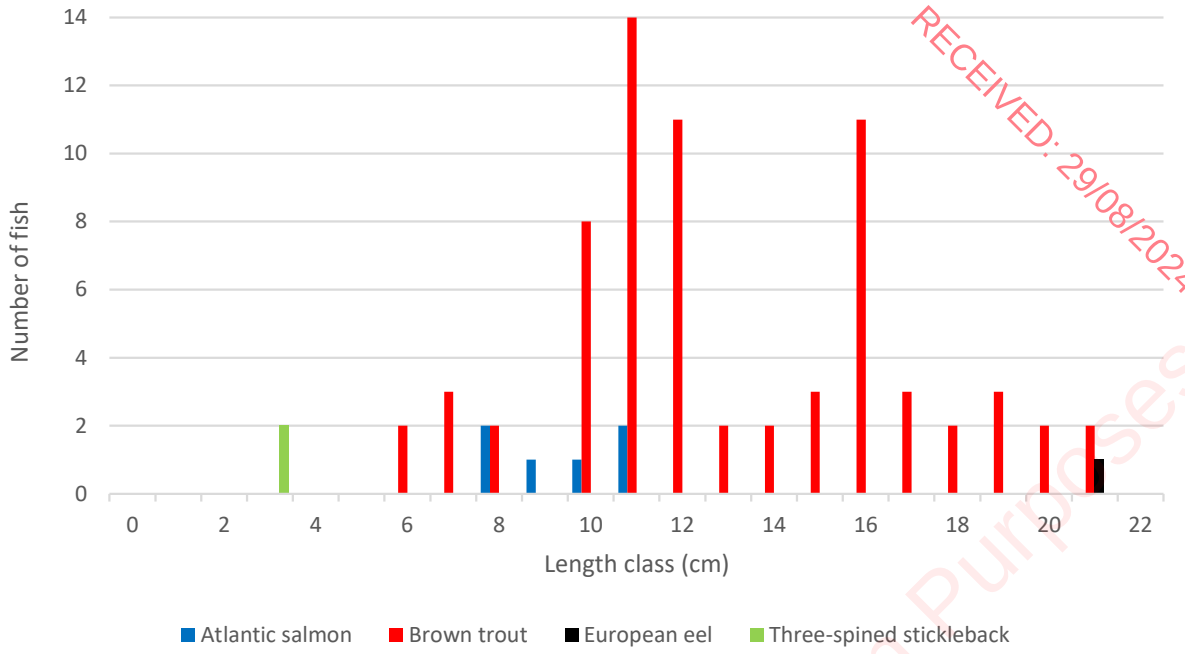

Figure 3.10 Length frequency distribution recorded via electro-fishing at site B4 on the Ballinglen River, August 2022

Plate 3.16 Juvenile brown trout (top) and Atlantic salmon (bottom) recorded at site B4 on the Ballinglen River, August 2022

3.2.17 Site B5 – Annagh More Stream, Annagh More

No fish were recorded via electro-fishing at site B5 on the Annagh More Stream. The site was not of fisheries value given very shallow water, heavy siltation and the location in the uppermost reaches of the channel. However, the fisheries value increased downstream near the Ballinglen River confluence.

Plate 3.17 Representative image of site B5 on the Annagh More Stream, August 2022

3.2.18 Site B6 – unnamed stream, Annagh More

Site B6 was not of fisheries value at the time of survey given its dry, ephemeral nature and absence of aquatic habitats. However, given likely seasonality (spate channel), the lower reaches of the stream near the Ballinglen River confluence may support fish (salmonids & European eel) during higher flow periods.

Plate 3.18 Representative image of site B6 on an unnamed Ballinglen River tributary, August 2022 (dry, ephemeral channel)

3.2.19 Site B7 – Annagh Beg River, Annagh Beg

Brown trout was the only fish species recorded via electro-fishing at site B7 on the Annagh Beg River (**Figure 3.11**).

The site was of poor value for salmonids given low summer flows and poor seasonal connectivity with downstream habitats. However, despite its semi-dry nature, small pools of standing water supported very low densities of juvenile brown trout, signifying it had some value as a salmonid spawning and nursery habitat during higher flow periods. Holding habitat for adults was absent. The stream had some low suitability for European eel but these would likely migrate to downstream-connecting habitats given the semi-dry nature of the stream. The upland eroding site was unsuitable for lamprey.

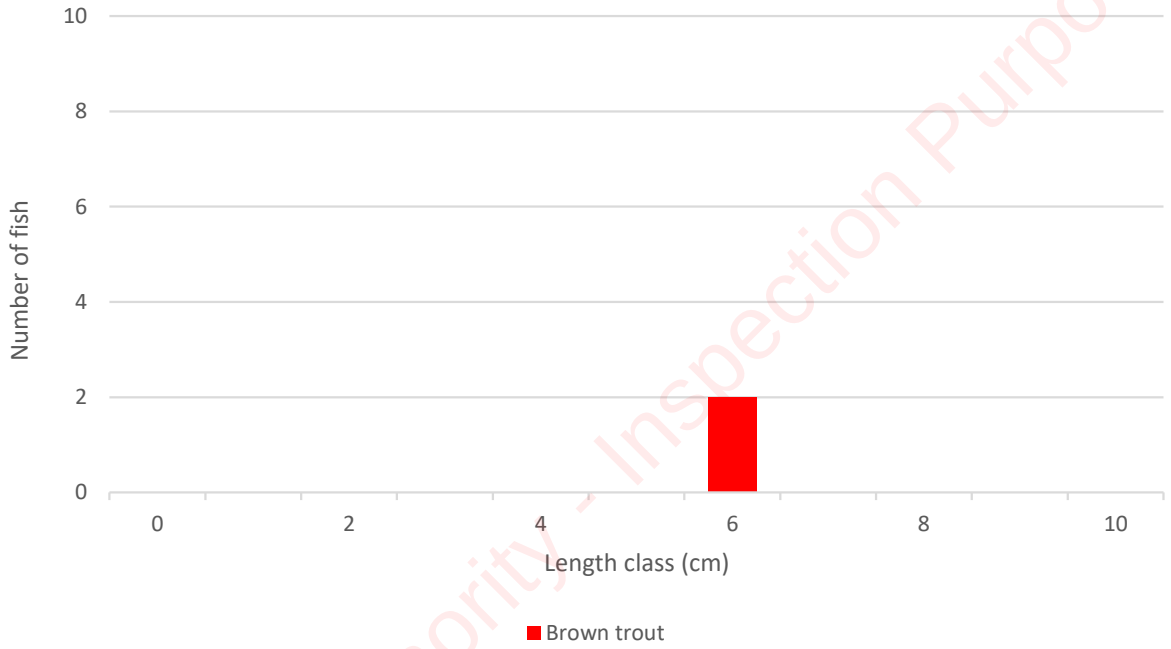

Figure 3.11 Length frequency distribution recorded via electro-fishing at site B7 on the Annagh Beg River, August 2022

Plate 3.19 Representative image of site B7 on the Annagh River, August 2022

3.2.20 Site B8 – unnamed river, Creevagh More

No fish were recorded via electro-fishing at site B8 on an unnamed Ballinglen River tributary. The site was not of fisheries value at the time of survey, with no fish recorded from standing pools of water. However, given the site characteristics (spate channel) and connectivity with the downstream Ballinglen River, the river likely supports a seasonal population of salmonids (brown trout) and European eel, at least in its lower reaches. The upland eroding site was unsuitable for lamprey.

Plate 3.20 Representative image of site B7 on an unnamed Ballinglen River tributary, August 2022

3.2.21 Site B9 – Farmhill Stream, Kincon

Brown trout (*n*=12) and three-spined stickleback (*n*=25) were the only fish species recorded via electro-fishing at site B9 on the Farmhill Stream (**Figure 3.12**).

The site was of moderate value (at best) for salmonids, supporting a low density of juvenile brown trout only. The stream suffered from low summer flows, water quality issues and significant hydromorphological modifications, which removed much of the fisheries value. However, the site provided some low value nursery and spawning habitat, both of which were compromised by heavy siltation and low seasonal flows. Holding habitat for adults was now absent in the vicinity of the road crossing given recent modifications. European eel habitat was poor and none were recorded. Despite the presence of abundant organic-rich soft sediment deposits, no lamprey ammocetes were recorded (likely due to poor seasonal flows and instream modifications).

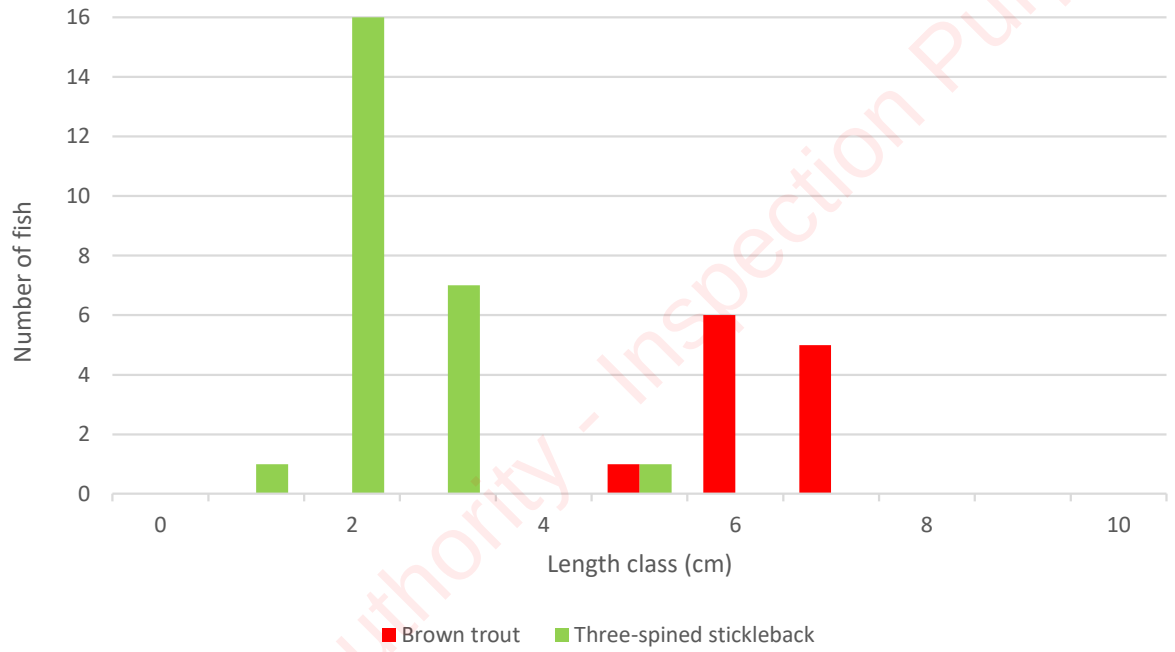

Figure 3.12 Length frequency distribution recorded via electro-fishing at site B9 on the Farmhill Stream, August 2022

Plate 3.21 Representative image of site B9 on the Farmhill Stream, August 2022 (recent instream modifications evident)

3.2.22 Site B10 – Cloonaghmore River, Tonrehown Bridge

Atlantic salmon (*n*=57), brown trout (*n*=10), European eel (*n*=6), minnow (*Phoxinus phoxinus*) (*n*=4) and three-spined stickleback (*n*=1) were recorded via electro-fishing at site B10 on the Cloonaghmore River (**Figure 3.13**).

The site was of high value for salmonids, supporting a high density of Atlantic salmon parr and a lower density of mixed-cohort brown trout. The site was of most value as a nursery habitat, with bryophyte-rich cobble and boulder, in addition to extensive macrophyte beds, providing excellent quality refugia for juvenile salmonids (especially Atlantic salmon). Good quality holding habitat was localised and limited due to low seasonal flows but nevertheless present (mostly upstream in deeper glide). Given the nature of the substrata and calcification of the bed, spawning habitat was limited but present upstream of the bridge in cobble dominated glide (more suited to Atlantic salmon). European eel habitat was of good quality given an abundance of instream refugia, with the bridge arches and abutments providing particularly valuable diurnal refugia. The site was unsuitable for lamprey ammocoetes and none were recorded.

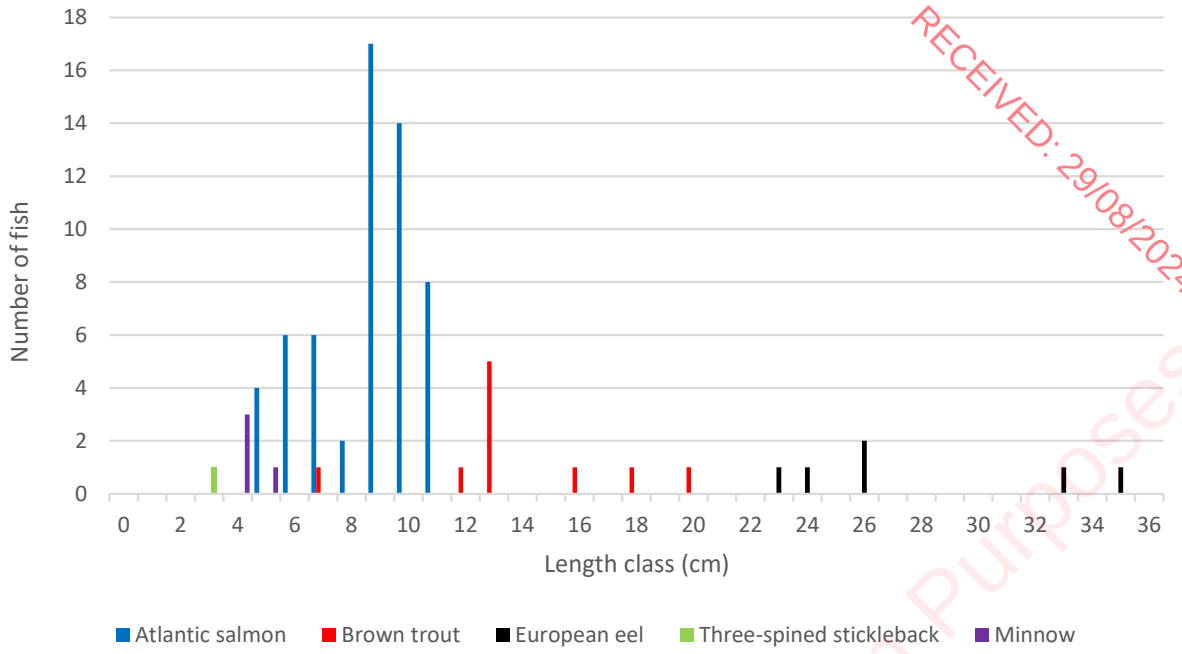

Figure 3.13 Length frequency distribution recorded via electro-fishing at site B10 on the Cloonaghmore River, August 2022

Plate 3.22 Mixed cohort Atlantic salmon and brown trout recorded at site B10 on the Cloonaghmore River at Tonrehown Bridge, August 2022

3.2.23 Site B11 – Farragh River, Clooncran

Three-spined stickleback (*n*=8) were the only fish species recorded via electro-fishing at site B11 on the Farragh River (**Figure 3.14**). With the exception of low densities of this species, the site was not of fisheries value given historical modifications, poor hydromorphology, low seasonal flows and heavy siltation.

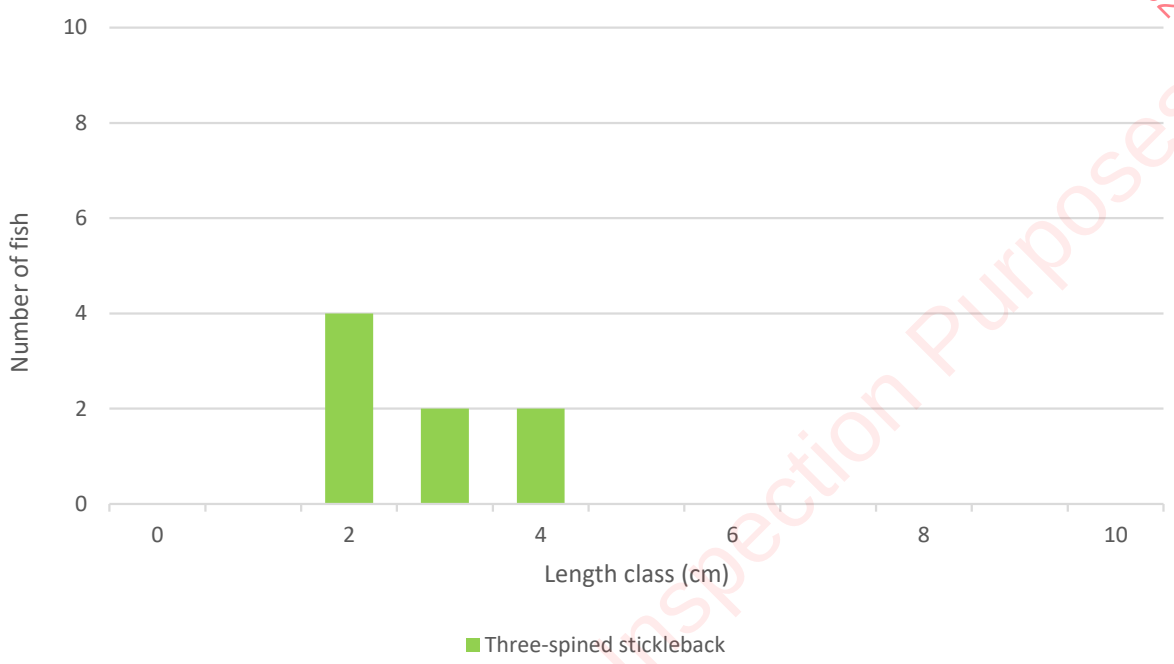

Figure 3.14 Length frequency distribution recorded via electro-fishing at site B11 on the Farragh River, August 2022

Plate 3.23 Representative image of site B11 on the Farragh River, August 2022

3.2.24 Site B12 – Magherabrack River, Cloonawillin

Brown trout (*n*=9), European eel (*n*=2) and three-spined stickleback (*n*=14) were recorded via electro-fishing at site B12 on the Magherabrack River (**Figure 3.15**).

The site was of relatively poor value to salmonids given historical modifications and evident siltation pressures. However, the site supported a low density of adult brown trout. Salmonid spawning and nursery habitat was of poor quality given siltation and poor flows. Holding habitat was of moderate value for adult salmonids given the predominance of deeper glide and pool. European eel habitat was of moderate value, with a low density recorded. The site was unsuitable for lamprey

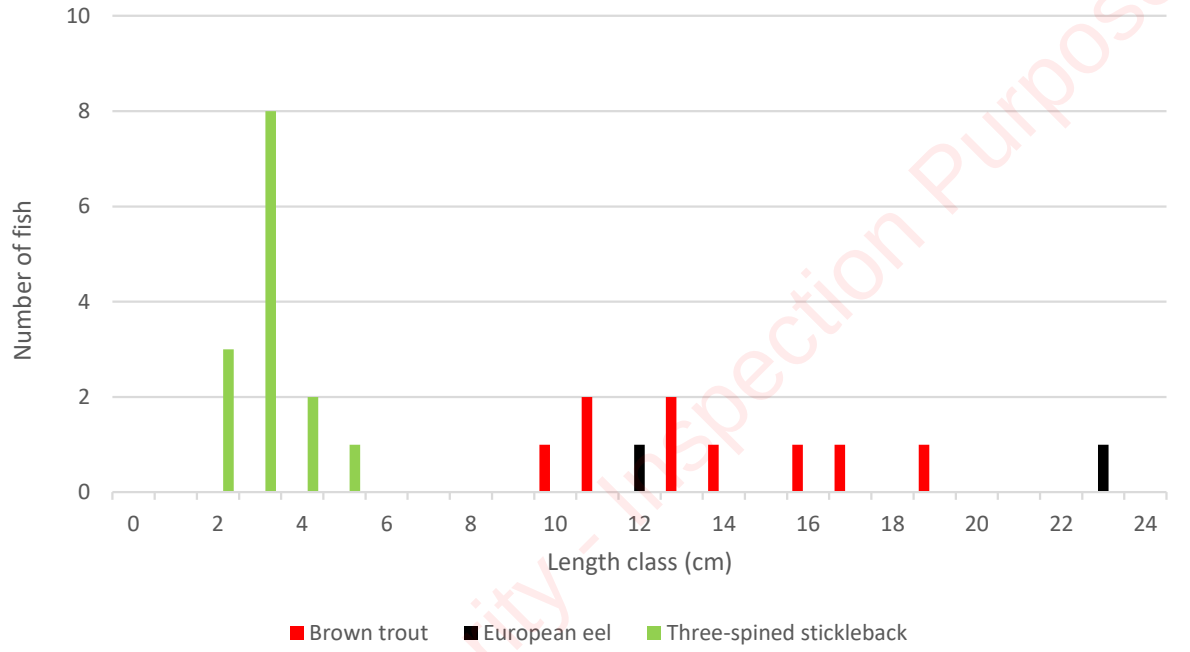

Figure 3.15 Length frequency distribution recorded via electro-fishing at site B12 on the Magherabrack River, August 2022

Plate 3.24 Adult brown trout and juvenile European eel (elver) recorded at site B12 on the Magherabrack River, August 2022

3.2.25 Site C1 – Duvowen River, Garranard

Atlantic salmon (*n*=60), brown trout (*n*=14), European eel (*n*=16) and three-spined stickleback (*n*=2) were recorded via electro-fishing at site C1 on the Duvowen River (**Figure 3.16**). This was the highest density of Atlantic salmon recorded during the survey (**Table 3.1**).

The site was of high value to salmonids, supporting a high density of Atlantic salmon parr in addition to a low density of mixed-cohort brown trout. The site was an excellent quality nursery for Atlantic salmon given the predominance of bryophyte-rich boulder and cobble habitat. However, the site was of poor value as a spawning area due to the compacted and calcified nature of the bed (some more suitable areas present upstream of the bridge). Holding habitat whilst present (e.g. under bridge arches) was localised and more prominent upstream of the bridge. The site was also an excellent quality European eel habitat, with a range of size classes present. Instream refugia were abundant, primarily boulder and cobble. The typically-high energy site was unsuitable for lamprey with no spawning or nursery habitat identified.

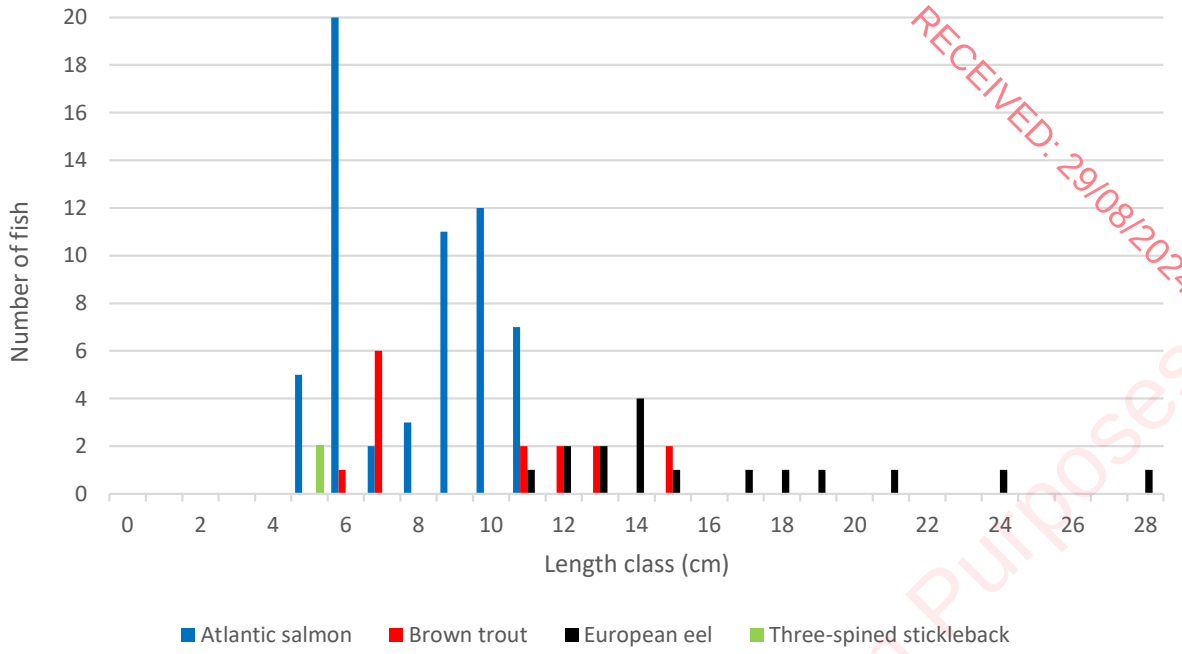

Figure 3.16 Length frequency distribution recorded via electro-fishing at site C1 on the Duvowen River, August 2022

Plate 3.25 Mixed cohort Atlantic salmon parr recorded at site C1 on the Duvowen River, August 2022

3.2.26 Site C2 – Garrynagran River, Garrynagran

Atlantic salmon (*n*=26), brown trout (*n*=32), European eel (*n*=7), minnow (*n*=49) and three-spined stickleback (*n*=2) were recorded via electro-fishing at site C2 on the Garrynagran River (**Figure 3.17**).

The site was of good value for salmonids, supporting a relatively high density of juvenile Atlantic salmon and mixed-cohort brown trout. The site was of most value as a salmonid nursery although evident hydromorphological and water quality pressures reduced the value overall. Whilst siltation and calcification of the substrata impacted the habitat, the site was nevertheless of good value as a spawning habitat, with relatively loose coarse gravels present (mostly upstream of the bridge). Holding habitat was poor given the generally shallow nature of the river at this location (improved under higher flows). The presence of a small ford downstream of the bridge was considered a minor barrier to fish passage at low flows. However, the rendered bridge apron were a significant barrier under low flow periods for salmonids. Whilst there was some localised suitability for lamprey spawning, ammocoete habitat was absent and none were recorded. European eel habitat quality was good overall but a paucity of suitable refugia reduced the value. The abundance of minnow and the presence of large three-spined stickleback were further indicative of enriched conditions

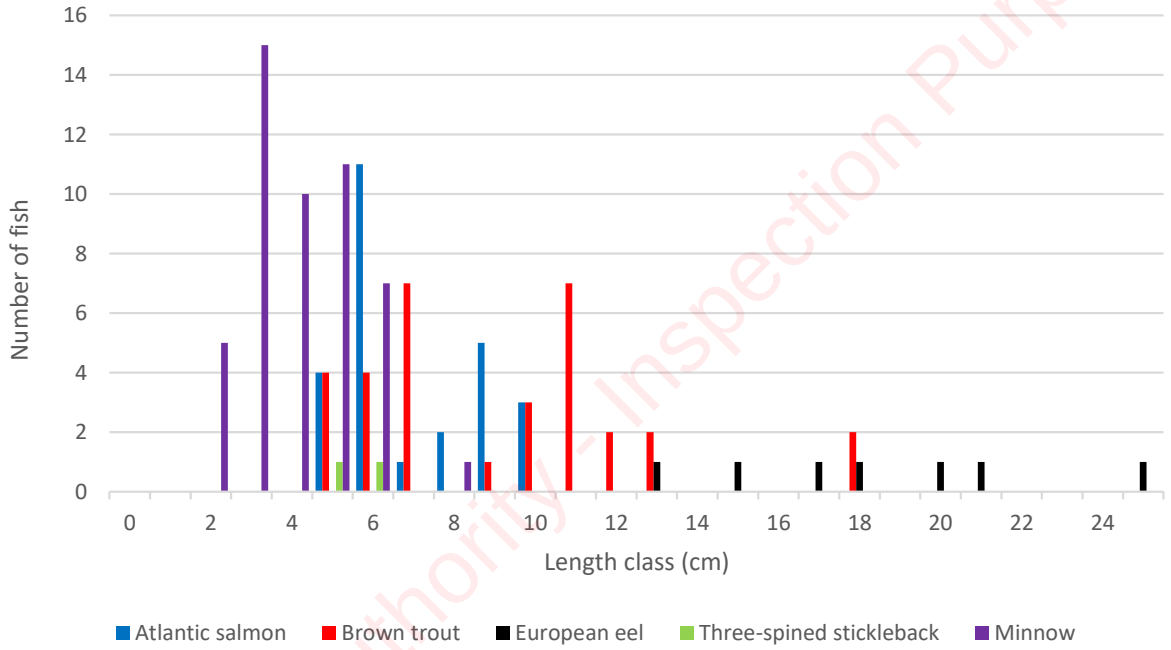

Figure 3.17 Length frequency distribution recorded via electro-fishing at site C2 on the Garrynagran River, August 2022

Plate 3.26 Atlantic salmon (top), brown trout (middle) and minnow (bottom) recorded at site C2 on the Garrynagran River, August 2022

3.2.27 Site C3 – Cloonaghmore River, Moygownagh

Atlantic salmon (*n*=64), brown trout (*n*=31) and European eel (*n*=3) were recorded via electro-fishing at site C3 on the Cloonaghmore River (**Figure 3.18**).

The site was of high value to salmonids, supporting a high density of Atlantic salmon parr and lower numbers of mixed-cohort brown trout. The site was of most value as a salmonid nursery, especially for Atlantic salmon given the abundance of bryophyte-rich cobble in shallow glide and riffle, in addition to riparian shading which provided valuable thermal refugia. These areas also provided good habitat for juvenile European eel. The site provided excellent quality spawning habitat for larger salmonids (abundant loose cobble). Holding habitat for adults, whilst present, was localised and of better quality in downstream areas. The high energy site was largely unsuitable for lamprey with no nursery habitat identified.

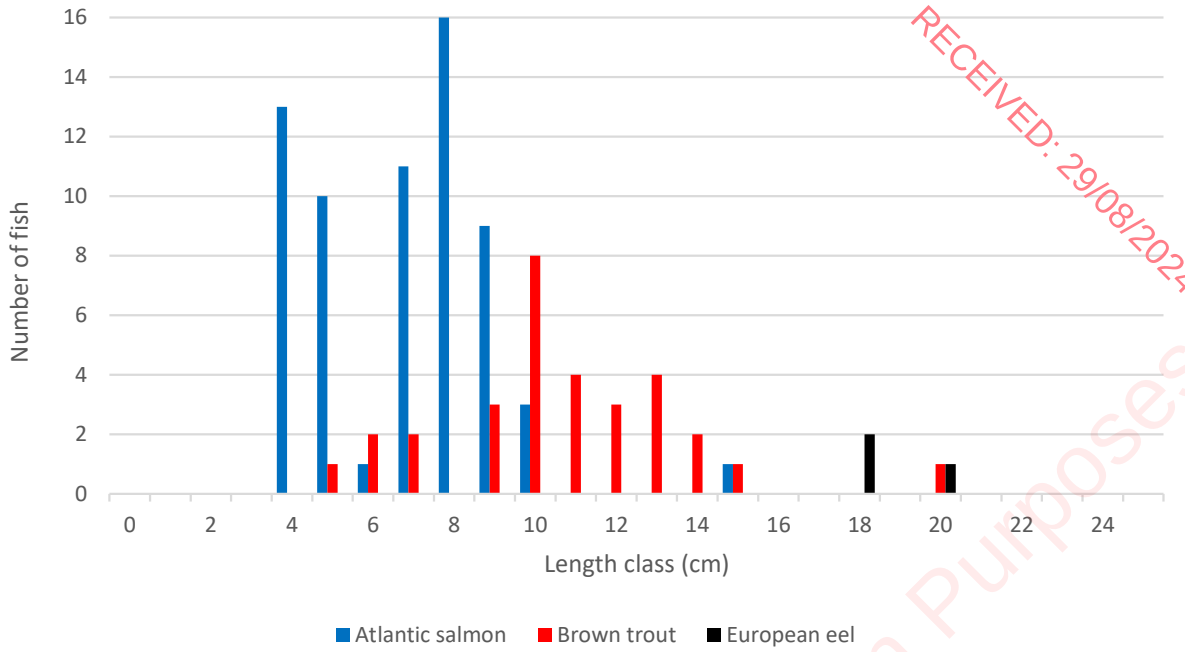

Figure 3.18 Length frequency distribution recorded via electro-fishing at site C3 on the Cloonaghmore River, August 2022

Plate 3.27 Adult brown trout and juvenile Atlantic salmon recorded at site C3 on the Cloonaghmore River, August 2022

Table 3.1 Fish species densities per m^2 recorded in the vicinity of the proposed Keerglen wind farm via electro-fishing in August 2022 & September 2023 (values in **bold** represent the highest densities recorded for each species, respectively)

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (per m^2)					
				Atlantic salmon	Brown trout	European eel	Three-spined stickleback	Minnow	Flounder
A1	Unnamed river	10	75	0.000	0.267	0.000	0.000	0.000	0.000
A2	Keerglen River	10	100	0.000	0.610	0.020	0.000	0.000	0.000
A3	Keerglen Stream	5	15	0.000	0.000	0.000	0.000	0.000	0.000
A4	Keerglen River	10	100	0.000	0.440	0.000	0.000	0.000	0.000
A5	Unnamed stream	10	140	0.000	0.000	0.000	0.000	0.000	0.000
A6	Keerglen River	10	120	0.000	0.575	0.000	0.000	0.000	0.000
A7	Unnamed stream	5	40	0.000	0.000	0.000	0.000	0.000	0.000
A7b	Unnamed stream	5	75	0.000	0.173	0.000	0.000	0.000	0.000
A7c	Unnamed stream	5	100	0.000	0.080	0.000	0.000	0.000	0.000
A7d	Keerglen River	10	200	0.000	0.150	0.000	0.000	0.000	0.000
A8	Unnamed stream	5	45	0.000	0.044	0.000	0.000	0.000	0.000
A9	Ballinglen River	10	210	0.181	**0.314**	0.014	0.000	0.000	**0.010**
B1	Unnamed stream	5	5	0.000	0.000	0.000	0.000	0.000	0.000
B2	Unnamed stream	5	30	0.000	0.000	0.000	0.000	0.000	0.000
B3	Unnamed stream	5	20	0.000	0.000	0.000	0.000	0.000	0.000
B4	Ballinglen River	10	225	0.027	0.307	0.004	0.009	0.000	0.000

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (per m^2)					
				Atlantic salmon	Brown trout	European eel	Three-spined stickleback	Minnow	Flounder
B5	Annagh More Stream	5	30	0.000	0.000	0.000	0.000	0.000	0.000
B6	Unnamed stream	n/a	n/a - dry channel	n/a	n/a	n/a	n/a	n/a	n/a
B7	Annagh Beg River	5	20	0.000	0.100	0.000	0.000	0.000	0.000
B8	Unnamed river	5	25	0.000	0.000	0.000	0.000	0.000	0.000
B9	Farmhill Stream	10	165	0.000	0.073	0.000	0.152	0.000	0.000
B10	Cloonaghmore River	10	280	0.204	0.036	0.021	0.004	0.014	0.000
B11	Farragh River	5	25	0.000	0.000	0.000	**0.320**	0.000	0.000
B12	Magherabrack River	5	75	0.000	0.120	0.027	0.187	0.000	0.000
C1	Duvowen River	10	175	**0.343**	0.080	**0.091**	0.011	0.000	0.000
C2	Garrynagran River	10	160	0.163	0.200	0.044	0.013	**0.306**	0.000
C3	Cloonaghmore River	10	250	0.256	0.124	0.012	0.000	0.000	0.000

Table 3.2 Summary of fish species of higher conservation value and relative abundances (low, medium, high & very high) recorded via **electro-fishing** per survey site in the vicinity of the proposed Keerglen wind farm, August 2022 & September 2023

Site	Watercourse	Atlantic salmon	Brown trout	*Lampetra* sp.	European eel	Other species
A1	Unnamed river		Medium			
A2	Keerglen River		High		Low	
A3	Keerglen Stream	No fish recorded				
A4	Keerglen River		High			
A5	Unnamed stream	No fish recorded				
A6	Keerglen River		High			
A7	Unnamed stream	No fish recorded				
A7b	Unnamed stream		Medium			
A7c	Unnamed stream		Low			
A7d	Keerglen River		High			
A8	Unnamed stream		Low			
A9	Ballinglen River	High	High		Low	Flounder
B1	Unnamed stream	No fish recorded				
B2	Unnamed stream	No fish recorded				
B3	Unnamed stream	No fish recorded				
B4	Ballinglen River	Low	High		Low	Three-spined stickleback
B5	Annagh More Stream					
B6	Unnamed stream	No fish recorded – dry channel				

Site	Watercourse	Atlantic salmon	Brown trout	*Lampetra* sp.	European eel	Other species
B7	Annagh Beg River		Low			
B8	Unnamed river	No fish recorded				
B9	Farmhill Stream		Low			Three-spined stickleback
B10	Cloonaghmore River	High	Low		Medium	Three-spined stickleback, minnow
B11	Farragh River					Three-spined stickleback
B12	Magherabrack River		Low		Low	Three-spined stickleback
C1	Duvowen River	High	Medium		Medium	Three-spined stickleback
C2	Garrynagran River	Medium	Medium		Medium	Three-spined stickleback, minnow
C3	Cloonaghmore River	High	Medium		Low	

Conservation value: Atlantic salmon (*Salmo salar*), brook lamprey (L*ampetra planeri*) and river lamprey (*Lampetra fluviatilis*) are listed under Annex II of the Habitats Directive [92/42/EEC]. Atlantic salmon and river lamprey are also listed under Annex V of the Habitats Directive [92/42/EEC]. European eel are 'critically endangered' according to most recent ICUN red list (Pike et al., 2020) and listed as 'critically engendered' in Ireland (King et al., 2011). Atlantic salmon and sea trout are also protected under the Wild Salmon and Sea Trout Tagging Scheme (Amendment) Regulations. With the exception of the Inland Fisheries Acts 1959 to 2017, non-anadromous brown trout and coarse fish species have no legal protection in Ireland.

4. Discussion

The relevant watercourses were typically upland spate channels draining peatland with high degrees of naturalness and habitat heterogeneity. However, siltation pressures (peat escapement) were widespread given the watercourses typically drain blanket bog and numerous higher gradient, low order tributaries suffered from low summer flows at the time of survey. Watercourses crossed by the proposed GCR often demonstrated historical modifications such as straightening and deepening. Despite these pressures, a number of (often larger) watercourses supported high conservation value Atlantic salmon and European eel. A typical diversity of fish species for north-west Ireland spate rivers – namely Atlantic salmon, brown trout, European eel, minnow and three-spined stickleback, in addition to flounder – were recorded during the electro-fishing survey (**Table 3.1**).

Salmonid populations were widespread in vicinity of the project (15 no. sites), with Atlantic salmon recorded from a total of 6 no. sites on the Ballinglen River (site A9 & B4), Cloonaghmore River (B10 & C3), Duvowen River (C1) and Garrynagran River (C2). Particularly high densities of juvenile salmon were recorded at sites on the Ballinglen River (A9), Cloonaghmore River (B10 & C3) and Duvowen River (C1) where high quality nursery and or spawning habitats were present. Whilst no Atlantic salmon were recorded from the Keerglen River or its surveyed tributaries during the current survey, habitat suitability was present[3] and the species is known from both the lower river (Triturus 2021 data; Holmes et al., 2022; IFI 2021 data) and the downstream-connecting Ballinglen River. Brown trout typically dominated in the upper reaches of rivers and lower order tributaries with the Keerglen River, in addition to the Ballinglen River, supporting the highest densities of brown trout recorded.

No lamprey were recorded during the electro-fishing survey and habitat suitability was poor or absent throughout. This reflected the upland, higher-energy, spate nature of the survey watercourses which reduces the extent of fine gravels required for spawning (Dawson et al., 2015; Rooney et al., 2013; Lasne et al., 2010) and discourages the deposition of fine, organic-rich sediment ≥5cm in depth generally required by larval *Lampetra* spp. (Aronsuu & Virkkala, 2014; Goodwin et al., 2008; Gardiner, 2003). Indeed soft sediment accumulations were typically flocculent and humic (peat-derived) or sand-dominated where present and thus unsuitable for larval settlement. Low summer flows on lower-gradient watercourses with higher habitat suitability, such as the Farmhill Stream or Garrynagran River also influenced lamprey distribution. Although located in close proximity to the sea, the lower reaches of the Ballinglen River are not known to support anadromous sea lamprey (*Petromyzon marinus*) or river lamprey (*Lampetra fluviatilis*) (no known records).

European eel are Red-listed in Ireland (King et al., 2011) and are classed as 'critically endangered' on a global scale (Pike et al., 2020). Given the close proximity to marine environments and an absence of significant instream barriers within the respective catchments, eel were widespread and recorded in low to medium densities from a total of 8 no. sites on the Keerglen River (A2), Ballinglen River (A9, B4), Cloonaghmore River (B10, C3), Magherabrack River (B12), Duvowen River (C1) and the Garrynagran River (C2) (**Table 3.1, 3.2**). Better quality eel habitat was confined to larger watercourses with higher frequency of instream refugia such as boulders (e.g. Keerglen River, Cloonaghmore River) which provide required diurnal refugia (Degerman et al., 2019; Laffaille et al., 2003).

[3] Low riparian cover & high thermal stress likely negatively influences Atlantic salmon recruitment in the Keerglen River

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Appendix 6.3

eDNA Analysis Lab Report

Keerglen Wind Farm

Appendix 6.3 – eDNA analysis lab report

SureScreen Scientifics

Folio No: E15385
Report No: 1
Client: Triturus Environmental Limited
Contact: Bill Brazier

TECHNICAL REPORT

ANALYSIS OF ENVIRONMENTAL DNA IN WATER FOR AQUATIC SPECIES DETECTION

SUMMARY

When aquatic organisms inhabit a waterbody such as a pond, lake or river they continuously release small amounts of their DNA into the environment. By collecting and analysing water samples, we can detect these small traces of environmental DNA (eDNA) to confirm the presence or absence of the target species within the waterbody.

RESULTS

Date sample received in laboratory: 12/09/2022
Date results reported: 20/09/2022
Matters affecting result: None

TARGET SPECIES: Crayfish plague *(Aphanomyces astaci)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK624	A9 - Ballinglen River, Keerglen WF	ITM 510209, 834207	Pass	Pass	Pass	Positive	1/12

(- SureScreen Scientifics

TARGET SPECIES: Freshwater pearl mussel *(Margaritifera margaritifera)*

lab ID	Site Name	OS Reference	SIC	DC	!!;	Result	Positive Reelicates
FK624	A9 - Ballinglen River, Keerglen WF	ITM 510209, 834207	Pass	Pass	Pass	Negat ive	0/12

TARGET SPECIES: White-clawed crayfish *(Austropotamobius pallipes)*

Lab ID	Site Name	OS Reference	SIC	DC	!!;	Result	Positive Reelicates
FK624	A9 - Ballinglen River, Keerglen WF	ITM 510209, 834207	Pass	Pass	Pass	Negative	0/12

If you have any questions regar ding results, please contact us: ForensicEcology@surescreen.com

Reported by: **M ScGabriela Danickova** Approved by:**Jennifer Higginbott om**

METHODOLOGY

The samples detailed above have been analysed for the presence of target species eDNA following scientifically published eDNA assays and protocols which have been thoroughly tested, developed and verified for use by SureScreen Scientifics.

The analysis is conducted in two phases. The sample first goes through an extraction process where the filter is incubated in order to obtain any DNA within the sample. The extracted sample is then tested via real time PCR (also called q-PCR) for each of the selected target species. This process uses species-specific molecular markers (known as primers) to amplify a select part of the DNA, allowing it to be detected and measured in 'real time' as the analytical process develops. qPCR combines amplification and detection of target DNA into a single step. With qPCR, fluorescent dyes specific to the target sequence are used to label targeted PCR products during thermal cycling. The accumulation of fluorescent signals during this reaction is measured for fast and objective data analysis. The primers used in this process are specific to a part of mitochondrial DNA only found in each individual species. Separate primers are used for each of the species, ensuring no DNA from any other species present in the water is amplified.

If target species DNA is present, the DNA is amplified up to a detectable level, resulting in positive species detection. If target species DNA is not present then amplification does not occur, and a negative result is recorded.

Analysis of eDNA requires scrupulous attention to detail to prevent risk of contamination. True positive controls, negative controls and spiked synthetic DNA are included in every analysis and these have to be correct before any result is declared and reported. Stages of the DNA analysis are also conducted in different buildings at our premises for added security.

SureScreen Scientifics Ltd is ISO9001 accredited and participate in Natural England's proficiency testing scheme for GCN eDNA testing. We also carry out regular inter-laboratory checks on accuracy of results as part of our quality control procedures.

SureScreen Scientifics

INTERPRETATION OF RESULTS

SIC: **Sample Integrity Check** [Pass/ Fail]
When samples are received in the laboratory, they are inspected for any tube leakage suitability of sample (not too much mud or weed etc.) and absence of any factors that could potentially lead to inconclusive results.

DC: **Degradation Check** [Pass/Fail)
Analysis of the spiked DNA marker to see if there has been degradation of the kit or sample, between the date it was made to the date of analysis. Degradation of the spiked DNA marker may indicate a risk of false negative results.

IC: **Inhibition Check** [Pass/Fail)
The presence of inhibitors within a sample are assessed using a DNA marker. If inhibition is detected, samples are purified and re-analysed. Inhibitors cannot always be removed, if the inhibition check fails, the sample should be re-collected.

Result: Presence of eDNA [Positive/ Negative/Inconclusive]

Positive: DNA was identified within the sample, indicative of species presence within the sampling location at the time the sample was taken or within the recent past at the sampling location.

Positive Replicates: Number of positive qPCR replicates out of a series of 12. If one or more of these are found to be positive the pond is declared positive for species presence. It may be assumed that small fractions of positive analyses suggest low level presence, but this cannot currently be used for population studies. Even a score as low as 1/12 is declared positive. 0/12 indicates negative species presence.

Negative: eDNA was not detected or is below the threshold detection level and the test result should be considered as evidence of species absence, however, does not exclude the potential for species presence below the limit of detection.

Inconclusive: Controls indicate inhibition or degradation of the sample, resulting in the inability to provide conclusive evidence for species presence or absence.

Appendix 6.4

Macro-invertebrates (biological water quality)

Keerglen Wind Farm

Appendix 6.4 – Macro-invertebrates (biological water quality)

Table A6.4a Macro-invertebrate Q-sampling results for sites A1-A9, August 2022 & September 2023															
Group	**Family**	**Species**	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A7b**	**A7c**	**A7d**	**A8**	**A9**	**EPA group**
Ephemeroptera	Heptageniidae	*Ecdyonurus dispar*		7		10	4	3	1	2		14		6	**A**
Ephemeroptera	Heptageniidae	*Rhithrogena semicolorata*										2		1	**A**
Plecoptera	Chloroperlidae	*Siphonoperla torrentium*										1		1	**A**
Plecoptera	Nemouridae	*Protonemura meyeri*	2	16		1						1			**A**
Plecoptera	Perlidae	*Dinocras cephalotes*										1			**A**
Plecoptera	Perlidae	*Perla bipunctata*						3						3	**A**
Ephemeroptera	Baetidae	*Alainites muticus*				3	1	1	1						**B**
Ephemeroptera	Baetidae	*Centroptilum luteolum*							5						**B**
Plecoptera	Leuctridae	*Leuctra hippopus*	3	2		11	1		1				1	1	**B**
Trichoptera	Odontoceridae	*Odontocerum albicorne*										1			**B**
Trichoptera	Beraeidae	*Beraeodes minutus*													**B**
Trichoptera	Cased caddis pupa	sp. indet.	1												**B**
Trichoptera	Limnephilidae	*Potamophylax cingulatus*				3	4								**B**
Trichoptera	Sericostomatidae	*Sericostoma personatum*										2			**B**
Ephemeroptera	Baetidae	*Baetis rhodani*	27	46		42	16	15	3	1		5	14	7	**C**
Ephemeroptera	Caenidae	*Caenis rivulorum*													**C**
Ephemeroptera	Ephemerellidae	*Serratella ignita*	22	34		49	12	38	1					4	**C**
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*		3			1	4				2	1		**C**
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*												2	**C**
Trichoptera	Philopotamidae	*Philopotamus montanus*				1		2		2				1	**C**
Trichoptera	Philopotamidae	*Wormaldia occipitalis*							1						**C**
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*	3		7		8				9				**C**
Trichoptera	Polycentropodidae	*Polycentropus kingi*				1	1	1		2					**C**
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*	2	1			1	2	1					2	**C**
Crustacea	Gammaridae	*Gammarus duebeni*	64	21	2	11		12	2	18	4	2	11	3	**C**
Coleoptera	Dytiscidae	sp. indet.			3										**C**
Coleoptera	Dytiscidae	*Ilybius fuliginosus*			1										**C**
Coleoptera	Elmidae	*Elmis aenea*		4				5	3					2	**C**
Coleoptera	Elmidae	*Esolus parallelepipedus*							2						**C**
Coleoptera	Elmidae	*Limnius volckmari*				6								2	**C**
Coleoptera	Gyrinidae	sp. indet.			1										**C**
Coleoptera	Hydraenidae	*Hydraena gracilis*				2									**C**

Table A6.4a Macro-invertebrate Q-sampling results for sites A1-A9, August 2022 & September 2023														
Group	**Family**	**Species**	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A7b**	**A7c**	**A7d**	**A8**	**A9**	**EPA group**
Coleoptera	Hydrophilidae	*Laccobius bipunctatus*					1								**C**
Coleoptera	Scirtidae	sp. indet.								1					**C**
Diptera	Chironomidae	Non-Chironomus spp.	1		6	25	16	1	1			1		2	**C**
Diptera	Pediciidae	*Dicranota sp.*												1	**C**
Diptera	Simuliidae	sp. indet.	2	8		2	4		1					2	**C**
Hemiptera	Corixidae	*Hesperocorixa linnaei*									4				**C**
Hemiptera	Corixidae	*Hesperocorixa sahlbergi*									1				**C**
Arachnida	Hydrachnidiae	sp. indet.	1			5	4		1					1	**C**
Gastropoda	Tateidae	*Potamopyrgus antipodarum*		12			2						1		**C**
Gastropoda	Sphaeriidae	sp. indet.			3		1								**D**
Diptera	Chironomidae	*Chironomus spp.*	2		1	3			1						**E**
Annelidae	Oligochaeta	sp. indet.			1							1		4	**n/a**
		Abundance	**130**	**154**	**25**	**175**	**77**	**87**	**25**	**26**	**18**	**33**	**28**	**45**	
		Q-rating	Q3-4	Q4	Q3*	Q4	Q4	Q3-4	Q3-4	Q4	Q3	Q4-5	Q3*	Q4	
		WFD status	Mod	Good	Poor	Good	Good	Mod	Mod	Good	Poor	High	Poor	Good	

*** tentative rating due to low flows or an absence of suitable riffle areas for sampling (as per Toner et al., 2005)**

Table A6.4b Macro-invertebrate Q-sampling results for sites A1-A9, August 2022																
Group	**Family**	**Species**	**B1**	**B2**	**B3**	**B4**	**B5**	**B7**	**B8**	**B9**	**B10**	**B11**	**B12**	**C1**	**C2**	**C3**	**EPA group**
Ephemeroptera	Heptageniidae	*Ecdyonurus dispar*				2		2		17				1		5	**A**
Ephemeroptera	Heptageniidae	*Rhithrogena semicolorata*									1						**A**
Plecoptera	Nemouridae	*Protonemura meyeri*														2	**A**
Ephemeroptera	Baetidae	*Alainites muticus*			1		2	3			2			1	1	1	**B**
Plecoptera	Leuctridae	*Leuctra hippopus*						1						8			**B**
Trichoptera	Beraeidae	*Beraeodes minutus*										11					**B**
Trichoptera	Cased caddis pupa	sp. indet.		3			3	6		9				5		4	**B**
Trichoptera	Glossosomatidae	*Agapetus fuscipes*							1	31	1						**B**
Trichoptera	Goeridae	*Silo pallipes*			4	12	4		1	4			1	22			**B**
Trichoptera	Limnephilidae	*Halesus radiatus*									3					1	**B**
Trichoptera	Limnephilidae	*Limnephilus lunatus*										3					**B**
Trichoptera	Limnephilidae	*Potamophylax cingulatus*									2			8		1	**B**

Table A6.4b Macro-invertebrate Q-sampling results for sites A1-A9, August 2022																	
Group	**Family**	**Species**	**B1**	**B2**	**B3**	**B4**	**B5**	**B7**	**B8**	**B9**	**B10**	**B11**	**B12**	**C1**	**C2**	**C3**	**EPA group**
Trichoptera	Sericostomatidae	*Sericostoma personatum*									2					2	**B**
Ephemeroptera	Baetidae	*Baetis rhodani*			8	26	5				49		3		24	11	**C**
Ephemeroptera	Caenidae	*Caenis rivulorum*								1							**C**
Ephemeroptera	Ephemerellidae	*Serratella ignita*				12	1			1	44		6	7	4		**C**
Trichoptera	Caseless caddis pupa	sp. indet.			4												**C**
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*												15		14	**C**
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*				1											**C**
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*		1	1		1										**C**
Trichoptera	Polycentropodidae	*Polycentropus kingi*								4			5		5		**C**
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*								1	1				7		**C**
Crustacea	Gammaridae	*Gammarus duebeni*	11	10	15	22		2			94	1	51	2	32	27	**C**
Coleoptera	Dytiscidae	sp. indet.				1						2					**C**
Coleoptera	Dytiscidae	*Ilybius ater*										1					**C**
Coleoptera	Dytiscidae	*Ilybius fuliginosus*								1							**C**
Coleoptera	Dytiscidae	*Nebrioporus depressus*											2				**C**
Coleoptera	Dytiscidae	*Oreodytes sanmarkii*				3									1		**C**
Coleoptera	Dytiscidae	*Stictonectes lepidus*								1							**C**
Coleoptera	Dytiscidae	*Stictotarsus duo-decimpustulatus*					1										**C**
Coleoptera	Elmidae	*Elmis aenea*				1				5	3			10	16	2	**C**
Coleoptera	Elmidae	*Esolus parallelepipedus*		1					1								**C**
Coleoptera	Elmidae	*Limnius volckmari*				2									3	11	**C**
Coleoptera	Gyrinidae	*Gyrinus substriatus*	3	12													**C**
Coleoptera	Gyrinidae	*Orectochilus villosus*										1					**C**
Coleoptera	Halipliidae	*Brychius elevatus*											1				**C**
Coleoptera	Hydrophilidae	*Helophorus brevipalpis*						1		1							**C**
Coleoptera	Scirtidae	sp. indet.							1								**C**
Diptera	Chironomidae	Non-Chironomus spp.	7			2	5		1		3	2	1			3	**C**
Diptera	Culicidae	sp. indet.											1				**C**
Diptera	Pediciidae	*Dicranota sp.*								2					1		**C**
Diptera	Simuliidae	sp. indet.				1	1				1			3		4	**C**
Hemiptera	Corixidae	sp. indet.		2			1										**C**
Hemiptera	Corixidae	*Hesperocorixa sahlbergi*		1													**C**
Hemiptera	Gerridae	sp. indet.											1				**C**
Hemiptera	Veliidae	*Velia caprai*	2	1													**C**
Hemiptera	Veliidae	sp. indet.			1		1			1							**C**
Arachnida	Hydrachnidiae	sp. indet.								4	1		2			1	**C**

Table A6.4b Macro-invertebrate Q-sampling results for sites A1-A9, August 2022																	
Group	**Family**	**Species**	**B1**	**B2**	**B3**	**B4**	**B5**	**B7**	**B8**	**B9**	**B10**	**B11**	**B12**	**C1**	**C2**	**C3**	**EPA group**
Gastropoda	Bithnyiidae	*Bithynia tentaculata*											1				**C**
Gastropoda	Planorbidae	*Ancylus fluviatilis*				6											**C**
Gastropoda	Planorbidae	sp. indet.								2							**C**
Gastropoda	Planorbidae	*Planorbis planorbis*										1					**C**
Gastropoda	Lymnaeidae	*Lymnaea stagnalis*										2	1				**C**
Gastropoda	Tateidae	*Potamopyrgus antipodarum*		26	14	55	24	9	48	61	68	16	45	97	202	76	**C**
Hirudinidae	Piscicolidae	*Piscicola sp.*											1				**C**
Crustacea	Asellidae	*Asellus aquaticus*									1	18	12				**D**
Gastropoda	Lymnaeidae	*Ampullacaena balthica*								1							**D**
Gastropoda	Sphaeriidae	sp. indet.									1						**D**
Megaloptera	Sialidae	*Sialis lutaria*											1				**D**
Hirudinidae	Glossiphoniidae	sp. indet.								1	3						**D**
Diptera	Chironomidae	*Chironomus spp.*	2	1			6	1				15					**E**
Annelidae	Oligochaeta	sp. indet.		1	1	1											**n/a**
		Abundance	**25**	**59**	**49**	**147**	**55**	**25**	**53**	**149**	**280**	**73**	**135**	**179**	**296**	**165**	
		Q-rating	Q3*	Q3*	Q3*	Q3-4	Q3	Q4*	Q3*	Q4	Q3-4	Q2-3	Q3*	Q3-4	Q3	Q3-4	
		WFD status	Poor	Poor	Poor	Mod	Poor	Good	Poor	Good	Mod	Poor	Poor	Mod	Poor	Mod	

* tentative rating due to low flows or an absence of suitable riffle areas for sampling (as per Toner et al., 2005)